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Panos Pashardes

Economics Research Centre & Department of Economics, University of Cyprus

Alexandros Polycarpou

Economics Research Centre, University of Cyprus

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Panos Pashardes* Alexandros Polycarpou
University of Cyprus *University of Cyprus*

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Abstract

This paper estimates labour supply functions for males and females in Cyprus and computes the income and wage elasticities of different groups based on the age and the age of the youngest dependent child of individuals drawing data from the 2007 EU-SILC database. The results show that labour supply is relatively more responsive to wage changes among women, especially among those with young children, and persons in the 55-64 age group. The total, (income and substitution) effect of a wage rate increase on labour supply is negative for men and positive for women. Thus, in-work benefits to women can increase working hours, while the opposite is true for men. This is especially true for women with young dependent children. In contrast, we find that policies aimed at increasing the non-labour income of individuals can decrease working hours.

JEL: J2, H3

Keywords: labour supply, non-linear taxation, wage/income elasticity, kinked budget constraint, EU-SILC

*Corresponding author: University of Cyprus, POBox 20537, 1678 Nicosia, Cyprus. Email addresses: Pashardes, p.pashardes@ucy.ac.cy; Polycarpou, polycarpou@ucy.ac.cy.

1 Introduction

The role of labour supply issues in economic growth and in reinforcing social cohesion are especially emphasised in the European Union. Employment-friendly tax and benefit reforms are among the key policies of the European Employment Strategy (EES) and, since 2002, are incorporated in the Lisbon Strategy. Among the current eight employment guidelines of the Lisbon Strategy, guideline 19 clearly seeks to promote full employment through tax and benefit reforms. It requests county members to ensure inclusive labour markets, enhance work attractiveness and make work pay for job-seekers, including disadvantaged people and the inactive. That is, member countries have to review and reform their tax-benefit system to ensure that no incentives exist for individuals to leave the labour market early; in contrast there should be incentives to stay active in the labour market. Also the tax-benefit system has to encourage working age individuals - especially women, low-skilled workers, older workers and people with disabilities - to seek, find and stay in work by making employment more financially attractive than benefit dependence (i.e. lower the replacement rate of benefits). In addition, the European Economic Recovery Plan for facing the ongoing recession in EU, following the economic and financial crisis in 2008, encompass fiscal policy measures aiming at enhancing the labour market participation incentives in tax systems, and their contribution to long-term growth prospects. It includes increased support for the unemployed, the poorest households, low-skilled labour and small businesses by strengthening unemployment insurance schemes, lowering taxes on labour and reducing VAT on labour-intensive sectors. In spite of national competence in taxation, there is a need for coordination in this field because of possible inter-dependence and spill-over effects between national economies and social systems in the face of jointly agreed social and employment policy priorities (e.g. making work pay, flexicurity, active ageing, life-long learning, active labour market policies, modern social security systems, etc.).

The literature on work behaviour of individuals goes back to Douglas (1934) and has multiplied many times over the last decades, as labour supply is among the most active areas of economics research. The early attention devoted to the study of labour supply derives from the effort of answering questions of public interest like regulating the use of child labour and compulsory school attendance, or putting restrictions on the length of the working day. More recently, labour sup-

ply literature is concerned in assessing the consequences of a wide array of public policies, ranging from tax and welfare programs to the alteration of institutional features of labour supply. The formal analysis of labour supply in economic research started in the 1960 with Mincer (1962), Becker (1965) and Cain (1966), who employed a more careful approach to separating and measuring the income and substitution effects. The research developed further in the 1970's by, among others, Ashenfelter and Heckman (1974), Gronau (1974), Heckman (1974a, 1974b) and Burtless and Hausman (1978)[1]. This led to the standard labour supply model, which is the heart of studying the incentive effect of tax and welfare benefits on labour supply.

The literature on how tax-and-benefit reforms affect work behaviour is voluminous and trying to review it is outside the scope of this paper[2]. Here we will simply adopt the approach based on the consumer theory of utility maximisation, where individuals derive demand for each commodity under the assumption that prices are constant and independent of the quantity demanded. Thus, in empirical estimation consumer demand depends on commodity prices and the consumer budget (total expenditure). Of course, there exist cases where the 'fixed' price assumption is not valid, e.g. in block pricing schemes used in the water market (Hewitt and Hanemann 1995), electricity market (Reiss and White 2005) and recycling (Hong and Adams 1999) where the marginal price paid by the consumer is not constant and exogenous but depend on the quantity consumed. Government income tax and income transfers also violate the assumption that prices are given and results in nonlinear consumer budgets. As noted by Burtless and Hausman 1978, net, after-tax wage rates almost always depend on the number of hours of work supplied. For instance, workers facing a progressive income tax have net wage rates that decline as their gross earnings rise. Income transfers also cause prices to be nonlinear; and because they are accompanied by high marginal tax rates also cause budget sets to be nonconvex, which further complicates the theory and estimation of labour supply.

When the endogeneity of the net wage rate described above is ignored, only reduced form estimates can be obtained. These estimates depend on the particular sample information and cannot be used to evaluate the expected effect of policy

[1]For a comprehensive literature review on labour supply up to the 1980's see the surveys of Pencavel (1986) and Killingsworth and Heckman (1986).

[2]For an overview of the literature on tax and labour supply see Meghir and Phillips (2010).

changes (Burtless and Hausman 1978). The use of a structural model, however, necessitates the application of methods to account for nonlinear net wages that depend on hours of work supplied. This implies that individual choice depends on all net wages that comprise the budget set so that policy changes can be evaluated using the parameter estimates. In addition structural models of labour supply allow for the preference of heterogeneity in the labor-leisure choice.

As already mentioned, the progressivity of the income tax and the public income transfers complicate the analysis of the labour supply because the consumer's budget constraint becomes nonlinear or piecewise linear, with kinks at the points where the income tax-rates or the marginal tax-rates of the income transfers change. For estimating this kind of models there are two options: the use of the complete budget constraint maximum-likelihood procedure which has been proposed by Burtless and Hausman (1978) and developed by Hausman (1985b) and Moffitt (1986, 1990); or the use of the instrumental-variable procedure that treats the observed net wage and virtual income, which results from linearising the budget constraint (Killingsworth 1983), as endogenous. Based on Monte Carlo evidence, the resulting parameter estimates are, on average, very similar to those of the maximum-likelihood procedure (Triest 1988). Although empirical approaches and data used in the literature differ there exists a broad consensus on some issues. The size of work incentives created by the tax and benefit system differs by demographic and education group. For some groups like women with young children, taxes and benefits can affect the participation decision (whether to work or not) as well as the hours they work. In the case of low educated men, tax and benefit incentives affect only their participation decision, while their hours of work are insensitive to changes in taxes and benefits. In contrast, taxes and benefits do not appear to have an effect on the way highly educated and wealthy men behave in the labour market, although they affect their total as well as their taxable income, i.e. they shift consumption and income to non-taxable forms and adjust their work effort.

