Optimal Commodity Taxes in Australia and Their Sensitivity to Consumer Preference and Demographic Specification*

by

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Abstract

This study provides evidence on optimal commodity tax rates in Australia, and on their sensitivity to demand function and demographic specification. The optimal tax algorithm, proposed and used here, allows the social welfare weights to depend on prices, household composition and aggregate household expenditure. The optimal commodity tax rates are compared with the actual tax rates not only with regard to their magnitude but, also, in terms of their redistributive impact.

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Tax Design, Optimal Commodity Tax,
Uniform Tax Rate, Inequality Aversion

JEL Classification:
B23, D12, H21

1. Introduction

With the proposals on commodity tax changes that followed the election of the Coalition government in Australia in 1996, and with the introduction of GST in the second half of 1999, the design and reform of commodity taxes has recently received renewed and vigorous attention in this country[1]. The debate has taken place against the background of a large literature on optimal commodity taxes and tax reforms[2]. Though the two are inter related in the sense that optimal commodity taxes can be viewed as the culmination of a sequence of Pareto improving marginal tax reforms when there is no possibility of further welfare improvement, the analytical literature has concentrated on the former, while much of the empirical literature has been on the latter[3]. The reason for the empirical work on commodity taxes to concentrate on marginal tax reforms is three fold: (i) they need much less information than optimal commodity taxes, (ii) the calculations on marginal tax reforms are considerably easier, and (iii) as the results of Madden (1996) and Ray (1997) confirm, the marginal tax changes are relatively insensitive to demand specification and can, hence, be based on estimates of simple but restrictive demand functional forms, eg., the Linear Expenditure System (LES).

An additional reason, often cited for favouring marginal tax reform calculations over optimal taxes, is that the former are of greater practical relevance since they recognise the reality of a given vector of actual commodity tax rates. In contrast, tax design or optimal taxes deal with a move from the hypothetical but unrealistic case of no commodity taxes to the optimum. However, this perceived practical advantage of marginal tax reform calculations is more apparent than real since (a) they can only indicate directions of tax changes, not their

[1] See, for example, Johnson, et. al. (1998, especially Chs. 3, 4).
[2] See Myles (1995) for a recent review of the literature.
[3] Examples of commodity tax reform studies include Ahmad and Stern (1984)'s work on India, Madden (1995) on Ireland, Madden (1996) on UK, Creedy (1998, Chs. 7, 8) and Ray (1997, 1999) on Australia.

magnitude[4], and (b) the analysis is valid for only infinitesimally small tax changes, and their impact on behaviour is ignored in the analysis. As Ray (1999) reports, the advantages of marginal tax reforms mentioned earlier, namely, easier calculations and their insensitivity to demand specification, quickly disappear in case of the more useful non marginal tax reforms analysis where the impact of proposed tax changes on behaviour is taken into account. As the logical culmination of a sequence of non marginal tax reforms, and notwithstanding the complexities in the calculations, optimal commodity taxes provide a particularly useful set of benchmarks that can guide in discussions on tax policy.

Notwithstanding a large literature, the empirical evidence on optimal commodity taxes is still relatively scarce and none, that we are aware of, exists for Australia. Much of the optimal tax literature has been spent on deriving the set of sufficient conditions for optimal commodity taxes to be uniform rather than finding out what they are by estimating them from actual tax and expenditure data. And the limited empirical evidence that does exist is based on the restricted LES [see, for example, Harris and Mackinnon (1979)] or its still more restricted specialisation, the Cobb Douglas [Atkinson and Stiglitz (1972)]. While in a many person economy with individually varying preferences, there is no a priori presumption that these utility specifications necessarily imply uniform commodity taxes, they still distort the price, expenditure responses and, consequently, the optimal commodity taxes that are based on them.

