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Taxation, Labour Supply and Welfare:

A micro-simulation analysis for Cyprus

Panos Pashardes
Economics Research Centre & Department of Economics, University of Cyprus

Alexandros Polycarpou
Economics Research Centre, University of Cyprus

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Taxation, Labour Supply and Welfare:
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Panos Pashardes
Economics Research Centre
& Department of Economics,
University of Cyprus

Alexandros Polycarpou
Economics Research Centre,
University of Cyprus

Abstract

In this paper we investigate the effect of three revenue equivalent tax systems on labour market participation, working hours and welfare: (i) a progressive tax system with high income allowance, (ii) a progressive tax system with family related allowances and (iii) a proportional taxation. For this we combine a structural labour supply with a micro-simulation model and data from the 2007 EU-SILC database. The results show that the "best" regime for improving the labour supply is the proportional taxation one, as it generates a small decrease in working hours and participation, while the deadweight loss is low and mostly negative. The most suitable system for improving the participation rate, especially of females or individuals over 55, appears to be progressive taxation with high income allowance; while the working hours of these groups are most increased with a proportional tax system. On the other hand, a progressive tax system combined with high income allowance is most suitable for decreasing income inequality.

JEL: J2, H3

Keywords: labour supply, labour market participation, income taxation, micro-simulation analysis, welfare, deadweight loss, EU-SILC

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Προσφορά Εργασίας και Φορολογία:

Ανάλυση μικρο-προσομοίωσης για την Κύπρο

ΠΕΡΙΛΗΨΗ

Σε αυτή την μελέτη αναλύουμε τρία εισπρακτικά ισοδύναμα φορολογικά συστήματα ως προς την επίδραση τους στη συμμετοχή των ατόμων στην αγορά εργασίας, στις ώρες εργασίας και στην ευημερία τους: (i) ένα προοδευτικό φορολογικό σύστημα με υψηλό φοροαπαλλαγμένο εισόδημα, (ii) ένα προοδευτικό σύστημα με φοροαπαλλαγές βάσει της οικογενειακής σύνθεσης και (iii) ένα σύστημα με σταθερό φορολογικό συντελεστή. Για το σκοπό αυτό συνδυάζουμε ένα δομημένο μοντέλο προσφοράς εργασίας, που περιλαμβάνει φορολογία, με ένα μοντέλο μικρό-προσομοίωσης για ανάλυση της συμπεριφοράς των ατόμων στην αγορά εργασίας και χρησιμοποιούμε στοιχεία από την βάση δεομένων EU-SILC.

Τα αποτελέσματα είναι ως εξής.

- Το καταλληλότερο φορολογικό καθεστώς για βελτίωση της προσφοράς εργασίας είναι το σύστημα με σταθερό φορολογικό συντελεστή, εφόσον προκαλεί μικρή μείωση στις ώρες εργασίας και στη συμμετοχή στην αγορά εργασίας, ενώ η απώλεια οικονομικής αποτελεσματικότητας που συνεπάγεται είναι αρκετά χαμηλή - και στις περισσότερες περιπτώσεις αρνητική.

- Για να αυξηθεί η συμμετοχή στην αγορά εργασίας γενικά, αλλά και συγκεκριμένα των γυναικών ή των ατόμων άνω των 55 ετών, το καταλληλότερο φορολογικό σύστημα είναι το προοδευτικό με υψηλό φοροαπαλλαγμένο εισόδημα.

- Για να αυξηθούν οι ώρες εργασίας των ατόμων το καταλληλότερο σύστημα είναι αυτό με σταθερό φορολογικό συντελεστή.

- Το καταλληλότερο φορολογικό σύστημα για να μειωθεί η εισοδηματική ανισότητα είναι το προοδευτικό συνδυασμένο με ψηλό φοροαπαλλαγμένο εισόδημα, εφόσον επιδρά θετικά στη μείωση της εισοδηματικής ανισότητας - ενώ το αναλογικό σύστημα αυξάνει οριακά την ανισότητα.

1. Introduction

Welfare programs and taxation can create work disincentives and this is a major concern among policy makers burdened with the design of employment-friendly tax-benefit systems. Many countries nowadays are in the process of reviewing and reforming their tax-benefit system to create incentives for individuals to enter and remain in the labour market and in particular on encouraging employment among women, low-skilled and older workers.

A very large body of research has studied the labour market incentives and the effects of tax-benefit reforms implemented in various countries. Overall, the empirical approaches and data used in the literature differ from study to study, yet some findings appear to be common. For instance, work incentives created by the tax-benefit reforms appear to have different effects among demographic and education groups (Hoynes 1997; Moffit 1992, 2002); affect both the participation decision and the working hours among women with young children, (Eissa et al 2005; Brewer et al 2006); affect only the labour market participation decision among low educated men (Moffit 2002); have no effect on the labour market behaviour of highly educated and wealthy men.

In this paper we investigate the effects on labour participation and working hours of alternative income tax system reforms in Cyprus. In addition, since we are using a structural approach for deriving the labour supply function, we also assess the welfare loss of these reforms. This is important because ignoring the welfare loss from encouraging individuals to substitute leisure for consumption and thus change their labour market behaviour and enter the labour market can give rise to biased policy conclusions. When considering alternative reforms of the tax-benefit system the standard approach in the literature is to try to reach policy conclusions by balancing the efficiency gains from increased employment against the socially undesirable inequity, arising from differences in the consumption-leisure substitution possibilities among benefit recipients, e.g. under a benefit system paid only to employed individuals those unable to work would end up without income. However, the efficiency gains can be exaggerated when the deadweight loss (due to consumption-leisure substitution) is ignored. This can result in biased conclusions in favour of employment increasing measures achieved through increasing the price of leisure (net wage).

One can argue that deadweight loss is a second order effect and would normally be of minor importance compared to the positive macro (increased growth, lower fiscal deficit etc) and potential micro (e.g. elimination of poverty traps) effects from increasing employment through in-work benefits and other wage subsidisation measures. The existence of potentially large positive effects from such measures cannot, however, be a justification for not investigating its negative effects. More importantly, if these measures are indeed successful in encouraging

labour market participation and increased employment, then they must also be causing a large substitution of consumption for leisure; hence, they also cause a large deadweight loss. In simple words, if the deadweight loss from measures encouraging substitution of consumption for leisure is trivial, then so is their potential employment gain.

In the paper the behavioural consequences of the different tax system reforms are studied with the use of microsimulation model. The tax and benefit system gives rise to nonlinear or piecewise linear budget constraints and makes the marginal tax rates to differ across individuals (Kuismanen, 2005). In addition, tax system reforms change the income distribution since individuals react differently after the reform. As a consequence, a detailed knowledge of the labour supply curve for each individual is needed for the correct analysis of the effects of tax system reform, which only with the use of microsimulation can be obtained. The use of average wage and income elasticities do not contain the information needed to analyze the labour supply consequences of a tax reform. Instead, individual behaviour and the distribution of individuals over the entire budget constraint are needed to compute the effects of tax reform on labour supply.

Research on labour supply and the effects of taxation in Cyprus is limited. Kontolemis (1994) investigates the institutional characteristics of the labour market in Cyprus, Christofides and Pashardes (2000, 2002) study the gender wage gap in paid employment in Cyprus as well as the double selection problem resulting from the choice of self- versus paid-employment and employment in the public versus the private sector. Also Christofides et al. (2007) study the impact of foreign workers on the Cyprus labour market; Christofides and Vrachimis (2007) examine the gender wage gap in Cyprus over time; while Christofides et al. (2009) study the gender pay gap across the EU countries and compare it with the one in Cyprus. A first attempt to explore the relation between labour supply and taxation in Cyprus was made by Pashardes and Polycarpou (2009), who investigate the impact of alternative forms of income taxation on labour market participation, however, without using a structural labour supply model. To our knowledge, the only study estimating labour supply functions (for males and females) in Cyprus through the use of a structural labour supply model is Pashardes and Polycarpou (2010). The latter study incorporates taxation and computes income and wage elasticities, however, the welfare effects of taxation are not considered.

The rest of the paper is structured as follows. Section 2 briefly describes the labour supply theory and the effect of taxation on labour market behaviour of individuals. Section 3 outline the advantages of using micro simulation analysis for studying the effect of alternative tax reforms on labour supply. Section 4 describes the data, outlines the theoretical and empirical labour supply model as well as the estimation method used for the empirical analysis used in the paper and reports the empirical results for the labour supply estimation. Section 5 describes the

microsimulation procedure and the welfare measures used for the evaluation of alternative tax reforms on labour supply and welfare. Section 6 describes the alternative revenue equivalent tax system reforms and presents the simulation results for labour market participation, working hours, welfare and earnings inequality. Section 7 concludes the paper.

