A review of the theory and empirical studies on optimal commodity taxation

Notes for the students of the postgraduate course on Economic Policy

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A. Introduction

The term 'optimal taxation' in the context of modern public finance theory conveys a meaning which may not be obvious to the layman. Sandmo (1976) suggests that one could identify at least three criteria for 'optimality' of a tax system. First, one could think of a good tax system as one which minimises the resource cost in assessing, collecting and paying the taxes. Second, alternative tax systems can be ranked in terms of some criterion of justice or fairness. And third, it is possible to evaluate tax systems in terms of economic efficiency, that is in terms of the distortion they cause in agents' behaviour. Optimality in this last sense has been the original point of departure of optimal commodity taxation theory. Distributional considerations were later embodied in the analysis. However, the costs of administration of a tax system have not yet been systematically integrated into the theory.[1]

The theory of optimal commodity taxation has as its starting point the breakdown of the basic theorems of welfare economics. The first theorem states that a competitive equilibrium is Pareto efficient and the second states that any prescribed Pareto efficient allocation can be achieved as a competitive equilibrium if prices are set appropriately and individual-specific lump-sum taxes or transfers are possible such that each individual can buy the consumption bundle given in the allocation at the prevailing prices. The assumptions for the second theorem to apply are stronger than for the first, since in addition to the existence of a complete set of markets and the absence of externalities, one has further to assume decreasing or constant returns to scale for private producers, diminishing marginal rates of substitution for consumers and the ability to impose

[1] This is due to the apparent complications of doing so, rather than the lack of acknowledgement from economists of the importance of doing so. Slemrod (1990), for example, argues that future research in the

differentiated lump-sum taxes and transfers for the government.

By definition, a lump-sum tax on individuals is a payment that the individual can not alter by action, so that there is no efficiency cost involved as a result of behavioural distortions. Unalterable sex or genetic characteristics, upon which it is in principle feasible to condition individual-specific lump sum taxes, are not usually considered as ethical grounds for differential taxation. Optimality requires lump sum payments to be based on relevant economic characteristics, such as preferences, attributes and endowments, for example determinants of human capital or expected future labour income of individuals. Subsequently, optimal lump sum taxation would be possible either if the government were able to directly observe such characteristics or if individuals honestly reported them despite the apparently strong incentives to conceal such information. In practice, neither is likely to be the case. Hence, it is generally agreed among economists that individual-specific lump sum taxes are hardly ever feasible (Mirrlees, 1976).[2] The consideration that this key assumption of the welfare theorem might on informational grounds or due to an incentive compatibility problem fail to hold in the real world leads us directly to a «second-best» world where individual-specific lump sum taxes are limited and to the need to develop a theory of optimal taxation taking account of restrictions on the set of feasible instruments.

In the absence of lump sum taxes the natural focus is on commodity and factor taxes. Optimal commodity taxation theory essentially began with Ramsey (1927), who gave the first solution to the problem of raising revenue by indirect taxes in a one-consumer economy. Other early contributions have been by Pigou (1947), Boiteux (1956), Corlett and Hague (1953) and Meade (1955). However, general models of optimal taxation did not appear until the beginning of the 1970s, when a rapid analytical development of the field commenced. The seminal paper in the area has been by Diamond and Mirrlees (1971a and b), who analysed optimal indirect taxation in the context of a many-person economy, stated and proved the production efficiency theorem and provided a discussion of existence of an optimum. A historical analysis of the optimal commodity taxation problem is given in Baumol and Bradford (1970) and Sandmo (1976), while extensive

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theory of taxation should shift from optimal tax rate structures to optimal tax systems.

[2] Stern (1982) actually examines a more realistic case, where some form of lump sum taxation is possible. More specifically, the government arranges lump sum taxation on the basis of a classification of individuals with an error margin which depends on the classification variable chosen (for example, age, "natural ability"). The author compares this regime with one involving income taxation and finds that the choice between the two depends on the size of errors and the egalitarian values of the government.

accounts of optimal tax theory and its extensions are available in Atkinson and Stiglitz (1980), Tresch (1981), Auerbach (1985), Mirrlees (1986), Stern (1987c) and Ray (1997).[3]

It should be stressed that the conclusions of any model on the optimal design of the tax system critically depend on the set of tax instruments that the model allows to be used. The classical models on optimal commodity taxation mentioned above, for instance Ramsey (1927) or Diamond and Mirrlees (1971a and b), analysed in sections B and C, solve the optimal tax problem assuming that commodity taxes are the only instrument the government can use to achieve its goals regarding both efficiency and redistribution. The results sensitively rely on this assumption and may be seriously modified in the context of more general models, which allow for a broader set of tax and transfer instruments. We saw earlier that certain taxes (individual lump sum) have to be precluded as the necessary information to levy such taxes is not available to the tax authorities. However, uniform lump sum payments to all might be possible and this critically changes the structure of the arguments. More general models might be considered more policy relevant and will also be briefly analysed in section D.

Section E briefly deals with some extensions of the theory of optimal taxation that consider the production side of the economy, imperfect competition, externalities and the administrative costs of the tax system. Section F concentrates on the theory of commodity tax reform in the Ahmad and Stern (1984 and 1987) tradition, which comprises a useful perspective in evaluating indirect tax structures studying positions away from the optimum.

Section G reviews the most important empirical studies which have used this theory to assess indirect tax systems. A main conclusion of analysing the empirical literature on the estimation of optimal commodity taxes, for example Atkinson and Stiglitz (1972), Deaton (1977), Ray (1986a), Kaiser and Spahn (1989), is that the results of most studies are explained and largely determined by assumptions regarding the structure of preferences and the set of tax instruments available to the policy maker. In most cases, these assumptions are rather unrealistic, especially concerning the narrow view of indirect taxes, so that these studies are good illustrations of arguments, but rather incomplete guides for policy making. For example, unless there are good reasons to preclude the use of other tax/transfer instruments on the grounds of country specific circumstances, considering only the indirect tax system fails to address the actual policy problem that governments are

[3] The theory of optimal commodity taxation is related to the theory of excess burden, see Appendix 3.1.

facing and seriously limits the scope of analysis. An empirical study less subject to such limitations and therefore more interesting is by Ebrahimi and Heady (1988), who consider non-uniform preferences, non-separability between goods and leisure and a broader view of tax instruments. One of the most important findings is that even in the case where non-separability or non-optimality of transfers produce appreciable non-uniformity in optimal commodity tax rates, the cost in terms of social welfare of ignoring optimal tax theory suggestions and imposing uniformity in the indirect tax structure is fairly small in GNP terms. The argument in favour of simple indirect tax structures becomes more compelling considering the reduction in the implementation and administration costs of the system and in the resources wasted in lobbying efforts to reclassify goods such a structure would imply. This point is convincingly argued by Davies and Kay (1985).

Several studies on marginal tax reform and some of its extensions are also reviewed, for example Ahmad and Stern (1984 and 1987), Decoster and Schokkaert (1989). These studies provide quite useful results about where indirect taxation should be redirected at the margin carefully balancing equity and efficiency considerations. However, they have certain theoretical limitations, most importantly regarding the confinement of attention to indirect taxation alone and the implicit labour-goods separability assumption. Nevertheless, such a narrow view of the tax system could be justified in cases of developing countries, for example India, where designing income taxation and a transfer system not vulnerable to corruption is hardly feasible.

B. The theory of optimal commodity taxation in a single-person economy: the Ramsey rule

As stated above, the first contribution to the optimal taxation literature was given by Ramsey (1927). The problem considered by Ramsey is to raise a given amount of revenue from a consumer through the taxation of the commodities consumed so as to minimise the loss in utility arising from taxation, or equivalently, so as to maximise social welfare subject to the revenue constraint. No other tax or transfer instrument is assumed to be available. Furthermore, the single consumer basis implies that all equity considerations are readily excluded in the setting of taxes rates, so that the solution to the Ramsey problem describes an efficient tax system.

The production is pushed to the background by assuming that the economy is competitive, that firms face a constant returns to scale technology and produce a single output and that producer prices are fixed, or that there is only one factor of production. Fixed producer prices in this context imply that an increase in taxes corresponds to an equal increase in consumer prices.[4] That means that the problem of selecting a tax structure is equivalent to choosing a structure of consumer prices. The production assumptions also imply that the firms earn zero profits. The consumer therefore receives no profit income. There are n consumption goods available and a single form of labour, l, which is the only factor supplied by the individual.[5] Goods may be either sold or bought by consumers and sales are treated as negative purchases. Producer prices are $\mathbf{p}$ and the wage rate faced by the consumer is w. If there is lump-sum income, M, and if the revenue requirement does not exceed M, then the optimal tax system would be to tax either M, or equivalently all goods and labour at the same rate. This would correspond to a lump-sum tax, with no distortionary behavioural effects and would, thus, be optimal. However, we have ruled out lump-sum taxation.[6] Assuming that there are no lump-sum incomes (M=0 and $\mathbf{qx} = wl$), then we can choose a good to be untaxed without loss of generality. For convenience, we choose that good to be labour.

We consider one representative consumer, who faces consumer prices $\mathbf{q}$, wage rate w and has no endogenous income. The producer price vector $\mathbf{p} = (p_1, p_2, ..., p_n)$ is assumed to be fixed. The government has to raise a certain amount of revenue $\overline{R}$ by imposing unit taxes $\mathbf{t} = (t_1, t_2, ..., t_n)$. $\overline{R}$ is defined as the value at $\mathbf{p}$ of the bundle of goods and factors required by the government. The preferences of the representative consumer are represented by the indirect utility function V, defined over prices, $U = V(\mathbf{q}, w)$. The problem then formally becomes

$$\underset{\mathbf{t}}{\text{Maximise}} \quad V(\mathbf{q}, w)$$

[4] We further assume that the producer prices reflect social costs, i.e. there are no externalities.

[5] The structure of results in no way depends on the assumption of labour being the only factor supplied by the households or of constant returns to scale, as long as profits are 100% taxed and the disconnection between firms and individuals holds.