Ray (1986), Murty and Ray (1989) provide evidence on Indian data that suggests that the optimal commodity taxes are quite sensitive to departure from the linearity/separability assumptions of the LES. However, due to the nature of the data used there, household compositional variables were ignored in these studies. The principal motivation of the present study is to re-examine the empirical evidence on optimal commodity taxes by taking explicit

[4] See Ahmad and Stern (1984) for a discussion of the cone of welfare improving tax changes that is implied by marginal tax reform analysis.

note of household size and composition in the calculations. Moreover, this paper extends the optimal tax algorithm, proposed in Murty and Ray (1989), by allowing the social welfare weights to vary with, besides prices and aggregate expenditure, the household composition between adults and children. The exercise is conducted on Australian data taking advantage of time series of unit record data from various years containing a host of price, expenditure and demographic information.

This study seeks to answer the following questions:

(a) What is the structure of optimal commodity taxes in Australia, and how sensitive is that structure to departure from the linearity/separability assumptions of the LES?

(b) What is the demographic impact on optimal commodity taxes, ie., are they sensitive to the admission or otherwise of household composition changes in the estimated demand systems?

(c) What are the distributional implications of the optimal commodity taxes in relation to: (i) the actual taxes prevailing in Australia, and (ii) a hypothetical tax regime where a zero rated Food, Alcohol taxed at the current rate, are supplemented by uniform commodity taxes on other items.

The rest of the paper is organised as follows. Section 2 focuses on the theoretical framework. The data is described in Section 3. The results are presented and analysed in Section 4, and we summarise and conclude the paper in Section 5.

2. Theoretical Framework

Let p, q, $\tilde{t}$ denote (n x 1) vectors of consumer prices, producer prices and nominal commodity taxes. Let A and d represent the n x n fixed input-output coefficients matrix and the n x 1 vector of labour inputs in the production of various commodities, respectively. If the commodity taxes are specific, we have:

$$p = q + \tilde{t} \quad (1)$$

The competitive pricing conditions with commodity taxes are:

$$q' = p'A + md' \quad (2)$$

where m is the wage rate. Substituting (1) into (2), we have:

$$\begin{aligned} p' &= \tilde{t}'(I-A)^{-1} + md'(I-A)^{-1} \\ &= t' + md'(I-A)^{-1} \end{aligned} \tag{3}$$

where t is the n x 1 vector of effective taxes, as in Ahmad and Stern (1984). The government revenue constraint with commodity taxes alone is given as:

$$\tilde{t}'Y = R, \text{ or } t'X = R \tag{4}$$

where Y, X represent (n x 1) vectors of gross output and final demands of commodities, respectively. Since in a static Leontief model, $Y = (I-A)^{-1}X$, we have the following relation between nominal and effective commodity taxes:

$$\tilde{t}'Y = t'X$$

In this study, expenditure and labour supply decisions are assumed separable. Let $u_h(x_h, m_h), v_h(p, m_h, \mu_h)$ denote household h's $(h = 1,\ldots,H)$ direct and indirect utility function, respectively, x_h denote the household's vector of commodity demand, m_h (scalar) is the equivalence scale, and $\mu_h = p'x_h$ is the household's aggregate expenditure. Hence,

$$v_h(p, m_h, \mu_h) = u_h(x_h, m_h) \tag{5}$$

Let us define social welfare V over the households' indirect utilities, so that it is specified as a function of prices, equivalence scales and aggregate expenditures:

$$V(p, m, \mu) = W[v_1(p, m_1, \mu_1), \ldots, v_H(p, m_H, \mu_H)] \tag{6}$$

where m, μ denote, respectively, the vector of household equivalence scales (m_h) and aggregate household expenditures $(\mu_h, h = 1,\ldots,H)$. If X(p) denotes the aggregate demand vector, then:

$$X(p, m_1, \ldots, m_H, \mu_1, \ldots, \mu_H) = \sum_{h=1}^{H} x_h(p, m_h, \mu_h) \tag{7}$$

The revenue constraint is given by:

$$R = R_0 = \sum_{i=1}^{n} t_i X_i \tag{8}$$

where R_0 is set exogenously by the authorities.