2. Labour Supply and Income Taxation

Labour supply models express the trade-off between hours of work and leisure. Since leisure time is a consumption good, the analysis of labour supply is based on the theory of consumer behaviour. Thus, individual i is assumed to maximise a quasi-concave utility function $U(C_i, L_i; z_i)$ subject to the budget constraint $C_i + w_i L_i = y_i + w_i T_i$ and time constraint $L_i + h_i = T_i$; where C_i is consumption, L_i leisure time, z_i a vector with individual characteristics, w_i hourly net wage rate, y_i non-labour income, h_i working hours and T_i total available hours. The right-hand side of the budget constraint, defined as the "full income" and denoted by M_i, includes the value of one's endowment of time ($w_i T_i$) and income from sources outside employment (Y_i). Individuals use M_i to purchase consumption goods and leisure and solving the optimisation problem we obtain the labour supply as a function $h(w_i, y_i; z_i)$.

Taxes and benefits affect the participation and hours of work decision of individuals (Hausman 1985; Blundell and MaCurdy 1999; Meghir and Phillips 2008) since taxes and means-tested benefits lower the net compensation of work (net wage) while non-means tested benefits increase the non-labour income, which has a negative effect on the labour supply (Burtless and Hausman 1978; Moffitt 2002). An important feature for a labour supply model is to provide a framework for understanding and measuring the way that tax and welfare systems affect labour market incentives (Meghir and Phillips 2008). Ignoring taxes in the empirical investigation of labour supply results in biased estimates of labour supply effects, since the returns to work are not measured correctly. From a policy point of view ignoring the effect of taxes on labour supply can result in measures that fail to have the desired effects on employment.

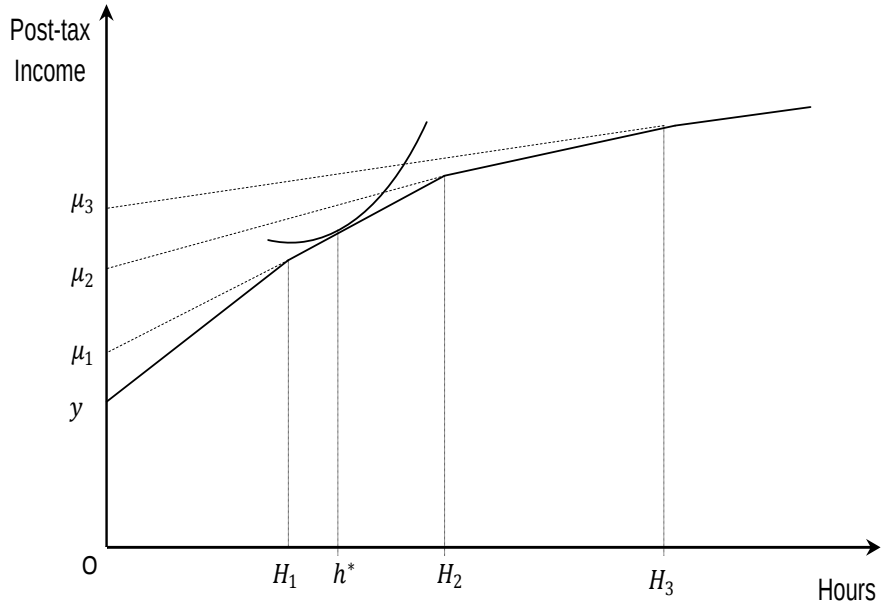
In a world with no taxes the analysis of labour supply is simple because the desired hours of work for individual i, h_i^*, are determined by the labour supply function $h_i^* = h(w_i, y_i; z_i)$ where w_i is the wage rate and y_i is the non-labour income. The analysis of labour supply continues to have this simple form also in the case of proportional taxation. A proportional tax rate τ lowers the net wage rate to $w_{i\tau} = (1 - \tau)w_i$; if it is also applied to non-labour income, the latter becomes $y_{i\tau} = (1 - \tau)y_i$. Thus the desired hours of work are given by $h_i^* = h(w_{i\tau}, y_{i\tau}; z_i)$. Also the effect of tax rate τ on hours of work is given by

$$\frac{dh^*}{d\tau} = \frac{\partial h}{\partial w_\tau}\frac{dw_\tau}{d\tau} + \frac{\partial h}{\partial y_\tau}\frac{dy_\tau}{d\tau} \quad (1)$$

and can be expanded further using the Slutsky equation.

Progressive income taxation in Cyprus, as in many countries, makes the determination of desired hours of work more complicated since both the wage rate and the non-labour income are affected non-linearly by the tax system. To see this suppose that individuals face the following tax schedule: earnings up to the threshold A_1 are tax-free ($\tau_0 = 0$), earnings between A_1 and A_2 are taxed at rate τ_1, earnings between A_2 and A_3 are taxed at rate τ_2 and earning above A_3 are taxed at rate τ_3. Figure 1 shows how the hours of work and post tax income relate under this progressive tax system: H_1, H_2 and H_3 correspond to the kink point working hours for reaching tax thresholds A_1, A_2 and A_3 respectively, e.g. $H_k = {}^{A_k}/_{w}$, where $k = 1,2,3$. Also, shown on the diagram, are the "virtual" incomes μ_0, μ_1, μ_2 and μ_3, which follow from extrapolation a given budget segment to the vertical axis. They are termed "virtual" income to denote that an individual who chooses hours of work h^* with wage w and non-labour income y under the progressive tax system would still choose h^* if faced with a proportional tax system with rate τ_k and income μ_k.

Figure 1: Progressive tax schedule



In the case of progressive taxation (i.e. a convex budget set) labour supply decisions can be expressed as if the tax system were proportional with tax rate equal to the one the individual faces on the tax bracket he belongs and with non-labour income equal to the virtual income of that tax bracket. Thus if under the progressive tax system, the optimal hours of work are in the first tax bracket ($\tau_0 = 0$) then these can be determined from $h_i^* = h(w_i, y_i; z_i)$. If the optimal hours are in the tax bracket with tax rate τ_k , $k = 1,2\ or\ 3$, then the optimal hours are given by $h_i^* = h(w_{ik}, \mu_{ik}; z_i)$ where $w_{ik} = w_i(1 - \tau_k)$ and $\mu_{ik} = y_i + \sum_{j=1}^{k}(\tau_j - \tau_{j-1})A_j$ is the virtual income of the segment with tax rate τ_k. The virtual income for the segment with tax rate τ_1 is $\mu_1 = y + (\tau_1 - \tau_0)A_1$, with tax rate τ_2 is $\mu_2 = y + (\tau_1 - \tau_0)A_1 + (\tau_2 - \tau_1)A_2$, and with tax rate τ_3 is $\mu_3 = y + (\tau_1 - \tau_0)A_1 + (\tau_2 - \tau_1)A_2 + (\tau_3 - t_2)A_3$.

In the case of progressive taxation there is a situation which cannot be described using the approach described above, i.e. when the individual chooses hours exactly on one of the kinks. This happens when an individual wants to supply more hours than the threshold when facing with a lower tax rate and less hours than the threshold when facing with a high tax rate; thus, the only feasible point is the kink.

3. Why use micro-simulation analysis

Labour supply models provide the framework for analyzing the effect of tax and benefit reforms on labour market incentives, participation and hours of work. Using the labour supply modelling approach described above we study the effect of reforms on tax rates and thresholds under a progressive tax system.

We illustrate this considering an individual whose optimal hours for work, h_i^*, are on the segment with tax rate τ_1; thus, he has net wage $w_{i1} = w_i(1 - \tau_1)$, virtual income $\mu_1 = y + (\tau_1 - \tau_0)A_1$ and $h_i^* = h(w_{i1}, \mu_{i1}; z_i)$. Next, consider the following.

- *The tax rate on earnings above those earned by the individual changes, e.g. τ_2 decreases*. The optimal labour hours of work of the individual will not change since neither net wage nor virtual income is affected by the change.

- *The tax rate on earnings the individual faces changes, e.g. τ_1 decreases*. The effect of this change on individual's desired hours of work is

$$\frac{dh_i^*}{d\tau_1} = \frac{\partial h}{\partial w_{i1}}\frac{dw_{i1}}{d\tau_1} + \frac{\partial h}{\partial \mu_{i1}}\frac{d\mu_{i1}}{d\tau_1} = -\frac{\partial h}{\partial w_{i1}}w_i + \frac{\partial h}{\partial \mu_{i1}}A_1 \qquad (2)$$

Substituting the Slutsky equation $\frac{dh}{dw} = \frac{\partial h^c}{\partial w} + \frac{\partial h}{\partial m}h$, where h^c is compensated labour supply and m total income, into equation (2) and rearranging terms we obtain the following expression for the effect of the tax rate on hours of work

$$\frac{dh_i^*}{d\tau_1} = -w_i\left(\frac{\partial h^c}{\partial w_{i1}} + \frac{\partial h}{\partial \mu_{i1}}\left(h^* - {A_1}/{w_i}\right)\right) \tag{3}$$

From equation (3) we can see that the effect of the tax rate on hours of work is ambiguous and depends on the income and substitution effect as well as on how close the individual's hours are to those that he would have to work in order to reach the tax threshold. Nevertheless, for individuals with hours of work near the tax threshold, i.e. with $h^* - {A_1}/{w_i}$ close to zero, the effect from a change in the tax rate is driven by the substitution effect, which is always positive; thus, the effect in this case is negative, e.g. a decrease in the tax rate increases the working hours.