[6] Note that in the present context, where competition and constant returns to scale rule out pure profits, positive values of M would be possible, if income is defined as full income consisting of both consumption of commodities and the consumption of leisure, i.e. $\mathbf{qx} + wL = wT$, where T is an endowment of time. In this case, the inability to use proportional taxes to raise revenue without distorting consumer behaviour stems from the restricted nature of tax instruments; the government can tax only explicit purchases rather than ``full`` consumption (Auerbach, 1985, pp 88-89).

$$\text{subject to} \quad R(\mathbf{t}) = \sum_k t_k x_k \geq \overline{R} \tag{3.1}$$

where x_k is the consumption of the kth good by the consumer. The Lagrangean corresponding to (3.1) is given by

$$L = V(\mathbf{q}, w) + \lambda\left[R(\mathbf{t}) - \overline{R}\right] \tag{3.2}$$

and the first-order necessary conditions for maximisation set the partial derivatives with respect to t_i equal to zero

$$\frac{\partial L}{\partial t_i} \equiv \frac{\partial V}{\partial t_i} + \lambda \frac{\partial R(\mathbf{t})}{\partial t_i} = 0 \tag{3.3}$$

Since producer prices are fixed, differentiation with respect to t_i and q_i are equivalent, so that (3.3) gives

$$\frac{\partial V}{\partial q_i} + \lambda\left(x_i + \sum_k t_k \frac{\partial x_k}{\partial q_i} \right) = 0 \tag{3.4}$$

Using duality in consumer theory, Roy's identity gives

$$\frac{\partial V}{\partial q_i} = -x_i \frac{\partial V}{\partial M} = -a x_i \tag{3.5}$$

where a is the marginal utility of income. Furthermore, Slutsky's equation gives the standard decomposition of $\partial x_k / \partial q_i$ into a symmetric substitution effect and an income effect

$$\frac{\partial x_k}{\partial q_i} = s_{ki} - x_i \frac{\partial x_k}{\partial M} \tag{3.6}$$

where s_{ki} is the utility-compensated change in demand for the kth good when the price of the ith good changes. Replacing (3.5) and (3.6) in (3.4) and after rearranging and using the symmetry property of the Slutsky matrix, we have:

$$\frac{\sum_k t_k s_{ik}}{x_i} = -\vartheta, \quad \vartheta = 1 - \frac{a}{\lambda} - \sum_k t_k \frac{\partial x_k}{\partial M} \tag{3.7}$$

This is the Ramsey tax rule, as formulated by Samuelson (1951). Notice that ϑ is a positive number independent of *i*. One could give an intuitive explanation of the tax rule that follows from equation (3.7). We can view $\sum_k t_k s_{ik}$ as a first-order approximation of the compensated change in demand for the *i*th good resulting from the imposition of a vector of taxes, **t**. If the taxes are small, then this should be a relatively good approximation. Recalling that the Slutsky matrix is negative semi-definite, it follows that the left-hand side of (3.7) is negative and, therefore, that ϑ will have the same sign with revenue, *R*, so that an increase in taxes will lead to a fall in the compensated demand of a commodity. The Ramsey tax rule then can be interpreted as saying that at the optimum the proportional reduction in compensated demand that results when the set of taxes is imposed should be the same for all goods.

The implications are clear. The Ramsey rule invalidates arguments in favour of uniform taxation or equal proportional price changes as minimising the efficiency costs of taxation. It is quantities that matter, not prices.[7] Prices are only important in so far as they determine demands. Furthermore, the Ramsey rule directs taxation towards goods which cannot be varied by consumers, i.e. goods that are unresponsive to price changes. Thus, 'necessities' like food and housing will be prime candidates for higher taxes compared to 'luxuries' with an elastic demand pattern.

Another intuition behind the Ramsey rule can be gained by exploiting the existence of the untaxed good, i.e. labour and its relation with leisure. This has been formally developed in Corlett and Hague (1953). The presence of an untaxed good allows the optimal tax formula to be expressed in terms of the complementarity or the substitutability of the taxed commodities with the untaxed good. In the two good case, for example, the optimal tax formula can be expressed in terms of the elasticities of the compensated demands of taxed goods, ε_{ij}^c, as follows (Myles, 1995):

[7] This has been explicitly acknowledged by Mirrlees (1976), who suggests the definition of an index of discouragement to measure the effect of taxes.

$$\frac{\frac{t_1}{1+t_1}}{\frac{t_2}{1+t_2}} = \frac{\varepsilon_{12}^c - \varepsilon_{22}^c}{\varepsilon_{21}^c - \varepsilon_{11}^c}, \qquad \text{where} \quad \varepsilon_{ij}^c = \frac{q_j s_{ij}}{x_i} \tag{3.8}$$

If leisure is good 0 and using the fact that the expenditure function is homogeneous of degree 1 in prices, we can rewrite (3.8) as

$$\frac{t_1}{1+t_1} = \frac{t_2}{1+t_2}\left(\frac{-\left(\varepsilon_{11}^c - \varepsilon_{22}^c\right) - \varepsilon_{10}^c}{-\left(\varepsilon_{11}^c - \varepsilon_{22}^c\right) - \varepsilon_{20}^c}\right) \tag{3.9}$$

so that if the two goods are equally complementary to leisure ($\varepsilon_{10}^c = \varepsilon_{20}^c$), then they should be taxed at the same rate. If, on the other hand, $\varepsilon_{10}^c < \varepsilon_{20}^c$, i.e. good 1 is more complementary to leisure, then this good should be taxed more heavily.[8] Sadka (1977) generalised this result in the case of *n* goods to show that a uniform tax is optimum on all commodities if and only if $\varepsilon_{10}^c = \varepsilon_{20}^c = ... = \varepsilon_{n0}^c$. Sandmo (1976) showed that this would be true if the utility function has such a form that allows weak separability of leisure (i.e. all goods supplement leisure equally) and homotheticity for all other goods (i.e. linear parallel Engel curves). Deaton (1981) derives a similar result working with the form of the expenditure function. Although restrictive, the above assumptions ensure the simple prescription of uniformity in tax rates across commodities.

While the general intuition behind the Ramsey rule is clear, it does not offer an explicit formula for the calculation of optimal taxes. More precise tax rules can be derived at the expense of additional assumptions. Baumol and Bradford (1970), for example, discuss in detail the case where all cross-price effects are assumed to be zero. This assumption is a particularly strong one, turning the general equilibrium into a partial equilibrium one and is essentially equivalent to minimising the excess burden of taxation in a partial equilibrium framework (see Atkinson and Stiglitz, 1980 and Hicks, 1947). Under this assumption, we can derive the inverse elasticity rule as follows. Take equation (3.4) as a starting point and replace Roy's identity

[8] Note that this conclusion is an outcome of the homogeneity of the expenditure function and the normalisation of taxes and does not impose any further restriction on the tax problem. On the other hand, if we accept that there exists an untaxed and, in principle untaxable, endowment of time on which we would ideally wish to levy a tax (lump-sum), then levying higher taxes on goods which are complementary with leisure can be seen as an effort to tax the endowment of time.

$$ax_i = \lambda\left(x_i + \sum_k t_k \frac{\partial x_k}{\partial q_i} \right) \tag{3.10}$$

If demands are independent, the only non-zero effect at the sum in the right-hand side of equation (3.10) is $t_i \frac{\partial x_i}{\partial q_i}$, so that (3.10) becomes

$$ax_i = \lambda\left(x_i + t_i \frac{\partial x_i}{\partial q_i} \right) \tag{3.11}$$

Rearranging (3.11) and multiplying with q_i gives

$$\frac{t_i}{q_i} = \left[\frac{a-\lambda}{\lambda} \right]\left[\frac{x_i}{q_i} \frac{\partial q_i}{\partial x_i} \right] \tag{3.12}$$

Considering that $\frac{\partial x_i}{x_i} / \frac{\partial q_i}{q_i}$ is the price elasticity of demand for good i, ε_i^d, (3.12) becomes

$$\frac{t_i}{p_i + t_i} = \left[\frac{a-\lambda}{\lambda} \right] \frac{1}{\varepsilon_i^d} \tag{3.13}$$

This is the well known inverse elasticities rule, which states that at the optimum, proportional rates of tax should be inversely related to the price elasticity of demand of the good on which they are levied. This rule directly relates high taxes to 'necessities', which have low price elasticities, and low ones on 'luxuries', which have high price elasticities. This is an extreme version of Ramsey rule.

Another extreme version arises when the problem is solved in its original formulation (i.e. with direct rather than indirect utility function) and we assume a completely inelastic labour supply. In this case it can be shown (see Atkinson and Stiglitz, 1980) that a uniform tax on all goods is optimal. This is equivalent to a tax on labour alone and stands in agreement with the conventional prescription that a factor in completely inelastic supply should bear all the tax. Finally, another interesting case examined in Atkinson and Stiglitz (1972) is where the utility function is assumed to be directly additive and the resulting optimal tax rule says that optimal rates should inversely

depend on the income elasticity of demand. All these models, are exclusively concerned with the efficiency cost of taxation, totally ignoring distributional considerations, to which we now turn.

C. The theory of optimal commodity taxation in a many-person economy

The Ramsey model serves rather illustrative purposes, since in the Ramsey one-consumer economy, a poll tax should be used to raise required revenue in a completely non-distortionary way. The extension of the Ramsey rule to a many person economy is theoretically more relevant. The seminal contribution in this area has been by Diamond and Mirrlees (1971a and b). Other important contributions are by Diamond (1975) and Mirrlees (1975). The economy now consists of H individuals. The problem still is to maximise social welfare subject to the revenue constraint and substantially simplifies matters by assuming that all revenue is raised via commodity taxes and no other tax/transfer instrument is allowed for. Individual welfare is defined as before in terms of the indirect utility function, depending on consumer prices $\mathbf{q}$ and the wage rate w^h ($V^h(\mathbf{q}, w^h)$). Social welfare is determined by a Bergson-Samuelson social welfare function, which is defined over the vector of individual indirect utilities

$$W = W(V^1, V^2, ..., V^h, ..., V^H) \tag{3.14}$$

Total demand $\mathbf{X}(\mathbf{q},\mathrm{w})$ is $\sum_h x^h(\mathbf{q}, w^h)$, where $x^h(\mathbf{q}, w^h)$ is the demand function of individual h. The total demand for commodity i is now expressed as $X_i = \sum_h x_i^h$. The optimisation problem becomes

$$\underset{\mathbf{t}}{\text{Maximise}} \quad W(V^1, V^2, ..., V^h, ..., V^H) \tag{3.15}$$

$$\text{subject to} \quad R(\mathbf{t}) = \sum_k t_k X_k \geq \overline{R}$$

$$L = W(V^1, V^2, ..., V^H) + \lambda\left[\sum_k t_k X_k - \overline{R}\right] \tag{3.16}$$

and the first-order necessary conditions for maximisation set the partial derivatives with respect to t_i (q_i) equal to zero[9]

$$\frac{\partial L}{\partial q_i} = \sum_h \frac{\partial W}{\partial V^h}\frac{\partial V^h}{\partial q_i} + \lambda\left(X_i + \sum_k t_k \frac{\partial X_k}{\partial q_i}\right) = 0 \tag{3.17}$$