If $\lambda_i \left(i = 1,...,n\right)$ denotes the marginal social cost of raising an extra unit of revenue by taxing the ith. commodity, then:

$$\lambda_i = -\frac{\partial V}{\partial t_i} \Big/ \frac{\partial R}{\partial t_i} \tag{9}$$

If $\lambda_i \neq \lambda_j$, then social welfare can be increased by reducing taxes on commodities with higher than average λ_is and raising taxes on others. In other words, the scope for welfare improving tax changes exists until the λ_is are all equal, which characterises the state where commodity taxes are optimal. This forms the basis for the following algorithm[5] used in the calculation of optimal commodity taxes:

$$\Delta t_i^{(r)} \equiv t_i^r - t_i^{r-1} = k\left[\bar{\lambda}^{(r-1)} - \lambda_i^{(r-1)}\right] \tag{10}$$

where $k\left(0 < k \leq 1\right)$ is the step length (speed of adjustment) fixed for a particular set of calculations, r denotes the round of iteration, $\Delta t_i^{(r)}$ denotes the change in taxes between successive rounds, and $\bar{\lambda}^{(r-1)}$ is the mean of the λ_is in round $\left(r-1\right)$.

The first order conditions for optimal commodity taxes are given by:

$$\sum_{h=1}^{H} \beta_h p_i x_{ih} = \lambda\left[p_i X_i + \sum_{j=1}^{n} t_j X_j e_{ji}\right] \tag{11}$$

where β_h is the social marginal utility of income of household h, and e_{ji} is the uncompensated price elasticity of demand for j with respect to the price of item i. Note that (8), (11) constitute

[5] See Murty and Ray (1989) for more details on the optimal tax algorithm. The algorithm ensures that the optimal taxes are revenue neutral with respect to initial taxes.

a set of simultaneous equations that is non linear in the unknown parameters, t_i, since the p_i, X_i, x_{ih} and the elasticities e_{ji} all depend on taxes. In view of the demographic dependence of the quantities, X_i, and the elasticities, e_{ji}, the optimal commodity taxes will also be dependent on household compositional variables. The tax algorithm, proposed by Murty and Ray (1989) and described above in eqn. (10), was extended for the purpose of the present study by the first author to include household size and composition in the calculations, and is available on request.

Differentiating (6) with respect to prices, using Roy's identity, and noting that under the present assumption of fixed producer prices, differentiating with respect to prices and taxes are equivalent, we have:

$$\frac{\partial V}{\partial t_i} = -\sum_{h=1}^{H} \beta_h x_{ih} \tag{12}$$

where $\beta_h = \frac{\partial W}{\partial \mu_h}$. Assuming the social welfare function, W, to be additive in individual utilities, we have:

$$W = \frac{1}{1-\varepsilon} \sum_h v_h^{1-\varepsilon} \tag{13}$$

where $\varepsilon \geq 0$ denotes "inequality aversion"[6].

Normalising $\beta_h = 1$ for the poorest household (h = 1), the social marginal utility of income for household h is given by:

$$\beta_h = \left(\frac{v_1}{v_h}\right)^{\varepsilon} \left(\frac{v'_h}{v'_1}\right) \tag{14}$$

[6] Strictly speaking, "inequality aversion" is reflected not only by the value of ε but also by the particular cardinalisation chosen for the v_h function [see equation (15) below].

where $v'_h = \frac{\partial v_h}{\partial \mu_h}$ is the 'private' marginal utility of income of h. Expression (14) implies that the β_hs depend, via the v_hs, on prices, household composition and income. This dependence is allowed for in the iterative calculations and the results reported below.

The demand system used here is the RNLPS functional form proposed in Blundell and Ray (1984). The indirect utility functional form for the demographically extended RNLPS is given by

$$v_h = \frac{\left(\frac{\mu_h}{m_{0h}}\right)^{\alpha} - \sum_i p_i^{\alpha}\gamma_i}{\prod_k p_k^{\alpha\beta_k}} \tag{15}$$

$$0 < \alpha \leq 1, \sum_K a_k = 1$$

where $\overline{m}_{0h} = \left(n_{ah} + \theta_1 n_{1h} + \theta_2 n_{2h} + \theta_3 n_{3h}\right)^{1-\phi}$ is the equivalence scale, n_{ah}, n_{1h}, n_{2h}, n_{3h} denote, respectively, the number of adults, number of young children (aged 0 to less than 5 years), number of older children (aged 5 to less than 14 years), and young people (aged 15 to less than 24 years) in household h, ϕ is the economies of household size parameter which, if statistically significant, establishes the presence of household size effects even in the presence of adult/child/youth relativities.