- *The tax rate on earnings below those earned by the individual changes*, *e.g.* τ_0 *decreases*. The effect of this change is given by

$$\frac{dh_i^*}{d\tau_0} = \frac{\partial h}{\partial w_{i1}}\frac{dw_{i1}}{d\tau_0} + \frac{\partial h}{\partial \mu_{i1}}\frac{d\mu_{i1}}{d\tau_0} = -\frac{\partial h}{\partial \mu_{i1}}A_1 \tag{4}$$

since only the virtual income is affected. The effect of this change is the same as an increase of the non-labour income which, assuming that leisure is a normal good, decrease the working hours of the individual.

- *The upper or the lower tax threshold, corresponding to the segment the individual located on, change*, *i.e.* A_1 *or* A_2 *change*. A change of A_2 has no effect of the optimal working hours of the individual, since it does not have an effect on net wage or virtual income. The effect of a change in A_1, given by

$$\frac{dh_i^*}{dA_1} = \frac{\partial h}{\partial w_{i1}}\frac{dw_{i1}}{dA_1} + \frac{\partial h}{\partial \mu_{i1}}\frac{d\mu_{i1}}{dA_1} = \frac{\partial h}{\partial \mu_{i1}}(\tau_1 - \tau_0) \tag{5}$$

is negative, assuming that leisure is a normal good and that the individual does not change tax-segment. In contrast, the effect of a change in A_1 is possible when the individual changes tax-segment and faces a different tax rate. Therefore, the effect in question, in general, is ambiguous.[2]

[2] For a more detailed description of the effect of tax rate and tax threshold changes on working hours as well as for a graphical representation see Meghir and Phillips (2008).

From the simple tax system reforms considered above it is obvious that the policy implications can only be summarised with the combination of different income and wage elasticities. In addition the same type of reform (change of tax rates or tax thresholds) can have a different effect on individuals located at different parts of the budget set.

In conclusion, the overall outcome of a tax reform on labour supply depends on how sensitive is the labour supply to changes in the wage rate and non-labour income as well as how individuals are distributed over the budget set. The complexity of analysing the effect of taxation on labour supply can be tackled by micro-simulation. Furthermore micro-simulation, allows one to study reforms involving combined changes of tax (or benefit) rates, thresholds, the introduction of tax credits or exceptions etc. Micro-simulation analysis need not be based on hypothetical (if not dubious) circumstances and characteristics, such as those corresponding to a 'representative' individual. Analysis based on such circumstance can be misleading, as the diversity of individual characteristics and their distribution along the non-linear budget constraint can have important consequences for the results obtained from this analysis.

4. Data and labour supply function

The data used in the analysis are drawn from the 2007 European Union Statistics on Income and Living Conditions (EU-SILC) database[3]. The EU-SILC database is prepared by the Statistical Service of the Member States for Eurostat and contains information for each country of the EU25 (except Malta), plus Norway and Iceland. The dataset contains cross-section data at household and personal level. The data at household level include income, social exclusion and housing/household characteristics and the data at personal level, for each member of the household, contains information about health and employment status, the level and sources of income, and demographic, education and other personal characteristics. The advantage of this dataset is that it contains sufficient information (hours of work, wages and socio-demographic characteristics of each member living in a household) for estimating the parameters of a neoclassical labour supply model.

The data contain information for 8470 individuals over 16 years old living in Cyprus, but in our empirical analysis a subsample of 4638 individuals is used. This subsample consists of individuals between the age of 25 and 65 who are employees or inactive; employers or self-employed individuals are dropped from the sample to avoid income under-reporting problems and problems arising from the fact that the determinants of the labour supply behaviour of these persons are likely to differ from the rest of the population. Also dropped are individuals with

[3] European Commission, Eurostat, cross-sectional EU SILC UDB 2007 - version 1 of March 2009. Eurostat has no responsibility for the results and conclusions of this paper.

incomplete or unreliable personal and occupational information. Table A1 in the Appendix shows the descriptive statistics of the variables used in the empirical analysis.

The choice of the labour supply function is very important in the context of this paper, as our objective is to use the empirical results to draw policy conclusions. Thus we need a functional form of the labour supply function which is integrable i.e. can be used to obtain the indirect utility function it is derived from and, thereby, compute welfare effects. It should also be flexible enough to capture a wide range of individual responses that are consistent with the fundamentals of utility theory, e.g. allow for labour supply to have a positive slope at low wage rates but be backwards bending at high wage rates. At the same time it should be possible to estimate and use a micro-simulation model to compare the effect of alternative tax policies not only on labour supply but also on welfare.

We can obtain a labour supply function that satisfies the above requirement by using the following indirect utility function

$$u(w_i, y_i; z_i) = \frac{{w_i}^{\beta(z_i)+1}}{\beta(z_i)+1}\left[\frac{y_i}{w_i}(\beta(z_i)+1) + \alpha(z_i)log(w_i) + \gamma(z_i) - \frac{\alpha(z_i)}{\beta(z_i)+1}\right] \quad (6)$$

where w_i is the net wage rate, y_i the non-labour income, z_i a vector of individual demographic and other characteristics, and $\alpha(z_i)$, $\beta(z_i)$, and $\gamma(z_i)$ parameters that depend on personal and other characteristics of the individuals.

Applying Roy's identity we obtain the labour supply function

$$h(w_i, y_i; z_i) = \alpha(z_i)log(w_i) + \beta(z_i)\frac{y_i}{w_i} + \gamma(z_i) \quad (7)$$

which belongs to the family of semi-logarithmic labour supply functions introduced by Duncan (1993). For leisure to be a normal good, the derivative of hours in work with respect to non labour income should be negative i.e. $\beta(z_i) < 0$. In addition, labour supply function is backward bending when $\alpha(z_i) < 0$ and $w_i > \frac{\beta(z_i)}{\alpha(z_i)}y_i$.

There are two complications in estimating (7): the non-linearity in variables; and endogeneity of the net wage rate, created from the progressiveness of the income tax - which makes the after tax wage rate to depend on the hours of work. The non-linearity problem can be tackled using maximum likelihood estimation; whereas both the non-linearity and endogeneity problems can be tackled by using either the complete budget constraint maximum likelihood procedure proposed by Moffitt (1986, 1990) or the instrumental variable estimation for the endogenous net wage and non-labour income proposed by Killingworth (1983). The method we follow in this

paper is the complete budget constraint maximum likelihood procedure, where the observed hours are generated by a generalised Tobit model.

The parameter obtained from the estimation of the labour supply (7), separately for males and females, as well as jointly for the two genders, are presented in Table A2 of the Appendix.[4] Table 1 here reports the income and wage elasticities of labour supply calculated from these parameters and correspond to the 'average' individual, i.e. the person with the average level of explanatory variables in the sample. The income elasticity shows the percentage change of labour supply (hours worked) from 1% change of non-labour income, whereas wage elasticity shows the percentage change of labour supply from 1% change of wage.

Table 1: Labour supply elasticities for the 'average' male, female and all persons

		Males		Females		All	
		Income elasticity	Wage. elasticity	Income elasticity	Wage elasticity	Income elasticity	Wage elasticity
Age Group	25-34	**-0.021**	-0.042	**-0.061**	**0.326**	**-0.050**	**0.273**
	35-44	-0.008	**-0.165**	**-0.029**	**0.296**	**-0.067**	**0.192**
	45-54	**-0.049**	**-0.175**	**-0.052**	**0.224**	**-0.049**	0.026
	55-64	**-0.202**	**-0.146**	**-0.332**	**0.687**	**-0.194**	**0.242**
Age of youngest child	Less than 5	-0.012	**-0.165**	**-0.084**	**0.474**	**-0.099**	**0.432**
	6-12	-0.009	**-0.183**	-0.004	**0.346**	**-0.016**	**0.180**
	13-18	**-0.059**	-0.175	-0.004	0.162	**-0.051**	0.023
	No children	**-0.024**	**-0.174**	-0.030	**0.334**	**-0.055**	**0.225**
All		**-0.055**	-0.134	**-0.078**	**0.328**	**-0.075**	**0.173**

Note: Figures in bold are significant at 10% significance level.