Research on the labour supply in Cyprus is limited. Kontolemis (1994) investigate the institutional characteristics of the labour market in Cyprus, Christofides and Pashardes (2000, 2002) studied the gender wage gap in paid employment in Cyprus as well as the double selection problem of choice between self- and paid-employment and employment in the public or private sector. Also Christofides et al. (2007) studied the impact of foreign workers on the Cyprus labour mar-

ket. 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.

Our research is the first attempt to study the labour market in Cyprus using the structural neoclassical labour supply model and, in addition, incorporate the tax system using data. Further to the use of a theoretically correct model, this approach enables the indirect utility/expenditure function and create money metric indices for welfare analysis can be recovered from the parameter estimates of labour supply function. This enables one to study the welfare effects of alternative tax-benefit policies for increasing labour market participation and hours worked.

The next section of the paper presents a brief overview of the empirical literature on labour supply. Section 3 considers the theoretical foundations of the model used to investigate labour supply in the paper and Section 4 outlines the estimation method used for the empirical analysis. Section 5 describes the data and reports the empirical results obtained for labour market participation and supply of hours. Section 6 concludes the paper and considers policy implications that can be drawn from our analysis for Cyprus.

2 Findings in the Literature

A large number of studies in the literature have concentrated on female labour supply. Women have a lower labour market participation and work fewer hours compared to men. Moreover their hours of work are more dispersed and there is a belief that they are more responsive to incentives. These arguments imply that tax or benefit system reforms targeted on increasing women's incentives to work are likely to have significant effects on economic growth. Nonetheless, as shown by Meghir and Phillips (2010), predictions about the behaviour of women in the labour market (wage and income elasticities of hours of work) differ among the various published studies, although very few studies predict uncompensated wage elasticity higher than unity and those that do are based on annual hours of work. On an annual basis individuals have more margins for adjustments, such as weeks per year or hours per week and estimated elasticities tend to be clustering close to unity.

An important issue in estimating wage elasticities and wage equations, in general, are the treatment of censoring which arises because of non-working individuals, the endogeneity of wages, and treatment of taxes. Heckman (1974b) was the first to incorporate the effect of non-working individuals in the estimation procedure of wage equation and found that US married women have an annual hours of work elasticity of 0.8 at 2000 hours; and an income elasticity, given the male wage, around 0. Cogan (1981) allow also for fixed costs of work and using US data on females aged 30-35, also found an annual hours of work elasticity around 0.8 (more precisely 0.864) but at 1400 hours; while his estimated income elasticity at income $10000 is 0.16. Arellano and Meghir (1992) allow for fixed costs, endogeneity of taxes and pre-tax wages and non-labour income and using UK data on married females aged 20-59, find elasticities for weekly hours of work in the range of 0.3 to 0.7 with a mean of 0.37, depending on the age of women and the number of dependent children. Their estimated income elasticity is between -0.13 to -0.40 (on average -0.13). Using cross sectional data on UK married females aged 20-50, for a number of years, Blundell, Duncan and Meghir (1998) relax many of the assumptions imposed in earlier studies (and allowing for endogeneity of pre and post tax wages as well as fixed costs) found the uncompensated wage elasticity to be in the range of 0.13-0.37 depending on the age of the youngest child. The estimated income elasticity is between -0.19 and 0.

Some authors, in addition to the wage and income elasticities of hours working, evaluate participation elasticities of women. Arrufat and Zabalza (1986), using data for UK married women less than 60, find a wage elasticity of participation, evaluate at the mean, of 1.41. On the other hand, Blundell, Ham and Meghir (1987) using data for married women aged 16-60 find the same wage elasticity to be 0.04 or 0.08, depending on the approach used. Pencavel (1998) conducts a comprehensive study using US data for women aged 25-60 using various approaches and finds wage elasticities of participation to be in the range of 0.7-1.8. Based on these results labour market participation seems to be more elastic among married women and among women in poor families.

Lone mothers are a policy interest group who attracted much attention, as they tend to be poor and face very high labour market participation cost. The government in the US, the UK and other countries have been actively promoting in-work benefit programs for increasing the work incentives of lone mother. A number of papers estimate the effect of these programs. For instance, Dickert,

Houser and Scholz (1995), Eissa and Liebman (1996) and Keane and Moffitt (1998) using different approaches evaluate the participation elasticities of lone mother in USA to be 0.85, 1.16 and 0.96 respectively. For UK, Ermisch and Wright (1991) and Jenkins (1992) estimate the same elasticity to be 1.7 and 1.8, respectively. Brewer et al (2006) using a structural model of labour supply to investigate the effect of the 1999 reform of the in-work transfer system in UK estimate the participation elasticity of lone mothers with respect to in-work income to be 1.02. In general, there is a consensus in the literature that the participation elasticity of lone mothers is among the highest of all demographic groups. This implies that carefully designed in-work benefit programs for lone mothers can be effective towards increasing the participation of women in the labour market.

In contrast to females, estimates on males' labour supply behaviour are rather limited. Males in many countries work full time and based on estimates they have very low, and in some cases close to zero, income and wage elasticities for hours of work. Ashenfelter and Heckman (1974), for instance, using US data for married men aged 25-54 estimate the uncompensated wage elasticity to be 0.06 and the income elasticity at -0.11. Similarly low elasticities (wage elasticity in the range of 0.06-0.08 and income elasticity at -0.02) are reported by Blomquist and Newey (2002) using Swedish data for married men aged 20-60. On the other hand, Flood and MaCurdy (1992) using Swedish data for married men aged 25-65 estimated somewhat higher wage elasticities (in the range of -0.25 to 0.21) but similarly low income elasticity (in the range 0.04 to -0.1). MaCurdy, Green and Paarsch (1990) using US data of married males aged 25-55, evaluate wage elasticities between -0.24 and 0.032 and income elasticity around -0.01. Due to the high labour market participation of men there are very few studies on this subject and those that estimate the male labour market participation elasticity, find this to be close to 0 (e.g. Aaberge et al, 1999).

