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Zusammenfassung/ Abstract

This paper considers optimal linear tax structures that are differentiated according to group membership. Groups can be heterogeneous with respect to both preferences and abilities. Contrary to most arguments in favour of tax privileges for certain groups, e.g. gender-based taxation, it is shown that consideration of the first moment of the relevant distributions (the average labour supply elasticity of the groups) is insufficient. We discuss the factors on which efficient differentiation would depend.

JEL-Klassifikation / JEL-Classification: H21; D31

Schlagworte / Keywords: optimal linear income taxation; preference heterogeneity; gender-based taxation; horizontal equity

1 Introduction

Since Ramsey's (1927) seminal contribution, behavioural elasticities take centre stage in what is now a vast literature on optimal taxation. One part of this literature focuses especially on optimal tax discrimination *between groups*. Recent examples include an argument by Alesina, Ichino and Karababournis (2011) that females ought to be taxed more lightly through the income tax than males because their *average* elasticity of labour supply is demonstrably lower.

While the early optimal tax literature typically assumed homogenous agents, there is now also an increasing interest in allowing for heterogeneous individuals. Brander and Spencer (1985) already provided a formal model to discuss the impact on the Ramsey rule of introducing heterogeneous groups of customers. Sandmo (1993) analyses the case where redistribution arises as a result of heterogenous preferences for leisure time although individuals face equal budget constraints. More recently, Lockwood and Weinzierl (2012) allow for a two-dimensional heterogeneity, i.e. for differences in productivity as well as taste, finding that this would under fairly general conditions call for *less* redistribution than in the standard homogenous preference case.

The Lockwood and Weinzierl (2012) paper is typical of the literature in that it starts from a standard Mirrlees model and adds additional dimensions of heterogeneity. We take a different route in the present contribution, focussing on the taxation of *groups*, which may differ in the distribution of parameters in the various dimensions. All members of any given group face the same tax rate in our model. We also explicitly consider the properties of said distributions. Our paper therefore extends the literature on optimal taxation of heterogenous agents by analyzing a situation where the government can apply different tax rules to different groups, e.g. females and males, but cannot discriminate according to leisure tastes.

In order to motivate the fundamental assumption that leisure preferences differ by gender, table 1 on page 3 displays some descriptive statistics for selected countries.[1]

[1]The data are taken from the third wave of the World Value Survey. As a proxy for leisure preferences, we used the response to the following question: *"Which point on this scale most clearly describes how much weight you place on work (including housework and schoolwork), as compared with leisure or recreation?"* Subjects answered this question on

The simple descriptive statistics in table 1 indicate some difference in attitudes between males and females as well as considerable variation between countries. In general, if we find gender differences with respect to the preference for leisure time, females have a lower preference for leisure compared to male.[2]

	female	male	χ^2 test stat.
Finland	3.22 (0.91)	3.14 (1.01)	9.14*
Germany	3.05 (1.00)	2.99 (1.06)	12.58**
Hungary	3.75 (0.98)	3.51 (1.10)	16.96***
Latvia	3.37 (0.93)	3.18 (1.02)	19.42***
Norway	3.18 (0.80)	3.14 (0.92)	9.68**
Romania	3.09 (0.70)	3.01(0.84)	17.02***
Russian Fed.	3.45 (0.98)	3.36 (1.02)	10.85**
Slovakia	3.80 (1.30)	3.71 (1.29)	8.71*
Spain	3.28 (1.32)	2.96 (1.40)	20.76***
United States	3.24 (0.70)	3.13 (1.13)	8.06*

Table 1: Mean of leisure preferences (World Value Survey); standard deviation in parentheses; ***/**/* denotes significance relationship between preferences and sex on the 1%/5%/10% level

In analysing the impact of such differences on the optimal taxation of groups, we also diverge from the existing literature in that we examine *differentiated linear tax structures*, which consist of a separate marginal tax rate for each group and a lump-sum tax component that is uniform across groups. In a sense that will be made clear below, this can be interpreted as a part of a larger optimal tax problem, in which the different treatment of (small) groups of the same ability is analyzed, all else being held equal. We show that in such a context in general it is not optimal to implement taxes on labor

a five-point Likert scale, where a value of 1 corresponds 'It's leisure that makes life worth living, not work' and 5 corresponds to 'Work is what makes life worth living, not leisure'. We mistreat the categorical response as a cardinal metric and compute average responses as well as standard deviations. Results of a χ^2 test for significant differences between male and female responses is also performed.