Commenting on the results reported in Table 1, the labour supply of women is more responsive to income and wage changes than that of men. Also, persons aged between 55 and 64 have much higher elasticities compared to individuals in other age groups. Based on the age of the youngest child, women with children aged less than 12, as well as women with no children, are more responsive to changes in wage than other women; while the labour supply of men with similar family characteristics has near zero wage elasticity. Furthermore, men have negative and women positive wage elasticity of labour supply. Thus wage rate increases the labour supply of men and decreases the labour supply of women. In other words, men appear to be on a backward bending whereas women on a positively sloped labour supply curve.

[4] For more information about the theoretical and empirical model as well as for the estimation method see Pashardes and Polycarpou, 2010.

The information given by the elasticity estimates in Table 1 have some interesting policy implications. For example, policies that increase the net wage rate (e.g. tax credits or deductions) can decrease working hours of men and increase the working hours of women, especially among those aged between 55 and 64 or with young children. On the other hand, tax reforms which increase the tax rate on labour income may result in men working more and women working less hours. As for policies that increase the non-labour income (e.g. increase in cash benefits) can decrease working hours among both men and women, as both genders have a negative income elasticity.

The labour supply elasticities reported in Table 1 can give a crude indication about the labour supply response of a hypothetical individual from a change in net wage or non-labour income. As argued earlier in the paper, however, one cannot rely on them for an estimate of how a tax or benefit reform will change the labour supply behavioural and welfare of a particular population. For the latter one has to employ a micro-simulation technique as described next.

5. Micro-simulation procedure

5.1 Optimisation procedure

Recall that the need for a micro-simulation based calculation of the labour supply effects of a tax reform arises from the fact that the majority of income tax systems make the budget constraint non-linear. Here we shall study tax system reforms which make the budget constraint piecewise-linear, convex and create discontinuities only from kinks.

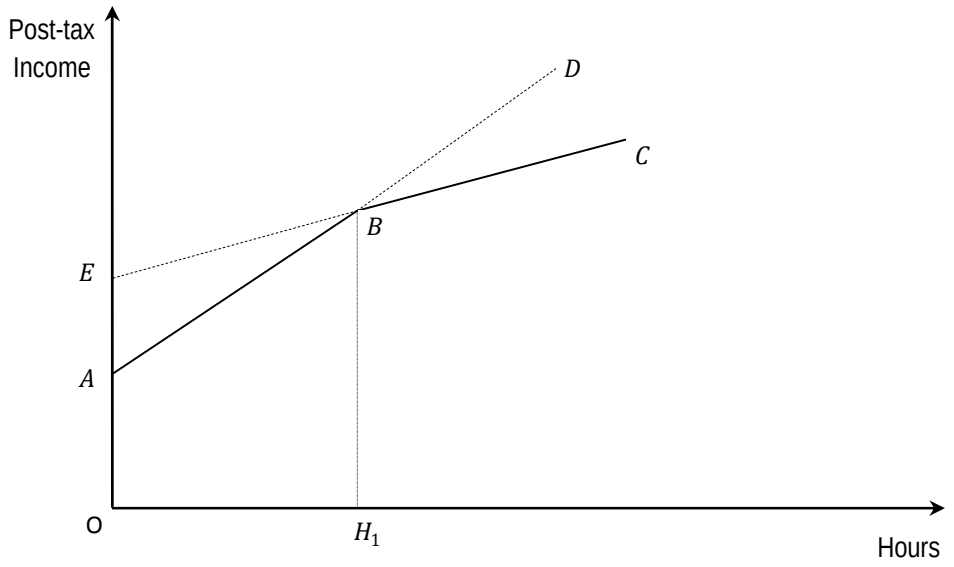
Any piecewise linear budget constraint can be separated into a series of linear segments, each of which can be described by a relation of the form

$$I(h) = \big(1 - t(h)\big)wh + \mu(h) \qquad (8)$$

where $I(h)$ is the net income, $t(h)$ is the tax rate, and $\mu(h)$ is the virtual income, each of which, when the gross wage w is known, depend on hours of work, h. The simulation algorithm proceeds by identifying the locally optimal hours on all the linear segments and kinks of the budget constraint by using the hours (labour) supply function. Then for all feasible optima, i.e. for all locally optimal hours which are within the range of hours over which the relevant linear segment is defined, the level of utility is evaluated; and the global optimum is the one which yields maximum utility.

Figure 2 shows a budget constraint with two linear sections and can be use for describing the procedure[5] (Creedy and Duncan, 2002). The line section AB is associated with net wage w_{AB} and virtual income μ_{AB} while the line section BC is associated with net wage w_{BC} and virtual income μ_{BC}. The first step of the algorithm is to find the optimal hours with net wage w_{AB} and virtual income μ_{AB} i.e. $h_1 = h(w_{AB}, \mu_{AB})$. If the value of h_1 is less than zero then the local optimum is at the corner point A and the individual does not work. To find the utility associated with this point we need the net wage for which individual given the virtual income μ_{AB} would choose zero hours of work. To find this virtual wage rate we set the labour supply equation equal to zero and solve it numerically, i.e. find the wage rate $\overline{w_A}$ for which $h(\overline{w_A}, \mu_{AB}) = 0$. If the value of h_1 lies between A and B then this is the local optimum (and global optimum if the budget set is convex) and utility can be obtained using net wage w_{AB} and virtual income μ_{AB}. If the value of h_1 lies on the right of B, on the extension BD, then no decision can be made about the local optimum until the optimal hours with net wage w_{BC} and virtual income μ_{BC} i.e. $h_2 = h(w_{BC}, \mu_{BC})$ are evaluated. If the value of h_2 lies on the left of B, along the extension EB, then the local optimum is at the kink point B.

Figure 2: Simulation algorithm



To find the utility associated with the local optimum we have to find the virtual wage rate $\overline{w_B}$ and virtual income μ_B for which $h(\overline{w_B}, \mu_B) = H_1$ and the budget constraint $c_B = \mu_B + \overline{w_B} H_1$ is satisfied[6]. Since we have two equations and two unknowns we can seek as system solution to

[5] The procedure can be easily extended for budget constraints with more than two line segments.

[6] c_B is known and equal to the net total income e.g. the non labour income plus the income from employment.

find the virtual wage rate and income for which the individuals chooses H_1 hours of employment. In case of the semi-logarithmic supply function described in the previous section we obtain the value of the virtual wage rate by solving the budget constraint for μ_B and substituting into the labour supply function. We then obtain the following equation

$$\alpha log(\overline{w_B}) + \beta \frac{c_B}{\overline{w_B}} + \gamma - (1+\beta)H_1 = 0 \tag{9}$$

which we solve numerically for the value of w. The value of μ_B is obtained by substituting into the budget constraint[7].

If the value of h_2 lies between B and C then the local optimum is at h_2, and the utility can be obtained using net wage w_{BC} and virtual income μ_{BC}. When the budget set is known to be convex then the local optimum is also a global one; thus, when a local optimal is found there is no need to investigate other line sections of the budget. On the other hand, when the budget set is not known to be convex, the procedure has to be applied on the complete budget constraint to identify all the local optima and set the global optima as the local optimum which is associated with the highest utility level.

5.2 Welfare measure

Microsimulation analysis gives the opportunity to compute welfare changes for each individual under alternative tax system reforms. As described in the previous sections of the paper, a change in the tax system, influence both the net wage rate and the virtual income, thus welfare changes are more complicated to compute than in the context of a price change for a standard commodity (Creedy and Duncan, 2002).

We use the notion of compensated variation (CV) as a measure of welfare, defined here as the lump-sum change in income needed for making an individual after as well off as before the reform of the tax system, e.g. to have the same level of utility before and after the reform. Thus, the CV is written by

$$CV_i = \mu\left(w_i^1, U_i^o; z_i\right) - \mu_i^1 \tag{10}$$

where w_i^1 is the net wage rate and μ_i^1 is the (virtual) income after the reform, and U_i^o is the utility level of individual i before the reform. The expenditure function $\mu(w, U; z)$ gives the minimum expenditure at wage w of achieving a fixed level of utility U. For the model used in this

[7] For some individuals the value of virtual wage rate and virtual income at kink points cannot be defined because equation 9 have no solution or they may obtain a negative value. Those individuals are excluded from the welfare analysis.

paper the expenditure function can be obtain by solving the indirect utility function (eq.(6)) for y_i and replace $u(w_i, y_i; z_i)$ by U_i and y_i by $\mu(w_i, U_i; z_i)$ i.e

$$\mu(w_i, U_i; z_i) = U_i w_i^{-\beta(z_i)} - \frac{w_i}{\beta(z_i)+1}\left[\alpha(z_i) log(w_i) + \gamma(z_i) - \frac{\alpha(z_i)}{\beta(z_i)+1}\right] \quad (11)$$

The compensated variation in (10) is expressed so as to be positive for a welfare loss. The deadweight loss for individual i (DWL_i) is defined as the difference between the CV_i and the change in tax payment ΔT_i, i.e. $DWL_i = CV_i - \Delta T_i$, where $\Delta T_i = T_i^1 - T_i^0$ and T_i^0, T_i^1 are respectively the pre- and post- reform tax payments of individual i. That is, the deadweight loss is the income which must be given to (or taken from) the consumer, in addition to the tax taken away from him/her, in order to return to his/her pre-tax-reform utility level under the post-tax-reform conditions (net wage and virtual income). The deadweight loss for the whole economy (DWL) is the sum over all individual's DWL_i.

