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Estimates of Employment and Welfare Effects of Personal Labour Income Taxation in a Flat-Tax Country: The Case of Estonia*

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Abstract: This paper presents estimates of the employment and welfare effects of personal labour income taxation in Estonia. The labour supply decision of individuals is estimated based on data from the 2005 Estonian Labour Force Survey. Economic incentives are found to affect the participation decision of individuals, but not the number of hours worked by individuals already working. The participation elasticities are higher for individuals in the middle income groups than for individuals in the low and high income groups. Increasing the proportional tax rate by 1 percentage point is found to reduce total employment by 0.35 percentage points. The baseline estimate of the marginal cost of public funds is 1.6 if the proportional tax rate is increased and 1.8 if the basic exemption is lowered. The marginal cost of public funds varies across different income groups, which may suggest possible gains in efficiency from reallocating the taxation burden of the existing system of proportional taxation. The employment and welfare estimates are subject to substantial uncertainty.

JEL classifications: H21, H24, J21, J22.

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"The art of taxation consists in so plucking the goose as to obtain the largest amount of feathers with the least possible amount of hissing", *Jean-Baptiste Colbert, 1619-83, Minister of Finance for 22 years under Louis XIV*.[1]

1. Introduction

Jean-Baptiste Colbert's dictum on optimal taxation has many interpretations. A modern reading would be that tax revenue should be raised so as to minimise the costs borne by the taxpayers. Such costs consist of the excess burden resulting from taxes distorting price signals in the economy, but possibly also employment costs if these are of separate interest.

This paper provides proximate estimates of the employment and welfare effects of personal labour income taxation in Estonia. Personal labour income taxes, along with social security taxes and taxes on consumption, create a wedge between the costs of employing labour and the purchasing power attained by providing labour. This distortion of the relative price of labour generally affects the labour supply and induces a loss in welfare (Auerbach & Hines 2002).

The estimation of the employment and welfare effects of taxation is particularly important in the case of Estonia as the country has a "flat tax" system with proportional taxation of all personal income in excess of a basic exemption. Estonia was the first European country to introduce a flat tax in 1994 and a large number of central and east European countries have since adopted similar systems (Keen *et al.* 2006).

The academic literature dealing specifically with flat taxes is rather limited. Keen *et al.* (2006) provide an overview of a number of theoretical and administrative issues concerning flat taxes, while Saavedra *et al.* (2007) mainly focus on the revenue effects of flat tax reforms. Both of these two influential policy studies shied away from empirical analyses of the employment or welfare effects of a flat income tax system.

Ivanova *et al.* (2005) use micro-level data to examine the employment effect of the introduction of a flat tax in Russia in 2001. The main conclusion is that while revenues increased, this was largely the result of better compliance, while the *total* (formal and informal) labour supply effect was relatively limited. A large number of studies have examined the employment effects of changes to the after-tax pay, and these studies may thus provide insights into the employment consequences of reforms changing the degree of progression of the income tax system. It is generally found that economic incentives are of importance for whether or not individuals work, while their effect on the number of hours worked by already economically active individuals is minor (Heckman 1993, Evers *et al.* 2005). It has also been found that there are substantial differences in the labour supply responses across different income strata, with low income earners typically being more responsive to changes in after-tax income than high income earners (Kleven & Kreiner 2006a). It should therefore be expected that the employment effect of introducing a flat tax would depend critically on the specific redistribution

[1] Cited from The Economist (2000).

of the tax burden, i.e. on the pre-existing tax schedule and the design of flat tax system.[2] Similarly, the employment effects of changing the basic exemption or the flat tax rate should depend on the different responses across the taxpayers in the economy.

Gorodnichenko *et al.* (2008) is the only study that has analysed the welfare effects of a flat tax reform in a country that has already undertaken such a policy reform. Gorodnichenko *et al.* (2008) have access to detailed micro-data for Russia and show that the increase in revenue after the introduction of the flat tax in Russia in 2001 partly stemmed from reduced tax evasion and not from increased economic activity *per se*. They conclude that the shift from informal to formal production activities meant that the benefits of the flat tax reform in Russia are smaller than frequently asserted.

Other studies have considered the hypothetical effects of moving from a non-proportional income tax system to a proportional one. Aaberge *et al.* (2000) use a labour supply model to simulate the effects of revenue-neutral flat tax reforms in Norway, Sweden and Italy. In Norway, the labour supply response is estimated to be very elastic and a flat tax reform therefore entails a substantial increase in employment and social welfare. The consequences of a flat tax reform are, however, found to be less pronounced in Sweden and Italy. Cajner *et al.* (2006) use a general equilibrium model for Slovenia to simulate the welfare effects of different tax regimes. In their model, a flat tax regime provides less insurance against income shocks and also reduces labour market participation in lower income brackets indicating that flat tax systems are generally outperformed by progressive tax systems in terms of welfare.

Personal income taxation contributes to the wedge between the cost of labour and the purchasing power of labour, and the main distortionary effect of labour income taxation stems from its impact on taxable labour supply.[3] In line with this reasoning, the empirical analysis in this paper therefore entails two parts; namely, regression analyses to provide estimates of labour supply responses followed by simulations to assess the impact of different tax experiments on employment and welfare.

The labour supply responses are estimated for different income groups using microeconometric methods based on data from the 2005 Estonian Labour Force Survey. By employing Heckman's selection model it is possible to distinguish between the responses along the extensive margin (i.e., labour market participation or the lack of it) and the intensive margin (i.e., the number of hours worked by participants). The employment effects of changes in personal income taxation can be calculated based on the labour supply responses of the different income groups.

The welfare analysis seeks to determine the marginal cost of public funds (MCPF) when the government raises revenue by increasing the taxation of personal income. Specifically, the MCPF is equal to one plus the excess burden in monetary terms per one currency unit of extra revenue. The MCPF for each income group depends on a range of factors, including the initial tax rates and exemptions as well as the group's labour response, participation rate and in-

[2] Tondani (2006), Rutkowski & Walewski (2007), Bicakova (2006) and Vork *et al.* (2007) are recent papers that analyse the employment effects of taxation for different countries or country groups using a range of empirical approaches.

[3] Personal income taxation may also potentially have distortionary effects on other economic decisions concerning, for instance, education, savings and the incorporation of economic activities. These distortions are not considered in this paper.

come. The MCPF for each of the groups can be aggregated to provide an overall measure of the MCPF under different tax policy assumptions.

The estimation of the employment and welfare effects of raising tax revenue is important for economic policymaking. Reliable estimates of the MCPF of taxation are particularly useful (Robson 2005). First, such estimates may be used to assess the overall efficiency of the tax system; for instance by comparing them with similar estimates for other countries. Second, the estimates may reveal inefficiencies within the tax system if, for example, different taxes exhibit markedly diverging MCPF values, in which case redistributing the tax burden may reduce the social costs of taxation. Third, the estimates can be used to assess the welfare effects of new government spending programmes and how such programmes based on the financing of the programmes.

The main contribution of this paper is that it provides numerical estimates of the welfare costs of personal income taxation for Estonia. As such the paper represents the first study to consider these important aspects of taxation in the case of Estonia. The study, however, have significance beyond the borders of the Republic. Very few studies have considered the quantitative estimates of the welfare effect of taxation for the post-communist transition countries. More importantly, as mentioned above, only one existing study has explicitly considered the welfare consequences of a flat or proportional personal income tax.[4]

At the methodological level, this paper incorporates a number of relatively recent advancements in the analysis of the welfare effects of taxation policies. First, using Heckman's selection model, the paper explicitly distinguishes between the extensive and intensive margins of the labour supply. Second, the paper allows for different labour supply responses across different income groups. Third, the marginal cost of public funds is found both across different income groups and on the aggregate level. The marginal cost of public funds is a very useful welfare measure in the context of economic policy.

The focus of the paper is on the effects of taxation across individuals with different incomes. The empirical literature on labour supply typically finds that the labour response of men is less elastic than the response of women. The labour supply response of the elderly is usually more elastic than that of younger individuals. It may thus be possible to attain efficiency gains by redistributing the tax burden from women to men (Alesina *et al.* 2007) and from older to younger individuals (Kremer 1997). However, such policy measures would be highly controversial and of little immediate relevance; therefore, we only consider heterogeneous labour supply responses across the income distribution.

The study should be seen as an initial attempt at trying to assess the employment and welfare effects of personal income taxation in Estonia. As with most studies of the effects of taxation, the results are subject to a substantial margin of error as the derivations are based on restrictive assumptions and numerous simplifications (see also Browning 1987). Further empirical analyses are warranted to pin down more precisely the welfare effects of the Estonian flat tax regime – and of flat tax systems elsewhere.

The rest of the paper is structured in the following way. Section 2 provides a brief introduction to the Estonian system of taxation. Section 3 provides information on the Estonian La-

[4] Gorodnichenko *et al.* (2008) examine the effect of switching to a system of proportional income taxation in Russia, while this paper considers the welfare consequences of hypothetical changes to an already established flat tax system.

bour Force Survey and the variables used in the empirical analysis. Section 4 estimates the labour supply response of different income groups and examines the possible employment consequences of different tax changes. Section 5 analyses the excess burden arising from raising extra tax revenue. Section 6 summarises the results, assesses the limitations of the study and points out areas for future research.

2. A primer on the Estonian tax system

The Estonian tax system is well known for its application of flat rates and – particularly in international comparison – overall simplicity. Nevertheless, as with all other tax systems in modern market economies, the Estonian system exhibits substantial complexity and grey areas where the delimitation between taxes and non-tax contributions is difficult to ascertain. This section provides an overview of the main taxes in the Estonian taxation system with the main focus on the personal income tax, the social tax (social security contribution) and the unemployment insurance contribution.[5] The labour supply estimations below employ data from 2005, and the rates and exemptions for this year are therefore spelt out explicitly.

With a major tax reform taking effect in 1994, Estonia thoroughly overhauled its system of income taxation and in the process became the first country in Europe to embrace a flat personal income tax (Saavedra *et al.* 2007). The overall framework of personal income taxation has remained in place since 1994, although exemptions and rates have been altered on several occasions, a pension reform has changed the allocation of social tax revenue, and a compulsory unemployment insurance contribution has been introduced.

The *social tax* is paid by employers on wage income paid to employees and on business income by sole proprietors (self-employed in unincorporated firms). The social tax amounts to 33 percent of the wage or business income without any exemptions. In total, 13 percentage points of the social tax are transferred to the national health fund, while 20 percentage points are earmarked for pension contributions. Adults are, with exceptions for students, pensioners and some part-time employed persons, only eligible for health and pension coverage if their social tax payment is at least 33 percent of a minimum base amount set in the annual budget; in 2005 this minimum social tax payment amounted to 231 per month.[6] For sole proprietors the social tax is capped at 33 percent of 15 times the minimum wage; in 2005, the maximum social tax for sole proprietors was thus 13,316 EEK per month.

A pension reform has phased in a three-pillar system since the end of the 1990s (Raudla & Staehr 2003). The first pillar is comprised of the compulsory public pension scheme, the second pillar is made up of contributions to private pension accounts, and the third pillar consists of voluntary tax-advantaged pension savings. Participation in the second pillar was made compulsory for younger individuals; middle-aged individuals could decide whether or not to participate, while the elderly could not participate. For participants in the second pillar, 4 percentage points of the social tax payment is transferred to a personal pension account along with an additional 2 percent of the gross wage (paid by the participants). The Estonian pension system exhibits very high-powered incentives: the individual's future pension payout

[5] The overview is largely based on information from the Ministry of Finance (2008).
[6] Estonia has operated a currency board since 1991 with an exchange rate equal to 15.65 EEK/EUR since the introduction of the euro in 1999. The purchasing power is, however, comparatively higher in Estonia than in West European countries. In 2005, the Estonian price level of final consumption by private households amounted to 61% of the average price level in the EU15 (Eurostat 2008).

from the first pillar depends, to a large extent, on the accumulated contributions prior to retirement, with only a small minimum pension for individuals with limited or no contributions. The total payout from a second pillar individual account is a function of the contributions paid in and the return on its investment.