Using $\partial V^h / \partial q_i = -a^h x_i^h$, where a^h is the marginal utility of income of individual *h* (Roy's identity), we have

$$\sum_h \frac{\partial W}{\partial V^h}\frac{\partial V^h}{\partial q_i} = -\sum_h \frac{\partial W}{\partial V^h} a^h x_i^h \tag{3.18}$$

Define $\beta^h = \frac{\partial W}{\partial V^h} a^h$ (3.19)

β^h can be interpreted as the *social marginal utility of income* for individual *h*, that is the increase in social welfare resulting from a marginal increase in the income accruing to individual *h*. Replacing (3.18) and (3.19) in (3.17),

$$\sum_h \beta^h x_i^h = \lambda\left(X_i + \sum_k t_k \frac{\partial X_k}{\partial q_i}\right) \tag{3.20}$$

Substituting from the Slutsky equation, as before, and after simple algebraic manipulations, (3.20) gives the following tax rule

$$\frac{\sum_h \sum_k t_k s_{ik}^h}{X_i} = \frac{1}{\lambda}\frac{\sum_h \beta^h x_i^h}{X_i} - 1 + \frac{\sum_h x_i^h \sum_k t_k \frac{\partial x_k^h}{\partial M^h}}{X_i} \tag{3.21}$$

In contrast to (3.7), the proportional reduction in the consumption of the *i*th commodity

[9] It should be noted that the first-order conditions do not necessarily describe a maximum, unless the conditions of quasi-concave programming are satisfied. More specifically, the first order conditions would uniquely identify the optimum **q** if we are maximising a concave function of relative prices over a convex set, which holds if the indirect utility function is concave in relative prices and the production set is convex (Diamond and Mirrlees, 1971b, pg 267). This might not always be the case, for example, Varian (1984) gives the example of an indirect utility function which is convex in prices. For a recent assessment of this problem, see Besley and Jewitt (1990).

along the compensated demand schedule is not necessarily the same for all commodities. If rearranged, (3.21) becomes

$$\frac{\sum_h \sum_k t_k s_{ik}^h}{X_i} = -\left[1 - \sum_h \frac{b^h}{H} \frac{x_i^h}{\overline{x_i}}\right] \tag{3.22}$$

where $b^h = \frac{\beta^h}{\lambda} + \sum_k t_k \frac{\partial x_k^h}{\partial M^h}$ (3.23)

represents the net social marginal valuation of income, measured in terms of government revenue.[10] b^h consists of two elements, the welfare weights (β^h) which depend on the distributional value judgements of the government and the marginal propensity to pay indirect taxes out of extra income, $\mathbf{t}\partial\mathbf{x}^h / \partial M^h$. Therefore, in general, the tax should be lower (i) the more the good is consumed by individuals with a high social valuation of income (reflecting equity criteria) and (ii) the more the good is consumed by individuals with a high marginal propensity to consume taxed goods (reflecting efficiency considerations). If the demand and tax structure is such that the rich (with low β^h) have a higher propensity to spend their extra income on highly taxed goods at the margin, the two elements in b^h will be negatively correlated and this will tend to make the spread of b^h lower than the distributional weights alone would imply. This brings out explicitly the conflict between equity and efficiency criteria in the design of an optimal tax system. The way in which these two considerations balance each other critically depends on the structure of the demand function and the form of the differences among the population. If, for example, the government's aversion to inequality is low and the curvature of the Engel curves is large, then we would expect the efficiency criteria to dominate the determination of optimal tax rates.

Again explicit calculations of optimal tax rates is not straightforward and additional restrictions have to be imposed to obtain detailed results. Note that the conditions that ensure uniformity in the single-consumer case, weak separability with leisure and homotheticity, are sufficient to ensure uniformity here. Separability and homotheticity of

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[10] b^h measures both the gain in social welfare, β^h, due to an increase in income to *h* and the increase in tax payments of *h* due to this increase in income.

the utility function imply not only that the compensated cross price elasticities with respect to the wage are equal across commodities, but also that Engel curves are linear and parallel, so that the marginal propensity to consume any good is equal across individuals. In general, the right-hand side of (3.22) is the same for all goods if either b^h is the same for all h or if $x_i^h / \overline{x_i}$ is the same for all commodities (there are no goods that are consumed disproportionally by rich and poor).

D. Optimal commodity taxation and income taxation

So far, we have assumed that indirect taxation is the only tax instrument available to the government to balance its equity and efficiency goals. In practice, however, this is not so. It would be, thus, important to ask how the above conclusions might be modified if an income tax, to mention the most prominent example, were also available.

Since we have assumed without loss of generality that uniform taxation of all goods is equivalent to a proportional tax on income (under constant producer prices), a linear income tax can be included simply by adding a poll tax or grant. The first interesting exercise, therefore, is to specify the conditions under which uniform indirect taxation combined with an optimal poll tax or grant would be optimum.[11] These conditions, according to Atkinson (1977) are that individuals have identical preferences and differ only in the wage rate and that the direct utility function has the Stone-Geary form, which gives rise to the linear expenditure system.

Deaton (1979 and 1981) slightly generalised this result by dispensing with the LES labour supply formulation and showed that uniform taxation is optimal in the presence of an optimal *linear* income tax if Engel curves are linear and have the same intercept (i.e. the marginal propensity to consume on each good and the minimum requirement is the same for everyone) and if leisure is weakly separable from goods in the utility function. The intuition is that, with the optimum grants taking care of redistribution, everybody has a common pattern of marginal propensities to spend on each good and if leisure separates

[11] Notice that a poll tax/grant would be optimal if $\overline{b}$ =1, that is if the benefit in terms of social welfare of the marginal euro (the average of the net social marginal utilities of income) is equal to the cost to the government (one euro). Furthermore, it can be shown, Atkinson and Stiglitz (1980), that where individuals are identical the first-order conditions for maximising social welfare under the revenue constraint is zero

out from the utility function, there are no grounds for discriminating indirect taxes across commodities.

Deaton and Stern (1986) further generalised the Deaton result to show that even when the intercepts of the Engel curves vary across households on the basis of observable and unobservable household characteristics, uniformity of indirect taxation is still optimal provided that the government can apply an optimal system of family grants which depend on observable household structure and that the unobservable household characteristics are independent of social marginal utilities of money.[12]

The range of instruments typically available in developed countries is a combination of a non-linear income tax schedule (i.e. an income tax schedule with variable marginal tax rates) with linear commodity taxes. In this case, the prescription of uniform indirect taxation can be justified under less restrictive assumptions on preferences. Atkinson and Stiglitz (1976) and Deaton (1981) show that if labour is separable and if households have identical preferences (they differ only in the wage rate), then optimal commodity taxes are uniform. So, the particularly restrictive and easily rejectable assumption of linear Engel curves may be dropped. Although the proof of the argument involves quite complicated calculus (for an exposition see Atkinson and Stiglitz, 1980), the intuition behind it is clear. If differences across individuals arise only in labour, which separates out from the utility function, there is not sufficient correlation between consumption choice and ability, which the government attempts to tax, consumption patterns are not a useful screening device, hence indirect taxes are unnecessary. A flexible income tax instrument, such as a non-linear one, is sufficient.

An alternative perspective on the role of linear commodity taxes in the presence of an income tax is offered by Christiansen (1984). The point of departure in this study is a situation in which the income tax has been optimised over a continuum of individuals. The latter are distributed by ability, which is equated with the wage rate. The author then determines the welfare effects of introducing commodity taxes in a revenue-neutral way. The analysis concludes that goods for which demand increases if more leisure is obtained, with income being constant, should have positive tax rates introduced. If demand falls from the increase in leisure, again with no change in income, then a subsidy should be introduced and the commodity tax should be zero if no change in demand for that

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commodity taxes and all the revenue is to be raised by the non-distortionary lump-sum tax.

[12] Crucial is the assumption that the intercepts of the Engel curves corresponding to different family

commodity follows from a change in leisure.

The most intuitive results on the mixed tax case (that is the availability of linear commodity taxes and a non-linear income tax) are perhaps provided in a theoretical paper by Edwards *et al* (1994). The results on optimal mixed taxation are derived in terms of the self-selection approach to optimal taxation. There are two types of individuals, a high and a low ability one. The ability level is reflected in the wage rate, so that a high-ability individual can earn the same income with a low-ability individual working less hours. The government can observe individual earnings, but not individual wage rates, so that lump sum taxation based on innate ability is ruled out. Furthermore, a high-ability individual can always mimic a low-ability one by choosing to work less and face the pre- and post-income tax earnings bundle intended for the low-ability types. Thus, the government faces two constraints: the usual revenue constraint and the self-selection constraint on the high-ability types. The latter constraint requires that the government chooses a combination of commodity and income taxes, such that each ability type (weakly) prefers the pre- and post income tax earnings bundle intended for them to that intended for the other. The government then maximises the utility of the low-ability individuals subject to achieving utility of at least a certain level for high-ability types subject to the two constraints explained above.

The first-order conditions, for second-best Pareto efficiency to be ensured, as far as the structure of commodity taxation is concerned, indicate that the proportional reduction in the compensated demand for good i,[13] should be greater, the more marked is the tendency for the high ability mimicker to consume more of good i than does the true low ability individual. The authors show that this results in making mimicking less attractive, thus weakening the self-selection constraint. Considering that the only difference between a low-ability type and a mimicking high-ability type is that the latter works fewer hours to earn the same income with the former as he/she has a higher wage, what the above result implies is that the reduction in aggregate compensated demand for good i should be greater, the larger is $\partial X_i / \partial w$, that is the larger the complementarity between that good and leisure.

The optimality of uniform commodity taxes under the assumptions on preferences

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structures are uncorrelated with the wage.

[13] Strictly speaking, this term is similar to the left-hand side of the Ramsey rule on optimal commodity taxation (equation 3.7). Thus, the definition given here will be precise only for very small intensification of the commodity tax structure.

imposed in the Atkinson and Stiglitz (1976) result, presented above, has then a simple intuitive explanation. Weak separability between private goods and leisure implies (Stern 1987c) that all goods substitute leisure equally, or, more formally, that the marginal rate of substitution between any two taxed goods is independent of amounts of leisure consumed at constant utility. Since the only difference in the low-ability and mimicking high-ability persons is precisely the higher consumption of leisure by the latter, weak separability implies that the two types not only earn the same income, but also spend it in the same way, so that consumption patterns are not a useful screening device and differential commodity taxation is unnecessary.