Hence, from (14), the social marginal utility of income of h is given by:

$$\beta_h = \left[\frac{\left(\frac{\mu_1}{\overline{m}_{01}}\right)^{\alpha} - \sum_i p_i^{\alpha} b_i}{\left(\frac{\mu_h}{\overline{m}_{0h}}\right)^{\alpha} - \sum_i p_i^{\alpha} b_i}\right]^{\varepsilon} \left(\frac{\frac{\mu_h}{\overline{m}_{oh}}}{\frac{\mu_1}{\overline{m}_{01}}}\right)^{\alpha-1} \tag{16}$$

The parameter α, if different from unity, allows for both non linear Engel curves and non separable preferences. It is readily verified that if $\alpha = 1$, (15) specialises to the indirect utility form of the LES. It may also be noted that because of the non linear Engel curves ($\alpha < 1$) allowed for in RNLPS, $\varepsilon = 0$ does <u>not</u> imply utilitarianism.

The demographically extended RNLPS is given in budget share terms, w_{ih}, by :

$$w_{ih} = \gamma_i p_{ih}^{*\alpha} \overline{m}_{oh}^{\alpha} + \beta_i \left[1 - \left(\sum_k \gamma_k p_{kh}^{*\alpha} \right) \overline{m}_{oh}^{\alpha} \right] \tag{17}$$

where $p_{kh}^{*} = \dfrac{p_k}{\mu_h}$ is normalised price, and the other variables are as defined before.

3. Data and Demand Estimates

The demographic demand estimation is based on pooled data on expenditure and household composition of 25,649 households using unit records from 1984, 1988-89 and 1993-94 Household Expenditure Surveys (HES) published by the Australian Bureau of Statistics (ABS). The budget system is defined over nine goods: Food and Non Alcoholic Beverages; Fuel, Electricity and Gas; Housing Rent, Mortgage Interest, Equipment and Services; Clothing and Footwear; Transport and Communications; Medical and Personal Tax; Alcohol and Tobacco; Entertainment; Miscellaneous (including Education and Interest payments as the main items). The demographic demand parameters were estimated using the whole sample. However, the tax analysis is carried out using only the data points (8,389 observations) in the final year ie., from the 1993/94 HES.

The optimal commodity taxes, presented in the next section, are revenue neutral with respect to the actual commodity taxes[7] prevailing in 1995/96. Let $t_j^* = {t_j}/{p_j}$ be the tax rate of item j, expressed as a proportion of the consumer price level, p_j. The effective tax rates for Australia in 1995/96 were calculated by Scutella (1997), using an extension of a method

[7] See Johnson, et. al. (1998, Ch. 2) for a recent review of the indirect tax system in Australia.

suggested by Chisholm (1993), from the nominal tax rates, $\tilde{t}_i$, and the input output tables to allow for all the inter-industry transactions, and assuming that taxes are fully shifted forward at each stage[8]. The optimal commodity tax rates presented later are revenue neutral with respect to the effective tax rates, calculated by Scutella (1997), for the nine goods chosen for this study.

Table 1 presents the parameter estimates of the demographic RNLPS. The following features are worth noting: (i) the non linearity/non separability parameter, α, is significantly different from unity, thus, confirming the rejection of LES preferences, (ii) the estimates of the equivalence scale parameters (θ_i) are well determined and increase with age as expected, and (iii) the magnitude and statistical significance of ϕ establishes the presence of large economies of household size even in the presence of adult/child/youth relativities. In view of the convincing rejection of the LES, a not unsurprising result in itself, the issue of sensitivity of optimal commodity taxes to departure from the use of LES acquires importance.

4. Results

Table 2 presents the LES, RNLPS optimal commodity tax rates under alternative values of the 'inequality aversion' parameter, ε. The effective tax rates, t_i^*, are also presented for ready reference. The following features are worth noting:

i) At zero inequality aversion, the LES optimal tax rates approach uniformity, as the theory tells us to expect. The many person case with non identical preferences, considered here, along with the absence of a demogrant scheme to counter the impact of household composition on consumer preferences, prevents the optimal commodity tax rates from being exactly uniform [see Ray (1988)]. The LES optimal commodity tax rates quickly move away from uniformity as ε rises though, with the significant exceptions of Fuel, Electricity and Gas (item no. 2), Transport (item no. 5) and Alcohol and Tobacco (item no. 7), these optimal commodity tax rates are never far away from one another.