Since 2002 *unemployment insurance* for employed persons has been obligatory, financed by a compulsory unemployment insurance contribution levied on employees' salaried income. In 2005 the employer paid 0.5 percent and the employee 1.0 percent of the salaried income. The insurance contribution rates have been reduced in later years.

The *personal income tax* is levied at a flat rate on taxable income exceeding the basic exemption and other personal tax exemptions. Taxable income comprises on income from employment, business income of non-incorporated firms, pensions, interest receipts, rental income etc. Notice, however, that taxable income does not include distributed dividends when the underlying profit is taxed at the firm level. The latter rule implies that taxable income for most taxpayers in Estonia comprises only labour income from employment or self-employment. The flat income tax rate was initially set at 26 percent of taxable income in excess of exemptions, but the rate was reduced to 24 percent effective from 2005 and has since been reduced further.

The exemptions comprise the basic exemption and other exemptions. The basic exemption has been raised several times since the inception of the flat tax. In 2005, the basic exemption amounted to 20,400 EEK per year or 1,700 EEK per month. Individuals receiving state old-age, disability or survivor's pension are entitled to an *additional* exemption of 36,000 EEK in 2005.[7] Parents also have additional exemptions based on the number of children in the household. Estonian law, furthermore, grants exemptions for a number of expenses such as interest payments on housing loans, educational expenses and third pillar pension contributions. The total of these exemptions is capped at 50,000 EEK per year or 50 percent of taxable income. Legally married copies can file a joint tax return and in this way share the available exemptions.

The indirect taxes in Estonia are made up of a value added tax (VAT) and various excise duties. The VAT rate has been levied at 18 percent since 1994 with a lower rate of 5 percent levied on medicines, books and newspapers. The government levies excise duties on alcohol, tobacco, energy and packaging. Other taxes include taxes on enterprise income, land values and gambling establishments. Estonia does not levy taxes on property (except land), gifts, inheritances or wealth.

In 2005, the *broad-based taxes* on labour and consumption – i.e. the social tax, personal income tax and value-added tax – brought in more than 80 percent of the tax revenue of the general consolidated government in Estonia (Statistics Estonia 2008a). The social tax and the unemployment insurance contribution accounted for 34.1 percent of the total tax revenue (10.3 percent of GDP), the personal income tax accounted for 18.3 percent (5.6 percent of GDP), and the value added tax 28.1 percent (8.5 percent of GDP).

[7] In 2005 the average pension in Estonia amounted to 2,315 EEK per month or 27,781 EEK per year (Statistics Estonia 2008b). For the average pensioner, the pension amounts to a little less than the state pensioners' additional exemption of 36,000 EEK per year. In other words, a pensioner receiving the average pension and who takes up employment in order to earn additional income has a slightly higher exemption (36,000 – 27,782 = 8,212 EEK per year), but otherwise face the same tax incentives as other taxpayers.

3. Data

The Estonian Labour Force Survey (ELFS) is undertaken through face-to-face or telephone interviews by Statistics Estonia. The survey has been carried out on an annual basis since 1997, but the methodology of collection was changed considerably in 2000 (European Commission 2004). Data from ELFS is not published, but has been made available to Eesti Pank for research purposes.[8] This section provides background knowledge on the ELFS, discusses the limitations of using the ELFS for estimations of the labour supply and, finally, describes most of the variables used in the empirical analysis.

The rapid structural and economic changes in the Estonian economy during recent years have led us to employ data exclusively from 2005, the most recent year available at the time of research. Alloja (2005b) finds somewhat different labour supply elasticities across different sample years. The sample comprises 14,605 individuals that have answered at least one question on the questionnaire.

The Estonian Labour Force Survey takes the household as its unit of data collection. A household is defined as comprising all individuals who usually live together and share a common family budget. Thus, members of a household are mutually dependent in economic terms. All members of the household aged 15 to 74 (i.e. being of working age) are interviewed. Participation in the interview is voluntary.

The ELFS has a number of features that makes it suitable for labour supply estimations at the micro level. First, data on employment, income and background variables are collected for each individual in the household who is of working age. This allows for an estimation of a labour supply relationship where a large set of individual specific factors can be used as controls. Second, the ELFS contains detailed information about all working age individuals in a household, as well as some information on any dependents present. Consequently, this, in principle, makes it feasible to explain the labour response of an individual by the behaviour of other individuals in the household.

The main drawback of the ELFS is that the only income variable in the dataset is the labour income during the last month, net of taxes. There is no information on pension receipts, unemployment benefits, social assistance, parental and child exemptions, rents and other forms of capital income, etc. This limits our ability to control for heterogeneity stemming from these sources and also complicates the estimation of the *compensated* labour supply response, which involves an estimation of the labour supply response to – ideally – lump sum income.

The ELFS also lacks other measures of individual characteristics, which may affect the pay obtained and the supply of labour. This includes variables reflecting the individual's present state of health and the prevalence of chronic diseases. A variable indicating membership in a trade union had to be dropped due to a disproportionate number of missing observations.

The collection of data is stratified so as to ensure broad geographical coverage, implying an overrepresentation of individuals from the countryside and an underrepresentation of individuals from the major cities. The oversampling of countryside individuals implies that unweighted statistical moments based on the ELFS sample is expected to differ from moments

[8] Some documentation of the database, the methodology applied and the survey questions is available at Statistics Estonia (2008c). See also European Commission (2004).

of the Estonian population. However, the differences are likely to be relatively minor. For instance, the weighted average of the hourly post-tax labour income of individuals in the ELFS sample is approximately 5.5 percent higher than the corresponding unweighted average. We generally do not use sample weights when undertaking estimations in Section 4, while the weights are used in the simulations of employment and welfare effects in Section 5.[9]

Labour supply is measured by the variable HOURS, which denotes the number of hours the interviewed individual usually works in his or her *main job* during any given month. The individual can work as an employee, a sole proprietor, an employer, a freelancer, etc. The variable HOURS is constructed as the reported "usual" number of working hours in a week multiplied by 4.35. The variable is equal to 0 if the individual does not participate in the labour market.

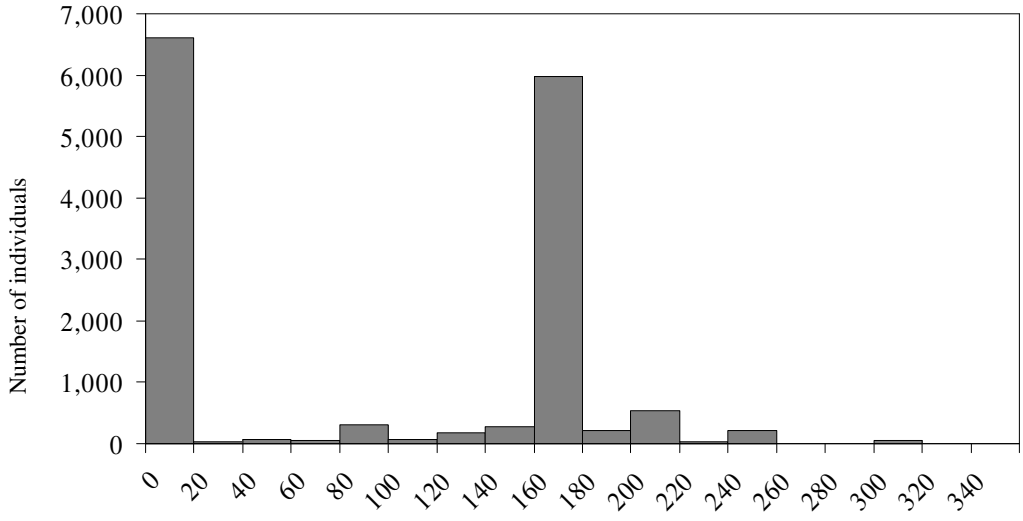
The reliability of the HOURS variable can be cross-checked using the answers to the question where the individual is requested to provide his or her working hours for the week *preceding the interview*. The reported usual number of working hours during a typical week and the actual working hours during the last week are very closely correlated and the econometric results using any of the two measures are essentially identical. Therefore, the variable HOURS is used as the only measure of monthly working time.

The ELFS also contains information on the number of hours the individual spends on one or more "second jobs." Unfortunately, no income data is available for these second jobs. Relatively few (less than 5 percent of all those employed, i.e. having HOURS > 0) indicate that they have jobs beside their main job.

Figure 1 shows the number of observations for intervals of monthly working time HOURS. The monthly working time results shown clusters at two points, namely HOURS = 0 and HOURS = 174 corresponding, respectively, to no employment and employment 40 hours per week. The variation around the 40 hours of employment per week is limited. This may suggest that changes in post-tax labour income are unlikely to have a substantial effect on employment due to the choice of hours (intensive margin) – a result which is confirmed in the econometric analyses in Section 4.

[9] The decision to leave out sample weights from the estimations rests on two factors. First, the main estimation results are carried out on four subsamples where the main sample is partitioned based on income levels. The differences between the weighted and unweighted estimation results in these sub-samples are very small. Second, some estimation procedures (e.g. Maximum Likelihood estimation of Heckman's selection model) cannot be undertaken in the Stata estimation programme using sample weights. Overall, we have concluded that the costs of using sample weights in the form of lower precision of the coefficient estimates outweighed the potential gains.

Figure 1: Monthly working hours, intervals of 20 hours



Source: ELFS (2005), author's calculations.

An interesting finding from the ELFS is the relatively high participation rates in Estonia. Overall, 8009 or 54.8 percent of all persons aged 15-74 years old are employed. The employment rate is 57.8 percent among men and 52.3 percent among women. The overall participation rate is held down by the participation rate of the elderly; in 2005, the participation rate among individuals between 55 and 74 years old was 36.4 percent.

Labour income during the last month net of the social security contribution, unemployment insurance contribution and income tax for each individual of working age is denoted by PAY. Evidently, individuals who are not working will have PAY = 0. The construction of the variable PAY brought up two minor issues. First, 1843 individuals had indicated monthly working times above 0 (in most cases 40 hours per week corresponding to 174 hours per month), but had either not answered the question concerning labour income in the preceding month and, consequently, PAY is coded as missing for these individuals.

A more worrying possibility is a bias towards underreporting of income in the ELFS (2005). When non-working individuals are excluded, the average monthly post-tax labour income PAY is 4,643 EEK. Statistics Estonia conducts a separate survey among enterprises to ascertain the monthly wage of their employees, and the average full-time equivalent net wage was according to this methodology 6,430 EEK for 2005 (Statistics Estonia 2008d).

The Estonian Tax and Customs Board reports the average taxable (i.e. pre-tax) income of Estonians filing tax returns and report the number in an annual press release. For 2005 the average taxable income was 7,562 EEK for individuals with annual income above 0 EEK for the year (EMTA 2008). If it (unrealistically) is assumed that all individuals have income above 1,700 EEK, then the after-tax tax income can be calculated as approximately 6,155 EEK.

The heavy right-hand tail of the Estonian income distribution may not render it very informative to compare averages of income distributions, but the discrepancy is still so substantial that it warrants some discussion.

First, the discrepancy cannot be explained by the stratification of the ELFS sample. The weighted average monthly post-tax labour income PAY is 4,924 EEK, which is 6 percent above the unweighted measure, but still 23 percent below the wage measure from Statistics Estonia.

