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Distributional and employment effects of labour tax changes: Finnish evidence over the period 1996-2008**

Abstract

Labour income taxes have decreased considerably in Finland in the period 1996-2008. At the same time the Finnish economy has grown rapidly. Nevertheless, there has been another coincident trend in this period: A rapid rise in inequality. This study aims to answer to what extent labour income tax reductions between 1996 and 2008 have contributed to this trend in inequality. The study also examines how much more employment has been attained due to the labour tax reforms. To answer these questions, I build a dynamic general equilibrium model with heterogeneous agents. The model is calibrated to fit the Finnish economy. The study finds that the labour income tax cuts have fractionally raised the Gini coefficient for net labour income. They have also increased the concentration of wealth. The employment gains due to the reforms have been modest but nevertheless significant.

Key words: Labour taxes, Income distribution, Heterogeneous agents, General equilibrium

JEL codes: D31, E60, H24, C68

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1. Introduction

Since the middle of the 1990s the Finnish labour income taxes have decreased considerably. Also many other Western countries have seen major tax reforms during last decades. Not only level but also the progressivity of tax systems has been changed. The shift in many countries has been towards a less progressive tax system, at least when all the tax forms are taken into account. This result holds for instance for the United States or the United Kingdom as examined in Piketty and Saez (2007).[1] However, when examining only labour taxes, the trends in progressivity are not that clear since in many countries, Finland being one example, the tax rates for low incomes have decreased even more than the rates for higher incomes.

The motivation of the Finnish government(s) for the changes has been to improve employment and lower the marginal tax rates that have historically been relatively high in Finland. How much the employment has improved due to the reforms is still a matter of debate. For instance Sinko (2002) finds rather modest estimates for the gains. However, the changes in the tax system together with the recent development have raised another concern that is now shared with the whole Western world: the increase in inequality. The rise in inequality has been particularly rapid in Finland during the period between 1990 and 2005 as stated by OECD (2008).[2] Also OECD (2011) reports the rapid rise in inequality from mid 1990s to late 2000s. OECD (2008) finds that the development is partially due to changes in taxation but gives much bigger weight to the decreased role of the income transfers paid by the government. On the other hand, Riihelä et al. (2001, 2010) state that rise in inequality is mainly due to changes in the Finnish tax system, especially the reform in 1993 in which the comprehensive income tax system was replaced with a dual system that treats capital and labour income with a different tax code. Riihelä et al. (2001, 2010) stress the changes of capital incomes of households and are particularly interested in their development at the top of the income distribution.

This study examines the role of labour income tax changes on recent development in Finland. More explicitly, I aim to answer to what extent the labour income tax reductions between 1996 and 2008 are responsible for rising inequality. In this context changes both in income and wealth distribution are examined. The study also contributes to the question of how much more employment has been attained due to the labour tax reforms. To answer these questions the paper builds a dynamic

[1] Turkkila (2011) finds a similar result for Finland with a somewhat different approach.
[2] Inequality measured by the distribution of disposable incomes of households.

general equilibrium model with heterogeneous agents. The model is calibrated to fit certain features in the Finnish economy, in particular the labour markets. The progressive labour income tax systems of 1996 and 2008 are explicitly incorporated into the model structure.

The basic features of the model build up on the seminal work done by Aiyagari (1994). The model used in this paper is still more closely related to the model presented in Heer and Trede (2003) and Heer and Maussner (2009). Heer and Trede use the model to analyze the efficiency and distribution effects of flat tax and consumption tax reforms for the German economy. The setting has also many similarities with Castaneda, Diaz-Gimenez and Rios-Rull (2003) who examine switching to a proportional tax in the US and to a smaller degree with Ventura (1999) who also examines a flat-tax reform for the U.S. These previous studies end up with a conclusion that efficiency gains from flattening taxes come in expense of more inequality. Still, there are relatively wide differences in quantitative results among papers. On the other hand, Nishiyama and Smetters (2005) find that progressive taxes also increase efficiency by adding the insurance provided by the tax system. Nevertheless, one needs to stress that these papers deal with more comprehensive tax reforms which also encompass large changes in capital taxation while this study is only interested in particular changes in the level and progressivity of labour taxes.

Heterogeneous agent framework allows us to look at how different types of agents respond to labour tax changes. Substitution effect makes agents work more, while the wealth effect has an opposite impact on behaviour. On the other hand agents have precautionary motives to save due to the idiosyncratic unemployment risk assumed in the model (see for instance Pijoan-Mas 2006). Hence the paper carefully analyzes all these effects among different type of agents in order to understand the employment and distributional effects of tax changes.