Another rather interesting paper in the area of the optimal direct-indirect tax mix is by Boadway *et al* (1994), who address the question in a context where income tax evasion is possible. Non-linear income taxation is available, but now uniform commodity taxation is not equivalent to a proportional income tax due to the evasion possibilities in the latter. The authors examine the optimal income and indirect tax schedules simultaneously and conclude that in the presence of income tax evasion uniform indirect taxation is optimal if the usual condition of separability between leisure and commodities holds (as found above) and additionally indifference curves are quasi-homothetic.

Finally, Newbery (1997) in a theoretical paper considers the dependence of the rules on optimal commodity taxation on the other instruments available at the government during systemic reform in Eastern European countries. The author examines the balance between income and commodity taxation, the optimal level of taxes and the desirable degree of redistribution through the transfer system in a period when the government becomes less averse to inequality, the inequality in skills increases, enterprise revenue fall and evasion erodes the direct tax basis. Thus, a decrease in the efficiency of tax collection, provides an argument for reducing both the tax share in GDP and the tax rates, while reduced tax coverage suggests a lowering of the optimal level of transfers. As regards the balance between indirect and direct taxation, it critically depends on the degree of tax evasion on personal income tax on the one hand and the incompleteness of coverage on the indirect tax side on the other. In this sense, a linear income tax and a uniform VAT, though theoretically broadly equivalent, might both be desirable in practice, as they may display different evasion patterns and thus jointly capture a broader part of income and purchasing power. Furthermore, sole reliance on one tax instrument may give too strong incentives to tax evasion.

E. Various extensions of the theory of optimal commodity taxation

So far the production side had been pushed to the background. It would be worth to briefly summarise the implications to the optimal commodity taxes of introducing the production side of the economy. Several aspects of production have been considered in the literature. The purpose here is to give the intuition behind the main findings rather than to present a fully documented exposition and derivation of the arguments involved.

1. Production in the models of optimal taxation

Although the analysis of more recent theoretical models on optimal commodity taxation concentrates on the consumer and demand side of tax rules, the original article of Diamond and Mirrlees (1971a and b) dealt with the optimal taxation problem in a general equilibrium framework. Assuming that production takes place only in the public sector, Diamond and Mirrlees (1971a and b) showed that under fairly weak assumptions (most importantly the convexity of the production set and the absence of lump-sum incomes), government production can be decentralised by using a set of producer prices **p** and asking public sectors to maximise profits with respect to these prices. This is known as the production efficiency theorem and establishes both the desirability of production efficiency at the optimum and the possibility of decentralisation of production decisions using prices. We can use this model to generate optimal tax rules, which are found to be of the same form with the ones produced in the above section (see Stern, 1987c), where the tax vector is the difference between the consumer and the producer price vectors. Thus, the problem of optimal taxation in this general equilibrium framework is equivalent to maximising social welfare subject to a revenue constraint as in the earlier case. Therefore, concentrating on the demand side of the problem is not as restrictive as the simple assumptions made there might suggest.

Competitive private production can be incorporated in this framework and poses no conceptual difficulties as long as it does not generate profit incomes to households. This is ensured by assuming either constant returns to scale (which combined with the assumption of perfect competition implies zero profits) or that any profits can be taxed at

100 per cent. The production that would emerge at the optimum can be decentralised as before using prices **p**. The only difference is that some firms are now in the private sector.

One implication of the production efficiency theorem is that goods that enter into production processes as inputs and intermediate goods should not be taxed. All firms should buy and sell at the same prices in order for the whole production sector to be efficient. If different industries face different relative prices, then the marginal rate of transformation between inputs, or between an input and an output will not be equal across industries. Then, in principle, it would be possible by reallocating inputs to have strictly more of one good while having no less of another. Thus, this situation is inefficient. The principle of not taxing intermediate goods is heavily dependent on the assumptions of no pure private sector profits, perfect competition and the possibility to tax all final goods.[14]

In the case where not all final goods can be taxed, the production efficiency theorem no longer applies. Newbery (1986), among others, has addressed the problem of restricted taxation in the context of production. Where the output of a firm cannot be taxed for some reason (e.g. administrative feasibility) then it may be desirable to tax its inputs. This implies taxing transactions between firms and thus introducing an inefficiency in the production process, since marginal rates of transformation between a pair of goods will be different across producers. The inefficiency is balanced against the gains from the surrogate taxation of the final good. The problem of restricted taxation often acquires greater importance for developing countries where administrative feasibility directs taxation towards a few easily taxable targets. This is hardly the case in Greece, where almost all final goods are taxed.

Finally, based on the undesirability of input taxation if the production efficiency theorem applies and following a similar line of reasoning, one can argue for not imposing tariffs on inputs into production and for taxing all final goods the same regardless of whether the source is domestic or foreign (at least when the country is small). Again violation of this principle can be justified if the production efficiency theorem does not hold; then tariffs on inputs and intermediate goods would be desirable to compensate for possible production distortions or restricted taxation on final goods, to improve distribution where there are non-zero profits and so on. In the case of Greece, imports and export taxes were gradually abolished as a result of EC membership.

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[14] The principle of not taxing intermediate goods is rather well satisfied by the VAT system, also applied in Greece, which has a built-in mechanism by which taxes on inputs are rebated.

2. Commodity taxation and imperfect competition

The introduction of imperfect competition in the production side significantly complicates the analysis of optimal taxation. The additional complications arise from the fact that commodity taxes are no longer necessarily passed forward by firms to consumers by 100% and from the possible existence of non-zero profits to firms.

While perfect competition always implies a degree of tax shifting between zero to 100 per cent, with 100 per cent shifting occurring only where the elasticity of supply is infinite (constant returns to scale), in non-competitive models a very broad range of outcomes is possible. This issue has been theoretically examined in Stern (1987a) and Stern (1987b). For an interesting recent empirical study, which illustrates in reality the variety of shifting patterns of different commodities using price information in over 150 US cities, see Besley and Rosen (1998).

In models of imperfect competition the Ramsey rule has to be modified. This is done in Myles (1989 and 1995). The author derives the modified Ramsey tax rule which includes an additional term representing a correction for the existence of the induced price and profits effects. The reduction in compensated demand of a commodity becomes smaller the higher the degree of tax shifting for this commodity and the more a tax on this good reduces firms' profit and the tax induced changes reduce tax revenue. This theoretical rule is apparently important, but it imposes rather heavy informational requirements which impede its operationalisation.

3. Externalities, merit goods and optimal commodity taxation

Where there are externalities in production and lump-sum taxes are possible, the standard solution is to impose a Pigouvian tax (Pigou, 1920) to correct for the distortion. Such taxes would normally be differentiated between commodities and between consumers unless extreme conditions hold.[15]

For each private good creating an externality, each household should face a household specific tax equal to the marginal disecocomy inflicted on others, measured by the marginal willingness of the latter to pay to avoid an increase in the consumption of that good by the household. When lump-sum household specific taxes are not possible, the appropriate marginal tax is given by the sum of marginal willingness to pay weighted by β^h (the social marginal utility of income) plus any marginal gain/loss in government revenue associated with demand shifts that follow from a rise/fall in the consumption of the private good. In principle, the Pigouvian tax provides arguments for taxing certain commodities, which seem independent from the optimal tax rules derived earlier. However, strictly speaking, Pigouvian taxes depend on the actual level of the externality, which is itself dependent on the actual equilibrium attained and hence on optimal tax rates.[16]

Finally, the standard models of optimal commodity taxation presented above assume that individuals act in a way which maximises their welfare. In the case, however, of 'merits' (for example, education or preventive medicine) or 'demerits' (for example alcohol or tobacco), individuals might perceive incorrectly the value of such goods. Society might consider these goods of special interest or moral social value, or the opposite. This would call for treating them differently in the tax system, so as to encourage or discourage their consumption by individuals.

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[15] For example, if consumers are identical with each given the same weight in social welfare or if the externality is such that the marginal contribution of each individual to the total is identical, then uniform taxation across consumers would give the first-best result. See Myles (1995).

[16] For a recent analysis of the modifications introduced in optimal tax formulae in the presence of externalities, see Cremer *et al* (1998).

4. Optimal commodity taxation, administrative costs and evasion

Although profoundly important, the administrative costs and evasion possibilities of indirect tax rates have not yet been formally incorporated in the optimal commodity taxation theory. Perhaps the most notable exception is the work by Cremer and Gahvari (1993)[17] who derive optimal commodity tax formulae for a single-consumer competitive economy, where evasion of commodity taxes by firms is possible. Their results modify the Ramsey rule in two important aspects. First, expected rather than nominal taxes enter the optimal tax formula, the latter being a function of the nominal taxes, the detection rate and the punishment rate. Second, the optimal tax rate becomes an increasing function of the rate at which the expected tax rate increases relative to price as the nominal tax is raised. The authors prove that the traditional results on the desirability of «proportional reduction in compensated demands» or on the conditions for uniformity to be optimal (see sections B and C above) no longer hold. This approach, however, cannot easily be operationalised as it imposes heavy informational requirements, but it indicates an area where future research would be valuable given the administrative inefficiency of taxation in even developed countries.

F. The theory of commodity tax reform

Given the restrictive underlying assumptions of probably all detailed and practically relevant prescriptions of optimal taxation models, it is important to explore the position away from the optimum. Identifying desirable directions of tax reform might also be more important for a policy maker, since rarely do governments have the privilege to design a tax system from the beginning. Any given government at any given time is more likely to face an accretion of taxes accumulated over time, so that empirically robust and theoretically consistent suggestions on improvements over the status quo is probably all that a policy maker can reasonably expect. In what follows, the basic theory of marginal tax reform is examined. Non-marginal tax reform theory is also briefly analysed.

Building on the basic theory of optimal taxation described earlier, Ahmad and Stern

[17] Other less elaborate models have been produced by Usher (1986) and Kaplow (1990). Also, Ray (1998) has derived the optimal tax rules for a many-person economy, when evasion is possible.