[2]Note, for Bulgaria, Czech Republic, Lithuania, Slovenia, Sweden and Switzerland we do not find evidence for gender differences with respect to the preference for leisure time in the data.

income according to the mean preference of the group, somehow contradicting Ramsey's inverse elasticity rule. We provide an example where the group with the smaller average elasticity of labour supply should be taxed more heavily, and also provide some more general results demonstrating the factors on which an efficient differentiation of tax rates would depend.

Section 2 sets out the model, while sections 3 and 4 prove the main results. Section 5 concludes.

2 The model

Assume a fixed mass of individuals who derive benefit from consumption and leisure time. Moreover assume that taxpayers can be partitioned into n groups of unit mass, so that an individual taxpayer i of group j is indexed by ij where $i \in [0, 1]$ and $j = \{1, \ldots n\}$. Taxpayer groups are in all respects identical, except being characterized by different and independent distributions of the preference for leisure time, α_{ij}, and (possibly) different wage rates. The distribution of the preference parameter for taxpayer group j is given by $f_j(\alpha_{ij})$.

In this paper we will analyse optimal tax rates when groups can be taxed differently while their is no differentiation within groups. The government can set a group-specific linear income tax schedule with the marginal rate t_j and a lump-sum component T.

Each individual i of group j maximises its quasi-linear utility function

$$u_{ij}(c_{ij}, l_{ij}) = c_{ij} + \alpha_{ij}\sqrt{l_{ij}} \tag{1}$$

over the choice of consumption, c_{ij} and leisure time, l_{ij}, where the entire time budget is normalized to unity. The wage rate (labour productivity) w_j is exogenous and can vary across groups, but not within groups.

As there are no income effects in our model, we can ignore T when computing the optimal labour-leisure choice. When labour income is taxed proportionally at the rate t_j, individual's budget constraint is

$$c_{ij} \leq (1-t_j)(1-l_{ij})w_j. \tag{2}$$

This simple problem affords a closed form solution for leisure and consumption

$$l^*_{ij} = \frac{\alpha^2_{ij}}{4(1-t_j)^2 w^2_j}\,, \quad c^*_{ij} = (1-t_j)w_j - \frac{\alpha^2_{ij}}{4(1-t_j)w_j} \tag{3}$$

where individual i enjoys indirect utility

$$v_{ij}(w_j, t_j) = (1-t_j)w_j + \frac{\alpha^2_{ij}}{4(1-t_j)w_j}. \tag{4}$$

Note that the indirect utility increases in the weight α of the non-linear preference for leisure, so individuals who are relatively less interested in consumption are better off in this framework, *ceteris paribus*. From the solution (3), we can easily compute the (compensated) elasticity of labour supply with respect to the net wage as

$$\eta_{ij} = \frac{\partial(1-l^*_{ij})}{\partial w_j(1-t_j)} \cdot \frac{w_j(1-t_j)}{1-l^*_{ij}} = -\frac{2\alpha^2_{ij}}{\alpha^2_{ij} - 4(t_j-1)^2 w^2_j}. \tag{5}$$

Taking the first derivative of (5) with respect to α_{ij}, we see immediately that η_{ij} is strictly increasing in α_{ij}. In the remainder of this paper, we will therefore argue in terms of α_{ij} instead of the elasticity of labour supply itself.