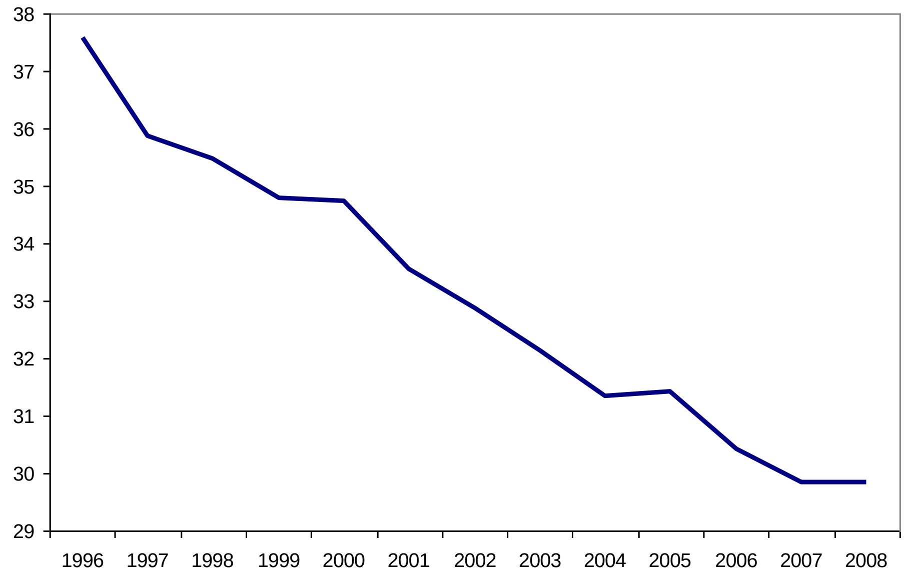
The paper finds that changes in the Finnish labour taxation in the period 1996 – 2008 have improved employment by 1.4 per cent. Hence the reforms have produced gains in employment but these are relatively modest in magnitude. Also, as a result of the tax cuts the capital stock of the economy has increased by 3.2 per cent. The improvements in employment and capital stock imply 2.1 percent increase in total output. On the other hand, the tax changes have increased the concentration of net labour incomes and wealth of households. However, the distributional changes are moderate and hence it is possible to conclude that the labour tax reforms only partly explain the observed rise in the Finnish inequality.

The paper is organized as follows. Section 2 summarizes the main changes in the Finnish labour taxation and inequality in the period 1996-2008. Section 3 presents the model used in analysis and in section 4 the parameters of the model are calibrated. Section 5 analyzes the results of the paper carefully. Final section concludes.

2. Finnish trends in labour taxation and inequality

Since 1996 the level of labour income taxes in Finland has decreased considerably. The main motivation of the Finnish government for the reforms has been to improve employment. High tax rates were seen to cause major distortions in the Finnish labour markets as they produced poor incentives to supply labour. As a result the income tax rate for an average productive worker has decreased from 37.6 percent in 1996 to less than 30 percent in 2008 which is depicted in figure 1.

Figure 1. Labour income taxes of an average productive worker in Finland, %[3]



The taxes have been lowered in all wage brackets. Nevertheless, the greatest reductions in tax rates have been targeted at low-income workers. This has been done to reduce incentive traps for people who prefer to stay outside of the labour force in order to retain the income transfers received from the government. Hence not only has the level of taxes been changed, but also the progressivity of the tax system. This is depicted in figure 2 which shows the average tax rates for each (nominal)

[3] The data is from Government Institute for Economic Research and Labour Institute for Economic Research

wage rate in 2008 and 1996 and in figure 3 which shows the change in average tax rate for each nominal wage.