(1984 and 1987) also developed an operational framework for calculating desirable welfare-improving directions of marginal tax reforms from a given status-quo, which need not be optimal. As before, we assume that the government maximises a social welfare function, *W*, of a Bergson-Samuelson type. Furthermore, we assume that production takes place under competitive conditions and constant returns to scale technology, so that an increase in the tax of a commodity, t_i, will raise its consumer price (q_i) by an equal amount leaving its producer price (p_i) unaffected. Suppose the government wishes to raise its revenue by one euro through the taxation of good *i*. An increase in the tax of good *i* raises revenue at a rate $\partial R / \partial t_i$, so that in order to raise an extra euro, we have to increase the tax by $\left(\partial R / \partial t_i\right)^{-1}$. Furthermore, there will be a response of social welfare to the tax change equal to $\partial W / \partial t_i$. For a tax increase the consumer will be worse off, hence there will be a decrease in social welfare. We define, the fall in social welfare, λ_i, as the reduction in social welfare, *W*, resulting from rising government revenue by one euro through the tax on *i*th good

$$\lambda_i = \frac{-\left(\partial W / \partial t_i\right)}{\left(\partial R / \partial t_i\right)}, \qquad R = \mathbf{t} \cdot \mathbf{X} \tag{3.24}$$

This expression can be interpreted as the marginal cost in terms of social welfare of raising one more euro of revenue from the *i*th tax. A tax reform $\Delta\mathbf{t}$ will be beneficial if it satisfies $\Delta W>0$ and $\Delta R\geq 0$, i.e. if it results in a rise in welfare without decreasing the collected tax revenue. The statistics λ_i are a useful guide in this regard, since they indicate directions of welfare improving tax reforms without any loss in revenue. Suppose, for example, that the marginal cost, λ_i, in terms of social welfare of an extra euro of revenue raised via the *i*th good exceeds that for the *j*th good. Then we can increase welfare by switching taxation on the margin from good *i* to good *j*, that is by decreasing taxes on the *i*th good by an amount sufficient to lose one euro and raising taxes on good *j* by an amount sufficient to gain one euro -the change in welfare would be $\lambda_i - \lambda_j$.[18] Notice that in the case where λs differ across commodities, it will in general be possible for the government to choose among a range of possible welfare improving marginal tax

[18] It should be stressed that, as Myles (1995) notes, «the requirement that goods with higher values of λ_i should have their taxes reduced is based on the assumption that the problem has sufficient regularity so that

reforms.

The theory of marginal tax reform and optimal commodity taxation are very close, considering that the optimum can be defined as a state of affairs where no beneficial reform can be identified. In the above framework, a tax system is said to be optimal if marginal social costs of taxes on all goods and services are identical, i.e. $\lambda_i = \lambda_j = \lambda$. This allows equation (3.24) to be transformed into:

$$\frac{\partial W}{\partial t_i} + \lambda \frac{\partial T}{\partial t_i} = 0 \tag{3.25}$$

Ahmad and Stern (1984 and 1987) have applied the above analytical framework to explore tax reform in India. They come up with simple measurable estimates of $\partial W / \partial t_i$ and $\partial R / \partial t_i$. Using again the indirect utility function and employing Roy's identity and the welfare weights β^h defined in section C above, we write:[19]

$$-\frac{\partial W}{\partial t_i} = \sum_h \beta^h x_i^h \tag{3.26}$$

while the change in revenue $\partial R / \partial t_i$ is given by

$$\frac{\partial R}{\partial t_i} = \frac{\partial}{\partial t_i}(\mathbf{t} \cdot \mathbf{X}) = X_i + \sum_k t_k \frac{\partial X_k}{\partial t_i} \tag{3.27}$$

Note that a change in one tax, t_i, will change revenue both through changing the revenue from good i and through changing the level of consumption of other goods. Replacing (3.26) and (3.27) into (3.24) we have

$$\lambda_i = \frac{\sum_h \beta^h x_i^h}{X_i + \sum_k t_k \left(\frac{\partial X_k}{\partial t_i} \right)} \tag{3.28}$$

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the direct effect of t_i on λ_i dominates the cross effects caused by the adjustment of other tax rates.»

[19] Note that the assumption of constant producer prices is crucial here, so that differentiation with respect to **q** and **t** are equivalent.

where t_k are taxes on final goods,[20] x_i^h are household demands, $X_i = \sum_h x_i^h$ is the total demand for good i and β^h are the welfare weights. A simple and useful reformulation of (3.28) is

$$\lambda_i = \frac{\sum_h \beta^h q_i x_i^h}{q_i X_i + \sum_k \left(\frac{t_k}{q_k}\right) q_k X_k \varepsilon_{ki}} = \frac{\sum_h \beta^h q_i x_i^h}{q_i X_i +} + \frac{\sum_h \beta^h q_i x_i^h}{\sum_k \left(\frac{t_k}{q_k}\right) q_k X_k \varepsilon_{ki}} \qquad (3.29)$$

where ε_{ki} is the uncompensated elasticity of good k with respect to the ith price. This is a particularly convenient form which facilitates calculation. $q_i x_i^h$ is simply the expenditure of household h on good i, β^h can be subjectively calculated and ε_{ki} are aggregate demand elasticities which can be estimated from a consumer demand study. Notice that the right hand side of equation (3.29) conveniently decomposes λ_i into two terms. The first term is the distributional characteristic, d_i, of the good and it incorporates all the distributional considerations. The conventional welfare assumption that β^h declines as income (or consumption) rises implies that the value of d_i will be higher, the lower the income elasticity of demand for good i is, i.e. d_i will be higher for a necessity than for a luxury. Thus, d_i essentially measures how concentrated consumption of good i is on the socially deserving (i.e. those with high marginal utility of income, β^h). The second term isolates the contribution of demand effects on λ_i and these effects are the only relevant ones if the equity objectives are disposed of.

One of the main advantages of marginal tax reform analysis is that it heavily relies on observable consumption patterns and tax systems, so that it is less dependent on arbitrary assumptions.[21] Nevertheless, it relies on the robust estimation of own- and cross-price elasticities of commodities and usually estimable demand systems based on either micro- or macrodata allow such estimation only for a very high level of commodity aggregation. Furthermore, it confines attention to commodity taxes, precluding the use of other tax/transfer instruments, which would potentially significantly alter any conclusions.

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[20] In developing countries where taxation of inputs and intermediate goods is common, t_k represents the effective tax on final goods.

[21] However, note that tax reform rules are not completely independent from assumptions on preferences, for instance additivity properties. Furthermore, under certain restrictive assumptions on preferences (linear Engel curves, additive separability and optimal benefit levels with compete coverage), tax reform rules suggest movements toward uniformity. For an illustration see Deaton (1987, page 97).

Furthermore, marginal tax reform analysis assumes fixed incomes, thus implicitly assuming separability between goods and leisure. Finally, it confines the analysis to small movements around the status quo ruling out the analysis of substantial changes. Despite the above limitations, marginal tax reform analysis is attractive since it is robust and has small informational requirements, relative to optimal tax theory rules. It has thus been quite extensively used in the empirical analysis of actual tax systems (see section G below).

In order to study non-marginal reforms in the indirect tax system, working with differentials of welfare and revenue is not sufficient. Welfare and revenue before and after the tax reform have to be compared. As before, a desirable tax reform would be one that would raise welfare without decreasing tax revenue (denoting W^1, W^0 *a*nd R^1, R^0 the post- and prereform social welfare and revenue, the condition would be $W^1 > W^0$ and $R^1 \geq R^0$). Direct reference to the social welfare function, *W*, can be dropped with the use of the individual indirect utility function before and after the reform, V^{h0} and V^{h1}, so that the difference between the two utility levels ($V^{h1} - V^{h0}$) serves as an indicator of who gains and who looses. This difference can be expressed in money terms using the notion of equivalent variation E_{01}^h, defined for a change in prices holding income constant. More specifically E_{01}^h is defined as the amount of money that would need to be given to household *h*, if the pre-reform prices were ruling, to allow it to reach the post-reform utility level. Formally,

$$V^{h1} = V^h(\mathbf{q}^0, M^{h0} + E_{01}^h) \tag{3.30}$$

where M^{h0} is the pre-reform income of household *h*. Using the expenditure function $e^h(\mathbf{q}, U^h)$, E_{01}^h is defined explicitly as:

$$E_{01}^h = e^h(\mathbf{q}^0, V^{h1}) - M^{h0} \tag{3.31}$$

E_{01}^h is a money measure of the benefit/loss of the reform to household *h* and is positive for a utility increase and negative for a utility decrease. More detailed analysis of the theory and its practical implementation are given in Ahmad and Stern (1987) and is not further developed here. It is clear, however, that now we need a full specification of the indirect

utility function and the related demand function so as to be able to calculate new revenue and welfare levels. Also the form of (3.31) will depend on the utility and demand system employed.

A similar more general approach is developed in King (1983) for evaluating tax reforms based on microdata. This is summarised as follows. King again tries to find a method for comparing the levels of a household's welfare when it faces different consumption possibility sets. Suppose that a household faces a given budget constraint, (**q**, *M*). 'Equivalent income', M_E, can then be defined as the level of income which at a reference price vector, affords the same level of utility as can be attained under the given budget constraint. Formally,

$$v(\mathbf{q}^r, M_E) = v(\mathbf{q}, M) \tag{3.32}$$

In terms of the expenditure function, M_E can be written in terms of the expenditure function, as

$$M_E = e(\mathbf{q}^r, v) \qquad \text{or} \qquad M_E = f(\mathbf{q}^r, \mathbf{q}, M) \tag{3.33}$$

It turns out that a convenient measure of the value of a reform can be given by the equivalent gain, which is the change in equivalent income choosing as a reference price vector the pre-reform prices. The equivalent gain, EG_h, can be evaluated for each household and is given by

$$EG_h = f(\mathbf{q}_h^0, \mathbf{q}_h^1, M^{h1}) - f(\mathbf{q}_h^0, \mathbf{q}_h^0, M^{h0}) = f(\mathbf{q}_h^0, \mathbf{q}_h^1, M^{h1}) - M^{h0} \tag{3.34}$$

As King (1983) notes, "the distributional impact of the reform is measured by the distribution of equivalent gains, and the efficiency gain to the economy as a whole by the mean equivalent gain". Notice that when there is no change in household income, the equivalent gain and equivalent variation measures are the same. King (1983) also calculates a measure of the 'social value' of a reform. In this case, an explicit social welfare function must be defined.

Finally, in another strand in the literature of indirect tax reform, some authors have proposed the marginal dominance approach, see Yitzhaki and Thirsk (1990), Yitzhaki and Slemrod (1991) and Mayshar and Yitzhaki (1995), for an application see Gastaldi and

Liberati (1998). The main advantage of the approach lies in that it requires only an ordinal ranking of households and not a cardinal measure of how deserving they are, thus overcoming the need for a specification of a social welfare function, whose exact properties are note likely to be known. Once a social ranking of households is agreed on, directions of tax reform are identified by comparing shifted concentration curves of commodities[22] and applying the marginal conditional stochastic dominance rules, see Yitzhaki and Slemrod (1991), or alternatively by observing cumulative gains and losses evaluated at initial consumption bundles and solving an optimisation problem, see Mayshar and Yitzhaki (1995). However, compared with approaches which impose a more stringent structure on the social welfare function, this approach is more liable to come up with an empty set of reform directions, especially when more and finer commodity groups are considered. This constitutes the main shortcoming of the marginal dominance approach.