[8] Ahmad and Stern (1984) pioneered the calculation of effective indirect taxes, using input output tables, through their study on Indian tax and expenditure data.

ii) In contrast to the LES, the RNLPS optimal tax rates deviate sharply from uniformity even at zero inequality aversion, with the non uniformity increasing with ε. In this more general case, the nature and extent of variation of the optimal commodity tax rates with ε is sensitive to the item. The necessary items, namely, Food and Non Alcoholic beverages (i = 1) and Fuel, Electricity and Gas (i = 2) witness a sharp reduction in their optimal tax rates as the planner's inequality aversion increases to Rawlsian levels (ε = 25). The latter item shows a large subsidy at high levels of ε. Note, however, that the LES based optimal tax rates for these two items, especially of Food, decline much less sharply as ε increases. In contrast, the optimal tax rate of Alcohol and Tobacco increases with ε quite sharply in case of the LES but is fairly static in case of the RNLPS. Consequently, at ε = 25, the LES based optimal tax rate of Alcohol and Tobacco is more than three times than that of the RNLPS.

iii) In general, and consistent with the results of Ray (1986), Murty and Ray (1989) for India, the LES and RNLPS tax rates tend to agree at very low levels of inequality aversion but disagree widely for most items at Rawlsian levels. The optimal commodity tax rates, especially of Alcohol and Tobacco at higher levels of ε, bear very little resemblance with the actual commodity tax rates. It is interesting to note that, even at high levels of inequality aversion, the optimal tax rate of Alcohol and Tobacco does not come anywhere near the high rate of effective taxes levied on this item. It is, also, significant that the effective taxes on the necessity items, Food (i = 1) and Fuel (i = 2) are much higher than their optimal tax rates, especially those based on the RNLPS.

A significant feature of the present study is the incorporation of the impact of household size and composition changes on demand in the optimal tax calculations. To examine whether these demographic effects on consumer preferences impact on the optimal commodity tax rates, we recalculated them on the conventional assumption of no demographic effects on demand. Table 3 compares, at ε = 1.0, the optimal commodity tax rates in the presence and absence of demographic effects on household demand. The table presents the calculations for both the demand systems considered in this study. The following features are worth noting from this table.

i) The introduction of household size and composition effects in demand estimation seems to matter much less for the LES than for the RNLPS. Fuel, Electricity and Gas (i = 2) is a striking example of an item whose RNLPS based optimal tax rate changes sharply, on admission of demographic effects, from a relatively large tax rate of 12% to a moderately sized subsidy of 3.4%.

ii) The introduction of demographic effects in the RNLPS framework generally leads to a movement in the optimal commodity tax rates away from uniformity. Recalling the earlier discussion, household size and composition effects play a role that is analogous to non linear Engel curves in making a case for non uniformity in setting commodity tax rates. While the former require an "optimal demogrant" scheme, the latter require an optimal non linear income tax to counter the move towards non uniformity.

iii) The optimal tax rates are, generally, less sensitive to the presence or otherwise of demographic effects than to the underlying demand functional form. Housing (i = 3), Clothing and Footwear (i = 4) and Alcohol and Tobacco (i = 7) are examples of items whose tax rates change much more between LES, RNLPS than between their demographic/non demographic variants.