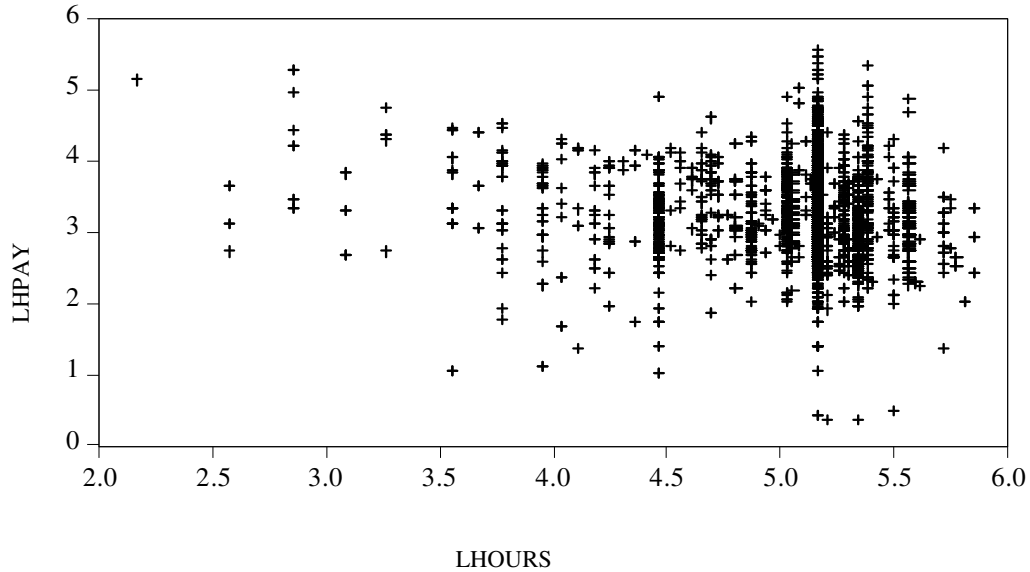
Second, the different measures are not directly comparable. For instance, the ELFS measure comprises all labour income (including income from self-employment), while the Statistics Estonia measure only includes wage income earned by employees. The income measure from the Estonian Tax and Customs Board also comprise non-labour taxable income like pensions etc.

Third, the analyses in Subsection 4.2 seeking to predict the labour income of individuals based on their individual characteristics show that in particular persons with high predicted labour income have failed to report their income in the ELFS. In conclusion, the likely under-reporting of labour income by especially high income individuals in the ELFS (2005) implies that labour supply estimations based on that dataset must be interpreted with caution. We return to these issues when discussing the estimation and simulation results.

The vast majority of economically active individuals work 174 hours per month, but others work either more or less than this total. Therefore, in order to obtain a measure of the return on supplying labour, it is necessary to calculate the hourly labour income. The hourly income for active individuals is found as HPAY = PAY/HOURS, for HOURS > 0.

In the econometric specifications in Section 4, we will frequently employ logarithmic values of the monthly working time and hourly labour income. A pre-imposed "L" indicates the natural logarithm of the variable. Thus, LHOURS denotes the log of the number of hours worked per month and LHPAY denotes the log of the income per hour. Figure 2 shows a scatter plot of the logarithm of the monthly number of working hours and the logarithm of the hourly pay. The concentration of observations with monthly working times equal to 174 (LHOURS = 5.16) is noticeable. No clear correlation pattern is discernable from the plot.

Figure 2: Hourly labour income and monthly working time, logarithms



Source: ELFS (2005), author's calculations.

The Labour Force Survey allows us to include a large number of background variables. The centred and scaled age of the interviewed individual is denoted by AGE, with AGE2 being the square of AGE. The variable FEMALE is a dummy variable taking the value 1 if the individual is a woman. The dummy variable ESTCITI is equal to 1 if the interviewed individual is an Estonian citizen, while ESTETHN is 1 if the individual is of Estonian ethnicity. The language variable LANGEST takes the value 1 if the first language of the interviewed individual is Estonian, whereas LANGOTH is 1 if the interviewed person knows at least one language besides his or her mother tongue (excluding Estonian).

The education acquired by the interviewed individuals is captured by the variables ISCED01, …, ISCED6 following the classification by UNESCO in the International Standard Classification of Education (UNESCO 1997). The lowest education level ISCED01 denotes that the interviewed individual only has a pre-primary or primary education; while the highest level ISCED6 denotes that the person has a graduate university degree.[10]

For individuals who at the time of the interview were studying at the secondary level, the dummy variable STUDYSEC takes the value of 1. For individuals studying at the tertiary level, the variable STUDYTER takes the value of 1.

The variable ADULTS denotes the number of individuals from 15 to 74 years old living in the same household as the interviewed individual, while DEPENDENTS is the number of individuals below 15 and above 74 in the household. The dummy variable MARRIED takes the value 1 if the individual is married or lives in a common marriage relationship.

A number of variables capturing the location of the domicile of the individual are also available. The dummy variables REGNORTH, REGEAST, REGSOUTH and REGWEST indicate the geographical region. The variables are coded based on the county in which the individual lives. The regions are chosen to be relatively large in order to reduce the prevalence of individuals living in one region and working in another region. The dummy variable TALLINN is equal to 1 if the individual lives in the capital.[11] The dummy variable RURAL is equal to 1 if the individual lives in the countryside.

Finally, two variables relate explicitly to the working time of working individuals. The variable PARTTIME is a simple dummy variable indicating whether the interviewed individual works part time in his or her main job. The dummy variable WORKMORE captures whether the individual would like to work more hours in his or her job. Part-time employment is relatively infrequent in Estonia, cf. also Figure 1. Part-time employment is not always desired by the employee, but may be dictated by the employment situation; the correlation between PARTTIME and WORKMORE is 0.35. Table 1 lists the variables and provides a brief description along with selected summary statistics.[12]

[10] There are very few individuals who only have a pre-primary education (ISCED 0) and they have been included in the group of individuals with only a primary education (ISCED 1). The resulting group of individuals with at most a primary education is labelled ISCED01.
[11] Tallinn is situated in the northern region, so REGNORTH = 1 if TALLINN = 1, while TALLINN = 1 does not necessarily imply that REGNORTH = 1.
[12] A Stata programme generating the variables used in this study from the data in ELFS (2005) can be obtained from the author upon request.

Table 1: Notation, description and summary statistics of main variables

(1.1)	(1.2)	(1.3)	(1.4)
Variable	**Definition and description**	**Mean**	**S.D.**
AGE	Age of individual minus sample mean 42.8 and divided by 100	0.000	0.172
AGE2	AGE squared	0.030	0.028
FEMALE	1 if individual is a woman, 0 otherwise	0.531	0.499
ESTCITI	1 if individual is an Estonian citizen, 0 otherwise	0.871	0.335
ESTETHN	1 if individual is of Estonian ethnicity, 0 otherwise	0.764	0.424
LANGEST	1 if Estonian is native language of individual, 0 otherwise	0.762	0.426
LANGOTH	1 if individual knows at least one non-native language, 0 otherwise	0.862	0.345
ISCED01	1 if highest education is at the pre-primary or primary level, 0 otherwise	0.054	0.226
ISCED2	1 if highest education is at the lower secondary level, 0 otherwise	0.210	0.407
ISCED3	1 if highest education is at the upper secondary level, 0 otherwise	0.441	0.497
ISCED4	1 if highest education is at the post-secondary non-tertiary level, 0 otherwise	0.058	0.234
ISCED5	1 if highest education is at the lower tertiary level, 0 otherwise	0.227	0.419
ISCED6	1 if highest education is at the higher tertiary level, 0 otherwise	0.004	0.061
MARRIED	1 if individual is married or lives in a common-law relationship, 0 otherwise	0.566	0.496
ADULTS	Number of persons in the household aged 15 to 74 years old	2.683	1.139
DEPENDENTS	Number of persons in the household below 15 and above 74 years old	0.562	0.889
REGEAST	1 if individual lives in the eastern region, 0 otherwise	0.187	0.390
REGNORTH	1 if individual lives in the northern region, 0 otherwise	0.307	0.461
REGSOUTH	1 if individual lives in the southern region, 0 otherwise	0.333	0.471
REGWEST	1 if individual lives in the western region, 0 otherwise	0.172	0.378
TALLINN	1 if individual lives in the capital, 0 otherwise	0.157	0.363
RURAL	1 if individual lives in a rural area, 0 otherwise	0.450	0.497
STUDYSEC	1 if individual studies at the secondary level, i.e. ISCED classifications 2-4, 0 otherwise	0.122	0.327
STUDYTER	1 if individual studies at the tertiary level, i.e. ISCED classifications 5-6, 0 otherwise	0.048	0.214
PRIMARY	1 if individual works in primary sector, otherwise 0	0.049	0.215
SECONDARY	1 if individual works in secondary sector, otherwise 0	0.186	0.389
TERTIARY	1 if individual works in tertiary sector, otherwise 0	0.315	0.464
PARTTIME	1 if individual works part time, 0 otherwise	0.048	0.214
WORKMORE	1 if individual works but would prefer to work longer hours, 0 otherwise	0.023	0.149
HOURS[a)]	"Usual" monthly working time in hours, 0 if individual does not work	94.568	89.347
LHOURS	Natural logarithm of HOURS	5.123	0.269
PAY[b)]	Net of tax labour income per month, EEK	2,294.79	3,266.72
HPAY[c)]	Net of tax labour income per hour for working individuals, EEK; HPAY = PAY/HOURS if HOURS > 0	13.55	18.93
LHPAY	Natural logarithm of HPAY	3.233	0.495
RESTPAY	Sum of labour income of all other household members, EEK	3,722.81	4,809.33
LRESTPAY	Natural logarithm of PAYREST	8.600	0.639

[a)] When non-working individuals are *excluded*, the mean of HOURS is 172.451 and the standard deviation is 33.545.
[b)] When non-working individuals are *excluded*, the mean of PAY is 4642.76 EEK and the standard deviation is 3270.60 EEK.
[c)] When non-working individuals are *excluded*, the mean of HPAY is 27.42 EEK and the standard deviation is 18.567 EEK.
Source: Variables constructed based on data from ELFS (2005).

4. Estimation of labour supply

4.1 Modelling labour supply

Labour supply decisions are part of the overall time allocation problem of individuals (Feldstein 1999, Robson 2005). An individual has 24 hours each day of the year available and has to decide how much time to work in the formal part of the economy where the returns on labour are taxable and how much to devote to other activities including:

- Formal sector work, where taxation can be *avoided* through legal means.
- Informal sector work, i.e. work where the taxation is *evaded*.
- Non-taxable production activity, e.g. home production.
- Education and training activity.
- Unemployment or other inactivity with social transfers.
- Economic inactivity without social transfers.

When analysing the effect of taxation on (formal) employment, the main distinction is between taxable labour supply and other uses of time, as taxation only affects the return on taxable work, while generally leaving the returns on the other activities unchanged. The distinction between the many different activities beyond formal employment is still useful in different contexts. First, the choice of control variables in the labour supply estimations should take into account the returns on the many different activities available and thus not presume that non-working individuals are inactive. The ease with which individuals can avoid or evade taxation, engage in home production, obtain social transfers, etc. will be important determinants of the individual's allocation of time. Second, as explained in Section 5, the welfare cost of a tax increase will depend on how much initial tax revenue the tax increase displaces. The choice of activities when not working in the formal sector may affect, for example, the revenue intake of consumption taxes and, therefore, the welfare costs of taxation.

The Estonian Labour Force Survey only contains information on whether an individual works (presumably in the formal, taxed sector) or does not work. Consequently, it is impossible to fully model the choice of time allocation, and we have to resort to estimating only the formal labour supply as a function of the hourly after-tax return on employment and various control variables.

In practice it is difficult to devise the control variables to be included in the labour supply estimation. Most of the control variables will – in principle – be observable, but others might be essentially unobservable characteristics as e.g. the individual's stamina, physical strength, norms, etc. Even among the observable characteristics, it is often difficult to obtain the required information. For instance, the ELFS does not contain information on whether a non-working individual receives non-labour income such as an old-age pension, disability pension, unemployment benefits, social welfare or possibly engages in informal sector activities.[13]

The preceding discussion has implicitly assumed that working time is continuous in the sense that the individual can choose any number of working hours. In practice, the norms, legislation or fixed costs of employment often make the choice of working time discontinuous so that, for example, very short weekly or daily working hours are not feasible choices

[13] However, this lack of information may not be a big problem in the case of Estonia as pensions are generally not dependent on other sources of income, unemployment benefits are relatively small and of limited duration, and welfare payments are small.