G. Empirical studies

Empirical studies on optimal commodity taxation are not very common, perhaps because the informational requirements needed cannot easily be met without restrictions on preferences that prejudge the results. The most important relevant studies are by Atkinson and Stiglitz (1972), Deaton (1977), Ray (1986a), Murty and Ray (1987), Kaiser and Spahn (1989) and Ebrahimi and Heady (1988). Despite several methodological differences, the common feature of all but the last of these studies is that they adopt a narrow view of the tax system concentrating on indirect taxation alone. With the exception of Ray (1986a) and Murty and Ray (1987), who refer to India, where due to institutional and political constraints indirect taxation might indeed be considered the only relatively effective tax policy instrument available, this feature is unrealistic and, as explained in section D, should be viewed with great caution, unless the aim is purely illustrative. Nevertheless, these studies comprise important contributions in understanding the structure of the arguments when the Ramsey (1927) and Diamond and Mirrlees (1971) theoretical conclusions are applied to actual data.

[22] The normal concentration curves are shifted so as to incorporate the marginal efficiency cost of taxing a commodity.

Atkinson and Stiglitz (1972) calculate the optimal commodity tax rates satisfying the Ramsey rule for a single household economy, so that equity considerations are precluded from the analysis. The direct addilog demand system is used to calculate optimal tax rates for Sweden, Canada and the OECD. Parameters and data are taken from Houthakker (1960). Also, the linear expenditure system estimated by Stone (1954) is used for the UK. In order to avoid further complications arising from the estimation of the labour supply function, additive separability in labour supply is assumed and labour supply is completely elastic. Their results support the interpretation of the Ramsey rule: sole efficiency considerations lead to the high taxation of necessities, like food and rent, and the low taxation of luxuries, like durable goods. Furthermore, the optimal indirect tax system is, as expected from the theory, non-uniform. Note that the non-uniformity of optimal tax rates, despite the use of the highly deterministic linear expenditure system, see Atkinson (1977) and section D above, arises mainly because no other tax/transfer instrument, for example a uniform lump-sum grant set optimally, is assumed to be available.[23]

Deaton (1977) also presents numerical results for optimal tax rates, trying to incorporate efficiency and equity considerations in the tax design. He identifies the information difficulties in the empirical estimation of optimal tax rules of the kind presented in Diamond and Mirrlees (1971a and b). Therefore, he makes certain aggregation assumptions concerning individuals in order to facilitate the empirical analysis, so that his results are somewhere between the single-household and the true many-household economy. Assuming exogenous labour supply and linear Engel curves and ruling out income taxation and lump-sum transfers, the main conclusion of the analysis is that in general optimal tax rates move further from uniformity as equity considerations become more important. This is not surprising, considering that if equity considerations are ruled out, the problem collapses to the single-consumer case, where exogenous (and therefore completely inelastic) labour supply leads to the trivial result of a uniform commodity tax.

Ray (1986a) provides another study of optimal commodity tax calculations, on a nine commodity disaggregation level based on Indian data. The study serves to illustrate the sensitivity of optimal commodity tax rates to alternative demand functional forms, a point ignored until then in the empirical literature. Again, commodity taxes are considered

[23] The fact the results of this study are largely a consequence of the underlying assumptions is also argued in Fukushima and Hatta (1989).

in isolation, independent of the existence of other tax/transfer instruments. Ray solves the many-person Ramsey first-order conditions as a set of simultaneous equations, with the 'optimal' commodity tax rates being the unknown, estimable parameters. This is done using alternative sets of price-expenditure elasticities obtained from the Linear Expenditure System (LES), which assumes additive separability and linear Engel curves, and its one-parameter generalisation, the Restricted Non-Linear Preferences System (RNLPS), which allows non-linear Engel curves and non-separable preferences. In the absence of labour supply data, the simplifying assumption of weak separability between goods and leisure is maintained. Demand parameters are calculated from a time series of cross-section household budget survey data for India, while tax data and therefore optimal tax calculations refer to 1973-4. Finally, the social valuation of income to each household is based on an additive individualistic social welfare function of the kind proposed by Atkinson (1970). The findings suggest that «the empirical results confirm the extreme sensitivity of the calculated tax rates to the estimated demand specification; in many cases the tax rates differ not only in absolute magnitude but, more crucially, in sign as well. ... The 'optimal' commodity tax rates generally seem to agree at low levels of 'inequality aversion', but fairly substantial differences open up at high, i.e. 'Rawlsian', levels». Thus, Ray's (1986a) findings are rather disappointing regarding the possibility to estimate robust 'optimal' commodity tax rates.

In another paper also referring to Indian data, Murty and Ray (1987) examine the sensitivity of 'optimal' commodity tax rates to the deviation from the leisure/goods separability assumption and to variation in the wage-rate parameter. In the absence of labour supply data, the authors use a priori values about the leisure preference parameters and the wage rate and check their impact on commodity tax rates. The results indicate that 'optimal' indirect taxes are extremely sensitive to deviation from leisure/goods separability and furthermore move to reverse directions as the parameter in the indirect utility function allowing for non-separability, is assigned different values. This indicates that optimal tax calculations which assume separability between goods and leisure should be treated with great caution, especially if their aim is not purely illustrative.[24]

[24] One should also mention that there are a number of studies for India regarding the scope for redistribution through indirect taxation that can be achieved, see Sah (1983), Ray (1986b) and Srinivasan (1989). Interest in this area can be justified in terms of the extraordinarily high proportions of revenue raised via indirect taxes in this country. The common conclusion of these studies seems to be that the scope for significant redistribution through the indirect tax system is rather limited, while administrative or political reasons have not yet allowed to exhaust the existing limited potential.

Kaiser and Spahn (1989) calculate for Germany optimal tax formulae following the Ramsey rule and also the extended Diamond and Mirrlees (1971) many-person Ramsey rule, following the methodology of Ray (1986a). They also evaluate the efficiency gains of the calculated optimal tax systems against the actual tax system by means of the Hicksian equivalent variation. They, thus, identify alternative indirect tax structures, which either reduce the income regressivity of the indirect tax system without increasing the efficiency loss or reduce the efficiency loss without increasing the regressivity impact of the system. Finally, the authors identify directions of marginal tax reform, following the Ahmad and Stern (1984) methodology. Their empirical analysis, however, especially as regards the optimal tax calculations is largely restricted by their use of the additively separable Linear Expenditure System. The use of this demand system is largely imposed by the availability of only one year's Family Expenditure Survey data. Finally, their results should be viewed with caution for the additional reason that the well-identified problem of zero-expenditures was dealt with the elimination from the calculations of all households which recorded zero expenditures.

Perhaps the most important contribution among the empirical studies on optimal commodity taxation is the study by Ebrahimi and Heady (1988), who have developed and applied Deaton and Stern's (1986) theoretical analysis. In this study several real world features are modelled, for example non-uniform preferences, non-separability of goods and leisure and the ability to set optimum uniform or demographic specific lump sum payments. The effect of each of these features on optimal tax rates is explored. They use UK Family Expenditure Survey data and their sample consists of two-adult families with varying number of children. They then calculate optimal tax rates for four broad commodity groups under different scenarios about the separability of labour and the possibility of setting optimal child benefits, also allowing for a lump sum payment independent of demographics. Their results confirm the Deaton and Stern (1986) result that weak separability and the optimality of the child benefit lead to uniform indirect taxation,[25] while non-uniformity arises as the optimum if either non-separability is allowed or the child benefit is not set optimally.

Perhaps the most interesting result of the Ebrahimi and Heady (1988) study is that

[25] In fact, the results indicate an insignificant departure from uniformity, which can be easily justified, because there are two of Deaton and Stern's (1986) theoretical requirements that have not been met (i.e. same slope for Engel curves for all households and the possibility to vary the child benefit with the number of children).

imposing uniformity in the cases of non-separability or non optimality of benefits produces a welfare loss equivalent to at most 0.3% of GNP for even almost Rawlsian levels of inequality aversion (ε=6). This is true even when optimal tax rates are appreciably non-uniform. Results do not significantly change when demogrants are not available. This is an important finding suggesting that even when information for the calculation of optimal commodity tax rates is available and the policy maker knows what these rates are, the benefit in terms of social welfare of actually imposing them might not be so large. If furthermore one considers the implementation and administration costs of a highly differentiated tax structure, as well as the resources wasted in lobbying efforts to reclassify commodities, the evidence provided by the Ebrahimi and Heady paper is even more relevant. The argument that the optimal tax structure, even when know, might be too administratively and politically costly to impose is also set forth by Davies and Kay (1985), in a study reviewed later in this section.

It should be stressed that the rule in the above empirical studies on 'optimal' commodity tax calculations is that estimated tax rates are not fully optimal in the sense that they are strictly conditional upon the particular configuration of prices and expenditure levels observed at a particular time.[26] Consumer prices and expenditure levels are taken as given and the authors actually find out what the tax component in the consumer price would have to be in order to be described as an optimum. As Ray (1986a, p.256) correctly points out «for taxes to be strictly interpreted as optimal, the calculations must allow for the dependence of expenditure levels on taxes via a simulation algorithm which *simultaneously* arrives at the optimal value of these variables». The same point is made by Srinivasan (1989). Harris and MacKinnon (1978) and Murty and Ray (1989) have developed computational procedures based on algorithms which converge to the optimum taking account of the underlying interdependencies. Harris and MacKinnon (1978) present the results of some simulation experiments and Murty and Ray (1989) present some results for India. However, such computational procedures do not yet appear to have been applied to other empirical data.

In view of the methodological and practical difficulties of estimating optimal indirect taxes, there has been a substantial literature on evaluating positions away from the optimum and on the estimation of directions of marginal tax reform in the Ahmad and

[26] Note that Ebrahimi and Heady (1988) are an exception to this rule, since their results are based on an algorithm for finding the fixed point of a mapping, described in Heady and Mitra (1980).

Stern (1984) tradition. This paper, as well as subsequent studies applying this theory, consider the indirect tax system independent of other parts of the tax or transfer system. Thus, results are conditioned on commodity taxes being the only tool available to the government to balance its efficiency and equity considerations, which from a theoretical perspective will tend to have contradicting influences on tax rates. For reasons explained before, restricting attention to indirect taxation is justified in the cases of developing countries like India. Thus, the analysis of Ahmad and Stern (1984) and Hossain (1995) are more relevant from a policy perspective. Note that again, if a broader view of tax instruments is adopted results might change drastically and the marginal tax reform exercise takes on a very specific form. Empirical studies on non-marginal tax reform, like Ahmad and Stern (1987), Hossain (1995), Nikolaou (1989) and Labeaga and Lopez (1994) are subject to similar limitations. In addition, studies on non-marginal tax reform need a full specification of the indirect utility and the related demand function.