3 Theoretical Model

Labour supply at the microeconomic level is defined as the opposite of demand for leisure. Therefore, individuals decide their leisure (work) hours together with the level of consumption of other goods and services. A change in the price of leisure (net wage) - e.g. due to a change in income tax - creates a substitution and income effect in demand: when the price of leisure increases individuals substitute leisure

for other goods. They also face an income effect (change in their purchasing power) but, unlike other goods, this effect is more complicated: an increase in the price of leisure (net wage) reduces the purchasing power of the consumer, like it does in the case of an increase in the price of any other commodity; at the same time, however, it also raises income from employment. This multiple effect of changes in the price of leisure on the budget constraint (change in slope and position) together with complications arising from the non-linearity of this constraint (due to taxation) has led researchers to adopt a reduced form approach to specifying the labour supply function (Blundell and MaCurdy, 1999) in investigating the employment effects of tax-benefit reforms. While this approach is relatively easy to implement, it does not allow one to consider the full impact of tax-benefit reforms on welfare. The structural approach explained below can remedy this obscurity.

The theoretical basis of our analysis originates from the standard assumption that individual i maximises a quasi-concave utility function $U(C_i, L_i, z_i)$ subject to the budget constraint $C_i + w_i = Y_i + w_i T_i$ where C_i is consumption, L_i leisure time, z_i a vector with individual characteristics, w_i hourly wage rate, Y_i non-labour income and T_i total available time. 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 first order conditions of the maximisation problem, we obtain the Marshallian demand functions for consumption $C_i = C(w_i, M_i, z_i)$ and leisure $L_i = L(w_i, M_i, z_i)$. Then by using the time constraint relation $L_i + h_i = T_i$, i.e. the total time allocated to leisure (L_i) and work (h_i) must be equal to the total available time, and the definition of M_i in terms of Y_i, we obtain the Marshallian labour supply equation $h_i^m = h^m(w_i, Y_i, z_i)$, which we will seeks to estimate empirically.

The main goal of estimating the labour supply equation is the evaluation of the uncompensated (Marshallian) wage elasticity, s^u, and the compensated (Hicksian) wage elasticity, s^c. The uncompensated wage elasticity is defined as $s^u = \partial \ln h^m / \partial \ln w$ and the compensated wage elasticity, using the Slutsky equation $s^c = s^u - (wh/Y)(\partial \ln h^m / \partial \ln Y)$. Assuming that leisure is a normal good, i.e. $\partial \ln h^m / \partial \ln Y$ is negative, the compensated wage elasticity is larger than the uncompensated one[3]. Also the absolute difference between compensated and

[3]Income and substitution effects are in opposite directions in Marshallian demand.

uncompensated wage elasticities depends positively (negatively) on the share of income devoted to leisure (labour) and the income elasticity.

Labour supply is observed to have a positive slope at low wage rates and to be backward bending over high wage rates. Thus, it is important to define an explicit form of the labour supply function, $h_i^m = h^m(w_i, Y_i, z_i)$, that allows for this kind of behaviour. In addition, the empirical representation of consumer preferences should satisfy integrability, i.e. the ability to recover the parameters of the indirect utility function from empirical demand analysis. Integrability is mandatory in the context of our approach because we wish to derive a measure of the welfare (deadweight) loss associated with employment enhancing policy measures affecting the level of net wage.

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

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

where: w_i is the relative net wage rate; U_i the utility level; z_i a vector of individual demographic and other characteristics; and $\alpha(z_i)$, $\beta(z_i)$, and $\gamma(z_i)$ the parameters which depend on the characteristics of the individual.

Applying Shephard's lemma [4] we can derive the Hicksian labour supply function

$$h^h(w_i, U_i, z_i) = \frac{\beta(z_i)}{w_i^{\beta(z_i)+1}}U_i + \frac{1}{1+\beta(z_i)}\left[\alpha(z_i)\log w_i + \gamma(z_i) + \frac{\alpha(z_i)\beta(z_i)}{1+\beta(z_i)})\right] \quad (2)$$

and using $e(w_i, v(w_i, y_i, z_i), z_i) = y_i$, i.e. the definition of the minimum expenditure necessary for the individual i to reach the utility level $v_i = v(w_i, y_i, z_i)$, we can obtain the indirect utility function (Blundell and MaCurdy 1999)

$$v(w_i, y_i, z_i) = \frac{w_i^{\beta(z_i)+1}}{\beta(z_i)+1}\left[\frac{y_i}{w_i}(\beta(z_i)+1) + \alpha(z_i)\log w_i + \gamma(z_i) - \frac{\alpha(z_i)}{1+\beta(z_i)})\right] \quad (3)$$

where y_i is the non labour income of i^{th} individual.

Substituting equation (3) in equation (2) we obtain the Marshallian labour supply function

$$h^m(w_i, y_i, z_i) = \alpha(z_i)\log w_i + \beta(z_i)\frac{y_i}{w_i} + \gamma(z_i) \quad (4)$$

[4] Taking the derivative of the expenditure function with respect to the wage rate (w_i) we can obtain demand for leisure, i.e. the negative of the Hicksian labour supply function.

that belongs to the family of semi-logarithmic labour supply functions and was introduced by Duncan (1993). For leisure to be a normal good, we need $\partial h^m/\partial y_i = \beta(z_i)/w_i$ to be negative, thus it is required to have $\beta(z_i) < 0$. Also differentiation with respect to w_i yields $\partial h^m/\partial w_i = \frac{1}{w_i}\left(\alpha(z_i) - \beta(z_i)\frac{y_i}{w_i}\right)$. Hence, the labour supply function can be backward bending (negative sloped) when $\alpha(z_i) < 0$ and $w_i > [\beta(z_i)/\alpha(z_i)]y_i$ .Based on the labour supply function in equation (4) the income elasticity, which is defined as $s^{inc} = (\partial h^m/\partial y)(y/h)$, is given by

$$s^{inc} = \beta(z)\frac{y}{wh}. \tag{5}$$

Also, the uncompensated and uncompensated wage elasticities (as defined above) are given by

$$s^u = \frac{\alpha(z)}{h} - \beta(z)\frac{y}{wh}, \tag{6}$$

and

$$s^c = \frac{\alpha(z)}{h} - \beta(z)\frac{y}{wh} - \beta(z) = s^u - \beta(z), \tag{7}$$

respectively.