(Heckman 1993). The data from the ELFS indicates that indeed very few individuals report working less than 20 hours per week in Estonia, cf. Figure 1 in Section 2.

When this discontinuity is taken into account, decisions regarding working time can conveniently be thought of as entailing two steps. The individual must decide whether or not to participate in the formal labour market (the extensive margin) and, in the case of participation, then how many hours to work (the intensive margin). The two choices are clearly interrelated as, for example, the set of feasible working hours will affect the decision regarding participation.

The distinction between the intensive and the extensive margins is particularly important when ascertaining the employment and welfare costs of taxation (Kleven & Kreiner 2006a). First, the marginal tax rate affects the choice along the intensive margin, whereas the average tax rate affects the choice along the extensive margin. Second, the return on employment affects the intensive choice through both substitution and income effects, but affects the extensive choice only through the substitution effect (as no taxable income is earned when the individual is not working).

A minor complication relates to the fact that the labour supply elasticities may differ across different types of individuals. For many countries it is well established that males and females exhibit different (uncompensated) labour supply elasticities. It is also conceivable that the labour supply response will vary across individuals depending on their age and whether the individual is employed or self-employed. We have decided against estimating separate labour supply regressions for these groups. First, some of the groups would end up with relatively few data points reducing the precision with which the coefficients are estimated. Second, while tax policy can target different income groups (e.g. via the size of the basic exemption and different marginal tax rates dependent on income) it is often assumed to be unacceptable to make personal income taxation dependent on characteristics such as gender or age. Thus, we seek to determine an average estimate of the labour supply response to economic incentives.

It follows from the preceding discussion that the micro-econometric estimation of labour supply responses is complicated by several factors. First, the labour supply is likely to exhibit non-convexities as the individual decides whether or not to participate (the extensive margin) and – in the case of participation – the number of hours worked (the intensive margin). Second, for non-participants no data is available on the labour income these individuals are forsaking, i.e. the income they would be able to obtain if they were to enter the labour market. Third, for working individuals the decision regarding working hours may affect their hourly labour income. If left unaddressed, the endogeneity could give rise to biased coefficient estimates.

The standard solution to these problems is to employ a special version of Heckman's selection model, where the return on labour is "instrumented" or predicted based on the characteristics of the individual. We implement Heckman's selection model in the following phases: Subsection 4.2 derives the predicted hourly labour income for both working and non-working individuals, Subsection 4.3 estimates the Heckman model for the whole sample and Subsection 4.4 provides estimates of the Heckman model on sample quartiles.

4.2 Predicted hourly pay

The first stage entails the estimation of log hourly labour income (LHPAY) as a function of a range of characteristics of individuals participating in the labour market, including age, gender, ethnicity, language skills, education and geographical residence. Using these variables, it is possible to construct a predicted log hourly income for all individuals in the sample. The predicted log hourly income can then be used as an explanatory variable in the employment estimation. For working individuals, the use of predicted or instrumented values may reduce the risk of simultaneity bias in the estimated coefficients in the employment estimation. For non-working individuals, the construction of predicted or "notional" log hourly labour income facilitates the estimation of the effect of economic incentives on labour market participation.

Table 2 shows the results for two different specifications. It follows from (2.1) that most of the explanatory variables are statistically significant and have coefficients that are readily interpretable. There is an inverse U-shaped relationship between age and log hourly income with the maximum hourly income occurring for individuals who are approximately 36 years old. The coefficient of the dummy variable for women is precisely estimated and of very substantial magnitude. Taken literally, the point estimate suggests that women earn 29.3 percent less than men even when controlling for a range of other individual characteristics. Gender "pay gaps" of rather similar magnitudes are found in Vork (2004), Room & Kallaste (2004) and Alloja (2005a).

Table 2: Estimations of log labour income per hour of employed individuals (LHPAY)

	(2.1)		(2.2)	
	LHPAY		**LHPAY**	
	Coef.	**S.E.**	**Coef.**	**S.E.**
AGE	-0.456***	(0.045)	-0.453***	(0.045)
AGE2	-3.200***	(0.364)	-3.208***	(0.363)
FEMALE	-0.293***	(0.011)	-0.292***	(0.011)
ESTCITI	0.047**	(0.021)	0.045**	(0.021)
ESTETHN	0.012	(0.029)	0.010	(0.029)
LANGEST	0.190***	(0.029)	0.193***	(0.029)
LANGOTH	0.094***	(0.017)	0.098***	(0.017)
ISCED2	0.309***	(0.025)	0.347***	(0.031)
ISCED3	0.444***	(0.022)	0.482***	(0.029)
ISCED4	0.427***	(0.026)	0.466***	(0.032)
ISCED5	0.724***	(0.023)	0.759***	(0.029)
ISCED6	1.156***	(0.110)	1.189***	(0.111)
REGSOUTH	-0.187***	(0.018)	-0.187***	(0.018)
REGEAST	-0.127***	(0.021)	-0.125***	(0.021)
REGWEST	-0.191***	(0.020)	-0.191***	(0.020)
TALLINN	-0.007	(0.022)	-0.010	(0.022)
RURAL	-0.136***	(0.013)	-0.139***	(0.013)
CONSTANT	2.820***	(0.029)	-0.453***	(0.045)
R^2	0.265		0.269	
No. of obs.	6,078		6,078	

Notes: Standard errors (S.E.) are shown in brackets beside the coefficient estimates. The superscripts ***, ** and * indicate that the null hypothesis of the coefficient being equal to 0 is rejected at the 1%, 5% and 10% level of confidence, respectively. Monthly dummies are included, but not shown, in regression (2.2).

Language skills affect income in a positive direction. Being of Estonian nationality may also increase hourly income, but the effect is relatively modest in size and not very precisely estimated. The ethnicity variable is not statistically significant. The pay gaps based on nationality or ethnicity are arguably somewhat smaller than the corresponding measures found in Leping & Toomet (2007). Education affects income positively. Hourly incomes are higher in the northern region of Estonia, but living in Tallinn does not appear to bring about an additional effect. People living in rural areas have substantially lower income than people living elsewhere. Overall, the results are commensurable with previous microeconometric studies analysing wage or labour income formation in Estonia (Siliverstovs & Koulikov 2002, Vork 2004, Alloja 2005a). Before proceeding, we will discuss three possible problems concerning specification (2.1).

First, the determination of income may change across 2005 due to seasonal factors and a rapidly growing economy. Column (2.2) shows the results when monthly dummies for the first 11 months are added. (The dummy for December is omitted to avoid a perfect correlation across the explanatory variables). It follows that the econometric results change very little when monthly dummies are added. Among the monthly dummies, only the dummy for March was statistically significant (not shown). The share of explained variation increases only marginally when monthly dummies are added. Therefore, we conclude that seasonal and trend factors are unimportant for wage determination in the current data sample.

Second, it would have been desirable to include sector, firm and job function specific variables into the labour income regression. Average wages vary markedly across these dimensions, and sector, firm and job specific variables would have helped explain individual labour income (Room & Kallaste 2004). However, the inclusion of such variables would rule out the "prediction" of pay for non-working individuals since firm, sector and job specific information is unavailable for these individuals.

Third, specification (2.1) is based only on working individuals and thus it is implicitly assumed that all individuals can enter the labour market and obtain the predicted notional hourly income. In other words, non-working individuals are assumed to abstain from working solely because of insufficient economic incentives. This assumption may not be entirely realistic as factors like handicaps, addiction or (very) old age can make it impossible for the individual to enter the labour market irrespective of the attainable pay. We have also developed a model of hourly pay with a selection whose first step determines whether or not the individual participates in the labour market (Bicakova *et al.* 2006). Whereas the pay regression in the selection model differs somewhat from the specification in (2.1), the subsequent second stage employment estimation does not differ substantially from the corresponding results when (2.1) is used.

We use specification (2.1) to predict the pay for all individuals in our sample, including the approximately 1,600 individuals who reported no income in spite of being active in the labour market and the approximately 6,600 individuals who are not working. The predicted or "notional" logarithmic hourly income is denoted by LHPAYHAT, where the postfix HAT signifies that the variable is predicted. The average predicted notional log hourly rate for non-employed individuals is 2.97 (corresponding to an hourly income of 19.49 EEK) and hence substantially below the corresponding rate of 3.25 (equivalent to an hourly income of 25.78 EEK) for employed individuals. The result may suggest that non-participating individuals are partly discouraged by a lack of economic incentives.

4.3 Labour supply with selection

This subsection presents the results of Heckman's selection model for the labour supply decision of individuals using the *full* ELFS sample (see Appendix A for estimations without selection). The labour supply of an individual is taken to depend on the notional log hourly after-tax pay as well as a range of individual characteristics such as age, gender, education, family composition, educational activities, etc. The decision regarding participation and the number of hours worked are estimated using Heckman's two-step procedure, where the selection bias in the hours regression is corrected by the inclusion of the inverse Mill's ratio derived in the first stage selection regression.

We have chosen to identify the selection and the hours regressions through the non-linearity of the inverse Mill's ratio. As in many other empirical implementations of Heckman's selection model, there is not a straightforward way of finding variables suitable for the identification. The challenge is to find variables that ex ante (from a theoretical viewpoint) would be expected to affect the decision regarding participation but not the decision regarding working hours. Such variables are generally not available in labour supply models (Hogan 2004).

Vella (1997) surveys a number of studies applying Heckman's selection model and concludes that identification through the non-linearity of the inverse Mills ratio provides satisfactory results provided the explanatory variables exhibit sufficient variability. In light of this finding and the problems finding identifying variables, we have chosen not to include variables in the selection regression which do not appear in the hours regression.[14]

The upper panel of Table 3 shows the results of the choice of participation, whereas the lower panel shows the results of the choice of working hours by individuals participating in the formal labour market. The marginal effects are reported for the participation regression. For non-dummy explanatory variables, the marginal effect is calculated for the average value of the variable; for dummy variables the marginal effect denotes the change in the probability of employment when the variable increases from 0 to 1. The choice of a "double log specification" (i.e., both working hours and net-of-tax income in logarithms) implies that the intensive margin labour supply elasticity follows directly from the hours regression.

[14] We have undertaken a number of robustness checks to examine the impact of this choice. In one case we chose to identify the selection by a dummy for residence in the countryside (RURAL) based on the argument that longer distances and less well-developed public transportation make it less attractive to participate in the labour market, but might have little impact on the number of working hours of working individuals. This and other experiments with different (rather arbitrary) identification restrictions revealed that the choice of identification restrictions only has a minor impact on the estimation results, and we have therefore chosen to continue to identify the selection and the hours regressions through the non-linearity of the inverse Mill's ratio.