6. Simulation results

Using the simulation procedure described in the previous section and the results from the estimated parameters of the labour supply function we study the effect of alternative tax system reforms on employment and welfare. The Cyprus income tax system in 2006 is used as baseline for the alternative reforms.

Cyprus has a progressive income tax system with a high non-taxable earnings allowance and three tax brackets beyond this of 20%, 25% and 30%. The tax schedule of 2006 is shown in Table 2.

Table 2: Income tax system of 2006

Taxable Income (euro)	Tax rate	Accumulated tax (euro)
0-17.086	0%	0
17.086-25.629	20%	1709
25.629-34.172	25%	3845
20.001+	30%	

After the 2002 major reform of the tax system in Cyprus, almost all tax credits and deductions were abolished. In addition, incomes from interest and dividends as well as from social provision became exempted from the tax base, thus one can consider that income tax is applied mainly on income from employment, pensions and rent (20% of rental income is exempt from the tax base). Another important characteristic of the Cyprus income tax system is that each individual

is considered as a separate tax unit i.e. the income of one spouse does not affect the income tax liability of the other.

To illustrate the importance of the income tax system on employment and welfare we will simulate three revenue equivalent tax systems; a “progressive taxation with income tax allowance” tax system, a “progressive taxation with family tax allowances” tax system, and a “proportional taxation” tax system. We also simulate the “no taxation” scenario to find the maximum level of employment and welfare. The results of the reforms are reported as changes from the “no taxation” scenario.

- The “progressive taxation with income tax allowance” reform has the same income bands and tax rates as the 2006 tax system and its main characteristics are the high non-taxable earnings allowance and the non-existence of any other family related tax allowances.

- The “progressive taxation with family tax allowances” reform has also the same income bands and tax rates as the 2006 tax system, except that income up to 17.086 euro is not tax-free but are taxed at 10%. In addition, family related tax allowances exist as before the 2002 reform. In particular, a tax allowance exists for the spouse, for each dependent child under 16 and for each dependent child over 16 in secondary or tertiary education or in military service. The amount of the allowance is set to make this tax scenario revenue equivalent with the “progressive taxation with income tax allowance” reform.

- The “proportional taxation” tax reform has no (family or earning related) tax allowances and is not progressive, but all incomes are taxed at a rate that makes it revenue equivalent with the “progressive taxation with income tax allowance” reform.

- In the “no taxation” scenario earnings are not taxed at all, thus is totally hypothetical, and it is used here for comparison of the reform scenarios described above.

6.1 Effects by gender

Table 3 shows the effect of the alternative tax scenarios on working hours, labour market participation and welfare. The estimation of labour supply equation and the income and wage elasticities presented in Table 1 show that individual labour supply depends on the age of the person and the age of her/his dependent children. The participation rate of men does not change significantly under the different tax scenarios and is close to 95%. On the other hand, the participation rate of women is more volatile under the different tax systems. Under the “no taxation” and “progressive taxation with high income allowance” scenarios, the participation rate of women is around 79.7% and decreases to 78.2% under the “progressive taxation with family allowances” and to 78.8% under the “proportional taxation”.

Table 3: Simulation results under the different tax scenarios

	Males			Females			All		
	Mean hours	Participation rate (%)	Deadweight loss (%)	Mean hours	Participation rate (%)	Deadweight loss (%)	Mean hours	Participation rate (%)	Deadweight loss (%)
No taxation	40.1	95.3%	0	29.1	79.7%	0	34.7	88.4%	0
Progressive-income allow.	38.4	95.3%	-0.2%	27.3	79.7%	4.5%	32.3	88.4%	5.2%
Progressive-family allow.	39.8	95.2%	39.1%	27.7	78.2%	68.7%	33.6	87.3%	54.2%
Proportional taxation	40.5	95.3%	-2.7%	28.8	78.8%	-0.3%	34.5	87.6%	-0.9%

Note: Deadweight loss is presented as a percentage of tax revenues

The working hours of both men and women are affected more by the income tax system compared to the participation rate. Under the "progressive taxation with high income allowance" men work on average 38.4 and women 27.3 hours. The average working hours of men increase by 1.5 hours and of women by 0.5 hours under the "progressive taxation with family allowances", i.e. the working hours of men increase to 39.8 hours and of women to 27.7 hours. A further increase of the average working hours is observed under the "proportional taxation", with men's working hours being around 40.5 hours and of women's around 28.8 hours.

In general, the "progressive taxation with high income allowance" scenario has the highest and the "progressive taxation with family allowances" scenario the lowest participation rate (88.4% and 87.3%, respectively) among the alternative revenue equivalent tax scenarios considered in this paper. On the other hand, the scenario with the highest average working hours (34.5) is the "proportional taxation" and the one with the lowest working hours (32.3) the "progressive taxation with high income allowance". In the case of "no taxation" the participation rate is about 88.4% and the average working hours 34.7.

As for the welfare effects the "progressive taxation with family allowances" scenario creates the highest deadweight loss, which is equal to about 54.4% of the tax revenues. The "progressive taxation with high income allowance" scenario creates a deadweight loss equal to about 5.2% of tax revenues. The lowest deadweight loss is created by the proportional taxation, which is equal to -0.9% of tax revenues[8].

6.2 Effects by gender and age

Table 4 shows the effects on participation, average working hours and welfare under the different tax scenarios (as always, by comparison to the "no taxation" scenario) by the gender

[8] The negative deadweight loss means that we have a net welfare gain from taxation in the sense that although individuals are worst off under taxation compared to the no taxation case (CV is positive) the total tax revenues are higher than the total compensation needed for making all individuals under taxation as well off as they were under the no taxation.

and age of individuals. Later, in Table 5, we consider these effects based on the gender and age of youngest dependent child.[9]

Table 4: Participation, working hours and welfare changes under the different tax scenarios by age

		Males			Females			All		
		Mean hours	Participation rate (%)	Deadweight loss (%)	Mean hours	Participation rate (%)	Deadweight loss (%)	Mean hours	Participation rate (%)	Deadweight loss (%)
Progressive taxation with income tax allowances	25-35	-0.9	0.0%	3.7%	-2.1	0.0%	9.0%	-2.5	0.0%	11.6%
	35-45	0.9	0.0%	-5.2%	-1.5	0.0%	4.8%	-2.8	0.0%	5.7%
	45-55	-2.9	0.0%	0.6%	-1.7	0.0%	3.5%	-1.9	0.0%	2.9%
	55-64	-4.9	0.0%	4.7%	-2.2	0.0%	1.0%	-2.9	0.0%	5.5%
	All	-1.7	0.0%	-0.2%	-1.8	0.0%	4.5%	-2.4	0.0%	5.2%
Progressive taxation with family tax allowances	25-35	-0.4	0.0%	67.4%	-1.6	-1.4%	115.6%	-1.7	-1.0%	96.5%
	35-45	0.8	0.0%	51.5%	-1.1	-1.6%	71.8%	-1.2	-1.0%	59.8%
	45-55	-0.6	0.0%	33.7%	-1.5	-0.4%	52.8%	-0.7	-0.5%	42.9%
	55-64	-1.5	-0.7%	14.6%	-2.2	-2.6%	52.8%	-1.3	-2.2%	40.2%
	All	-0.3	-0.1%	39.1%	-1.4	-1.5%	68.7%	-1.1	-1.1%	54.2%
Proportional taxation	25-35	0	0.0%	-3.8%	-0.5	-0.8%	-1.5%	-0.7	-0.4%	-1.7%
	35-45	0.6	0.0%	-1.2%	-0.2	-1.3%	0.2%	-0.3	-0.6%	-0.6%
	45-55	0.5	0.0%	-2.6%	-0.4	-0.3%	-0.1%	0	-0.3%	-0.7%
	55-64	0.6	-0.2%	-5.0%	-0.6	-1.1%	-0.4%	0.2	-1.9%	-1.3%
	All	0.4	0.0%	-2.7%	-0.3	-0.9%	-0.3%	-0.2	-0.8%	-0.9%

Note: Deadweight loss is presented as a percentage of tax revenues

6.2.1 Effects among men

The participation rate of males is not affected by the different tax scenarios except for males aged between 55 and 64. The participation rate of individuals in the latter group, on average, decreases by 0.7 percentage points under the “progressive taxation with family allowances” scenario and by 0.2 percentage points under the “proportional taxation” compared to the “no taxation” scenario.