Figure 2. Average wage income tax and nominal incomes

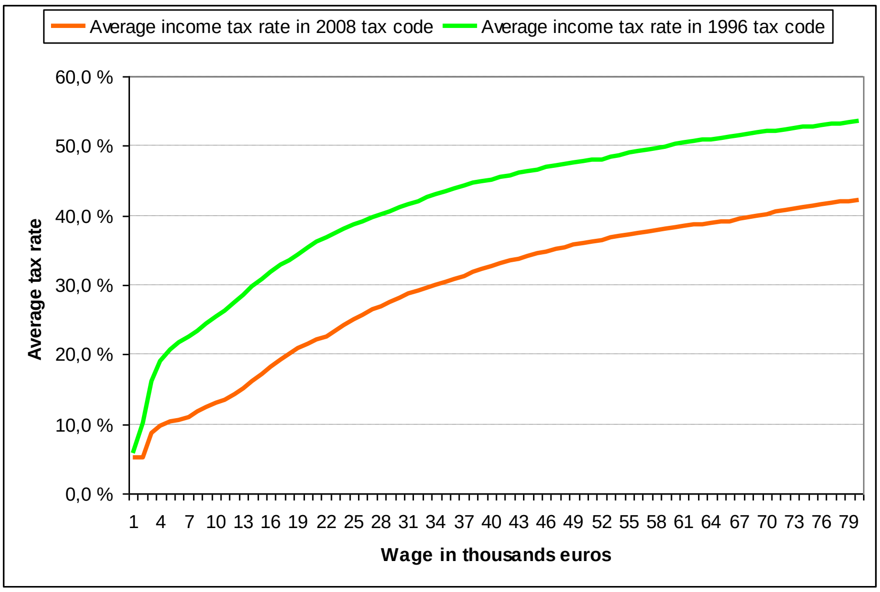
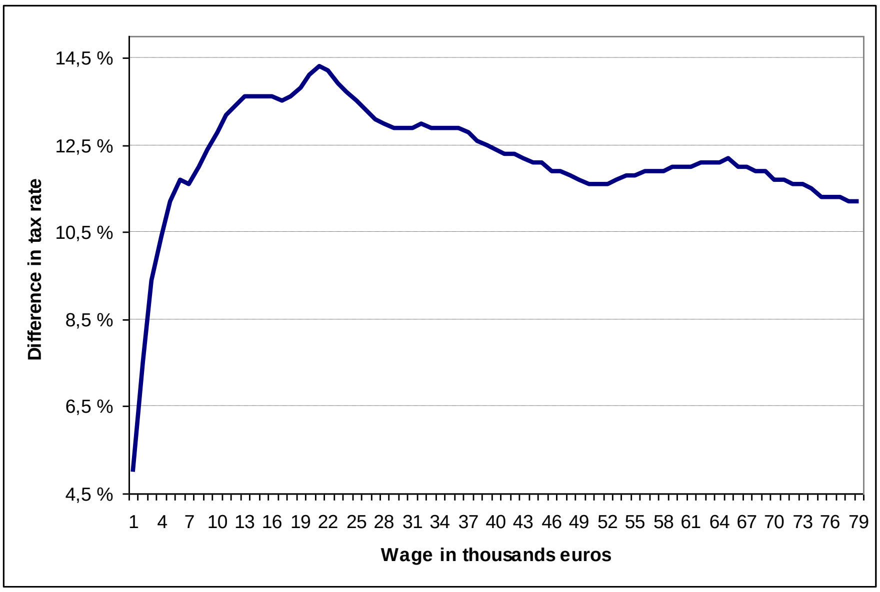
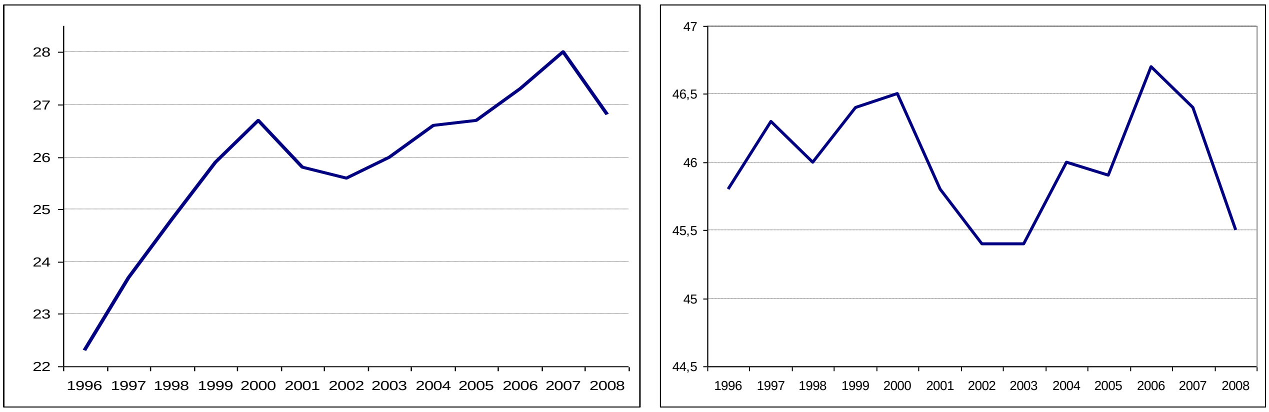


Figure 3. The differences between 2008 and 1997 tax codes



At the same time the Finnish economy has grown rapidly, at an average rate of 3.7 percent per year. Also the employment has improved considerably. Nevertheless, the contribution of tax cuts to improvement in employment is debatable while the outcome is more likely to be due to a good global economic performance in this period. The positive development has, however, occurred with another, clearly negative trend: A rise in inequality. The spread between high and low net incomes has widened. This can be seen by looking at the Gini coefficient of household disposable income in Finland in the period 1996-2008 (left in figure 4). The coefficient was 22.3 in 1996 but amounted to 26.8 in 2008 and has kept on rising after that. At the same period there is no trend in the Gini coefficient of factor income, which is the market income before taxes and transfers. Thus, the policy decisions have played an important role in determining the development.

Figure 4. Gini coefficient for household disposable incomes (left) and for factor income (right)



OECD (2008,2011) examines the trends in inequality in OECD countries and finds that the rise in inequality has been particularly rapid in Finland during last decades. In its report(s), OECD analyzes the factors behind this development and argues that the main factor contributing to the rise in inequality has been the decreased role of government transfers. According to the reports, also tax changes have contributed to the development, albeit not so crucially. On the other hand Riihelä et al. (2001, 2010) carefully analyze the trends in inequality in Finland and state that there is one factor that has mostly determined the recent development: The tax reform in 1993. In this reform the comprehensive income tax system was replaced with a dual income tax system that treats capital and labour income differently. Labour income is now taxed progressively but capital income with a proportional rate. Riihelä et al. associates the reform with the rapid increase in capital income at the top of the income distribution.