To calculate the excess burden caused by income taxation of individual ij, we need to compare the revenue from the proportional tax on labour income

$$R_{ij} = t_j w_j \big(1 - \frac{\alpha^2_{ij}}{4(1-t_j)^2 w^2_j}\big) \tag{6}$$

to the revenue generated by a lump-sum tax keeping the individual at the same level of indirect utility v_{ij}. With a lump-sum tax Θ_{ij}, the individual's problem becomes

$$u_{ij}(c_{ij}, l_{ij}) \to \max! \qquad \text{s.t.} \quad c_{ij} \leq (1 - l_{ij})w_j - \Theta_{ij} \tag{7}$$

with the closed form solution

$$l_{ij}^{**} = \frac{\alpha_{ij}^2}{4w_j^2}, \quad c_{ij}^{**}(T_{ij}) = w_j - \frac{\alpha_{ij}^2}{4w_j} - \Theta_{ij}. \tag{8}$$

Using (8) and (4), we find the lump-sum tax yielding the utility v_{ij} to be

$$\Theta_{ij} = t_j w_j - \frac{\alpha_{ij}^2 t_j}{4(1 - t_j)w_j} \tag{9}$$

and can finally compute the deadweight loss D_{ij} arising through the taxation of ij's labour income:

$$D_{ij} = \Theta_{ij} - R_{ij} = \frac{\alpha_{ij}^2 t_j^2}{4(1 - t_j)^2 w_j}. \tag{10}$$

Note that D_{ij} increases in the parameter α_{ij} and, therefore, in the labour supply elasticity, η_{ij}.

The overall deadweight loss, D_j and tax revenue, R_j, generated from the jth group (out of n) can then be found by simply integrating (10) and (6), respectively. This gives

$$R_j = \int \left(t_j w_j - \frac{\alpha_{ij}^2 t_j}{4(1 - t_j)^2 w_j} \right) f_j(\alpha_{ij}) \mathrm{d}\alpha_{ij} \tag{11}$$

and

$$D_j = \int \frac{\alpha_{ij}^2 t_j^2}{4(1 - t_j)^2 w_j} f_j(\alpha_{ij}) \mathrm{d}\alpha_{ij}. \tag{12}$$

We impose a balanced government budget and analyse a *differentiated linear tax structure* – which consists of a separate marginal tax rate per group and a uniform lump-sum compenent T – that minimises the overall deadweight loss subject to the budget constraint. We obtain the following well-behaved non-linear minimisation problem:

$$\min_{t_1,\dots t_n} \sum_{j=1}^{n} D_j(t_j) \quad s.t. \sum_{j=1}^{n} R_j(t_j) \geq T. \tag{13}$$

In solving (13), we treat T (i.e., the lump-sum subsidy for everyone) as exogenous and minimise the *unweighted* deadweight loss. This means that we effectively assign equal money metric distributional weights to all individuals and, because they have equal mass, to all groups. At first blush, this appears to be a rather restrictive assumption. It can, however, be justified in either of the two following ways:

1. As individual preferences (1) imply transferable utility in our model, the problem (13) is in fact compatible with maximising a utilitarian social welfare function.[3] Its solution determines the optimal structure of per-group t_j^*'s, given a target subsidy T^*. While we cannot endogenously determine the latter using the solution to (13), this is rather immaterial for our point about the optimal structural differentiation between groups.

2. Consider a problem where the overall redistributiveness of the tax system has been determined beforehand, and the only issue in question is the efficient treatment of two groups that are similar in terms of their ability. For concreteness, imagine that we are discussing possible tax relief for female professionals (as opposed to males in the same occupation). If the two groups in question are relatively small and about equally well-off, the sub-problem can then be couched in terms of equation (1).

In general, it is not possible to give a closed form solution for this minimisation problem without introducing additional assumptions concerning the distribution $f(\cdot)$.

[3]Formally, the marginal utility of income is the same for all individuals and equal to $\frac{\partial u_{ij}}{\partial c_{ij}} = 1$ given the assumptions of our model. For a classical utilitarian, a change in an individual's utility leads to a one-to-one increase in the social welfare and distributional weights only depend on the marginal utility of income.

3 First moments do not suffice: a counter-example

We begin by demonstrating that optimal labour income tax rates do not only depend on the *average* labour supply elasticity of groups, which is normally focused on in the application of optimal taxation theory to policy, but also on the heterogeneity within each group. Proposition 1 summarises this point.