On the other hand, the average working hours of males are affected significantly by the income tax system. The greatest effect on average working hours is observed for males aged between 55 and 64. Under the “progressive taxation with income tax allowances” scenario individuals in this age group decrease their working hours by almost 5 hours, and under the “progressive taxation with family allowances” scenario by 1.5 hours; while under the “proportional taxation” scenario they increase their working hours by 0.6 hours.

[9] The average hours, participation rate and deadweight loss under the different tax scenarios based on the age and age of youngest child are presented respectively in Table A3 and A4 of the Appendix.

Significant change in their working hours is also observed for individuals aged between 45 and 55: their working hours decrease by almost 3 hours under the “progressive taxation with income tax allowances” scenario, 0.6 hours under the “progressive taxation with family allowances” scenario and increased by 0.6 hours under the “proportional taxation” scenario. Interestingly males aged between 35 and 45, unlike males in the other age groups, increase their working hours under all tax scenarios. In particular, compare to the “no taxation” scenario, they increase their working hours by almost an hour under the “progressive taxation with income tax allowances” and “progressive taxation with family allowances” scenarios and by 0.6 hours under the “proportional taxation”.

As regards deadweight loss (DWL) the results in Table 4 show the following.

- The “progressive taxation with family allowances” scenario creates the greatest welfare loss. In total the DWL created by this tax scenario is equal to about 39% of the revenues and this percentage is inversely related to age, e.g. the DWL for males aged between 25 and 35 is almost 67.5% of tax revenues and decrease to 14.6% for males aged between 55 and 64.
- The DWL created by the “progressive taxation with income tax allowances” is negative (-0.2% of tax revenues). This means that a welfare gain is created in this case, because of the high and negative DWL of males aged between 35 and 45. In particular, under this tax scenario, the DWL of males aged between 25-35, 45-55 and 55-64 is 3.7%, 0.6% and 4.7%, respectively; while for males aged between 35-45 is -5.2%.
- The DWL under “proportional taxation” is also negative (-2.7%) but in this case all age groups have negative DWL. Males aged between 25-35 and 55-64 have the highest welfare gain, with DWL equal to -3.8% and -5.0% respectively; while for males aged 35-45 and 45-55 the DWL is equal to -1.2% and -2.6%, respectively.

6.2.2 Effects among women

The participation rate is affected more by taxation among women than men. The highest sensitivity of female participation is observed in the 55 to 64 age group. Under the “progressive taxation with family allowances” scenario the participation rate of females in this age group decreases by 2.6 percentage points and under the “proportional taxation” by 1.1 percentage points compared to the “no taxation” scenario. The decrease in the participation rate of women aged between 25-35 and 35-45 is also substantial (1.4 and 1.6 percentage points, respectively) under the “progressive taxation with family allowances” scenario and (0.8 and 1.3 percentage points, respectively) under the “proportional taxation” scenario. The participation rate of females aged between 45-55 is the least affected by tax reform: under the “progressive taxation with family allowances” scenario the participation rate of females in this age group decreases by 0.4

percentage points and under the “proportional taxation” scenario by 0.3 percentage points. In total, the participation rate of women, on average, decreases more under the “progressive taxation with family allowances” scenario (1.5 percentage points) compared to other tax scenarios; while the participation rate of women of any age group under the “progressive taxation with income tax allowances” scenario, on average, remain the same as in the case of no taxation.

The average working hours of women, regardless of age, decrease under all tax scenarios, with “progressive taxation with income tax allowances” producing the highest deduction (1.8 hours) and “proportional taxation” the smallest (0.3 hours). Among the age groups, the highest reduction is observed among females in the youngest (25-35) and oldest (55-64) age groups (around 2 hours) is observed under the “progressive taxation with income tax allowances” scenario. These age groups reduce their working hours by about 0.5 hours under the “proportional taxation” scenario, and by 1.6 and 2.2, respectively, under the “progressive taxation with family allowances” scenario. Females aged between 35-45 and 45-55 decrease their working hours, respectively, by 1.5 and 1.7 hours under the “progressive taxation with income tax allowances” scenario; by 1.1 and 1.5 hours respectively under the “progressive taxation with family allowances” scenario; and by 0.2 and 0.4 hours under the “proportional taxation” scenario.

The “progressive taxation with family allowances” scenario, as in the case of males, creates the highest (68.7%) DWL among females and the “proportional taxation” scenario the lowest (-0.3%). The “progressive taxation with income tax allowances” scenario creates a DWL equal to 4.5% of tax revenues. Under the two progressive taxation scenarios, the youngest age group (25-35) has the highest DWL; and as the age increases the DWL decreases. In particular, under the “progressive taxation with income tax allowances” scenario females aged between 25-35, 35-45, 45-55, 55-64 have DWL as a percentage of tax revenues equal to 9.0%, 4.8%, 3.5% and 1%, respectively; the corresponding DWL under the “progressive taxation with family allowances” is 115.6%, 71.8%, 52.8% and 52.8%. The “proportional taxation” scenario creates a negative DWL for all age groups except for females between 35-45 whose DWL is positive and equal to 0.2%. For the other age groups the DWL associated with the “proportional taxation” scenario is equal to -1.5%, -0.1%, 0.4% for ages between 25-35, 45-55 and 55-64, respectively.

6.3 Effects by gender and the age of youngest child

Table 5 shows the changes on participation, average working hours and welfare under the different tax scenarios compared to the “no taxation” scenario but instead of presenting them by the age of individuals, as in Table 4, we present them by the age of the youngest dependent child.

Table 5: Participation, working hours and welfare changes under the tax scenarios by age of youngest child

		Males			Females			All		
		Mean hours	Participation rate (%)	Deadweight loss (%)	Mean hours	Participation rate (%)	Deadweight loss (%)	Mean hours	Participation rate (%)	Deadweight loss (%)
Progressive taxation with income tax allowances	Less 5	0.8	0.0%	-4.9%	-3	0.0%	4.4%	-5.3	0.0%	6.5%
	6-12	1.4	0.0%	-5.1%	-1.2	0.0%	4.7%	-1.7	0.0%	5.5%
	13-18	-1.5	0.0%	-0.6%	-0.6	0.0%	4.3%	-0.6	0.0%	0.6%
	No child	-3.8	0.0%	6.3%	-2	0.0%	4.5%	-2.3	0.0%	6.7%
	All	-1.7	0.0%	-0.2%	-1.8	0.0%	4.5%	-2.4	0.0%	5.2%
Progressive taxation with family tax allowances	Less 5	0.8	0.0%	63.0%	-1.9	-2.0%	91.6%	-2.7	-1.3%	77.6%
	6-12	1.1	0.0%	49.4%	-1.1	-1.4%	82.2%	-0.8	-0.9%	56.1%
	13-18	0.3	0.0%	40.8%	-0.4	-1.1%	74.2%	0.1	-0.6%	60.7%
	No child	-1.5	-0.3%	17.3%	-1.7	-1.4%	51.7%	-1.1	-1.2%	38.3%
	All	-0.3	-0.1%	39.1%	-1.4	-1.5%	68.7%	-1.1	-1.1%	54.2%
Proportional taxation	Less 5	0.6	0.0%	-1.2%	-0.6	-1.5%	-0.3%	-1	-0.8%	-1.1%
	6-12	0.7	0.0%	-1.0%	-0.5	-0.7%	0.9%	-0.4	-0.4%	0.2%
	13-18	0.6	0.0%	-2.2%	-0.1	-0.8%	0.3%	0.2	-0.5%	-0.5%
	No child	0.2	-0.1%	-5.0%	-0.4	-0.8%	-1.0%	0	-0.9%	-1.7%
	All	0.4	0.0%	-2.7%	-0.3	-0.9%	-0.3%	-0.2	-0.8%	-0.9%

Note: Deadweight loss is presented as a percentage of tax revenues

6.3.1 Effects among men

The age of dependent children does not affect the participation rate of males, under the different tax reform scenarios considered in this paper. In contrast, males without dependent children decrease their participation rate by 0.3 percentage points under the “progressive taxation with family allowances” and by 0.1 under “proportional taxation” scenario.

The working hours of males with dependent children, however, are affected under the different tax scenarios. Males with youngest child aged less than 5 increase their working hours by between 0.6-0.8 hours under the different tax scenarios while the ones with youngest child aged between 6-12 by between 0.7 and 1.4. Males with youngest child aged between 13-18 decrease their working hours by 1.5 hours under the “progressive taxation with income tax allowances” scenario but decrease their working hours by 0.3 and 0.6 hours under the “progressive taxation with family allowances” and “proportional taxation” scenario, respectively.