4 Estimation Method

The Marshallian demand (or supply) equations in general, typically non-linear in the parameters and variables, can be estimated using maximum-likelihood methods. Notably, the estimation of the Marshallian labour supply (demand for leisure) equation is much more complicated since the after-tax wage (price of leisure) depends on hours of working (demanded/consumed hours of leisure). The progressive income tax and the variety of welfare programs create a set of discretely varying tax rates (positive or negative) that affect (after-tax) wage rate and net non-labour income (Aronsson, Wikstrom and Brannlund 1997). Consequently, the budget constraint is kinked (piecewise-linear).

Estimation of the supply (or demand) curves in the presents of a kinked budget constraint is a major issue in the area of applied econometrics.[5] Until the late 1970s simple estimation methods like least-squares or instrumental variable procedures were used for dealing with the piecewise-linear budget constraint problem.

[5]The estimation problem is that the kink points in the supply (demand) schedule and the nonlinearities in the response must be estimated along with the parameters of the supply (demand) function.

These methods, however, have been strongly criticised for producing biased and inconsistent estimates. A piecewise-linear budget constraint makes the price (forgone net wage) paid at the margin depend on the quantity of the good (leisure) consumed. This makes the covariance between the error term and the variables measuring the marginal wage and effective/virtual income nonzero. Two options have emerged in the literature for solving this estimation problem: (i) the use of the complete budget constraint maximum-likelihood procedure proposed by Burtless and Hausman (1978) and developed by Hausman (1985b) and Moffitt (1986, 1990); or (ii) the use of the instrumental-variable procedure that treats as endogenous the observed net wage and virtual income which results from linearising the budget constraint (Killingsworth 1983). Based on Monte Carlo evidence, the resulting parameter estimates obtained from the two methods are, on average, very similar (Triest, 1988). The method we follow here for estimating optimal supply of hours in the presence of a kinked budget constraint is the complete budget constraint maximum-likelihood procedure (Moffitt, 1990), where the observed hours are generated by a generalised Tobit model (Tobit, 1958; Kuismanen, 2005) and described as follows.

The labour supply function can be written as $h_i = h_i^*(w_i^*, Y_i, z_i) + e_i$, where z_i is a vector of individual demographic and other characteristics, and e_i represents measurement errors. The empirical specification of this function used for the empirical analysis in this paper is based on the generalisation of the semi-logarithmic labour supply function introduced by Duncan (1993) and be written as

$$h(w_i, y_i\ , z_i) = \alpha(z_i)\log(w_i) + \beta(z_i)\frac{y_i}{w_i} + \gamma(z_i) + e_i \tag{8}$$

where e_i is the error term.

Observed hours can be assumed to be generated by the generalised Tobit model

$$h_i = 0 \qquad if \quad h_i^* + e_i = 0 \tag{9}$$

$$h_i = h_i^*(w_i^*, Y_i, z_i) + e_i \qquad if \quad 0 < h_i^* + e_i < H_n \tag{10}$$

$$h_i = H_n \qquad if \quad h_i^* + e_i \geq H_n, \tag{11}$$

and the corresponding log likelihood function can be written as

$$l = \sum_{i:h_i=0} \ln\left[1 - \Phi\left(\frac{h_i^*}{\sigma}\right)\right] + \sum_{i:0<h_i<H_n} \ln\left[\frac{1}{\sigma}\phi\left(\frac{h_i - h_i^*}{\sigma}\right)\right] + \tag{12}$$

$$+ \sum_{i:h_i \geq H_n} \ln \left[1 - \Phi \left(\frac{H_n - h_i^*}{\sigma} \right) \right],$$

where $\phi(.)$ is the standardised normal density and $\Phi(.)$ the cumulative normal. The first term on the right-hand side of (12) corresponds to individuals whose observed hours are zero, the second term to individuals with observed hours on the segments or kind points and the third term to individuals with observed hours on the segment above the last kink point.

To determine the optimal supply of hours in the presence of a kinked budget constraint we need to build a search algorithm to operate inside the second term of the likelihood function. For segment k $(k = 1, 2, ..., n)$, the optimal supply of hours, h^*, satisfies the condition

$$H_{k-1} < h^*(w_i^*, Y_i, z_i) < H_k \tag{13}$$

and the algorithm should iterate subject to this condition being satisfied. In case of no solution then the optimal hours are on a kink point k $(k = 1, 2, ..., n)$ and optimal hours in this case must satisfy the 'corner' condition

$$h^*(w_k^*, Y_k, z) \geqslant H_k \text{ and } h^*(w_{k+1}^*, Y_{k+1}, z) \leqslant H_k. \tag{14}$$

5 Data and Estimation

The data used for the estimation of the model described above are drawn from the 2007 European Union Statistics on Income and Living Conditions (EU-SILC) database[6]. 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 main aim of the EU-SILC is the collection of timely and cross-country comparable multidimensional micro data on income, poverty and social exclusion. Two types of data are provided: the cross-section data pertaining to a given time period and the longitudinal data pertaining to changes at the individual person level over time (observed periodically over, typically, a four-year period). The data at household level include income, social exclusion and housing/household characteristics. For each member of the

[6]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.

household it 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. In addition, it gives the opportunity of applying the proposed method of analysis to several EU countries for country comparison purposes.

The data for Cyprus 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 to avoid income under-reporting problems and problems arising from the fact that the determinants of their labour supply behaviour are likely to differ from the rest of the population. Also dropped are individuals with incomplete or unreliable personal and occupational information.

5.1 Imputation of unobserved wage

For estimating equation (8) we need information for the wage rate of both working and non-working individuals. Yet, the hourly wage rates are observed only for the working individuals. The wage rates of the non-working individuals are unobserved and have to be imputed. Traditionally the imputation of the wage rates is based on the estimation of the expected market hourly wage rate given a set of observed characteristics. In this paper, the equation used for imputing the hourly wage rate of non-working individuals is estimated using the two-step (labour market participation and working hours) method proposed by Heckman (1979). Table 1 presents the estimation results obtained from the first step, the labour market participation equation.