Thus, there have been changes both in the tax and the benefit system of Finland. This study concentrates on the changes in labour taxation and analyzes to what extent they are responsible for rising inequality in Finland. Also, the study examines how much more employment is attained owing to the tax reforms, since, after all, this was the main aim for the government when changing the system.

3. The Model

In this study the effects of tax reforms are examined using a dynamic general equilibrium model with heterogeneous agents. The heterogeneity assumption is crucial in the sense that it allows to assess not only the employment effects of the tax reforms, but also the distributional effects. The heterogeneity is based on different productivities of the model agents. The markets are incomplete with agents facing idiosyncratic risk of unemployment. The basic features of the model structure build up on the seminal work by Aiyagari (1994). However the model is more closely related to the framework presented in Heer and Trede (2003) and Heer and Maussner (2009). These two studies examine a comprehensive tax reform in Germany in which taxes are first flattened and then the current system is replaced by only a consumption tax. This study instead analyzes particular reforms done in the Finnish labour tax system during last decades. So the paper carefully incorporates the changes done in the Finnish labour income tax system and calibrates the model to fit the Finnish data. When compared to the paper by Heer and Trede, I also assume that the risk of unemployment is little lower among high-income workers whereas Heer & Trede assume it to be equal among all workers. In general, the model has many similarities with Lehmus (2011) but in this paper consumption taxes are excluded in the analysis and it is the level of government expenditures that balances the government budget. Even more relevant difference is that the progressive income taxes are now explicitly incorporated into the model structure.

There are three sectors in the model: households, firms, and the government. Households maximize their discounted life-time utility while the firms maximize their profits with respect to their labour and capital demand. The government sets the progressive income tax schedule and uses the revenues gained for government consumption and unemployment compensations.

3.1. Households and productivity

Households are of measure one and live infinitely. Households differ with regard to their employment status, their productivity denoted by ε^j, and their wealth denoted by k^j, $j \in [0,1]$. Productivity takes a value from the finite set $\mathrm{E} = \{\varepsilon^1, \varepsilon^2, ..., \varepsilon^{n\varepsilon}\}$, and it is assumed that $\varepsilon^1 = 0$ is the state of unemployment. Following Heer and Trede (2003), the number of productivities in the model is set equal to 5, thus $n\varepsilon = 5$. I use a common assumption that productivity follows the first-order finite-state Markov chain with transition probabilities given by

$$\pi(\varepsilon'|\varepsilon) = \Pr\{\varepsilon_{t+1} = \varepsilon' | \varepsilon_t = \varepsilon\} \tag{1}$$

where $\varepsilon, \varepsilon' \in \mathrm{E}$. Household j, associated with productivity ε_t^j and wealth k_t^j in period t, maximizes his/her intertemporal utility with regard to consumption c_t^j and labour supply n_t^j, thus:

$$E_0 \sum_{t=0}^{\infty} \beta^t u(c_t^j, 1 - n_t^j) \tag{2}$$

Expectations are conditional on the information set of the household at time 0; β is a discount factor. The utility function is assumed to be additively separable between consumption and leisure and is the following:[4]

$$u(c_t, 1-n_t) = \frac{c_t^{1-\sigma}}{1-\sigma} + \gamma_0 \frac{(1-n_t)^{1-\gamma_1}}{1-\gamma_1} \tag{3}$$

There is no borrowing in the model, i.e. $k^j \geq 0$. Household receives income from labour n_t and capital k_t, consumes an amount of c_t, and saves the rest for next-period wealth k_{t+1}. Hence the budget constraint for household is:

[4] Castañeda et al. (2003) discuss the reasons for choosing a utility function in which preferences are additively separable. They state that with separable preferences the distribution of working hours varies less in response to changes in household productivities, and hence the behaviour is more in accordance with empirical observations.

$$k_{t+1}^{j} = (1+r_t)k_t^{j} + \left(1-\tau_w\left(w_t, n_t^{j}, \varepsilon_t^{j}\right)\right)w_t n_t^{j} \varepsilon_t^{j} - c_t^{j} + 1_{\varepsilon=\varepsilon^1} b_t \quad (4)$$

Here r_t denotes the interest rate and w_t is the wage rate. Progressive tax rate τ_w is a function of labour hours (n_t) and effective wage rate that is the average wage rate (w_t) of the economy multiplied by the productivity of an agent (ε_t^j). $1_{\varepsilon=\varepsilon^1}$ is an indicator function which takes the value one if the household is unemployed $(\varepsilon = \varepsilon^1)$ and zero otherwise. The unemployed agent is allowed for unemployment compensation b_t that is defined relative to the wage rate in the lowest quartile.