Table 3: Estimations of monthly logarithmic working hours with selection

	(3.1)		(3.2)		(3.3)		(3.4)	
	Selection		**Selection**		**Selection**		**Selection**	
	Marg. eff.	**S.E.**	**Marg. eff.**	**S.E.**	**Marg. eff.**	**S.E.**	**Marg. eff.**	**S.E.**
LHPAYHAT	0.590***	(0.040)	0.590***	(0.040)	0.336***	(0.063)	0.515***	(0.047)
AGE	-0.289***	(0.047)	-0.289***	(0.047)	-0.354***	(0.074)	-0.250***	(0.052)
AGE2	-7.744***	(0.273)	-7.744***	(0.273)	-9.828***	(0.500)	-8.622***	(0.323)
FEMALE	0.082***	(0.015)	0.082***	(0.015)	-0.032	(0.025)	0.009	(0.018)
ISCED2	0.046	(0.035)	0.046	(0.035)	0.220***	(0.056)	0.107***	(0.040)
ISCED3	0.075**	(0.037)	0.075**	(0.037)	0.282***	(0.059)	0.154***	(0.043)
ISCED4	0.098**	(0.040)	0.098**	(0.040)	0.260***	(0.056)	0.151***	(0.043)
ISCED5	0.075*	(0.044)	0.075*	(0.044)	0.267***	(0.065)	0.152***	(0.049)
ISCED6	0.201**	(0.094)	0.201**	(0.094)	0.368***	(0.098)	0.334***	(0.065)
MARRIED	0.077***	(0.012)	0.077***	(0.012)	0.045**	(0.023)	0.068***	(0.015)
ADULTS	0.015***	(0.005)	0.015***	(0.005)	-0.006	(0.009)	0.017***	(0.007)
DEPENDENTS	-0.045***	(0.006)	-0.045***	(0.006)	-0.094***	(0.009)	-0.046***	(0.006)
STUDYSEC	-0.419***	(0.018)	-0.419***	(0.018)	-0.434***	(0.025)	-0.416***	(0.021)
STUDYTER	-0.287***	(0.019)	-0.287***	(0.019)	-0.308***	(0.025)	-0.311***	(0.021)
LPAYREST	..	..	..	..	0.035***	(0.014)	..	..
LPAYRESTHAT	..	..	..	..	..	..	0.004	(0.008)
Total obs.	14,567		14,567		6,258		12,129	
	LHOURS		**LHOURS**		**LHOURS**		**LHOURS**	
	Coef.	**S.E.**	**Coef.**	**S.E.**	**Coef.**	**S.E.**	**Coef.**	**S.E.**
LHPAYHAT	-0.219***	(0.037)	-0.063***	(0.024)	-0.175***	(0.057)	-0.174***	(0.036)
AGE	-0.122***	(0.037)	-0.085***	(0.023)	0.010	(0.075)	-0.134***	(0.038)
AGE2	-0.366	(0.496)	-1.163***	(0.336)	2.413*	(1.254)	-0.087	(0.564)
FEMALE	-0.099***	(0.011)	-0.041***	(0.006)	-0.047**	(0.019)	-0.078***	(0.011)
ISCED2	-0.041	(0.033)	-0.004	(0.023)	-0.213***	(0.073)	-0.066*	(0.039)
ISCED3	-0.053	(0.034)	0.014	(0.024)	-0.248***	(0.787)	-0.081**	(0.040)
ISCED4	-0.056	(0.036)	0.013	(0.025)	-0.252***	(0.081)	-0.076*	(0.042)
ISCED5	-0.054	(0.037)	0.022	(0.025)	-0.249***	(0.084)	-0.086**	(0.043)
ISCED6	-0.078	(0.063)	-0.006	(0.038)	-0.160	(0.136)	-0.096	(0.071)
MARRIED	-0.033***	(0.009)	-0.004	(0.005)	-0.034*	(0.018)	-0.027***	(0.010)
ADULTS	-0.003	(0.003)	-0.002	(0.002)	-0.001	(0.007)	-0.004	(0.004)
DEPENDENTS	0.008*	(0.005)	-0.001	(0.003)	0.040***	(0.012)	0.006	(0.005)
STUDYSEC	-0.012	(0.041)	-0.067**	(0.030)	0.049	(0.087)	-0.060	(0.044)
STUDYTER	-0.026	(0.023)	0.001	(0.015)	0.063	(0.049)	0.012	(0.026)
PRIMARY	0.080***	(0.010)	0.091***	(0.007)	0.057***	(0.021)	0.089***	(0.010)
SECONDARY	0.035***	(0.006)	-0.004	(0.004)	0.026**	(0.011)	0.031***	(0.007)
WORKMORE	-0.358***	(0.014)	-0.015	(0.010)	-0.347***	(0.027)	-0.377***	(0.014)
PARTTIME	..	..	-0.725***	(0.007)	..	..	..	..
LPAYREST	..	..	..	..	-0.005	(0.011)	..	..
LPAYRESTHAT	..	..	..	..	..	..	-0.003	(0.005)
CONSTANT	6.094***	(0.141)	5.422***	(0.094)	6.144***	(0.255)	5.980***	(0.141)
Mill's lambda	-0.279***	(0.039)	-0.008	(0.028)	-0.383***	(0.087)	-0.259***	(0.043)
Uncensored obs.	7,983		7,983		3,491		6,949	

Notes: The marginal effects and their standard errors are shown in the selection regression. For the dummy variables, the marginal effect is the discrete change of the variable from 0 to 1. Standard errors (S.E.) are shown in brackets beside the coefficient estimates. The superscripts ***, ** and * indicate that the null hypothesis of the coefficient being equal to 0 is rejected at the 1%, 5% and 10% level of confidence, respectively.

It follows from the main specification in Column (3.1) that the decisions regarding hours and participation are not generally driven by the same factors. A large number of factors helps explain the decision regarding participation, while only relatively few of the explanatory variables enter significantly into the working hours regression. The latter result is consistent with the limited variability in the variable LHOURS.

The estimated coefficient of the notional log pay per hour, LHPAYHAT, in the selection regression is positive and highly statistically significant, while it is negative and significant in the working hours regression. The control variables enter the specification in reasonable ways. The elderly are more likely not to be employed than younger individuals and they work shorter hours if they do work. Women are more likely to work than men, but they work shorter hours. Higher education increases the probability of employment, but has no effect on the number of hours worked. Married individuals are more likely to be employed, but work shorter hours than individuals who are not married. The number of children or elderly dependents in the household decreases the likelihood of an individual working. Individuals working in the primary and secondary sectors work longer hours than individuals in the tertiary sector. Unsurprisingly, students have a lower probability of participation than individuals who do not study.

The negative elasticity of the hours worked in (3.1) is a surprising result. If taken literally, a 1 percent increase in after-tax hourly income would lead to 0.6 percentage point more individuals being employed, but the number of working hours among individuals already working would fall by 0.2 percent. The result that changes in hourly net-of-tax pay mainly affects the choice of participation and to a much smaller extent the choice of hours is consistent with most studies. There are other empirical studies that have found intensive labour supply elasticities in the vicinity of –0.2, but most studies suggest that the elasticity is higher (Evers 2005). The intensive elasticity estimated in (3.1) is also substantially below the elasticities found in Estonian studies based on data from earlier years (Vork 2004, Alloja 2005a, b). In the following paragraphs we discuss the negative elasticity of hours worked in (3.1) in more detail.

The first approach is to consider whether the negative coefficient could be related to the choice of sample and estimation techniques. When (3.1) is re-estimated using different subsamples (men and women separately, different age groups), the negative intensive elasticity prevails although the estimated coefficient is not always statistically significant. Re-estimating the model in (3.1) using Maximum Likelihood yields results very similar to the results using the two-step procedure.

The second approach builds on the conception that an individual might work fewer hours because of personal characteristics otherwise not controlled for or because a job with longer hours is not available. This might bias the estimated coefficient of the hourly after-tax pay if the working time affects the hourly remuneration.[15]

Estimation (3.2) includes the variable PARTTIME in the working hours part of the model to control for a possible reverse causality from the choice of working time to hourly pay. The selection part of the model is unchanged as the additional variable does not enter in this part.

[15] An example would be an individual who cannot hold a full time job because of bad health and who therefore chooses to work only half time. If at the same time the part-time job has a better hourly pay (e.g., directorships, consultancy work, teaching, etc.), then the lack of control for part-time employment will bias the estimated coefficient of the notional log hourly pay downwards.

In the hours part several coefficients change substantially, as would be expected. Most strikingly, the coefficient of the notional log hourly pay LHPAYHAT is now estimated at –0.05, which (in numerical terms) is substantially below the estimate found in (3.1). The coefficient is also imprecisely estimated and only significant at the 10 percent level. This result suggests that the large negative coefficient estimate of LHPAYHAT is largely related to individuals taking up part-time work, usually working around 87 hours per month.[16]

The third approach seeks to exploit the restrictions on the labour income elasticity imposed by theory. Economic theory does not impose sign restrictions on the uncompensated or Marshallian elasticity directly, but only on the compensated or Hicksian elasticity. The compensated elasticity is derived from the uncompensated elasticity by removing the income effect so as to isolate the substitution effect. The compensated intensive margin labour supply elasticity must be non-negative. The compensated elasticity is also used for the estimation of the excess burden of taxation affecting the number of hours worked for economically active individuals.

The (numerically) large negative estimated coefficient of LHPAYHAT in the working hours regression in (3.1) suggests that the income effect must be very strong. The income effect should ideally be estimated based on data on lump sum income, but individuals do not receive lump sum income in practice and the ELFS dataset contains only information on labour income.

In order to obtain estimates of how income not earned by the individual affects the labour supply of the individual, we have decided to include the logarithmic labour income of other individuals in the household.[17] This variable, LPAYREST, is clearly an imperfect proxy of lump-sum income, but it has been utilised in other studies (Hogan 2004, Bicakova *et al.* 2006, Tandani 2006). Column (3.3) in Table 3 shows the estimation when LPAYREST is included in both the selection and working hours regressions. The results indicate that the logarithmic income of the other household members enters with a positive and significant coefficient in the selection regression, while it is insignificant in the working hours regression.[18] Taken literally, the results suggest that a higher income from other household members leads to a *higher* probability of employment.

The poor results obtained when LPAYREST is included may result from the income of other household members being dependent of the income of the individual. To reduce this form of endogeneity bias, we instrumented the income of all individuals in the household using the same set of individual characteristics as used in the instrumentation of LHPAY in Table 2. The variable LPAYRESTHAT is calculated as the sum of the instrumented labour income of all other members of the household. Column (3.4) shows the results when the instrumented income proxy is used, but the results are once again unimpressive as the variable is insignificant, both in the selection and the working hours regressions.

The estimations using household income variables did not show that higher labour income from other household members led the individual to reduce his or her labour supply as would

[16] This conclusion is also confirmed if the estimation in Column (3.1) is redone on a sample restricted to individuals working more than 100 hours per month (not shown). The coefficient estimate of LHPAYHAT is insignificant in this case.

[17] This is admittedly a rather *ad hoc* approach to modelling the interdependence of an economic decisions within a household (see e.g. Chiappori 1988).

[18] The estimated coefficient of the individual's own pay, LHPAYHAT, is markedly lower in (3.3) than in (3.1), which is the result of the two income measures being positively correlated.

be expected. In other words, we failed to show that the income effect is very strong. This may due to a lack of satisfactory income variables, but no other variables are available in the ELFS dataset.

In the regressions the entire sample of individuals in the working age, i.e. individuals aged 15 to 74 are included. Individuals in the upper tail of the distribution may be regarded as pensioners, and they might have different labour supply behaviour than younger individuals. This, however, turns out not to be the case. If only individuals aged 15 to 65 are included in regression (3.1), the results are broadly similar. In particular, the labour participation elasticity is estimated to 0.554, which is only marginally below the value for the full sample. We therefore continue employing the full sample inclusive of the elderly, as this group potentially constitutes an important part of the total labour force.

The estimations in this subsection of the Estonian labour supply using the full sample of the 2005 ELFS have yielded important results. The participation elasticity can be estimated precisely and the point estimate is reasonable, whereas it has not been possible to derive a reliable estimate of either the conditional or unconditional working hours elasticities.

4.4 Labour supply for different income groups

This paper aims to evaluate how personal income taxation affects employment and welfare across different income groups. Therefore, it is expedient to divide the full sample into subsamples based on income and estimate labour supply elasticities separately for each subsample. Kleven & Kreiner (2006a, b) emphasise the importance of heterogeneity in the labour supply decision across different income groups, but also show that it is possible to attain more precise MPFC estimates by disaggregating the sample even if the labour participation and hours elasticities are identical across all income groups.

We consider four groups or sub-samples based on the notional hourly labour income of the individuals in the group. The 14,567 individuals have been divided into four groups based on their notional hourly income. The *low income* group comprises individuals that earn or are expected to earn an hourly income in the lowest quartile of the distribution. The *middle-low* income group is made up of individuals with a notional income in the second lowest quartile. The *middle-high* income group consists of individuals with notional incomes in the second highest quartile, while the *high* income group comprises persons with notional incomes in the highest quartile.