As expected, men have higher probability of participating in the labour market than women. Also age has a negative and increasing effect on this probability, e.g. individuals aged between 35 and 44 have lower probability of participating in the labour force than individuals aged between 25 and 34; and as the age increases the probability of employment decreases even more. This negative and increasing effect of age appears to be higher among women than men. In addition, years of experience have a positive effect on labour market participation, especially

among women, where years of experience appear to have decreasing returns - an additional year have a positive but smaller effect on the probability of participating in the labour force. We should, of course, keep in mind that the parameters reported in Table 1 represent the conditional (marginal) effects, i.e. when all other characteristics are held constant.

- Education level does not have a significant effect on the employment probability except at the higher level where both male and female post-secondary (college) or tertiary graduates have a statistically significant higher probability of participating in the labour market compared to individuals with lower lever of education.

- The health condition of individuals has also a significant effect on employment. Women in fair health have lower employment probability compared to women in good or very good health. Unlike women, fair health does not have a significant effect on the employment probability of men. Bad health, however, decreases the employment probability of men.

- Married men have a higher probability of participating in the labour market compared to non-married men; whereas the opposite holds true for married women. Family composition has also a significant effect on the employment probability of individuals.

- The number of children affect positively both the participation of men and women. Yet, the existence of young children in the household decrease the employment probability of women (but do not affect the employment probability of men). In particular, the presence of children less than 12 years old in the family decreases the employment probability of women and the decrease is larger if the child is less than 5 years old. Children above 12 years do not have a significant effect on the employment probability of either men or women.

- The negative effect of young children on the employment probability of women appears to be offset by the availability of child care services. Centre-based child care services before or after school hours and paid child care by a child minder have positive and similar in size effect on the employment probability of women. The most effective child care service for increasing

Table 1: Labour market participation equation

Variables	Male	Female	All
Male			0.458***
			(0.055)
Age 35-44	-0.235	-0.367***	-0.346***
	(0.168)	(0.119)	(0.091)
Age 45-54	-0.379*	-0.608***	-0.583***
	(0.228)	(0.145)	(0.113)
Age 55-64	-0.970***	-0.950***	-1.054***
	(0.286)	(0.190)	(0.143)
Experience	0.068***	0.123***	0.111***
	(0.024)	(0.013)	(0.010)
Squared Experience	-0.001	-0.002***	-0.001***
	(0.000)	(0.000)	(0.000)
Primary	0.245	-0.299	-0.110
	(0.275)	(0.233)	(0.175)
Lower Secondary	0.279	-0.111	-0.029
	(0.297)	(0.248)	(0.187)
Upper Secondary	0.391	0.287	0.224
	(0.279)	(0.230)	(0.174)
Post secondary-Tertiary	0.509*	0.383*	0.341*
	(0.284)	(0.232)	(0.175)
Health Condition: Fair	-0.153	-0.221**	-0.182**
	(0.118)	(0.111)	(0.080)
Health Condition: Bad	-0.445***	-0.215	-0.345***
	(0.157)	(0.171)	(0.116)
Married	0.370**	-0.381***	-0.099
	(0.178)	(0.146)	(0.101)
Number of dependent children	0.126**	0.121***	0.126***
	(0.050)	(0.047)	(0.033)
Age of youngest child less than 5	-0.043	-0.535***	-0.230*
	(0.176)	(0.168)	(0.120)
Age of youngest child between 5-12	0.031	-0.334**	-0.092
	(0.160)	(0.145)	(0.106)
Age of youngest child between 13-18	-0.179	-0.026	-0.037
	(0.138)	(0.123)	(0.091)
Child care at centre-based services (before or after school normal work time)	-0.059	0.448***	0.208*
	(0.172)	(0.159)	(0.118)
Child care at day-care center	-0.116	0.184	0.042
	(0.185)	(0.180)	(0.129)
Child care by a child-minder (paid)	-0.223	0.473**	0.177
	(0.234)	(0.215)	(0.159)
Child care by a relative etc (unpaid)	0.095	0.580***	0.386***
	(0.115)	(0.103)	(0.075)
Spouse works	-0.019	0.155	-0.070
	(0.091)	(0.134)	(0.073)
Non-labour Income (log)	-0.326***	-0.267***	-0.295***
	(0.029)	(0.028)	(0.020)
Mortgage Payments (log)	0.008	-0.009	0.003
	(0.013)	(0.013)	(0.009)
Constant	1.121***	0.614*	0.705***
	(0.409)	(0.338)	(0.248)
Number of Obs	1462	1790	3252

Notes: 1. standard errors in brackets
2. *, **, *** significant at 10%, 5%, 1% significance level, respectively.

the probability of employment among women in Cyprus seems to be the unpaid child care offered by relative, e.g. grandparents.

- As expected, the employment probability is negatively related to non-labour income. This income decreases the probability of employment of both women and, in particular, men.

Table 2 presents the results obtained from the wage equation which are used for the imputation of the unobserved (reservation) wage of individuals not participating in the labour market. In predicting the wages gender, age, education, marital status and experience in the labour market are used as explanatory variables.

Table 2: Wage prediction equation

Variables	Male	Female	All
Male			0.258***
			(0.026)
Age 35-44	0.182***	-0.052	0.003
	(0.067)	(0.059)	(0.043)
Age 45-54	0.317***	-0.088	0.003
	(0.094)	(0.077)	(0.058)
Age 55-64	0.313**	-0.094	-0.048
	(0.122)	(0.110)	(0.080)
Primary	-0.102	-0.109	-0.138
	(0.137)	(0.151)	(0.099)
Lower Secondary	-0.155	0.026	-0.133
	(0.145)	(0.157)	(0.105)
Upper Secondary	0.003	0.356**	0.104
	(0.139)	(0.146)	(0.100)
Post secondary-Tertiary	0.327**	0.757***	0.482***
	(0.141)	(0.147)	(0.101)
Married	0.172**	0.068	0.071
	(0.084)	(0.050)	(0.044)
Experience	0.004	0.037***	0.033***
	(0.011)	(0.011)	(0.007)
Squared Experience	-0.000	-0.000	-0.000***
	(0.000)	(0.000)	(0.000)
Constant	1.920***	0.999***	1.377***
	(0.193)	(0.202)	(0.145)
Number of Obs	1462	1790	3252

Notes: 1. standard errors in brackets
2. *, **, *** significant at 10%, 5%, 1% significance level, respectively.

- Male individuals receive, on average, 25.8 percent higher wages compared to women.

- The wage rate of men is affected positively by age. In particular, men between the ages of 35 and 44 receive by 18.2 percent, between 45 and 54 by 31.7 and between 55 and 64 by 31.3 percent higher wages, compared to males aged between 25 and 34. Years in the labour market (experience) do not affect the wage rate of men. The wage of men is also positively affected by education: post-secondary (college) or tertiary education graduates receive a wage rate 32.7 percent higher than those without post-secondary of tertiary education.