3.2. Production

Households are assumed to own firms that maximize their profits with respect to their labour and capital demand. The production function is a standard Cobb-Douglas with constant returns to scale:

$$Y_t = N_t^{1-\alpha} K_t^{\alpha} \quad (5)$$

where N_t denotes labour input and K_t capital input. In the equilibrium profits are zero and wages and interest rates equal to their marginal productivities. Thus:

$$r_t = \alpha \left(\frac{N_t}{K_t} \right)^{1-\alpha} - \delta \quad (6)$$

$$w_t = (1-\alpha)\left(\frac{K_t}{N_t} \right)^{\alpha}, \quad (7)$$

where δ is the capital depreciation rate.

3.3. Government

Government raises revenues by taxing wages of households. The revenues (T) are used for government consumption (G) and unemployment compensation payments (B). In this paper, government consumption does not enter the utility function nor has any effect on production. So in fact the role of government consumption is abstracted out here. The progressive labour income tax system of 2008 and in the other scenario, the tax system of 1996, is explicitly incorporated into the model structure. This is modelled with an exponential function that gives the income tax rate of a household as a function of his/her income and it looks the following:

$$f(x) = \phi_{year} - \varphi_{year} e^{\eta_{year} x} \tag{8}$$

where x denotes the labour income, i.e. the effective wage rate multiplied by working hours. ϕ, φ, and η are parameters that are calibrated so that the function fits the progressive labour income tax schedule in 1996 or 2008. The income tax rate data are collected with the help of the Taxpayers' Association of Finland (TAF). The wages in 1996 are deflated using the annual wage rate index to eliminate the effect of wage inflation. The calibration and fit of the tax function(s) are carefully discussed in section 4.3.

I will analyze the effects of replacing the progressive income tax schedule of 2008 with the tax system used in 1996. In this context both the employment and distributional effects are examined. In both cases, the level of government consumption balances the government budget so the following identity always holds:

$$G_t + B_t = T_t \tag{9}$$

3.4. Stationary equilibrium

The basic features of the stationary equilibrium are defined as in Heer & Maussner (2009). The study analyzes a stationary equilibrium for a given government tax policy with constant prices and the invariant distribution of both income and wealth. The stationary equilibrium with given policy is defined as a value function $V(\varepsilon, k)$, individual policy rules $n(\varepsilon, k)$, $c(\varepsilon, k)$, and $k'(\varepsilon, k)$ for labour supply, consumption, and next-period capital, respectively, a time-invariant relative prices of labour and capital $\{w, r\}$, time-invariant distribution $F(\varepsilon, k)$ for the state variable $(\varepsilon, k) \in \mathrm{E} \times [0, \infty)$, and a vector of aggregates K, N, C, T, and B such that:

1. Capital, (effective) labour, consumption, tax revenues, and unemployment compensation payments are aggregated over households:

$$K = \sum_{\varepsilon \in \mathrm{E}} \int_0^\infty k \, f(\varepsilon, k) dk \,, \tag{10}$$

$$N = \sum_{\varepsilon \in \mathrm{E}} \int_0^\infty \varepsilon \, n(\varepsilon, k) \, f(\varepsilon, k) dk \,, \tag{11}$$

$$C = \sum_{\varepsilon \in \mathrm{E}} \int_0^\infty c(\varepsilon, k) \, f(\varepsilon, k) dk \,, \tag{12}$$

$$T = \tau_w w N \,, \tag{13}$$

$$B = \int_0^\infty b \, f(\varepsilon_1, k) dk \tag{14}$$

2. $c(\varepsilon, k)$, $n(\varepsilon, k)$, and $k'(\varepsilon, k)$ are optimal decision rules that solve the household decision problem

$$V(\varepsilon, k) = \max_{c,n,k'} \left[u(c, 1-n) + \beta E \{ V(\varepsilon', k') | \varepsilon \} \right] \tag{15}$$

where k' and ε' are next-period wealth and productivity, and the value function is subject to the budget constraint (4), the tax policy in 2008 or 1996, and the Markov-type stochastic mechanism determining the productivity level (1).

3. Factor prices equal their marginal productivities as expressed in (6) and (7).

4. The goods market clears:

$$F(K, L) + (1-\delta)K = C + K' + G = C + K + G \tag{16}$$

5. The government consumption balances the government budget, thus $G + B = T$.

6. The distribution of the individual state variable is constant

$$F(\varepsilon', k') = \sum_{\varepsilon \in \mathrm{E}} \pi(\varepsilon' | \varepsilon) F(\varepsilon, k), \tag{17}$$

for all $k' \in [0,\infty)$ and $\varepsilon' \in E$ and with $k' = k'(\varepsilon, k)$

The stationary equilibrium of this type of model is further analyzed in Heer and Maussner (2009). Appendix 1 describes the solution algorithm for the benchmark simulation of the model.

4. Calibration

Most of this section follows the analysis presented in Lehmus (2011). However, one major difference comes from calibration of progressive taxes. Also, consumption taxes are excluded in this analysis. The model period corresponds to years. The data are provided by the Confederation of Finnish Industries (EK), the Statistics Finland, and Taxpayers' Association of Finland. The productivities ε^j and the transition probabilities $\pi(\varepsilon'|\varepsilon)$ together with parameters γ_0, γ_1, and b are chosen to replicate certain features in the Finnish labour markets. The parameters σ, β, α, and δ are chosen among typically used estimates in the literature with the aim of fitting the model the stylized facts of the Finnish economy. The next three sections discuss the calibration of these parameters in detail.