We have estimated the selection model in (3.1) using Heckman's two-stage procedure for each of the four sub-samples. Table 4 shows the results. In a number of cases, dummy variables have been omitted to avoid perfect collinearity.

Table 4: Estimation of monthly logarithmic working hours with selection, four sub-samples

	(4.1)		(4.2)		(4.3)		(4.4)	
	Low		**Middle-low**		**Middle-high**		**High**	
	Selection		**Selection**		**Selection**		**Selection**	
	Marg. eff.	**S.E.**	**Marg. eff.**	**S.E.**	**Marg. eff.**	**S.E.**	**Marg. eff.**	**S.E.**
LHPAYHAT	0.353***	(0.065)	0.643***	(0.172)	0.637***	(0.164)	0.319***	(0.073)
AGE	-0.084	(0.058)	-0.330***	(0.086)	-0.334***	(0.083)	-0.269***	(0.068)
AGE2	-4.052***	(0.328)	-7.957***	(0.512)	-7.409***	(0.494)	-4.901***	(0.435)
FEMALE	0.048**	(0.020)	0.116***	(0.027)	0.092***	(0.024)	0.009	(0.023)
ISCED2	-0.013	(0.026)	0.268***	(0.081)	0.666***	(0.084)	-0.307**	(0.142)
ISCED3	-0.006	(0.030)	0.250***	(0.082)	0.998***	(0.004)	-0.145	(0.091)
ISCED4	0.063	(0.046)	0.280***	(0.082)	0.464***	(0.042)	-0.297**	(0.135)
ISCED5	-0.051	(0.041)	0.275***	(0.089)	0.861***	(0.086)	-0.116*	(0.067)
ISCED6	..	..	..	..	..	..	..	..
MARRIED	0.010	(0.014)	0.069***	(0.022)	0.088***	(0.022)	0.092***	(0.018)
ADULTS	-0.002	(0.006)	0.028***	(0.009)	0.026***	(0.008)	0.002	(0.007)
DEPENDENTS	-0.022***	(0.008)	-0.062***	(0.011)	-0.044***	(0.010)	-0.025***	(0.008)
STUDYSEC	-0.201***	(0.015)	-0.380***	(0.028)	-0.418***	(0.047)	-0.356***	(0.074)
STUDYTER	-0.103***	(0.022)	-0.287***	(0.030)	-0.351***	(0.041)	-0.196***	(0.036)
Total obs.	3,641		3,638		3,647		3,641	
	LHOURS		**LHOURS**		**LHOURS**		**LHOURS**	
	Coef.	**S.E.**	**Coef.**	**S.E.**	**Coef.**	**S.E.**	**Coef.**	**S.E.**
LHPAYHAT	-0.102	(0.348)	-0.244	(0.168)	-0.793*	(0.431)	-0.253	(0.171)
AGE	-0.252*	(0.134)	-0.088	(0.099)	0.065	(0.249)	0.150	(0.180)
AGE2	0.486	(3.460)	0.232	(1.860)	6.453	(4.034)	1.928	(2.417)
FEMALE	-0.098	(0.067)	-0.136***	(0.030)	-0.185***	(0.064)	-0.072*	(0.044)
ISCED2	0.035	(0.058)	-0.198*	(0.109)	0.082	(0.099)	..	..
ISCED3	-0.011	(0.065)	-0.119	(0.107)	0.013	(0.072)	-0.090	(0.103)
ISCED4	-0.057	(0.080)	-0.124	(0.111)	..	..	-0.016	(0.112)
ISCED5	0.277**	(0.139)	-0.189	(0.115)	0.041	(0.083)	-0.117	(0.112)
ISCED6	..	..	..	..	..	..	-0.227	(0.185)
MARRIED	-0.014	(0.028)	-0.036*	(0.020)	0.084	(0.058)	-0.108**	(0.047)
ADULTS	0.004	(0.013)	-0.007	(0.008)	-0.026	(0.019)	0.003	(0.012)
DEPENDENTS	0.012	(0.025)	-0.003	(0.015)	0.037	(0.028)	0.023	(0.018)
STUDYSEC	-0.035	(0.303)	-0.175	(0.135)	0.544*	(0.293)	0.295	(0.217)
STUDYTER	-0.505	(0.170)	-0.092	(0.087)	0.375*	(0.193)	0.084	(0.096)
PRIMARY	-0.010	(0.032)	0.123***	(0.021)	0.109**	(0.051)	0.068	(0.047)
SECONDARY	0.031	(0.025)	0.049***	(0.013)	0.037	(0.034)	0.026	(0.024)
WORKMORE	-0.444***	(0.044)	-0.429***	(0.029)	-0.298***	(0.065)	-0.327***	(0.062)
CONSTANT	5.734***	(1.142)	6.257***	(0.640)	8.122***	(1.484)	6.376***	(0.679)
Mill's lambda	-0.308	(0.261)	-0.211	(0.146)	-0.939***	(0.352)	-0.692***	(0.267)
Uncensored obs.	836		1,732		2,485		2,930	

Notes: The marginal effects and their standard errors are shown in the selection regression. For the dummy variables, the marginal effect is the discrete change of the variable from 0 to 1. Standard errors (S.E.) are shown in brackets beside the coefficient estimates. The superscripts ***, ** and * indicate that the null hypothesis of the coefficient being equal to 0 is rejected at the 1%, 5% and 10% level of confidence, respectively.

The results in Table 4 reveal that there are substantial differences in labour response across the four income groups. As in the case of the full-sample estimations, the hourly after-tax wage affects the decision regarding participation positively and the participation elasticities of all four groups are estimated with relatively small standard errors.

Individuals in the middle income groups exhibit higher labour participation elasticities than individuals in the low and high income groups. The participation elasticity is around 0.35 in the low income group, 0.65 in the middle income groups, and slightly above 0.3 in the high income group.

Kleven & Kreiner (2006b, p. 23) summarise the empirical literature on labour supply elasticities in the following way: "[F]rom available evidence, it seems reasonable to conclude that participation elasticities are large, perhaps above 0.5, for the groups in the lower part of the income distribution. Participation elasticities in the middle part of the distribution are likely to be substantially lower, while there is almost no responsiveness of labor force participation at the top of the distribution." The results obtained in this study for Estonia are thus within the range of estimates reported in the empirical literature, although the elasticity at the lower end of the income distribution might be relatively small in Estonia.

It was discussed in Section 2 that individuals interviewed for the ELFS likely underreport their income. If a possible underreporting is proportional within each income group, the estimated elasticities will not be affected; the logarithmic transformation of the pay variable means that such proportional underreporting will only affect the constant terms in the selection and hours regressions. However, the elasticities will be biased if the underreporting is not proportional.

It follows from Table 4 that the intensive margin elasticities are insignificant (at the 5 percent level or better) for all the income groups. Thus, it is reasonable to assume that changes in after-tax hourly income do not affect the number of hours worked by individuals already working in any noticeable way. This result is reasonable in light of the dataset exhibiting an extreme concentration of observations with 0 and 40 hours worked per week, respectively, cf. Figure 1. Similar results have also been attained in recent empirical work for other countries (Evers 2005, Kleven & Kreiner 2006a).

We conclude from Subsections 5.3 and 5.4 that the main effect on the labour supply of variability in hourly after-tax income is via the extensive margin. Individuals with lower expected after-tax pay have a lower probability of participation even when controlling for a large number of other factors. It is difficult to obtain reasonable and reasonably precise estimates of the effect of hourly labour income on the number of hours worked by individuals already working. Likewise, attempts to estimate the income effect emerged as fruitless as no statically significant relationships could be established. In light of these inconclusive results, it seems reasonable to assume that both uncompensated and compensated working time elasticities will be close to zero.

5. Employment and welfare consequences of changes in personal income taxation

In this section we seek to estimate the effects of changes in the personal income tax on employment and welfare. The estimates are comparative static results based on the labour supply responses estimated in Section 4 along with information on employment, working hours and labour income for each of the four subsamples.

Table 5 provides summary information on each of the four income groups. The four groups comprise the quartiles based on hourly notional income. It is noticeable that the number of working individuals and, hence, the labour market participation ratio increase markedly

across the four income quartiles. The number of monthly working hours increases slightly across the four income groups.

Table 5: Summary statistics for the four income groups

	(5.1)	(5.2)	(5.3)	(5.4)
	Low	**Middle-low**	**Middle-high**	**High**
Number of individuals	3,641	3,638	3,647	3,641
Number of working individuals	836	1,732	2,485	2,930
Average HPAY of active individuals	17.05	20.88	25.15	33.39
Average HOURS of working individuals	163.4	170.9	173.3	175.2
Monthly income net of tax of working individuals	2,785	3,568	4,358	5,848
Estimated labour participation elasticity	0.353	0.643	0.637	0.319
Relative weight of group	0.874	0.905	0.968	1.253

A main conclusion from Subsections 4.3-4.4 was that economic incentives have a statistically and economically significant effect on the labour market participation of individuals in Estonia, while the effect on the number of working hours of individuals already working cannot be determined with any degree of certainty. The participation elasticity of each of the four income groups is reported in Table 5. While it seems reasonable to assume that both the compensated and uncompensated working time elasticities for participating individuals are close, they can be ignored, i.e. set equal to zero.

We consider only changes to the personal income tax system. One consequence of the finding that economic incentives mainly affect the labour supply through the decisions regarding participation is that an incremental change in tax policy only affects the labour supply insofar as it affects the *average tax rate* (Kleven & Kreiner 2006a). There is no income effect in this case as the non-participating individual has no income – or, alternatively, has only income sources that are not affected by the tax policy change.

It is important to make explicit the economic and behavioural assumptions underlying the experiments. First, we apply the "symmetry principle" when analysing the effect of changes in the income tax. Thus, it is assumed that individuals will react similarly to changes in after-tax income whether these are the result of tax policy changes or of other factors. In other words, the labour participation elasticities estimated in Section 5 and reproduced in Table 5 are assumed to capture the impact on the decisions regarding participation of changes in tax policy.

Second, it is assumed that changes in the system of personal income taxation exclusively affect those providing the employment. In other words, the hourly pay before personal income taxation is constant and unaffected by, for example, tax policy changes. This incidence assumption is consistent with a flat pre-tax labour demand schedule, which may be a realistic assumption depending on the technology used.

Third, the tax policy simulations seek to incorporate the effect of the "first round" of adjustments undertaken by individuals when tax changes affect their post-tax labour income. Consequently, the time horizon is such that the labour supply responses estimated in Section 4 have time to take place. These results, which are based on the first round of adjustments, should not be mistaken for "morning after" simulations that seek to assess the revenue effect and distributional consequences immediately after changes in tax policy have been imposed. The results from the first round simulations should also not be mistaken for general equilib-

rium effects such as changes in the pre-tax wage, employment and income patterns.[19] The choice of simulation for the first round of adjustments also suggests that the results are more reliable for relatively small changes in tax policy than for large-scale reforms that may affect wage and employment opportunities in more fundamental ways.

The choice of a partial adjustment model is based on the wish to retain a simple specification and to obtain results that are not the outcome of complex general equilibrium modelling. Browning (1987) finds that the specification of the main behavioural relationships is of greater importance for the results than the inclusion of general equilibrium effects. Browning (1987, p. 22) concludes that "arriving at a more precise estimate of marginal welfare cost may well depend more on empirical investigation that narrows the range of possible parameter values than on developing more rigorous models …".[20]

Fourth, the reliability of the simulations is constricted by the lack of information on the behaviour and income sources of individuals who are not working. For instance, the ELFS (2005) database does not contain information on whether or not a non-working individual receives taxable income in the form of unemployment benefits, scholarships or a disability pension. Furthermore, we do not know whether or not a non-working individual receives income from informal sector activities.

Fifth, the lack of information also implies that some details of the Estonian tax system as described in Section 2 cannot be implemented in the simulations. For instance, the pensioners' additional exemption cannot be incorporated.[21] We have similarly been forced to ignore exemptions for children, interest expenses and educational outlays.