- Women's wage rate is not affected by the age but is positively affected by the years in the labour market (experience). Each additional year in the labour market increase the wage rate of women by 3.7 percent. Also, upper-secondary and post-secondary or tertiary education have positive effect of the wage rate of women: those with upper secondary education receive a wage rate higher by 35.6% compared to women with primary education; and those with post-secondary or tertiary education receive wage rate higher by 75.7% compared to women with up to secondary education.

5.2 Optimal supply of hours

For the estimation number of hours in the labour market, i.e. the labour supply equation (8), we use the complete budget constraint maximum likelihood procedure in GAUSS described in Section 4, to account for the non-linearity of the budget constraint due to the progressive income tax in Cyprus. Individual's characteristics are assumed to affect the intercept of the hours equation (i.e. the minimum hours, $\gamma(z_i)$ which an individual with given characteristics, works independently of his/hers wage rate and non-labour income) while the effect of wage rate and non-labour income is allowed to differ only by gender. The regressors include dichotomous (dummy) variables for gender, age, education, health condition, marital status, whether wife works and childcare services; and continuous variables for children and age of younger child, mortgage payments (log), years in the labour marker, hourly wage rate (log) and the ratio of non-labour income to the hourly wage rate are also included. The descriptive statistics of the variables included in the estimation are presented in Table $A1$ of the Appendix, while Table 3 presents the results obtained from the estimation of the labour supply equation, separately for males and females as well as jointly for the two sexes.

- The constant term, representing the labour supply of the individual with the basic characteristics[7], is statistically significant only in the regression for females.

- Age has a negative and increasing direct effect on the labour supply of women (but not men). It also has a significant negative effect on (i) the labour supply of men through interaction the with the log hourly wage in the case of the age group 55-64; and (ii) the labour supply of men and women through interaction with the ratio of non-labour to labour income. We shall return to the discussion of these findings later.

- Experience has a positive and decreasing effect on the labour supply of both males and females[8]. By combining the negative effect of age and the positive but decreasing effect of experience we can infer that individuals increase their hours in the labour market up to the age of 55 and then do the opposite, i.e. start to substitute consumption with leisure. In addition, based on the results, females aged between 55-64 decrease their working hours much more than the males. Also each additional year of experience increases the supplied hours of females less than those of males; even though, marginally, the effect of experience on female labour supply depreciates with a lower rate.

- The level of education affects positively the labour supply of men, but has no statistically significant effect on the labour supply of women. Males with primary, lower-secondary and upper-secondary or tertiary education work on average about 8, 9, 12.5 and 17.6 more hours than males with no education. Based on the results of the pooled estimation for both men and women, primary education increases the labour supply by 5 hours, lower-secondary education by 9 hours, upper-secondary by 10.6 hours, and post-secondary or tertiary education by 12.5 hours.

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[7] In our analysis the basic (reference) group has the following characteristics: age between 25 and 34, illiterate, good health, non-married, without experience, dependent children, mortgage payments and out-of-labour market income.

[8] If we assume that on average individuals start work at the age of 25, then individuals in the youngest age group (25-34) have on average 5 years of experience, and individuals in the age groups between 35-44, 45-55 and 55-64 have respectively 15, 25 and 35 years of experience.

Table 3: 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-labor to labor income	-0.598***	0.181	-0.948***	0.191	-0.821***	0.134
Ratio of non-labor to labor income *Age 35-44	0.054	0.193	0.179	0.156	-0.093	0.130
Ratio of non-labor to labor income *Age 45-54	-0.151	0.222	0.273	0.177	0.116	0.140
Ratio of non-labor to labor income *Age 55-64	-0.878***	0.219	-0.848**	0.376	-0.455***	0.175
Ratio of non-labor to labor income *Age of youngest child less than 5	0.470***	0.147	0.215	0.242	0.029	0.171
Ratio of non-labor to labor income *Age of youngest child between 5-12	0.589***	0.152	0.768***	0.162	0.756***	0.123
Ratio of non-labor to labor 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.

- As expected, health problems decrease the hours individuals supply in the labour market. In particular, males with fair health condition supply almost 7 hours less in the labour market and those with bad health condition and 15.5 hours less compared to males with good or very good health condition. Similarly, females with fair or bad health reduce the supply of hours by about 7.5 and 13 hours compared to females with good or very good health condition, respectively.

- Family status and composition have a significant but varied effect on the labour supply. Marriage seems to decrease the labour supply of women by 3.6 hours per week, whereas the working hours of married and non-married males are not statistically different. On the other hand, married men whose spouse works supply about 2 hours per week more labour than non-married men or married men whose wife is not working. In contrast, the labour supply of women is not affected by the working status of their spouse. Nonetheless, the pooled regression suggests that, on average, the labour supply of an individual decreases by 2.6 hours per week when his/hers spouse works.

- The number of dependent children has a positive effect on the labour supply of men and no effect on the labour supply of women. In particular, each additional child increases the working hours of men by 1.3 hours. On the other hand, the labour supply of women is greatly affect by the age of the youngest dependent child. In the case of males, the interaction of age of youngest child with the hourly wage does not have a statistically significant effect but the interaction with the ratio of non-labour to labour income has such an effect[9]. For women, both interactions of age of youngest child with hourly wage and ratio of non-labour to labour income have a statistically significant effect: a child less than 5 years old or between 5 and 12 increases the positive effect that hourly wage on labour supply; and a child between 5 and 12 or 13 and 18 decreases the negative effect the ratio of non-labour to labour income. We investigate further this findings below.

[9]Using Wald-test we test the null hypothesis that the coefficient of the ratio of non-labur to labour income plus the coefficient of the interation with the age of youngest child less than 5 (between 5-12) is zero. Both in the joint and seperate test we can not reject the null hypothesis.

- Child-care services have a statistically significant effect only on the labour supply of women. The working hours of women increase by about 11, 7.5, 6.4 and 12.7 hours when, respectively, centre-based child care before or after school, when day-care centre, when paid child-minder and when unpaid child-minder services are used. Based on the pooled regression, the labour supply is increased by about 4 hours when center-based child care services before or after school are used, by 5.9 hours when services of day-care center are used, and by 7.1 hours when unpaid child-care services by relatives are used. Child care services by paid child-minder do not affect the working hours of individuals.