Let us now turn to the issue of redistributive impact of the optimal commodity tax rates in comparison with that of the actual tax rates. Since different tax rates imply differences in relative prices between items, hence, the real expenditure inequality will differ between tax regimes. However, in view of the assumed exogeneity of aggregate household expenditure to tax changes, the inequality of aggregate money expenditure will be invariant to the tax rate. Table 4 presents the Gini coefficient of inequality of real equivalent household expenditure under the RNLPS optimal tax rates corresponding to the various ε values. The corresponding Gini inequality estimates under actual taxes and the LES optimal taxes at $\varepsilon = 0$ are, also, presented for comparison. That the optimal commodity tax rates become less regressive or more progressive with increasing ε is evident from the fall in real expenditure inequality. It is interesting to note that, even at $\varepsilon = 0$, the RNLPS optimal tax rates are less regressive than actual taxes in implying a lower level of real expenditure inequality. In contrast, the LES optimal tax rates do not appear less regressive than the actual tax rates. Figure 1 provides confirmation of the increasingly progressive nature of RNLPS tax rates as ε increases. However, the graph, also, shows that the fall in Gini slows down at higher levels of ε. Keeping in mind the recent tax changes in Australia due to the GST, Table 4, also, presents the real expenditure inequality under two revenue neutral hypothetical tax regimes[9], namely, (a) Alcohol and Tobacco set at the actual tax rate, while the others are uniform, and (b) Food

[9] Note, however, that these hypothetical cases do not translate into the post GST regime in Australia since the tax changes that accompanied the introduction of GST are not revenue neutral with respect to commodity taxes alone.

and Non Alcoholic Beverages are zero rated, Alcohol and Tobacco are set at the existing tax rate, and the others are uniformly taxed. It is interesting to note that both these hypothetical tax regimes imply higher levels of real expenditure inequality than the optimal RNLPS tax rates, even at $\varepsilon = 0$. However, between these two hypothetical tax scenarios, the zero tax rating of Food and Non Alcoholic Beverages (ie. b) does bring about a sharp decline in inequality in relation to (a).

Table 5 presents the estimates of the Reynolds-Smolensky (1977) measure of redistribution[10], L, of these alternative vectors of commodity tax rates. $L = G_\mu - G_x$ measures the change in inequality between post-tax and pre-tax expenditure distribution, with μ denoting post tax expenditure, and $x = \mu - T(\mu)$ denoting pre-tax expenditure. $L > 0$ implies regressive taxes, ie., a worsening of inequality, on the imposition of taxes on producer prices. Table 5 shows that all the tax vectors, considered here, are regressive in the sense that they lead to an increase in Gini inequality over that based on producer prices. However, consistent with the earlier results, L, ie., the rise in inequality due to RNLPS optimal taxes falls, as we increase ε. It is worth noting that the actual tax rates are less regressive than the RNLPS optimal taxes at low ε values but not so at higher values of inequality aversion. It is also significant that at zero inequality aversion, the LES optimal commodity taxes are a good deal less regressive than those implied by the RNLPS.

5. Summary and Conclusion

This study seeks to provide evidence on the structure of optimal commodity tax rates in Australia, and on the sensitivity of that structure to demand functional forms and to their demographic generalisation. The former has acquired importance in the wake of the recent

[10] See Sah (1983) for a discussion of the maximum redistribution that can be achieved by indirect taxes, and Ray (1986) for empirical evidence.

changes to indirect taxes in Australia. While tax design or optimal taxes may seem less practically relevant than tax reforms, they nevertheless provide a very useful set of benchmarks in discussions on tax rates. The issue of sensitivity of optimal commodity taxes to demand and demographic specification is, also, of considerable importance since the limited evidence that does exist on optimal taxes is largely based on restrictive demand functions with little or no role for household composition effects on consumer preferences.

The results of this study suggest that non linear Engel curves and demographic effects both tend to push the optimal commodity tax away from uniformity. The conventional wisdom that an inequality insensitive tax planner will favour uniform commodity tax rates is seen to hold only for the LES, not for its non linear generalisation, the RNLPS. The results, also, show that disagreements between demand systems on the optimal tax rates widen with increasing 'inequality aversion'. The optimal commodity tax rates, obtained in this study, bear very little resemblance to the set of effective tax rates in the '90s calculated by researchers at the Melbourne Institute of Applied Economic and Social Research. It is significant that the RNLPS based optimal tax rates, even at zero inequality aversion, imply a lower real expenditure inequality than the effective tax rates in force.