5.1 Effects on labour supply

This sub-section considers the employment effects of two different tax policy experiments. The results are shown in Table 6 for each of the four income groups and for the full sample. The full-sample results are obtained by weighting the results for each of the income groups using the weights in Table 5.

[19] Notice that the incidence assumption discussed above is consistent with the simulation of the effects of the first round of adjustments.
[20] However, Goulder & Williams (2003) argue that the calculation of excess burdens based only on estimates of elasticities for one market can lead to biased results as interaction effects will be important in many cases.
[21] As explained in Section 2, the additional allowance for pensioners amounts to slightly more than the average pension, so the omission of pensions and the additional allowance from the simulations is likely to have relatively little impact for the average pensioner.

Table 6: The effects of two tax experiments on employment and tax revenue

	(6.1)	(6.2)	(6.3)	(6.4)	(6.5)
	Low	**Middle-low**	**Middle-high**	**High**	**Full sample**[a)]
Basic exemption lowered 10%					
Change in group post-tax hourly income, %	-1.46	-1.14	-0.94	-0.70	..
Change in group employment	-16	-24	-21	-10	-69
Change in employment, % of group population	-0.52	-0.74	-0.60	-0.22	-0.48
Change in tax revenue from group, 1000 EEK	6.4	15.0	42.7	111.4	200.7
Tax rate increased by 1 percentage point					
Change in group post-tax hourly income, %	-0.51	-0.68	-0.80	-0.90	..
Change in group employment	-6	-15	-18	-14	-53
Change in employment, % of group population	-0.18	-0.44	-0.51	-0.30	-0.36
Change in tax revenue from group, 1000 EEK	2.2	9.0	36.6	149.0	232.2

[a)] Full sample results are calculated using weights of each sub-sample.

Notes: The starting point is a basic exemption equal to 1700 EEK and a tax rate equal to 24%. Summary statistics for the four income groups are provided in Table 5.

The first experiment assumes that the basic exemption is reduced by 10 percent from 1700 EEK per month to 1530 EEK. The effect on the average post-tax hourly income in percentage terms depends on the initial average labour income in the group. The low and middle income groups experience substantial decreases in employment, whereas the effect is smaller in the high income group. The high income group is, in percentage terms, less affected than the other groups from the lowering of the basic exemption and in addition has a relatively low labour participation elasticity. Total employment decreases by 0.48 percentage points.

The second experiment is an increase of the tax rate by 1 percentage point. Average post-tax hourly labour income decreases the most in the high income group. Still, the largest increases in employment are found in the middle income groups because of the higher labour participation elasticities in these groups. Total employment decreases by 0.36 percentage point.

The simulation experiments suggest that there are sizeable employment effects of tax changes and that the total employment effects of the two experiments are of broadly comparable magnitudes. However, it is noticeable that the two experiments have very different effects across the four income groups; the lowering of the basic exemption reduces employment mainly in the low and middle income groups, while the increase of the personal income tax rate reduces employment disproportionately among individuals in the middle income groups.

The choice of tax instrument also affects the distribution profile in other ways. In Table 6 the extra tax revenue from each group is shown for the two experiments. The extra tax revenue is calculated as the net change in revenue intake from the personal income tax, the social tax and the unemployment contribution. The two tax experiments produce broadly the same increase in net tax revenue, but a larger share of the burden falls on the lower income groups when the basic exemption is reduced than when the income tax rate is increased.

The simulated employment effects of personal income tax changes shown in Table 6 depend closely on the labour participation elasticities estimated in Subsection 4.4. Given that the participation elasticities for Estonia are broadly in line with results found elsewhere, it is not surprising that the employment effects of income tax changes are comparable to results obtained

in other recent studies.[22] The effects in Estonia might, however, be in the upper tail of the distribution of employment effects found in other studies (i.e. be relatively large).

Section 2 brought up the possible underreporting of labour income in the ELFS. As argued above, proportional underreporting within each income group would have little or no effect on the estimated participation elasticities. However, proportional underreporting may still affect the simulation results as income above and below the basic exemption of 1700 EEK per month are taxed very differently. The lowering of the basic exemption by 10 percent (170 EEK) may thus lead to a larger percentage reduction in hourly after-tax income and a larger fall in employment than if underreporting did not take place. Conversely, an increase in the tax rate by 1 percentage point may lead to a smaller percentage reduction in hourly after-tax income and a smaller fall in employment than if underreporting did not take place.

5.2 The marginal cost of public funds

The excess burden or deadweight loss of (distortionary) taxation is the extra cost incurred by society because of behavioural changes resulting from distorted price signals. The excess burden of personal income taxation stems mainly from the tax affecting the return on taxable employment, when the returns on the alternative use of time remain unchanged by the tax.

A measure of the total excess burden of personal income taxation is often difficult to obtain. At the same time, such a measure captures the *average* cost to society of raising tax revenue, while in many circumstances it is more useful to know the *marginal* cost of raising tax revenue. The marginal cost of public funds (MCPF) denotes the cost to the private sector when changes in tax policy increase the tax revenue marginally. In the present context, it is useful to think of the MCPF as the private cost of the government raising an additional 1 EEK in tax revenue. The MCPF can then be thought of as the sum of the tax revenue (1 EEK) and the change in the excess burden per 1 EEK of tax revenue. The MCPF can only be less than 1 if the excess burden is negative, i.e. if the revenue is raised in a way that *reduces* distortions in the economy.[23]

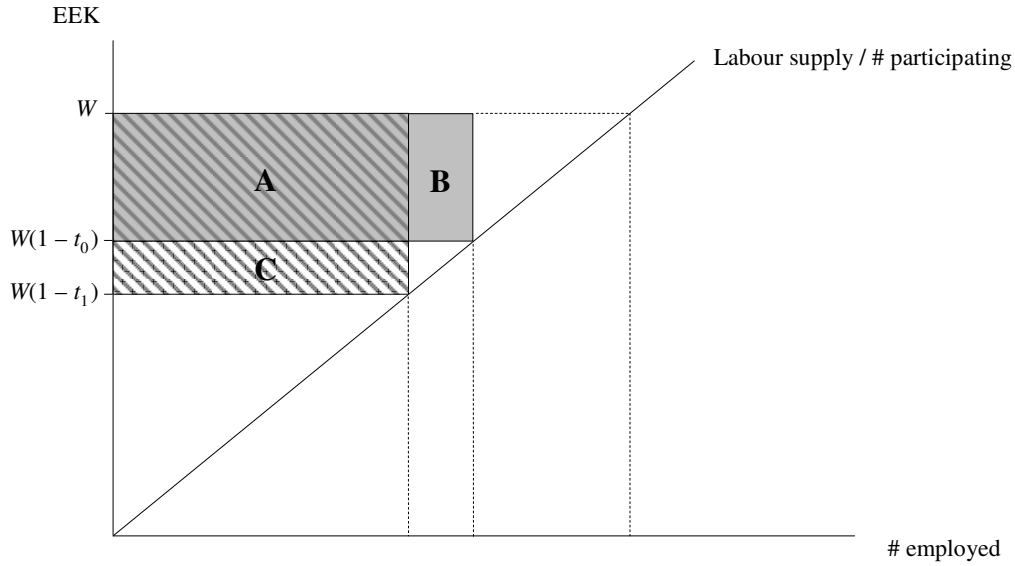
The calculation of the MCPF is relatively straightforward when the uncompensated and compensated elasticity of supplied hours is close to 0 as implied by the estimation results in Section 4. In this case, personal income taxation only affects social welfare via the extensive margin and there is no need to take into account income effects, as personal income taxation does not affect individuals who are not participating in the labour market.

The calculation of the MCPF is illustrated in Figure 3. The number of individuals participating is shown as an increasing function of the hourly labour income, net of tax (in EEK). The initial average tax rate is t_0, implying that the initial tax revenue is the area A + B. When the average tax rate is increased to $t_1 > t_0$, the number of active individuals is reduced and the tax revenue is the area A + C. The excess burden stems from the retrenchment of employment because of the lower after-tax pay. Thus, the excess burden is the area B plus the small Harberger triangle immediately below B. However, the Harberger triangle is of a second order of magnitude and can therefore be ignored for small changes in the average tax rate. Thus, the

[22] Kuismanen (2000), Tondani (2006), Rutkowski & Walewski (2007), Bicakova (2006) and Vork *et al.* (2007) are examples of recent studies using a number of different empirical methodologies.
[23] In models where both taxes and benefits are included, the MCPF will typically be below 1 if additional government revenue comes from a reduction of benefits that distort labour supply.

marginal cost of public funds can be calculated as MCPF = 1 + B/(C – B). This formula is used in the calculations below with group specific averages for the monthly pay, participation rates, tax rates, basic exemption, etc. inserted.

Figure 3: The marginal cost of public funds from a tax increase



Source: Figure adopted from Kleven & Kreiner (2005).

As stated above, the MCPF is 1 plus the amount of *initial tax revenue* displaced per 1 EEK generated. This raises the question of which taxes should be included in the initial tax revenue.[24] It was brought up in Section 2 that the Estonian pension system implies that pension contributions create future liabilities for the government (or the private pension fund) and therefore may not be considered a tax in its standard definition as a compulsory contribution for which the taxpayer receives no specific benefits or services. Thus, the pension contribution may – partially or fully – be regarded as a savings and not as a tax.

Likewise, to the extent that working individuals spend their post-tax income on goods and services that are subject to the value added tax or other forms of taxation in Estonia, the tax revenue from such taxes is also eroded if higher income taxes lead to lower employment and creation of income. The exact tax component of the social tax earmarked for pension contributions is virtually impossible to pin down and the spending patterns of individuals are not available in the ELFS. Therefore, we calculate the MCPF under three different assumptions based on which taxes are assumed to be displaced when additional tax revenue is raised through higher personal income taxation.

Table 7 shows the results for each of the four income groups and for the full (weighted) sample. A natural baseline is to assume that tax revenue includes revenue from the personal income tax, social tax and unemployment insurance contribution. It follows from the upper panel that the MCPF in this case is around 4.7 for the low income group, 4.3 for the middle-low income group, 2.3 for the middle-high income group and 1.3 for the high income group.

[24] Notice that possible derived effects on tax payments by employers are ignored so changes in employment are not expected to affect, for example, enterprise profits in any discernable way.

The estimated MCPF for each of the four income groups is identical whether the extra revenue from the group is generated by lowering the basic exemption or by increasing the tax rate. This is the consequence of a change in only the *average tax rate* affecting the labour supply response along the extensive margin.

Table 7: The marginal cost of public funds, two different tax policies

	(7.1)	(7.2)	(7.3)	(7.4)	(7.5)
	Low	**Middle-low**	**Middle-high**	**High**	**Full sample**[a)]
Baseline					
Basic exemption lowered	4.65	4.28	2.30	1.34	1.83
Tax rate increased	4.65	4.28	2.30	1.34	1.62
Excluding pension contributions					
Basic exemption lowered	1.56	1.58	1.38	1.15	1.28
Tax rate increased	1.56	1.58	1.38	1.15	1.23
Including value added tax					
Basic exemption lowered	18.24	108.11	3.74	1.49	2.45
Tax rate increased	18.24	108.11	3.74	1.49	1.99

[a)] Full sample results are calculated using weights of each sub-sample.

Notes: The starting point is a basic exemption equal to 1700 EEK and a tax rate equal to 24%. Summary statistics for the four income groups are provided in Table 5.

The marginal cost of income tax revenue differs markedly across the four income groups. The high MCPF for the low income earners is straightforward to explain: a given tax increase provides only modest additional revenue as the average income in the low income group is comparatively small, while the displaced employment leads to a substantial reduction in total tax revenue (since the social tax is paid on the entire wage bill without any exemptions). The consequence is that in order to generate an extra 1 EEK in revenue, the income tax pressure has to be raised substantially which consequently leads to a substantial drop in employment and hence a loss of initial tax revenue. At the other extreme, the MCPF is relatively moderate for the high income group. This is a consequence of the high rate of participation in this group, the high income and the low labour participation elasticity.