Ahmad and Stern (1984) apply the theory on tax reform, which they develop in the same article, to the Indian indirect tax system. Apart from identifying directions of welfare improving marginal tax reform, they provide and apply a strategy for solving the inverse optimum problem, that is computing the set of social welfare weights for which the existing tax system would be optimal,[27] and also the problem of Pareto improvements, that is of the possibility of a reform that leaves no one worse off and at least one better off. They use tax data for 1979/80 and the 1973/4 consumer expenditure survey, which is adjusted for compatibility with 1979/80 aggregates. The use of external aggregate demand elasticity estimates from Radhakrishna and Murty (1981) constrains commodity aggregation to nine groups. Social marginal costs are calculated and are found to be unequal among commodities regardless of the inequality aversion parameter employed. The ranking of commodities in terms of λ_i changes drastically with the level of inequality aversion. The authors then take the revenue requirement as given and solve the inverse

[27] Christiansen and Jansen (1978) deal exclusively with the inverse optimum problem and follow an alternative approach. They provide a methodology to assess the implicit social preferences reflected in an existing indirect tax system, which in the empirical analysis is the Norwegian one. This is done in terms of estimating the value of the inequality aversion parameter corresponding to a predefined form of a social welfare function such that the prevailing indirect system is identified as the optimal one. The design of taxes also takes into account externality effects for four out of fifteen commodity groups. The obtained value of the inequality aversion parameter is quite high (1.706) when externality effects are ignored and is less than 1 (0.88), if these effects are accounted for, suggesting that the Norwegian government behaves as if it were maximising a social welfare function which is close to a log-linear function of income.

optimum problem.[28] Obtained social welfare weights attain some negative values even for very low income groups. This indicates that Pareto-improving reforms are possible. Ahmad and Stern (1984) use linear programming to identify two such reforms (note that marginal analysis constrains the effect of tax changes on revenue to be smaller than one rupee for each good). Indeed, as a result of these marginal tax reforms welfare levels either increase or stay the same for the income groups. Results are not independent from the commodity and household aggregation level and from the aggregate demand elasticities, but the authors argue quite convincingly that the sensitivity of results to parameter estimates and model specification is much smaller for marginal analysis than for optimum taxation problems or problems of identifying directions of non-marginal tax reform.[29]

The Ahmad and Stern (1984) paper has provided the general framework for empirical analysis of marginal tax reform for other countries as well. An analysis of the social marginal cost and the identification of welfare-improving directions of tax reform is given by Decoster and Schokkaert (1989). The authors use Belgian data with a twelve commodity breakdown. They also calculate an alternative form of marginal social costs which includes a component reflecting merit good effects (that is when social welfare increases or decreases by one franc of an additional consumption of a commodity). The evaluation of these effects is based on the solution of the inverse optimum problem and the inference of the implicit value judgements embodied in the present tax structure (the method is described by Christiansen and Jansen, 1978). The authors conclude that the Belgian indirect tax system is not optimum for any value of the inequality aversion parameter, since the marginal social costs vary greatly across commodities. It turns out that the system could be improved by lowering the tax on tobacco and heating and increasing taxes on durables, housing and services.

Madden in a series of progressively more refined papers calculates directions for marginal tax reform for Ireland (Madden, 1989, 1995 and 1997). Madden (1989) attempts to evaluate the prevailing indirect tax system and to identify directions of marginal reform. He uses an 11 commodity classification and the analysis is based on microdata and

[28] Note that the solution of the inverse optimum requires equal number of commodity and household groups. Thus, households are grouped into nine commodity bands.

[29] Ahmad and Stern (1991) applied the same analytical framework to describe and evaluate the system of indirect taxes in Pakistan. Their book also explores in detail the ways in which the theory of marginal tax reform can be adapted for the case of developing countries (effective taxes, the use of shadow prices etc.).

external estimates of price elasticities calculated from National Accounts data. Marginal social costs are found to vary across commodities indicating the non-optimality of the indirect tax system and the scope for welfare-improving reforms. Furthermore, in an inverse optimum exercise, the social welfare weights consistent with the existing tax vector are calculated and are found to be negative for several even low income groups. This implies that Pareto improvements are possible. Linear programming is carried out identifying the direction of possible reforms. Results seem to be rather sensitive to the set of elasticity estimates used (restricted or unrestricted elasticities).

Madden (1995) extends the Ahmad and Stern (1984) marginal tax reform model to include labour supply and applies it to Irish data. Such extension is useful both because it allows the calculation of the marginal welfare cost of raising one unit of revenue via direct taxation and because it dispenses with the much debated weak separability assumption between goods and leisure, implicit under the fixed incomes assumption of Ahmad and Stern's model. Madden (1995) estimates a jointly determined commodity demand - labour supply model based on 1987 Household Budget Survey data and using elasticities estimated from 1958-1988 National Accounts data.[30] Perhaps the most significant finding of this paper is that the rankings of goods (10 categories) by marginal revenue cost (the reciprocal of λ_i), and subsequently tax reform recommendations, do not appear to be very sensitive to assumptions regarding separability between goods and leisure.

Madden (1997) again explores the sensitivity of marginal tax reform recommendations to the relaxation of the separability assumption, this time in an alternative way. Instead of estimating a jointly determined goods and leisure (labour) model, the approach involves the estimation of commodity demands which are conditional on the quantity of leisure being consumed, while the latter is assumed to be fixed. The functional form of the consumer demand model follows the flexible AIDS, there are two alternative conditioning variables (aggregate employment and the employment rate) and the estimation is based on aggregate time series National Accounts data for 1959-1988 for a ten good classification. Again, the inclusion of conditioning variables has relatively little impact on tax reform proposals, but results appear to be sensitive to the choice of the conditioning variable.

Cragg (1991) is another example of applied analysis of indirect taxation. The

[30] The functional form of the estimated equations is an augmented function of the LES, allowing for non-separability.

author, using Canadian microdata for 1978, first identifies the degree of inequality aversion implicit in government preferences (as reflected in the indirect tax system) by solving the inverse optimum problem. The estimated inequality aversion parameters are not significantly different from zero suggesting that social welfare weights are 1 for all individuals and that the derivative of social welfare with respect to indirect utility is increasing with income. The results are robust to the functional form of the social welfare function. The author then calculates the social marginal costs of 10 commodity groups and finds that if the government had more egalitarian views, it would find it desirable to lower taxes on alcohol, food, fuel, gas and reading materials and increase taxes on recreation, electricity, tobacco and communication. Apparently, externality effects which are not considered here would critically affect the results concerning alcohol taxation, since alcohol produces significant negative externalities regarding for example road accident rates.

Another interesting application of the marginal tax reform theory is provided by Irvine and Sims (1993), who study the effects of alcohol taxation in Ontario, Canada. They employ the methodology of comparing the social marginal costs of different commodities developed by Ahmad and Stern (1984), in order to identify welfare improving directions of reform. The novelty of this study is the explicit modelling of the externality connected with alcohol consumption. The implicit specific charge correcting for the externality is an increasing function of the alcohol content of the beverage. Thus, it is only the change in tax revenue in excess of the corrective amount that enters the computations. Marginal social costs of 19 alcoholic beverages are reported for different values of the externality corrective charge, on which results seem to be heavily dependent. The analysis abstains from any distributional considerations, due to data limitations. Still, the authors conclude that the existing system of taxation of alcoholic beverages in Ontario caries with it great inefficiencies and there exist equal-revenue reforms that would increase welfare.

Ahmad and Stern (1987) also use the method developed in section F to evaluate non-marginal reforms in indirect taxation in India for the year 1979-80. They consider two revenue neutral reforms; first, the replacement of existing taxes and subsidies with a uniform proportional VAT on all commodities and the replacement of existing taxes and subsidies with a proportional VAT on all commodities except cereals which are zero-rated. They examine the distribution of measure of the equivalent variation for 14 income groups

in the rural and 14 income groups in the urban sector based on the Stone-Geary utility function, for which estimates are taken from Radhakrishna and Murty (1981). Both reforms considered lead to greater losses for poorer households and thus do not qualify if distributional considerations are at all important. Perhaps not surprisingly, the selective VAT system is to be preferred to the proportional one and is also more beneficial to the rural population.

Hossain (1995) also uses the Ahmad and Stern (1987) method to evaluate non-marginal revenue-neutral indirect tax reforms for Bangladesh, involving the introduction of two VAT schemes. In the first scheme, all existing taxes are replaced by a uniform (proportional) VAT on all goods. In the second, existing taxes are replaced by a VAT applicable to a subset of goods with zero-rating for some other goods and the imposition of supplementary excises for some VAT-bearing goods. The choice of the commodities which are zero-rated or bear excises is guided by equity considerations and is based on the calculation by the author of the distributional characteristics of 15 commodity groups (agricultural products are chosen for zero-rating and tobacco, commercial energy and sugar are chosen to bear excises in addition to VAT). Measures of equivalent variations, based on the linear expenditure system, are calculated for 6 urban and 6 rural expenditure groups under the two reform packages. The results are in agreement with Ahmad and Stern's (1987) findings for India. The selective VAT system is clearly preferable to a completely uniform VAT system if distributional considerations matter. Still, the selective VAT system benefits richer households and adversely affects poorer groups.

Nikolaou (1989) applies King's (1983) methodology to assess the distributional and efficiency effects of harmonisation of tobacco and alcohol taxes to the EEC proposed levels. Such harmonisation in the case of Greece would imply huge price increases especially in the case of alcohol. In order to have a revenue neutral reform, the additional revenue generated is distributed as a lump sum percentage of total consumption. Behavioural responses are modelled by the parameters of the AIDS system, estimated for four commodity groups (food, alcohol, tobacco and others) from the data of four Family Expenditure Surveys at very different dates. The effects of the reform on the expenditure distribution slightly increased inequality for rather general levels of inequality aversion. The efficiency gain of the reform is measured by the mean value of the equivalent gain per household and is found positive. Nikolaou's (1989) contribution is hard to evaluate since the way of distributing extra revenue (in proportion to total consumption), is not

straightforward from a theoretical perspective.