4.1. Productivity

The parameter ε^1 characterizes unemployment, hence it is set to zero. The productivities $\{\varepsilon^2, \varepsilon^3, \varepsilon^4, \varepsilon^5\}$ are chosen to match the discretized distribution of monthly wages. These are estimated from the empirical distribution of the monthly wages of the connected Finnish industrial employee and service employer data. The data are provided by the Confederation of Finnish Industries (EK) and refer to year 2008. The data are large and cover more than 400,000 workers, and hence they can be said to approximate the Finnish economy. Thus, the productivity ε^i corresponds to the average monthly wage rate of earners in the $(i-1)$-th quartile. The average of the four nonzero productivities is normalized to unity, which finally gives:

$$\{\varepsilon^2, \varepsilon^3, \varepsilon^4, \varepsilon^5\} = \{0.5701, 0.7938, 1.0367, 1.5994\} \quad (18)$$

This can be compared to Heer & Trede (2003) for the German economy. The transition probabilities into and out of unemployment, i.e. $\pi(\varepsilon' = 0|\varepsilon > 0)$ and $\pi(\varepsilon' > 0|\varepsilon = 0)$, are chosen so that they imply the steady state unemployment rate of 8.64%, which is close to the current unemployment rate in Finland. They also imply an average duration of unemployment to be slightly more than one year. Also, I assume that the unemployment risk gradually decreases with the productivity; the way this is imposed can be seen in the first column of the transition probability matrix (19). This assumption makes a distinction from the previous studies by Heer and Trede (2003) and Heer and Maussner (2009). However it seems realistic to assume that high-productive persons face lower unemployment risk than their low-productive counterparts.

It is also assumed that after unemployment the agent can only reach productivity ε^2, so the skills of workers deteriorate during unemployment. This implies $\pi(\varepsilon' = \varepsilon^2|\varepsilon = 0) = 1 - \pi(\varepsilon' = 0|\varepsilon = 0)$ and $\pi(\varepsilon' > \varepsilon^2|\varepsilon = 0)$=0. All the other transition probabilities, comprising the rest 4×4 part of the transition matrix, are calibrated to match the observed quartile transition probabilities in the Finnish micro data. The transition probabilities refer to sequential years and they are estimated from the connected Finnish industrial employee and service employer data for years 2007 and 2008. The transition matrix I get looks like the following:

$$\pi(\varepsilon'|\varepsilon) = \begin{pmatrix} 0.3500 & 0.6500 & 0.0000 & 0.0000 & 0.0000 \\ 0.0800 & 0.6511 & 0.2557 & 0.0120 & 0.0013 \\ 0.0700 & 0.0200 & 0.7018 & 0.2023 & 0.0058 \\ 0.0600 & 0.0060 & 0.0141 & 0.7937 & 0.1263 \\ 0.0500 & 0.0011 & 0.0036 & 0.0140 & 0.9314 \end{pmatrix} \quad (19)$$

Lehmus (2011) discusses how these results relate to previous studies for countries like the U.S or Germany. One conclusion from (19) is that the persistence in the highest wage quartile is very high.

4.2. Production and utility

The share of capital in the production is calibrated to 0.36. This is in accordance with the literature where it is usually around 1/3. For instance Lehmus (2009) uses value 0.4 for the empirical macro model of the Finnish economy. The annual rate of capital depreciation is set to 0.04 which is used for instance by Heer and Trede (2003) for Germany. The intertemporal elasticity of substitution gets typically values ranging from 1 to 4 in the literature. In the benchmark case I use a value of 1.5, since with this value the model is able to replicate many features in the Finnish labour markets. The discount factor is set to 0.96. The preference parameters in the utility function are chosen to imply an average working time of approximately 30% and the variation for hours worked close enough to its empirical value in the Finnish micro data. Hence the preference parameters are calibrated to $\gamma_0 = 0.10$ and γ_1 =10. With these values the model produces an average working time equal to 0.29 and the coefficient of variation for hours worked equal to 0.32. These two values together with other benchmark simulation results are discussed further in section 5.1.