Males without dependent children decrease working hours the most under the two progressive scenarios and increase working hour the least under the proportional tax. In particular, they decrease their working hours by 3.8 and 1.5 hours under the “progressive taxation with income tax allowances” and “progressive taxation with family allowances”, respectively; and increase their working hours by 0.2 hours under the “proportional taxation” scenario.

The size of DWL created by the different tax scenarios varieties with the age of dependent children. Under the “progressive taxation with income tax allowances” scenario males with children incur negative DWL while the ones without dependent children positive. For males with child aged less than 12 the DWL is about -5% and for males with child aged between 13-18 the DWL is -0.6%. On the other hand the DWL for males without dependent child under the “progressive taxation with income tax allowances” scenario is 6.3%. In the case of “progressive taxation with family allowances” scenario the DWL is positive and decrease as the age of youngest dependent child increases. In particular, the DWL for males with child aged less than 5, between 6-12 and 13-18 is 63.0%, 49.4% and 40.8%, respectively. Males without dependent children under this tax scenario incur a DWL equal to 17.3%. The DWL under the “proportional taxation” scenario is negative for all ages of dependent children and increases (in absolute terms) with the age of the child. Males with children aged less than 5, between 6-12 and 13-18 incur DWL equal to -1.2%, -1.0% and -2.2%, respectively; and the ones without children equal to 5.0%.

6.3.2 Effects among women

The behaviour of females in the labour market is affected more than of men by the presence and age of dependent children. In general, taxation decreases their participation rate and hours in work.

As regards participation the simulation results suggest the following effects.

- Under the “progressive taxation with family allowances” the participation rate of women with children aged less than 5 decreases by 2 percentage points relative to the no tax scenario; while the participation rate of women with youngest dependent child between 6-12 and 13-18 decreases by 1.4 and 1.1 percentage points, respectively. Under this tax scenario the participation rate of females without dependent child decreases by 1.4 percentage points.
- The change in the participation rate of women under the “proportional taxation” scenario is smaller than under the “progressive taxation with family allowances”. In particular, the participation rate of women with children aged less than 5 decreases by 1.5 percentage points while the participation rate of women with youngest child aged between 6-12, 13-18 or without children decreases by about 0.7-0.8 percentage points.

The change in hours in work of women follows the same pattern as the participation rate

- Under the “progressive taxation with income tax allowances” scenario, females with youngest child aged less than 5, between 6-12 or between 13-18 decrease their working hours by 3, 1.2 and 0.6 hours respectively.

- Under the “progressive taxation with family allowances” scenario the decrease in the working hours of women with youngest child aged less than 5, between 6-12 or between 13-18 are 1.9, 1.1 and 0.4 hours, respectively; while under the “proportional taxation” scenario the corresponding figures are 0.6, 0.5 and 0.1.
- Females without children decrease their working hours by 2 hours under the “progressive taxation with income tax allowances” scenario, by 1.7 hours under the “progressive taxation with income tax allowances” scenario and by 0.4 hours under the “proportional taxation” scenario.

The DWL for females under the “progressive taxation with income tax allowances” scenario is between 4.3% and 4.7% of tax revenues, depending on the age of the youngest dependent child. On the other hand the DWL under the “progressive taxation with income tax allowances” scenario is much higher. Females whose youngest child is less than 5 year old incur DWL equal to 91.6% of tax revenues and the percentage fall as the age of the youngest child increase to 82.2% for females with a youngest child between 6-12, by 74% for females with a youngest child between 13-18 and by 51% for females without dependent children. Under the “proportional taxation” scenario females with whose youngest child is less than 5 year old incur negative DWL equal to -0.3% of tax revenues, while females with a youngest child between 6-12 or between 13-18 incur a positive DWL equal to 0.9% and 0.3% of tax revenues respectively. Females without dependent children incur a negative DWL equal to -1.0% of tax revenues.

6.3.3 Effects on inequality

An important objective of the a tax-benefit system is to decrease income inequality. Table 6 shows the effect of the simulated tax reforms on earnings inequality. As a measure of inequality we use the Gini index, which summarises the dispersion of income shares and ranges between 0 (perfect equality) to 1 (perfect inequality). As one would normally expect progressive taxation and especially the “progressive taxation with income tax allowances” scenario decreases income inequality. In contrast income inequality increases under the proportional taxation scenario, albeit by a small margin.

Table 6: Earning inequality under the different tax scenarios

	Males	Females	All
No taxation	0.323	0.579	0.476
Progressive taxation with income tax allowances	0.282	0.527	0.422
Progressive taxation with family tax allowances	0.302	0.562	0.452
Proportional taxation	0.326	0.584	0.480

5. Conclusions

In this paper, we simulate the effect on labour supply and welfare of (a) a progressive tax system with income tax allowances, (b) a progressive tax system with family allowances and (c) a proportional taxation; the no income tax regime is used as reference.

The “progressive taxation with family allowances” scenario affects mainly the participation rate of women and especially those aged between 55 and 64 or with a dependent child aged less than 5. The “proportional taxation” scenario also affects mainly the participation rate of women but the effect is lower than the decrease under the “progressive taxation with family allowances” scenario and is usually below the 1 percentile point. In addition the “proportional taxation” scenario generates the lower decrease in the working hours of women and in the case of men increase their working hours by on average 0.4 hours. The lowest deadweight loss is generated by the “proportional taxation” scenario; and the highest by the “progressive taxation with family allowances”. In the latter case the deadweight loss is near 40% of tax revenues for males and 70% percent for females. The deadweight loss under the “progressive taxation with family allowances”, although negative, is quite low and close to zero for males and 5 percent for females.

In the context of our analysis, on can therefore conclude that there is no “best” tax reform, as the effects on labour supply, equity and efficiency (as measured by deadweight loss) differ between tax regimes. For instance, a country is interested in improving the participation rate, especially of females or individuals over 55, the most suitable tax system is the "proportional with high income allowance" one; while if the country is interested in increasing the working hours of the same age groups the best system is "proportional taxation". On the other hand progressive taxation combined with high income allowance is best for decreasing income inequality; and "proportional taxation", although causing a small decrease in working hours and participation, is best for efficiency as the deadweight loss associated with it is low and mostly negative.

A limitation of our analysis is that we model labour supply at the individual level and not in the context of the family. Although the effects of this assumption may not be as serious as in other countries (where the income tax unit is the family rather than the individual) the labour behaviour of an individual can have a significant effect on the labour behaviour of the other members of the family. Further investigation incorporating family labour supply information and studying further the effect of alternative tax systems on income inequality and poverty would be an interesting extension of this paper.

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APPENDIX

Table A1 : Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Hours	4659	30.471	19.713	0	90
Male	4659	0.455	0.498	0	1
Female	4659	0.545	0.498	0	1
Age 35-44	4659	0.264	0.441	0	1
Age 45-54	4659	0.271	0.445	0	1
Age 55-64	4659	0.207	0.405	0	1
Primary	4659	0.165	0.371	0	1
Lower Secondary	4659	0.097	0.296	0	1
Upper Secondary	4659	0.374	0.484	0	1
Post secondary-Tertiary	4659	0.332	0.471	0	1
Experience	4659	18.473	12.167	0	52
Squared Experience	4659	489.245	525.025	0	2704
Health Condition: Fair	4659	0.120	0.325	0	1
Health Condition: Bad	4659	0.062	0.241	0	1
Married	4659	0.775	0.417	0	1
Spouse works	4659	0.586	0.493	0	1
Number of dependent children	4659	1.090	1.202	0	8
Age of youngest child less than 5	4659	0.166	0.372	0	1
Age of youngest child between 5-12	4659	0.170	0.376	0	1
Age of youngest child between 13-18	4659	0.134	0.341	0	1
Child care at centre-based services (before or after school)	4659	0.038	0.190	0	1
Child care by a child-minder (paid)	4659	0.018	0.132	0	1
Child care by a relative etc (unpaid)	4659	0.141	0.348	0	1
Mortgage Payments (log)	4659	1.234	2.710	0	9.508
Hourly wage (log)	4659	2.142	0.556	0.796	4.072
Hourly wage (log) -Female	2539	1.936	0.566	0.796	3.995
Hourly wage (log) -Male	2120	2.388	0.428	1.610	4.072
Ratio of non-labour to labour income	4659	9.473	33.261	0	1108.564
Ratio of non-labour to labour income-Female	2539	10.614	34.053	0	1108.564
Ratio of non-labour to labour income-Male	2120	8.107	32.241	0	679.301