PROPOSITION **1.** *A higher mean elasticity of a group is neither necessary nor sufficient for the optimal marginal tax rate for this group to be lower than for the other group.*

Proof. Our proof of proposition 1 is by counter-example for two groups $j = \{1, 2\}$ and uniformly distributed preferences, i.e. $\alpha_{ij} \sim \mathcal{R}[\mu_j - \sqrt{3}\sigma_j, \mu_j + \sqrt{3}\sigma_j]$. Fixing wage rates at $w_1 = w_2 = 2$ and $T = 1$, table 2 shows the optimal tax rates for various combinations of the means μ_1, μ_2 and standard deviations σ_1, and σ_2:

	μ_1	σ_1	μ_2	σ_2	t_1^*	t_2^*
Baseline	0.5	0.1	0.5	0.1	0.258	0.258
Increase in μ	**0.6**	0.1	0.5	0.1	0.236	0.282
Increase in σ	0.5	**0.2**	0.5	0.1	0.251	0.265
"Counter-example"	0.5	0.1	**0.45**	**0.35**	0.273	0.244

Table 2: Simulation results

The first line in table 2 establishes a baseline case, while the second shows the well-known effect of an increase in the *average* elasticity of labour supply for a group: the optimal group-specific tax rate goes down, while the other group is taxed harder. The third line confirms our intuition that an increase in the variance of the elasticity for a group, other things being equal, will lead to lower taxation of this particular group. The reason for this is the non-linearity of the deadweight loss; adding to the tail ends of the distribution will entail adding cases with a disproportionally higher excess burden on the right, which outweighs the reduction through the additional cases on the left of the median.

Finally, the fourth line demonstrates, though only by way of example, that the second effect discussed above can dominate the first. Even though group 2 exhibits a smaller elasticity of labour supply on average, its tax burden is lower, on account of the greater standard deviation in the distribution of the parameter α. It is possible, then, for a group with a *lower average elasticity of labour supply to be taxed less heavily in an optimum.* Clearly, a look at the first moment of the distribution alone does not suffice. $\square$

Note, that in the example the labour productivity is identically distributed in each group. Thus, the Mirrleesian optimal taxation theory would not call for any different treatment of the groups at all. In addition, the optimal differentiation of tax rates between groups which we derive clearly violates the "preference neutrality" requirement imposed in Lockwood and Weinzierl (Lockwood and Weinzierl, 2012), which states that in the absence of ability differences no redistribution should take place at all. We shall return to this point in the discussion.

4 Optimal differentiation of tax rates across groups

Consider the impact of a change in a moment of $f(\cdot)$ on the optimal tax rates, all other things being equal. Intuitively, it seems plausible to conjecture (cf. also table 2) that both an increase of the first and second moment for a group would lead to a *lower* tax rate for that group in the optimum. Given T and the independence of group distributions, we would also expect the tax rates for all other groups to rise, albeit to a different degree. This conjecture, however, would be premature, as proposition 2 shows.

PROPOSITION **2.** *Minimising the total (unweighted) excess burden of taxation through differentiating marginal tax rates across heterogenous groups, the optimal marginal tax rate for group j, $j \in \{1, \ldots, n\}$, is*

(i) decreasing in the second moment of group j's own distribution of the labour supply elasticity if

$$w_j^2 \quad > \quad \frac{1}{4(1-t_j)^2(1+2t_j)} sm_j \tag{14}$$

and

(ii) increasing in the respective value for any other group j' *(where* $j' \in \{1 \dots n\}$ *and* $j' \neq j$*) if*

$$w_{j'}^2 \quad > \quad \frac{1}{4(1-t_{j'})^2(1+2t_{j'})} sm_{j'} \tag{15}$$

where $sm_j \equiv \int \alpha_{ij}^2 f_j(\alpha_{ij}) \mathrm{d}\alpha_{ij}$ *is the second moment of the preference distribution of group* j*; respectively.*

Proof. Combining the first order conditions with respect to t_j and $t_{j'}$ we get:

$$\underbrace{\frac{2t_j sm_j}{(1+t_j)sm_j - 4(1-t_j)^3 w_j^2} - \frac{2t_{j'} sm_{j'}}{(1+t_{j'})sm_{j'} - 4(1-t_{j'})^3 w_{j'}^2}}_{\equiv \gamma(sm_j, sm_{j'}, t_j, t_{j'})} = 0. \tag{16}$$