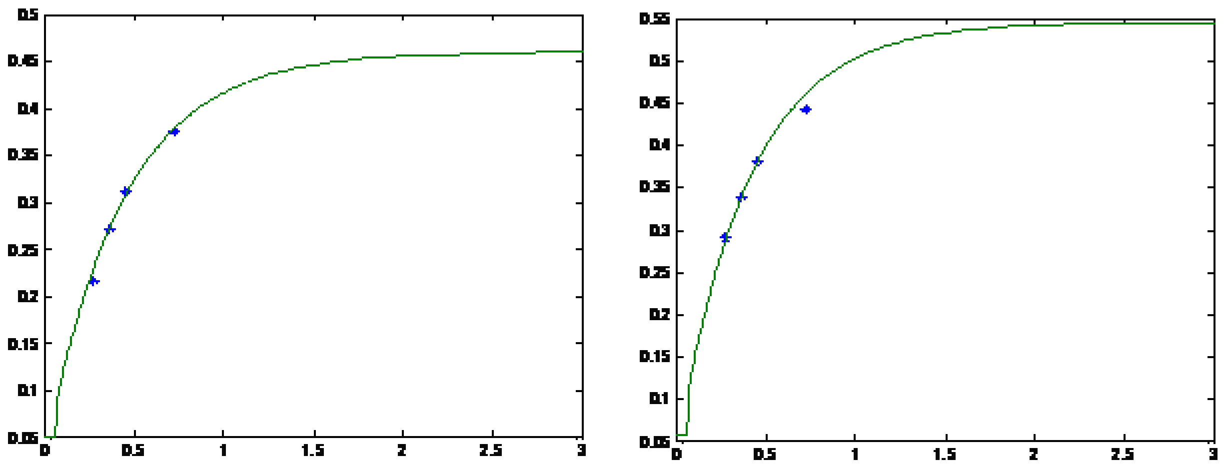
4.3. Government and progressive taxes

In the model, government consumption is endogenous while it balances the government budget every period. Government also pays for unemployment compensation. The replacement ratio is proportional to the monthly wage rate in the lowest quartile. In the Finnish system the unemployment compensation based on the previous earned salary is close to 60% of the salary. Nevertheless, the compensation paid on long-term unemployed or job seekers who enter the labour market for the first time is considerably smaller. Thus, the replacement ratio is calibrated to 0.52 in the model economy.

The progressive labour income tax schedules of 2008 and 1996 are imposed by parameterization of tax function equation (8). The parameters in (8) are set so that the function produces the average income tax rates that are consistent with the real tax rates observed in data. The parameters are found by minimizing the squared sum of the difference between real observations and model projections. So the parameters I get for (8) are ϕ_{08}= 0.46, φ_{08}=0.43, and η_{08}= -2.3 for year 2008 and ϕ_{96}=0.545, φ_{96}=0.51, and η_{96}= -2.5 for year 1996.The fit of the resulting tax functions can be seen from figure 5 that plots the real tax rates of the agents in each wage quartile and the average tax rates (for each earnings) produced by the model.[5] The average tax rate is plotted on the vertical axis and the labour income on the horizontal axis.

[5] The tax data for 2008 and 1996 are based on the calculations of the Taxpayers' Association of Finland.

Figure 5. Observed tax rates for each wage quartile in 2008 (left) and 1996 (right) and the model projections (lines)



From figures can be seen that the tax function (8) with appropriate parameterization is able to fit the Finnish progressive labour tax systems of 2008 or 1996 reasonably well.[6] While these figures only spot the real tax rate for each wage quartile, Appendix 2 also shows how the tax functions fit a more complete set of observed wage rates. Table 1 finally summarizes the parameter values of the model (excluding transition probability parameters).

Table 1. Model parameters

$\sigma = 1.5$	$\gamma_0 = 0.10$	$\gamma_1 = 10$	$\beta = 0.96$	$\alpha = 0.36$	$\delta = 0.04$	$b = 0.52$
$\{\varepsilon^1, \varepsilon^2, \varepsilon^3, \varepsilon^4, \varepsilon^5\} = \{0, 0.5701, 0.7938, 1.0367, 1.5994\}$						
$\phi_{08} = 0.46$	$\varphi_{08} = 0.43$	$\eta_{08} = -2.3$				
$\phi_{96} = 0.545$	$\varphi_{96} = 0.51$	$\eta_{96} = -2.5$				

[6] There is only little bias in the model projection for the tax rate in the highest wage quartile in 1996.

5. Results

This section analyzes how labour tax changes over the period 1996-2008 have affected employment and inequality in Finland. Inequality is measured by the Gini coefficients that are calculated for gross and net labour income and also for wealth. To understand the model dynamics, I carefully examine the changes in labour supply among different type of agents. I begin with discussion of the simulation results of the benchmark model and their consistence with Finnish data.

5.1. Benchmark model results

In the model, consumption increases with productivity. Agents with low wealth and productivity ($\varepsilon < \varepsilon^3$) are liquidity constrained. Labour supply is an increasing function of productivity; this is due to fact that substitution effect is stronger than income effect. Instead, labour supply is a decreasing function of wealth as higher wealth makes the marginal utility of income decline.

In table 2, the properties of the benchmark model and the Finnish data are compared. In the steady-state equilibrium the aggregate capital stock amounts to 3.25 which gives a capital-output ratio equal to 4.6. This equals to the average of the empirical capital-output ratio in Finland in the period 2006-2010.[7] The model produces the Gini coefficient for gross wages ($Gini_l$) equal to 22.0. This is very close to its empirical value, 22.4, calculated for the earnings of full-time employees in 2006 by Statistics Finland (2008).[8] In the benchmark simulation, the Gini coefficient for net wage income equals to 17.5 while the progressive labour taxes dampens the differences in the agents' incomes. The difference between these two figures (22.0 and 17.5) illustrates the progressivity of the Finnish labour tax system in 2008.