The full-sample results in (7.5) are derived under the assumption that the tax policy instrument in question is applied to *all* groups in order to raise 1 EEK in extra tax revenue. This also explains why the MCPF for the full sample is higher when the basic exemption is lowered than when the tax rate is increased. The increase in the tax rate brings in much revenue from the high income group and, consequently, the rate does not need to be raised much to bring in the additional revenue. However, the decrease of the basic exemption brings in less revenue from the high income group and must therefore be relatively large.

As argued above, the pension contribution component of the social tax may only partially – or not at all – be considered a tax as the individual paying the contribution builds up future claims on the Estonian government and in many cases also a private pension insurance provider. The centre panel of Table 7 shows the results when 20 percentage points of the 33 per-

cent social tax are left out of the tax measure used to calculate the MCPF.[25] It is striking how the MCPF is reduced as a consequence of this reclassification, particularly for the low and middle income groups. The explanation is evidently that the social tax payments of these groups comprise a larger share of total taxes than is the case for the high income group. The results underscore the importance of the classification of government revenue after the pension reforms in the late 1990s.

The lower panel of Table 7 shows the results when the baseline setup is amended with the assumption that all labour income net of income taxation is spent on goods and services for which an 18 percent value added tax is paid. The expansion of the tax measure used in the MCPF calculations increases the MCPF dramatically for the low and middle-low income group and markedly for the middle-high income group.[26] The result for the low income group suggests that with the expanded tax measure, the average individual in the low income group is not far from the maximum point of the Laffer curve.

We will now return to the baseline case which estimates the MCPF to be equal to 1.6 when additional tax revenue is raised via a higher proportional tax rate.[27] When assessing the size of the MCPF estimate, it is important to keep in mind that this is the *marginal* cost of public funds, not the average cost. The MCPF from the changes in personal income is typically much larger than the average cost of public funds as the MCPF, ceteris paribus, increases with the tax rate.

The aggregate MCPF estimate for Estonia is large compared to MCPF estimates in studies from the 1970-80s. These studies, however, did not distinguish between the intensive and the extensive labour supply margins. An often cited study is Browning (1976), which estimates the MCPF for the USA to be in the range of 1.09–1.16 depending on the progressivity of the tax increase analysed.[28] Stuart (1984) finds a somewhat larger MCPF estimate for the USA, namely 1.21–1.24 in the baseline scenario.[29] Kleven & Kreiner (2006b) provide MCPF estimates for the OECD countries explicitly incorporating both the intensive and extensive margins in their simulations. Their MCPF estimates for a proportional tax increase range from close to 1 to up to 4 depending on the assumptions concerning, for example, the labour supply elasticities. The MCPF estimates are indeed very large for specific income groups in some countries, and in some cases the tax rate is above the Laffer curve maximum.

The main difference between the welfare results in this study and the results in Kleven & Kreiner (2006b) is the distribution of the MCPF estimates across income groups. The results for Estonia presented in Table 7 show that the MCPF generally *decreases* with the average income in the group, while Kleven & Kreiner (2006b) find that the MCPF *increases* with the average income in the group, particularly so for countries with highly progressive income tax systems. The reason for this difference is likely to be the flat income tax rate in Estonia,

[25] The 20 percent is the payment to the first pillar government-administered pension fund paid by individuals who do not participate in the second pillar scheme, cf. also Section 2.
[26] With this definition of the labour tax revenue, the initial tax rate on the middle-low income group appears to be close the Laffer curve maximum.
[27] Incidentally, if pension contributions are excluded *and* value added taxation is included at the same time, then the MCPF estimates are close to the baseline results.
[28] An updated and "corrected" version of the paper was published as Browning (1987) and the possible range of the MCPF for the USA was then estimated to be from 1.1 to 4.0 depending on the parameter specification employed.
[29] See Ruggeri (1999) for an overview of MCPF results from earlier studies that employ partial and general equilibrium methodologies, but generally do not distinguish between the intensive and extensive margins.

which means that high income earners in Estonia face much lower tax rates than high income earners in most OECD countries. Thus, a tax rate increase on high income earners in Estonia displaces much less initial tax revenue than a similar increase in an OECD country with progressive taxation.

This insight also helps explain why the overall MCPF estimations for Estonia are in the lower range of the estimates provided by Kleven & Kreiner (2006b). The flat tax in Estonia means that the cost to society of raising tax revenue from the higher income groups is relatively small and since most of the revenue is derived from this group, the overall MCPF is relatively moderate in Estonia.

The employment and welfare results presented in Tables 6 and 7 are subject to numerous limitations and sources of uncertainty and should be interpreted in light of these concerns. First, the lack of general equilibrium effects implies that the results should be seen as playing themselves out in the short or medium term. Second, the labour participation elasticities are estimated with uncertainty. Third, underreporting may lead the employment response to be upward or downward biased depending on the experiment undertaken; possible biases will be carried into the welfare calculations. Fourth, no information on non-labour income is available, which may affect both the estimation of the employment elasticities, the calculation of the employment response and the simulations of the welfare effects. Fifth, numerous specificities concerning the tax system have not been taken into account. Finally, possibly the most worrying source of uncertainty is the uncertainty concerning which taxes to include in the calculation of the MCPF. This concern can only be addressed by including much more detailed information on the behaviour of non-working individuals and such information is not available in the case of Estonia.

6. Final comments

The paper has sought to provide estimates of the employment and welfare effects of changing the personal income taxes in Estonia. The empirical analysis entailed two steps; namely, an econometric analysis providing estimates of the labour supply responses of different income groups and simulations to assess the impact of different tax experiments on employment and social welfare.

The econometric analysis is based on the 2005 Estonian Labour Force Survey 2005 comprising approximately 16,500 individuals of working age, among which 8,000 are active in the labour market. The results suggest that the hourly after-tax wage primarily affects the participation decision, while it has a negligible effect on the number of working hours of individuals already working. Individuals in the middle income groups exhibit higher labour participation elasticities than individuals in the low and high income groups.

The participation elasticities – together with data on participation rates, incomes and tax rates for each of the four income groups – can be used to estimate the employment effect of different tax policies. For instance, lowering the basic exemption by 10 percent reduces total employment of working-age individuals by slightly less than 0.5 percent. Increasing the proportional tax rate by 1 percentage point reduces overall employment by 0.35 percent. Differing participation elasticities and mean incomes across the income groups imply that the effect differs across the groups. The low and middle income groups experience the largest employment reduction when the basic exemption is increased.

The excess burden of an incremental increase in tax revenue stems from reduced labour participation with a derived effect on tax revenue. The baseline simulations suggest that if the proportional tax rate is increased, the marginal cost of public funds is around 1.6, i.e. the extra cost of raising revenue is approximately 60 percent *in excess of the tax revenue generated*. If the basic exemption is lowered, the marginal cost of public funds is estimated to be around 1.8. The estimates of the marginal cost of public funds vary noticeably, dependent on the assumptions concerning pension contributions and value added taxes.

The marginal cost of raising public funds through personal labour income taxation differs markedly across different income groups. For instance, in the baseline scenario the marginal cost of public funds is estimated to be 4.7 for the low income group, 4.3 for the middle-low income group, 2.3 for the middle-high income group, and 1.3 for the high income group. These results may point to possible efficiency gains from redistributing the tax burden as compared to the existing proportional tax system. *On the margin,* a reduction of the tax burden of lower income individuals will bring about a substantial labour participation response and increase welfare. On the margin, an increase of the tax burden of higher income individuals may only lead to a modest reduction in employment and welfare for individuals in this group. Assuming a utilitarian social welfare function, a revenue-neutral tax reform reducing the income tax burden on lower income individuals and increasing it on higher income individuals may lead to higher societal welfare. Evidently, this result is based on a narrow assessment of the welfare consequences and overlooks, for example, administration costs, compliance issues and political economy issues.

The analysis in this paper represents a first attempt to assess the employment and welfare effects of personal income taxation in the Estonia context. As with most studies on the effects of taxation, the results are subject to a substantial margin of error. Future studies should seek to refine the analysis and incorporate a number of potentially important issues left out of this study.

The analyses in this paper could be augmented if heterogeneity in the form of gender, age, employment status etc. were taken into account in the estimation and simulation exercises. It would also be desirable if the labour supply elasticities could be estimated with more precision, but this would require a dataset of high quality (likely based on register data) and with detailed data on working time, labour income and other income sources. It would also be advantageous to determine the employment and distortionary effects in a micro-simulation model where the effects of tax policy changes on individual behavioural could be traced.

It may also be useful to model the general equilibrium effects of tax policies on the economy in order to get estimates of the longer-term employment and welfare effects. Such general equilibrium models can include different forms of imperfections in the economy in addition to possible labour supply effects from government spending on, for example, education, health and infrastructure. The models can also incorporate the intertemporal effect of tax policies including the possible effects on economic growth. Evidently, such models are complex and leave much discretion to the modeller.

Appendix A: Labour supply without selection

As an interim step, we estimate labour supply functions without explicit consideration of the selection issue in order to gain an understanding of the labour supply process. Table A.1 shows the results when the number of monthly working hours (HOURS) is explained by the predicted hourly pay (LHPAYHAT), along with a range of other covariates. We consider two different specifications, including and excluding non-working individuals, respectively.

Table A.1: Estimations of monthly working hours without selection

	(A.1)		(A.2)	
	HOURS		HOURS for HOURS > 0	
	Coef.	S.E.	Coef.	S.E.
LHPAYHAT	61.56***	(4.64)	-4.69	(2.90)
AGE	-55.53***	(5.78)	-27.17***	(3.63)
AGE2	-1,107.77***	(32.24)	-376.37***	(24.11)
FEMALE	2.52	(1.80)	-12.43***	(1.12)
ISCED2	-11.80***	(2.92)	7.75*	(4.34)
ISCED3	-5.00	(3.42)	7.77*	(4.37)
ISCED4	-1.60	(7.95)	7.76*	(4.54)
ISCED5	-4.83	(4.50)	6.44	(4.71)
ISCED6	-4.14	(11.27)	14.58**	(7.29)
MARRIED	10.22***	(1.44)	-0.86	(0.90)
ADULTS	2.02***	(0.56)	0.28	(0.35)
DEPENDENTS	-4.28***	(0.69)	-0.32	(0.44)
STUDYSEC	-56.77***	(2.88)	-29.69***	(3.47)
STUDYTER	-54.37***	(3.03)	-17.43***	(2.05)
CONSTANT	-59.60***	(14.29)	193.32***	(9.72)
No. of obs.	14,568		7,983	
R^2	0.402		0.095	

Notes: Standard errors (S.E.) are shown in brackets beside the coefficient estimates. The superscripts ***, ** and * indicate that the null hypothesis of the coefficient being equal to 0 is rejected at the 1%, 5% and 10% levels of confidence, respectively.

Column (A.1) shows the results when all observations in the sample are included, i.e. working individuals (HOURS > 0) as well as inactive individuals (HOURS = 0). The estimated coefficient of the predicted hourly log income is positive and statistically significant. The point estimate indicates that a 1 percent increase in the hourly income increases the number of hours worked by 0.6. The average working time for all individuals is 94.5 hours per month, implying a labour supply elasticity of around 0.7 when taken for working and non-working individuals in total.

However, estimation (A.1) blends the extensive and intensive choice of the individual, possibly leading to an unspecified regression and unreliable coefficient estimates (Heckman 1993). Therefore, it is necessary to employ estimation methods that explicitly model the combined selection and working hours choice. This is undertaken in Subsection 5.2 of the main text. Column (A.2) considers only the intensive choice, i.e. the number of working hours of individuals already employed. The results are markedly different from those obtained when the whole sample is used. In particular, the estimated coefficient of the predicted log hourly income is now insignificant (and with a negative sign). Many of the coefficients of the control variables also change substantially.

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