The effects of a change in the second moments on the first order condition are

$$\frac{\partial \gamma}{\partial sm_j} = -\frac{8(1-t_j)t_j w_j^2}{((1+t_j)sm_j - 4(1-t_j)^3 w_j^2)^2} \leq 0 \tag{17}$$

and

$$\frac{\partial \gamma}{\partial sm_j'} = \frac{8(1-t_{j'})t_{j'} w_{j'}^2}{((1+t_{j'})sm_{j'} - 4(1-t_{j'})^3 w_{j'}^2)^2} \geq 0, \tag{18}$$

respectively. The effect of a change in the tax rates are ambiguous. More precisely,

$$\frac{\partial \gamma}{\partial t_j} = \frac{2sm_j(sm_j - 4(1-t_j)^2(1+2t_j)w_j^2)}{((1+t_j)sm_j - 4(1-t_j)^3 w_j^2)^2} \tag{19}$$

which is negative if

$$w_j^2 \geq \frac{1}{4(1-t_j)^2(1+2t_j)} sm_j. \tag{20}$$

Analogously,

$$\frac{\partial \gamma}{\partial t_j} = \frac{2sm_j(sm_j - 4(1-t_j)^2(1+2t_j)w_j^2)}{((1+t_j)sm_j - 4(1-t_j)^3 w_j^2)^2} \tag{21}$$

is positive if

$$w_{j'}^2 \geq \frac{1}{4(1-t_{j'})^2(1+2t_{j'})} sm_{j'}. \tag{22}$$

$\square$

On inspection of conditions (14) and (15), we see that they cannot hold if the tax rates t_j and $t_{j'}$ approximate unity. We conclude that for very high tax rates, an increase in the second moment of the preference distribution implies an increase in the optimal tax rate for the respective group. For plausible values, on the other hand, the conjecture at the beginning of this subsection appears valid.

5 Discussion and conclusion

This paper analysed how linear tax systems could efficiently be differentiated to accommodate differences between heterogenous groups. In the context of political philosophy, this touches the question of whether the principle of horizontal equity should be jettisoned in favour of increased efficiency Stiglitz (1982).

We find that the introduction of tax privileges based on the properties of groups can indeed be efficient. However, *the usual focus on the first moment of the distribution of properties within groups turns out to be unacceptable.* For some symmetric distributions – the uniform and the normal distribution –, we establish by way of example and formally that the second moment also needs to be taken into account.

More generally, one would expect higher moments to come into play as soon as mean and variance fail to describe a distribution completely. The distribution of income, for instance, is often considered approximately log-normal. We also establish that there are *no clear-cut comparative statics*, even though we find that for moderate levels of taxation, an increase in the first and second moments for a group is likely to lead to some tax relief for that group.

The policy problem thus turned out to be a rather complex one. And this was for a *given* partitioning of taxpayers into groups, which we just posited for our analysis. In practice, the delineation of relevant groups would also be a major case of concern – in setting tax policy, do we compare all females to all males, or just single males to single females? How finely grained is the partitioning to be?

We also noted that the setup of our model is incompatible with a typical assumption on the cardinalisation of preferences in the literature on heterogenous preferences in taxation, namely that differences in preferences should not be taken into account. (While, obviously, differences in abilities and initial endowment should be recognised by optimal policy.) Lockwood and Weinzierl (2012), citing Fleurbaey and Maniquet (2006), introduce this as a formal "preference neutrality" requirement. In fact, all tax rate differences in our first example (table 2) are due to diverging preferences among groups.

This brings into stark relief the kind of normative assumptions that are implicit in differential tax treatment of groups. Formally, preference neutrality closely resembles horizontal equity in that it is a normative principle limiting the kind of information that can be taken into account in the formulation of optimal policy. From a practitioner's point of view at least, such limitations have the advantage of being much simpler to apply. This is because they do not require us empirically to disentangle the part of labour supply response that is due to diverging preferences from the one that is due to differences in endowments.

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