Before concluding, it is important to strike a note of caution and point to directions for further work. The present results do not necessarily suggest non uniform commodity tax rates. Three of the strongest arguments in favour of uniform commodity taxes, namely, (a) cost of administering non uniform taxes, (b) operation of a 'demogrant' scheme of subsidy to counter demographically varying preferences and (c) use of direct taxes as a more effective means of redistribution, have been ignored in this study. These issues, while important, are sufficiently complex to be left for a future exercise. The studies of Tuomala (1990), Saez (2000) and others contain parallel evidence on optimal income tax. The task of combining the two, via simultaneous calculation of optimal commodity and income tax rates, would be a valuable contribution to the literature.

Table 1: Demographic Demand Parameter Estimates[a]: RNLPS

Parameter	Estimate	Parameter	Estimate
β_1	-0.060 (0.010)	γ_4	0.435 (0.031)
β_2	-0.046 (.003)	γ_5	1.178 (0.091)
β_3	0.265 (0.005)	γ_6	0.453 (0.027)
β_4	0.103 (0.003)	γ_7	0.401 (.024)
β_5	0.301 (0.007)	γ_8	0.855 (0.067)
β_6	0.029 (0.002)	γ_9	0.536 (0.042)
β_7	0.048 (0.002)	α	0.349 (0.012)
β_8	0.223 (0.005)	θ_1	0.343 (0.028)
β_9	0.137 (0.004)	θ_2	0.543 (0.022)
γ_1	1.499 (0.112)	θ_3	0.771 (0.048)
γ_2	0.233 (0.027)	ϕ	0.314 (0.010)
γ_3	1.871 (0.108)		

[a] Standard Errors in brackets

Table 2: Estimates of Optimal Commodity Tax Rates $\left(t_i^*\right)^a$

	Effective Tax Rates	Optimal Tax Rates							
		LES					RNLPS		
		ε = 0.0	ε = 1.0	ε = 2.0	ε = 5.0	ε = 25.0	ε = 0.0	ε = 1.0	ε = 2.0
olic Beverages	0.114	0.103	0.075	0.085	0.086	0.094	0.081	0.053	0.039
Gas	0.087	0.053	-0.018	0.010	0.013	0.018	0.022	-0.034	-0.062
tgage Interest ent & Services	0.115	0.157	0.131	0.122	0.121	0.116	0.166	0.165	0.164
ear	0.068	0.168	0.106	0.086	0.086	0.087	0.181	0.192	0.197
unication	0.238	0.181	0.257	0.254	0.254	0.254	0.212	0.228	0.236
	0.091	0.115	0.078	0.078	0.078	0.080	0.122	0.110	0.104
)	0.495	0.158	0.430	0.482	0.483	0.485	0.150	0.150	0.149
	0.144	0.178	0.176	0.162	0.162	0.159	0.202	0.217	0.224
	0.138	0.177	0.170	0.157	0.156	0.156	0.191	0.205	0.212

Table 3: Optimal Commodity Tax Rates $\left(t_i^*\right)$ Implied by Non Demographic RNLPS

Commodities	ε **= 1.0**			
	Demographic LES	Non Demographic LES	Demographic RNLPS	Non Demographic RNLPS
1 Food & Non Alcoholic Beverages	0.075	0.066	0.053	0.135
2 Fuel, Electricity & Gas	-0.018	-0.080	-0.034	0.120
3 Housing Rent, Mortgage Interest Payments, Equipment & Services	0.131	0.124	0.165	0.154
4 Clothing & Footwear	0.106	0.134	0.192	0.161
5 Transport & Communication	0.257	0.272	0.228	0.195
6 Health Services	0.078	0.071	0.110	0.143
7 Alcohol & Tobacco	0.430	0.402	0.150	0.147
8 Entertainment	0.176	0.190	0.217	0.175
9 Miscellaneous	0.170	0.193	0.205	0.165