- Mortgage-payments seem to have a small but significant effect on the employment of men, but not of women. An increase of the logarithm of mortgage payments by 1 unit (i.e. the doubling the mortgage payment) increases the labour supply of a man by almost half an hours.

- The effect of hourly wage and the ratio of non-labour to labour income on the labour supply depends on the age of individuals as well as on the existence of under-aged dependent children. The level (or increase) of hourly wage has no statistically significant effect on the hours worked by male individuals aged less than 55 or with under-aged dependent children. On the other hand, an increase of the hourly wage decreases the labour supply of males aged between 55 and 64. The hourly wage has also a statistically significant and positive effect on the working hours of women. In addition, the labour supply of women with a dependent child aged less than 5 and between 5-12 increases by 8 hours and 6.25 hours, respectively.

- As expected, high non-labour relative to labour income has a negative effect on working hours. For instance, when the ratio of non-labour to labour income increases by 1 unit, the labour supply of men, on average, decreases by 0.6 hours and the labour supply of women by almost 1 hour. In addition, for individuals aged between 55 and 64 labour supply decreases even more. The presence of under-aged dependent children offsets the negative effect of the ratio of non-labour to labour income on the working hours of men. For women, young children do not offset the negative effect of the same ratio but dependent children aged between 5-12 or 13-18 do.

The income and wage elasticities of labour supply are reported in Table 4. These elasticities are based on the estimates presented in Table 3 and calculated using equations (5), (6) and (7). 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% of wage.[10]

Economic theory suggests that the income elasticity has a negative and the compensated wage elasticity a positive sign, but does not predict anything about the sign of the uncompensated wage elasticity, except that it should be smaller than the compensated one. The elasticities reported in Table 4 do not conform to economic theory in the case of the compensated wage elasticity for males between the age of 35-44 and for males with a youngest child aged less than 5 or between 6 and 12 i.e. they are negative instead of positive.However, they are not statistically significant.[11]

- The income elasticity of labour supply increases (in absolute terms) with age, and is greater for females in all age groups. Though it is quite low (below 0.05 in absolute terms) for individuals less than 54 years old. On the other hand individuals aged between 55 and 64 have a more income elastic labour supply. In particular, the income elastisticity of males between 55 and 64 group is -0.202 and of women -0.332. This means than if the non-labour income of males (females) between 55 and 64 is doubled then their labour supply decrease by 20 (33) percent.

- The presence of young dependent children in the family makes the labour supply of males more income elastic; and the labour supply of women more income inelastic. In particular, the income elasticity of males with at least one child aged below 5 years old or between 6 and 12 is close to zero and statistically insignificant. This means that an increase of the non-labour income has no effect on the number of hours worked by these individuals.

[10]The compensated (Hicksian) wage elasticity shows the response of labour supply to a change in wage when the utility level is kept constant (i.e. only the substitution effect); while the uncompensated wage elasticity shows the total (income and substitution) response of labour supply to a change in wage.

[11]This is because in the calculation of the above elasticities we use the negative and non-statistically significant coefficients of the interaction variables of hourly wage and age of youngest child less than 5 or between 5 and 12 . If we exclude these coefficients from calculations the elasticities conform to theoretical expectations.

On the other hand, an increase of the non-labour income of males with no dependent children or with children aged between 13 and 18 decreases their labour supply by 2.5% and 6%, respectively. The hours worked by women with at least one dependent child aged below 5 years old decrease by about 8.5% when their non-labour income is doubled. On the other hand, the income elasticity of women with no dependent children or with dependent children older than 6 years is not statistically different from zero.

Table 4: Labour supply elasticities

		Males			Females			All		
		Income elast.	Comp. elast.	Uncomp. elast.	Income elast.	Comp. elast.	Uncomp. elast.	Income elast.	Comp. elast.	Uncomp. elast.
Age Group	25-34	**-0.021**	**0.369**	-0.042	**-0.061**	**1.093**	**0.326**	**-0.050**	**1.023**	**0.273**
		(0.011)	(0.205)	(0.113)	(0.018)	(0.245)	(0.096)	(0.011)	(0.176)	(0.065)
	35-44	-0.008	-0.021	**-0.165**	**-0.029**	**0.592**	**0.296**	**-0.067**	**0.745**	**0.192**
		(0.007)	(0.131)	(0.079)	(0.016)	(0.167)	(0.098)	(0.014)	(0.140)	(0.065)
	45-54	**-0.049**	**0.321**	**-0.175**	**-0.052**	**0.627**	**0.224**	**-0.049**	**0.446**	0.026
		(0.016)	(0.173)	(0.093)	(0.020)	(0.178)	(0.087)	(0.014)	(0.135)	(0.056)
	55-64	**-0.202**	**1.284**	**-0.146**	**-0.332**	**2.454**	**0.687**	**-0.194**	**1.466**	**0.242**
		(0.021)	(0.172)	(0.076)	(0.060)	(0.430)	(0.144)	(0.019)	(0.160)	(0.063)
Age of youngest child	Less than 5	-0.012	-0.048	**-0.165**	**-0.084**	**1.142**	**0.474**	**-0.099**	**1.255**	**0.432**
		(0.010)	(0.156)	(0.092)	(0.027)	(0.275)	(0.113)	(0.018)	(0.197)	(0.074)
	6-12	-0.009	-0.119	**-0.183**	-0.004	**0.369**	**0.346**	**-0.016**	**0.277**	**0.180**
		(0.020)	(0.143)	(0.073)	(0.017)	(0.142)	(0.102)	(0.013)	(0.115)	(0.061)
	13-18	**-0.059**	**0.348**	-0.175	-0.004	0.207	0.162	**-0.051**	**0.361**	0.023
		(0.019)	(0.199)	(0.112)	(0.200)	(0.155)	(0.099)	(0.017)	(0.149)	(0.065)
	No children	**-0.024**	0.033	**-0.174**	-0.030	**0.577**	**0.334**	**-0.055**	**0.645**	**0.225**
		(0.013)	(0.163)	(0.091)	(0.021)	(0.190)	(0.105)	(0.016)	(0.153)	(0.067)
All		**-0.055**	**0.391**	-0.134	**-0.078**	**0.956**	**0.328**	**-0.075**	**0.834**	**0.173**
		(0.013)	(0.169)	(0.092)	(0.023)	(0.222)	(0.100)	(0.014)	(0.151)	(0.062)

Note: 1. Standard errors in brackets.
2. Figures in bold are significant at 10% significance level.