Table A2: Estimation of labour supply equation

Variables	Male		Female		All	
	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error
Constant	10.732	10.296	15.950**	6.349	2.487	4.948
Age 35-44	-2.318	11.934	-11.383*	6.395	-1.695	5.151
Age 45-54	0.376	15.501	-18.467***	3.405	-8.666	5.318
Age 55-64	16.746	13.697	-43.317***	8.983	-27.682***	6.244
Experience	2.460***	0.231	2.137***	0.211	2.472***	0.145
Squared Experience	-0.032***	0.004	-0.030***	0.005	-0.024***	0.003
Primary	8.077**	3.407	-4.601	3.532	5.076**	2.510
Lower Secondary	9.312***	3.591	-0.607	3.794	9.305***	2.687
Upper Secondary	12.499***	3.444	-1.818	3.615	10.666***	2.555
Post secondary-Tertiary	17.593***	3.555	-2.517	3.781	12.495***	2.636
Health Condition: Fair	-6.884***	1.378	-7.380***	1.652	-7.694***	1.109
Health Condition: Bad	-15.544***	1.899	-12.803***	2.521	-15.396***	1.647
Married	0.390	1.588	-3.606**	1.683	-1.908*	1.144
Number of dependent children	1.288**	0.572	0.786	0.738	1.603***	0.494
Age of youngest child less than 5	4.287	9.420	-32.186***	8.242	-31.906***	5.880
Age of youngest child between 5-12	-2.583	10.279	-27.804***	7.546	-27.225***	5.406
Age of youngest child between 13-18	0.513	14.506	-5.175	6.829	-5.914	5.224
Child care at center-based services (before or after school)	-2.938	1.911	11.272***	2.408	3.983**	1.672
Child care at day-care center	0.315	2.108	7.488***	2.737	5.858***	1.928
Child care by a child-minder (paid)	-2.811	2.794	6.448*	3.527	2.723	2.469
Child care by a relative etc (unpaid)	-0.293	1.277	12.694***	1.552	7.115***	1.068
Spouse works	1.963*	1.010	-2.422	1.564	-2.590***	0.882
Mortgage Payments (log)	0.469***	0.144	0.008	0.143	0.348***	0.124
Hourly wage (log)	-1.272	4.789	6.382**	3.086	4.217*	2.260
Hourly wage (log)*Age 35-44	-4.361	5.177	0.209	3.245	-4.831*	2.521
Hourly wage (log)*Age 45-54	-7.469	6.136	-0.456	3.137	-7.124***	2.520
Hourly wage (log)*Age 55-64	-13.433**	5.293	6.759	4.394	-2.503	2.884
Hourly wage (log)*Age of youngest child less than 5	-3.822	4.204	8.036**	4.040	11.638***	2.767
Hourly wage (log)*Age of youngest child between 5-12	-1.686	4.384	6.250*	3.617	7.320***	2.441
Hourly wage (log)*Age of youngest child between 13-18	-1.493	5.987	-0.629	3.260	0.684	2.390
Ratio of non-labour to labour income	-0.598***	0.181	-0.948***	0.191	-0.821***	0.134
Ratio of non-labour to labour income*Age 35-44	0.054	0.193	0.179	0.156	-0.093	0.130
Ratio of non-labour to labour income*Age 45-54	-0.151	0.222	0.273	0.177	0.116	0.140
Ratio of non-labour to labour income*Age 55-64	-0.878***	0.219	-0.848**	0.376	-0.455***	0.175
Ratio of non-labour to labour income*Age of youngest child less than 5	0.470***	0.147	0.215	0.242	0.029	0.171
Ratio of non-labour to labour income*Age of youngest child between 5-12	0.589***	0.152	0.768***	0.162	0.756***	0.123
Ratio of non-labour to labour income*Age of youngest child between 13-18	0.256	0.192	0.713***	0.160	0.466***	0.134
Number of Obs	2120		2539		4659	

Notes: *, **, *** significant at 10%, 5%, 1% significance level, respectively.

Table A3: Simulation results by age under the different tax scenarios

		Males			Females			All		
		Mean hours	Participation rate (%)	Deadweight loss (%)	Mean hours	Participation rate (%)	Deadweight loss (%)	Mean hours	Participation rate (%)	Deadweight loss (%)
No taxation	25-35	36.7	99.1%	0	31.5	93.2%	0	34.3	97.3%	0
	35-45	40.7	98.5%	0	30.8	89.3%	0	37.7	93.4%	0
	45-55	43.7	98.3%	0	29.0	82.8%	0	35.9	90.9%	0
	55-64	38.7	82.2%	0	20.0	47.2%	0	28.3	67.5%	0
	All	40.1	95.3%	0	29.1	79.7%	0	34.7	88.4%	0
Progressive taxation with income tax allowances	25-35	35.8	99.1%	3.7%	29.4	93.2%	9.0%	31.8	97.3%	11.6%
	35-45	41.6	98.5%	-5.2%	29.3	89.3%	4.8%	34.9	93.4%	5.7%
	45-55	40.8	98.3%	0.6%	27.3	82.8%	3.5%	34.0	90.9%	2.9%
	55-64	33.8	82.2%	4.7%	17.8	47.2%	1.0%	25.4	67.5%	5.5%
	All	38.4	95.3%	-0.2%	27.3	79.7%	4.5%	32.3	88.4%	5.2%
Progressive taxation with family tax allowances	25-35	36.3	99.1%	67.4%	29.9	91.8%	115.6%	32.6	96.3%	96.5%
	35-45	41.5	98.5%	51.5%	29.7	87.7%	71.8%	36.5	92.4%	59.8%
	45-55	43.1	98.3%	33.7%	27.5	82.4%	52.8%	35.2	90.4%	42.9%
	55-64	37.2	81.5%	14.6%	17.8	44.6%	52.8%	27.0	65.3%	40.2%
	All	39.8	95.2%	39.1%	27.7	78.2%	68.7%	33.6	87.3%	54.2%
Proportional taxation	25-35	36.7	99.1%	-3.8%	31.0	92.4%	-1.5%	33.6	96.9%	-1.7%
	35-45	41.3	98.5%	-1.2%	30.6	88.0%	0.2%	37.4	92.8%	-0.6%
	45-55	44.2	98.3%	-2.6%	28.6	82.5%	-0.1%	35.9	90.6%	-0.7%
	55-64	39.3	82.0%	-5.0%	19.4	46.1%	-0.4%	28.5	65.6%	-1.3%
	All	40.5	95.3%	-2.7%	28.8	78.8%	-0.3%	34.5	87.6%	-0.9%

Note: Deadweight loss is presented as a percentage of tax revenues

Table A4: Simulation results by age of youngest child under the different tax scenarios

		Males			Females			All		
		Mean hours	Participation rate (%)	Deadweight loss (%)	Mean hours	Participation rate (%)	Deadweight loss (%)	Mean hours	Participation rate (%)	Deadweight loss (%)
No taxation	Less 5	41.1	100%	0	29.7	86.3%	0	38.7	94.2%	0
	6-12	41	99.7%	0	29.3	86.9%	0	36.5	93.5%	0
	13-18	42.8	98.6%	0	27.2	89.0%	0	34.4	93.1%	0
	No child	38.7	91.5%	0	29.5	73.1%	0	32.8	83.7%	0
	All	40.1	95.3%	0	29.1	79.7%	0	34.7	88.4%	0
Progressive taxation with income tax allowances	Less 5	41.9	100%	-4.9%	26.7	86.3%	4.4%	33.4	94.2%	6.5%
	6-12	42.4	99.7%	-5.1%	28.1	86.9%	4.7%	34.8	93.5%	5.5%
	13-18	41.3	98.6%	-0.6%	26.6	89.0%	4.3%	33.8	93.1%	0.6%
	No child	34.9	91.5%	6.3%	27.5	73.1%	4.5%	30.5	83.7%	6.7%
	All	38.4	95.3%	-0.2%	27.3	79.7%	4.5%	32.3	88.4%	5.2%
Progressive taxation with family tax allowances	Less 5	41.9	100%	63.0%	27.8	84.3%	91.6%	36	92.9%	77.6%
	6-12	42.1	99.7%	49.4%	28.2	85.5%	82.2%	35.7	92.6%	56.1%
	13-18	43.1	98.6%	40.8%	26.8	87.9%	74.2%	34.5	92.5%	60.7%
	No child	37.2	91.2%	17.3%	27.8	71.7%	51.7%	31.7	82.5%	38.3%
	All	39.8	95.2%	39.1%	27.7	78.2%	68.7%	33.6	87.3%	54.2%
Proportional taxation	Less 5	41.7	100%	-1.2%	29.1	84.8%	-0.3%	37.7	93.4%	-1.1%
	6-12	41.7	99.7%	-1.0%	28.8	86.2%	0.9%	36.1	93.1%	0.2%
	13-18	43.4	98.6%	-2.2%	27.1	88.2%	0.3%	34.6	92.6%	-0.5%
	No child	38.9	91.4%	-5.0%	29.1	72.3%	-1.0%	32.8	82.8%	-1.7%
	All	40.5	95.3%	-2.7%	28.8	78.8%	-0.3%	34.5	87.6%	-0.9%

Note: Deadweight loss is presented as a percentage of tax revenues

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