Labeaga and Lopez (1994) investigate the welfare effects of the 1992 reform of the Spanish indirect tax system using the equivalent income approach of King (1983). They, however, base their analysis on the LES and therefore are forced to impose additive separability. They themselves recognise the restrictions in the results arising from this choice and suggest that their results should be viewed with caution. They use 4 consecutive FES data, which nevertheless prove inadequate to provide sufficient price variability for the estimation of more flexible functional demand forms. They thus stress the value of demographic effects which are indeed well documented in the LES. The tax reform they study is a real one and not revenue neutral. The vast majority of households seem to loose from the reform. These results do have some tentative value, though the restrictions regarding the description of preferences, the exclusion of excises and the consideration of only non-durables limit its policy relevance.[31]

There are also a number of empirical studies (Newbery, 1995a, Nichele and Robin, 1995, Davies and Kay, 1985 and Adams, 1980) which address particular issues of indirect tax policy without comprising direct applications of the methodology of the theoretical models described above.

The distributional impact of real relative price changes in Hungary (a former Soviet-type economy in transition) and the UK is studied in Newbery (1995a). The author uses the distributional characteristics of goods at a fine level of commodity aggregation to compare the distribution of commodities and underlying inequality levels in the two countries. He also builds on the theory of commodity tax reform to derive a measure of the impact of relative price changes resulting from tax reforms. Although tax reforms were much more radical in Hungary, the resulting distributional impacts over the last two decades seem to be negligible for both countries, while consumption goods seem to be still distributed considerably more equally in Hungary (even during the transition period) than the UK. As mentioned before, the data set used is detailed household microdata for Hungary and the UK.

Nich☺le and Robin (1995) study indirect tax reform for France in an attempt to evaluate EC proposals on VAT harmonisation and a carbon tax which aims at decreasing

[31] Baccouche and Laisney (1989) also apply King's (1983) methodology to evaluate the welfare effects of six alternative tax reform scenarios in France. The availability of one year cross-section data makes the employment of the LES almost unavoidable. Thus the results are largely determined by the implicit assumptions of linear Engel curves, direct additivity and labour separability.

carbon dioxide emissions. They are not directly concerned with the results of optimal indirect tax theory or the theory of marginal tax reform. Furthermore, there are no adequate data for the estimation of a complete demand system at an individual or household level. However, by making use of the aggregation properties of the Almost Ideal Demand System (Deaton and Muellbauer, 1980b) they suggest an interesting methodological approach for the robust estimation of income and price responses from pooled micro (Family Expenditure Survey) and macro (National Accounts) data. Subsequently, they use these responses to calculate the impact of the various tax reforms on household expenditure shares so as to evaluate the post-reform levels of expenditure, consumption, tax payments and government revenue. VAT harmonisation is found to lead to a decrease in government revenue, while the implementation of a carbon tax increases government receipts. However, both reforms seem to have adverse distributional effects, so that such proposals would be socially inequitable unless accompanied by additional social measures. Note that this study concentrates on the distribution of tax payments and not the efficiency or the overall assessment of the indirect tax system.

Davis and Kay (1985) criticise the zero-rating or exemption of distributionally sensitive commodities from the VAT base in the UK. Focusing mainly on distributional considerations, they conduct a simulation experiment based on 1982 Family Expenditure survey data and show that the regressive impact of an extension of the VAT base to currently exempted and zero-rated items can be more than offset by accompanying measures in income taxation and social security benefits. The authors argue that such reform would also have enormous administrative merits and political advantages in terms of avoiding rent-seeking activities. In this sense, even if the optimal indirect tax problem could be solved and optimal tax rates for every distinguishable commodities were known for each commodity, it would be administratively and politically too costly to implement such a tax system. The importance of the study lies in that it successfully demonstrates on the basis of reliable microdata that direct transfers and taxes are much more effective tools for redistributing income compared to indirect taxation. This comes to support the relevant theoretical literature, for example Deaton and Stern (1986). Thus, as far as redistribution is concerned, it seems reasonable to argue that any redistributive goals the government might have might be better served through the transfer system, provided that the latter is well-targeted.

Adams (1980) adopts a quantitative statistical method for evaluating the

distributional effects of VAT in Ireland, the UK, Belgium and Germany. He does not explicitly use optimal taxation theory (his analysis is based exclusively on tax payments as a function of expenditure and income) and discusses only the distributive effects of the VAT systems. He finds that VAT is progressive in the UK, Ireland and Belgium and concludes that on the grounds of equity a multi-rate VAT should be favoured. Using the income base produces substantially less equitable results and this is to be expected, since savings are an increasing function of income.

Finally, when referring to what is considered to be best practice in the field of empirical applications in indirect taxation, one has to mention the existence of a relatively large number of microsimulation models on taxation, some of which are specialised to indirect taxation. Perhaps the most well known ones are the SPIT Programme of the Institute for Fiscal Studies in the UK, see Symons and Walker (1988a) and the ASTER programme for Belgium, see Decoster *et al* (1996a). SPIT is a simulation programme based on microdata drawn from seventeen years of the UK Family Expenditure Survey. It is designed to predict and analyse the revenue and distributional consequences of changes to the levels and structure of indirect taxation. Much of its analytical rigor lies in the exploitation of the richness of the available microdata to estimate a complete demand system, where household expenditure levels depend on a range of expenditure, price and demographic variables. It has subsequently been used in a large number of studies on indirect taxation, see for example Lee *et al* (1988), Pearson and Smith (1990), Symons and Walker (1988b). Such studies provide valuable insights in public policy analysis and gain increasing interest for both the policy makers and the public.

ASTER is a simulation programme similar in structure with SPIT, where the user can define an indirect tax reform and the programme simulates the new expenditure patterns and tax payments for each household and examines the revenue and distributional consequences of the tax change. The demand specification follows the Quadratic Almost Ideal Demand System (QUAIDS) and demand parameters are mostly based on macrodata, since there is no long series of Family Expenditure Survey microdata available. In ASTER the distributional consequences of tax reforms can be analysed for different concepts of welfare, equivalence scales, aggregation level and so on.

Broader microsimulation programmes modelling, apart from indirect taxation, other parts of the tax and transfer system are available in many countries, for a survey see Sutherland (1995a). These models have proved very useful in the empirical analysis of tax

reforms. Just to mention an example, Heady and Smith (1995) assess the distributional effects and resulting marginal tax rates of several reforms including direct, indirect taxation and social benefits in the Czech and Slovak Republics based on the CZ microsimulation model of Coulter *et al* (1997).

H. Policy relevance of the theory of optimal commodity taxation

The basic theory of optimal commodity taxation, as surveyed above, establishes several important results and offers some principles which can be useful for policy makers. The question, however, remains as to the extent to which the theoretical suggestion of optimal commodity taxation can be transformed into an operational framework for designing an indirect tax system and setting tax rates.

Optimal commodity rules do not in general give an explicit statement of the optimal structure of taxes. Operationalisation of such rules requires complete information relating to own and cross price elasticities for all goods and unconstrained tax power of the government, neither of which is achievable in practice. Simpler practically relevant prescriptions of optimal tax rates can be obtained only at the expense of additional assumptions on the structure of preferences, the ways in which the population is allowed to differ, the existence and optimality of other tax and transfer instruments and so on. However, the simplifying assumptions which underlie simple tax rules, for example the absence of cross-price effects, linear Engel curves, identical preferences, are either evidently unrealistic and made for convenience or, when actually tested, tend to be rejected by real world data.[32] Furthermore, it is not easy to determine how an obvious divergence of the world from these conditions would influence the results on the optimal structure of indirect taxes and the balance between different tax instruments.

This has led some authors, for example Deaton (1987), to express some degree of pessimism concerning the possibility to calculate optimal commodity tax rates on the basis of observed data. Simplifying assumptions made for convenience and in absence of sufficient data can prejudge the results. Classic is the example of Atkinson (1977), who

[32] For example, the crucial assumption of weak separability between goods and leisure has been rejected for a number of countries, see Barnett (1979) for the US, Blundell and Walker (1982) and Browning and Meghir (1991) for the UK, Murphy and Thom (1986) for Ireland.

showed that given a linear income structure and a linear expenditure system with separability between goods and labour, uniform commodity taxation under certain conditions is optimal irrespective of parameter estimates. As Atkinson and Stiglitz (1980) and Deaton (1979) point out, the case for differentiating indirect taxes depends on second- and higher-order derivatives of the demand functions. The functional forms of demand typically assumed (or the ones that could be estimated using one year cross section data available, for example linear Engel curves) impose strong restrictions on those derivatives, thus pre-determining the results.

Upon reflection it would seem possible to avoid this problem by employing sufficiently general demand systems when plentiful appropriate data are available. However, even in this case, Deaton (1987) argues that estimation of optimal commodity taxes requires knowledge of the derivatives of demand functions (price and income responses) over a large range and not simply the current position or anything previously observed. He concludes that we can not hope to achieve such global knowledge of preferences, and, thus, optimal tax calculation is inherently problematic.[33]

Furthermore, even if precise and robust estimation of the optimal tax rate for every distinguishable commodity were theoretically possible, its practical implementation would be administratively and politically too costly to impose. The outcome would not be a rate structure which reflects a nicely calculated balance of equity and efficiency considerations, but a structure immensely expensive to administer and open to the rent-seeking power of different consumer and producer lobbies. This point is directly made by Davies and Kay (1985), who on this ground argue for an even simpler VAT structure for the UK and also by Ebrahimi and Heady (1988), who estimate the social welfare benefit of applying the 'optimal' tax structure to be an almost negligible percentage of GNP.[34]

Other authors, like Stern (1987a) appear to be more optimistic. He argues that even though it is hardly feasible to robustly estimate preference systems, we should not ignore available information about the relationship between consumption of goods and other household characteristics. Perhaps the most fruitful and confident direction of research exploiting such information is marginal tax reform in the Ahmad and Stern (1984) tradition, which can be addressed based on knowledge only of the current position and

[33] Deaton's view is supported by theoretical (Deaton, 1981) and empirical (Ray, 1986a) studies, which illustrate the extreme sensitivity of optimal tax calculations to goods-leisure separability specification and the employment of different functional forms representing consumer demand.
[34] A similar point is argued also by Fukushima (1991).

aggregate derivatives of demand functions, avoiding many of the problems referred above. It has several limitations regarding marginality, restricted view on tax instruments and so on, see section F above. However, it is a theoretically consistent exercise, which evaluates actual tax systems balancing equity and efficiency considerations. The informational requirements are reasonable (basically, household budget survey data, aggregate price responses and a method for subjectively calculating household welfare weights). Furthermore, results appear to be rather insensitive to the choice of consumer demand systems, see Decoster and Schokkaert (1990) and Madden (1996).[35]

References

(TO BE ADDED)

[35] Madden (1996) calculates directions of marginal tax reform for 11 demand specifications involving different demand systems and several versions of these systems. He finds that the results are not affected by the choice of the demand system, but they are more sensitive to dynamic specification. Madden bases his results on N.A. data and incorporated time trends. This is not possible in our case especially since the demand estimates used here are exogenous.

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