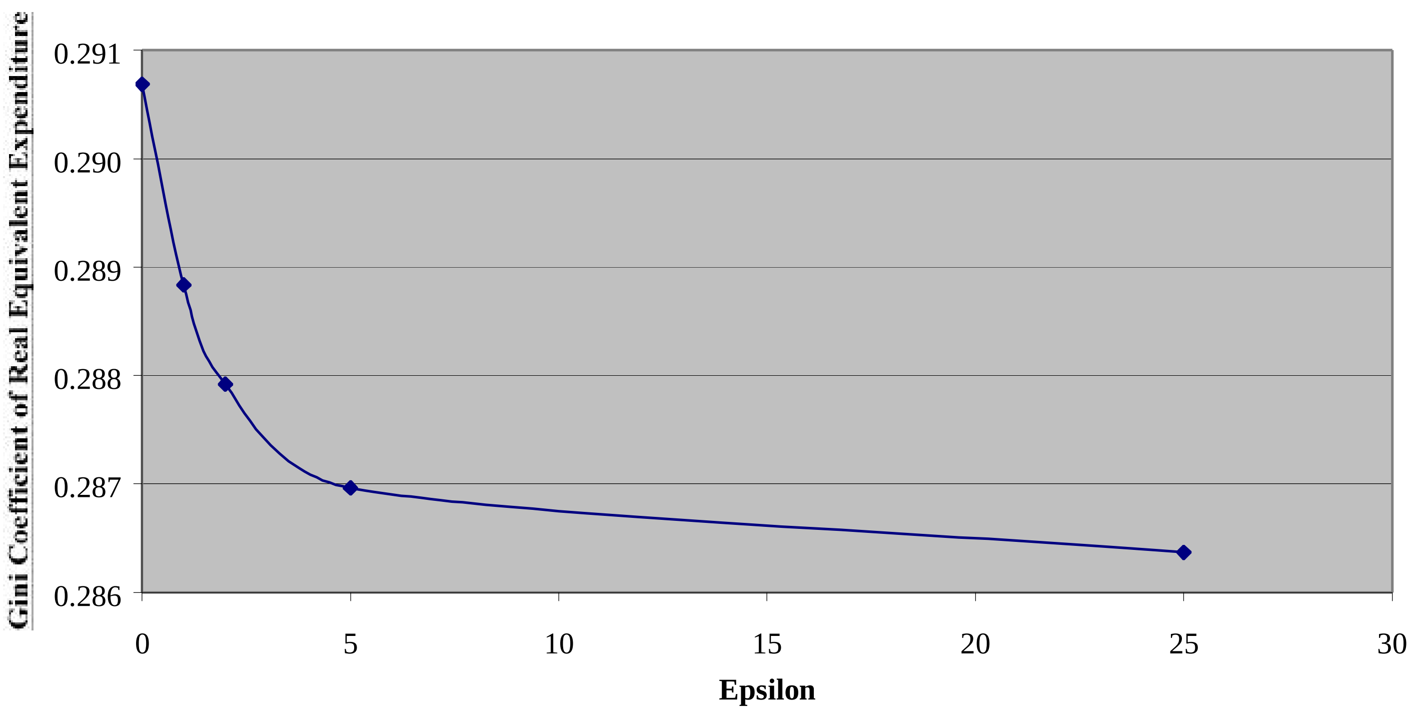
Table 4: Gini Inequality of Real Household Expenditure Under Alternative Revenue Neutral Tax Rates

Actual Tax	**LES Optimal Tax**	**RNLPS Optimal Tax**					$t_7^* = 0.495$, $t_i^* = 0.158$, $i \neq 7$	$t_1^* = 0$, $t_7^* = 0.495$ $t_i^* = 0.168$, $i \neq 1,7$
	ε **= 0.0**	ε **= 0.0**	ε **= 1.0**	ε **= 2.0**	ε **= 5.0**	ε **= 25.0**		
0.2929	0.2946	0.2907	0.2888	0.2879	0.2870	0.2864	0.2958	0.2918

Table 5: Reynolds-Smolensky Measure (L) of Redistribution Under Alternative Tax Rates

Actual Tax	**LES Optimal Tax**	**RNLPS Optimal Tax**				
	ε **= 0.0**	ε **= 0.0**	ε **=1.0**	ε **= 2.0**	ε **= 5.0**	ε **= 25.0**
0.1277	0.1242	0.1322	0.1300	0.1286	0.1269	0.1256

Figure 1: Variation of Real Equivalent Expenditure Inequality, Under RNLPS Optimal Taxes, with e



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