- The compensated wage elasticity is positive for both males and females and almost two times higher for women, i.e. the labour supply of women respond much more to changes in the wage rate. The hours worked of the males in the age brackets 25-34, 45-54 and 55-64 increase by 37, 32 and 128.5 percent, respectively, when the wage rate doubles; while the labour supply of males aged between 35 and 44 is not affected by changes in the wage rate. Similarly, an increase of the wage rate of women by 100 percent,

increases the labour supply of those in age brackets 25-34, 35-44, 45-54 and 55-64 by 109, 59, 62.7 and 245.4 percent, respectively.

- An increase of the wage rate does not increase the labour supply of males with no children or with at least one child less than 12 years old. In contrast, the presence of a dependent child aged between 13 and 18 increases the labour supply of males when their wage rate increases. In particular, when the wage rate of a male individual with a dependent child aged between 13 and 18 is doubled, his hours in the labour market increase by almost 35 percent. In the case of women with young children labour supply responds even more to changes in the wage rate: doubling the wage rate of women with at least one dependent child less than 5 increases their working hours by 114 percent. The working hours of women with at least one child aged between 6 and 12 are increased by 37 percent and of women with no dependent children by 57.7 percent when their wage rate is doubled. Women with a youngest child between 13 and 18 do not change their working hours when the wage rate is changed.

Commenting on the uncompensated elasticities, we find that this wage elasticity is negative for men and positive for women, i.e. an increase of the wage rate decreases the labour supply of men and increases the labour supply of women.[12]

- An increase of the wage rate by 100 percent, while not having any significant effect on the working hours of a male aged between 25 and 34, it decreases the working hours of males in the age groups 35-44, 45-54 and 55-64 by 16.5, 17.5 and 14.6 percent, respectively. In addition, the working hours of a male with no children, a youngest child less than 5 and a youngest between 6 and 12 decrease by 16.5, 18.3 and 17.4 percent, respectively. An increase of the wage rate of a male with youngest child between 13 and 18 does not affect his working hours.

- On the other hand, an increase of the wage rate increases the labour supply of women. In particular, a doubling of the wage rate increases the labour supply of women in the age brackets 25-34, 35-44, 45-54 and 55-64 by 32.6,

[12] A negative uncompensated elasticity means that the substitution effect is lower than and a positive one means that the substitution effect is higher than the income effect (in absolute terms).

29.6, 22.4 and 68.7 percent, respectively. The same increase in the wage rate also increases the labour supply of women without children by 57.7 percent; while for women with a youngest child age brackets less than 5 and 6-12 increases their working hours by 36.9 and 47.4 percent, respectively. Women with a youngest child aged between 13 and 18 do not change their working hours when their wage rate changes.

It is also interesting to take a look at the elasticities of non-labour income computed for all males and females and the population as a whole. In absolute terms, these elasticities are higher for females than males: a doubling the non-labour income decreases the working hours of men by 5.5 percent and of women by 7.8 percent. For the population as a whole, the same increase in non-labour income decreases the working hours by 7.5 percent. As regards substitution and income effects, for men the first is significant but the latter is not; but when we compute the total (income and substitution) effect there is no statistically significant change in the working hours. For women all the elasticities are statistically significant. For the whole population, the substitution effect of a doubling of the wage rate is 83.4 percent; when the income effect is also incorporated it becomes 17.3 percent.

6 Conclusions and Policy Implications

In this paper, we have estimated the labour supply functions for males and females in Cyprus under a progressive tax system. Furthermore, using the results of the estimation, we have calculated the income and wage elasticities of different groups based on the age and the age of the youngest dependent child of individuals. Due to the recent interest of the EU in designing policies for increasing labour market participation and working hours, the results of this study can be used for increasing the efficiency of these policies by targeting them to the population groups with the higher propensity to work.

For modeling the labour supply in Cyprus, a specification of the semi-logarithmic labour supply function was used, which allows for backward bending at high wage rates. For the estimation of the optimal supply of hours under a piecewise-linear budget constraint we used a complete budget constraint maximum likelihood procedure assuming that the observed hours are generated by a generalised Tobit model. The data for Cyprus, used in the estimation, are drawn from the 2007

EU-SILC database.

The results show that 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 elasticity compared to individuals in other age groups. Based on the age of the youngest child, women with very young children (aged less than 12), as well as women with no children, are responsive to changes in their wage rate; while the labour supply of men with similar family characteristics has near zero wage elasticity. Furthermore, men have negative and women positive uncompensated wage elasticities of labour supply. The total (income and substitution) effect of an increase of the wage rate is for men a decrease and for women an increase in labour supply. Based on this, we can conclude that men are on a backward bending whereas women on a positively sloped labour supply curve.

Differences between elasticities gender or age groups can be used to better target the employment increasing policies and make them more effective. For example, in-work benefits to males effectively increase their non-labour income or their wage rate but instead of increasing they decrease working hours because men have a negative wage elasticity of labour supply. In contrast, the backward bending of the labour supply curve of males means that an increase of the tax rate on their income may result in men working more hours. This is particularly true for males aged between 55 and 64 since they have much higher, in absolute terms, income elasticity compared to other aged groups.

Our findings also suggest that the employment increasing policies for females should differ from those for men. The (uncompensated) wage elasticities among women are positive, therefore in-work benefits that increase the wage rate of women can also increase their working hours, especially among those aged between 55 and 64. In addition women with dependent children less than 5 or between 6 and 12 have more wage elastic labour supply compared to women with older children. This means that in-work benefits offered to women and linked to dependent children can be an effective labour market policy aimed at increasing the working hours of women. Notably, the income elasticity of labour supply is negative among women, as is among men, especially for women between 55 and 64. Overall, policies aimed at increasing the non-labour income of individuals can decrease working hours.

Further analysis is required using simulation techniques to assess the behav-

ioural and welfare effect of alternative, revenue equivalent, employment increasing reforms of the tax and benefit system. This analysis can point to policies that can be targeted to specific population groups so as to optimise the impact on labour supply and welfare.

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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 at day-care center	4659	0.033	0.180	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-labor to labor income	4659	9.473	33.261	0	1108.564
Ratio of non-labor to labor income-Female	2539	10.614	34.053	0	1108.564
Ratio of non-labor to labor income-Male	2120	8.107	32.241	0	679.301

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