These figures only concern the employed model agents. The Gini coefficient for net labour income of all the model agents, i.e. the Gini that also includes the unemployed agents who receive the unemployment compensation, is 20.5. This can be compared to the empirical Gini coefficient for household disposable income that was 26.8 in 2008, which is then greater than the model coefficient. Nevertheless, the gap between these figures is explained with the fact that the net incomes calculated in the model coefficient do not include capital gains and dividends paid for

[7] In 2008 the empirical capital-output ratio was 4.4.
[8] This is the newest figure for the Gini coefficient of gross wages that is officially available.

households. Also, the model economy excludes some low-income groups as students and retired persons that do not attend in the labour markets, which gives the model Gini coefficient lower than in data. In the model steady-state, the Gini coefficient for wealth ($Gini_w$) equals to 41.8. This is somewhat smaller than its empirical counterpart which amounted to 57.9 in 2009.[9] Even if the model cannot fully replicate the empirical distribution of wealth, the estimates in general are consistent enough for comparison of distributional effects of tax policies.

The steady state unemployment rate of the model is 8.64. In 2008, when the Finnish output was probably above its potential, the unemployment rate was 6.4%. Nevertheless, the model figure is close to the Finnish unemployment rate in 2010 when it was 8.4%. The aggregate effective labour supply in the steady state of the model is N= 0.302 with an average working time equal to 0.29. The coefficient of variation for hours worked equals to 0.318. This is somewhat larger than its empirical estimate (0.24) calculated from the connected Finnish industrial employee and service employer data for year 2008. However, the calculated empirical estimate may be downwards biased due to reasons discussed in Lehmus (2011). In the model equilibrium, the labour supply elasticity with respect to wage rate is 0.24 for the average agent. This figure is reasonable since the empirical studies typically found estimates ranging from 0.05 to 0.4. In fact, some Finnish studies found even smaller estimates that are between 0.1 and 0.2.[10]

Table 2. The benchmark simulation and empirical values

	K/Y	Unemp.	$Gini_l$	$Gini_w$	$\sigma_n / \bar{n}$	$\eta_{n,w}$
Benchmark case	4.6	8.6	0.220	0.418	0.32	0.24
Empirical value	4.6	6.4 (8.4)	0.224	0.579	0.24	0.05-0.4

5.2. Responses to labour tax reforms

In 1996 the tax rates of an average production worker were approximately 7 percent above the level in 2008. The gradual tax cuts since 1996 have concerned all the wage-earners. The reductions have been slightly greater for low-incomes, even if the differences between wage brackets are small, as

[9] This is the Gini coefficient for gross wealth in 2009. The previous study is for 2004.
[10] See for instance Ilmakunnas (1997).

was depicted in figure 3. Hence as a result of the tax cuts, the incentives to supply labour have increased for all the agents. On the other hand, the substitution effect has been dampened by wealth effect that reduces work hours.

The results of the tax policy change are summarized in table 3 where “Labour taxes in 2008” and “Labour taxes in 1996” represent the steady state values for 2008 and 1996, respectively. As a consequence of the tax cuts done over the period between 1996 and 2008 total employment of the economy has increased by 1.4 percent (0.302/0.298). Hence the increase is relatively modest but, however, significant. There is also an equal change in the average working time of agents. Only part of the increase in agents’ net incomes has been used for consumption; thus, also the capital stock of the economy has risen by 3.2 percent (3.25/3.15). Using Cobb-Douglas production function of the model this contributes to a 2.0 percent increase in the total output of the economy.

The increase in labour supply is shared by all the model agents but there are some differences in size of responses between agents. As a result, the Gini coefficient for gross labour income amounts to 21.9 with labour taxes code of 1996. The minor change in the coefficient implies that the differences in agents’ responses are relatively small (this is analyzed further later on). Nevertheless, the changes in the Gini coefficient for net income and wealth are clearly greater. The Gini coefficient for net wage income ($Gini_{ln}$) decreases from 17.5 to 16.1. with labour taxes of 1996. This implicates that there has been a shift towards a less progressive labour tax system after 1996. Thus, the results show that the labour tax system has become less progressive even if low-income workers have benefitted from considerable tax cuts. Also, the Gini coefficient of net labour income including unemployment compensations ($Gini_{lna}$) changes from 20.5 to 18.7, hence it decreases by 1.8 percentage points. This also points a rise in inequality, although the magnitude of the change is moderate.

Also, the tax cuts have led to the increase in household savings. This is partly due to the precautionary motives of agents who consider the risk of unemployment that would reduce their incomes substantially. The increase in savings has been the greatest among high-productive agents, which contributes to a rise in the Gini coefficient of wealth. Thus, the wealth is more concentrated with its Gini coefficient almost one percentage points higher due to the tax cuts done after 1996.

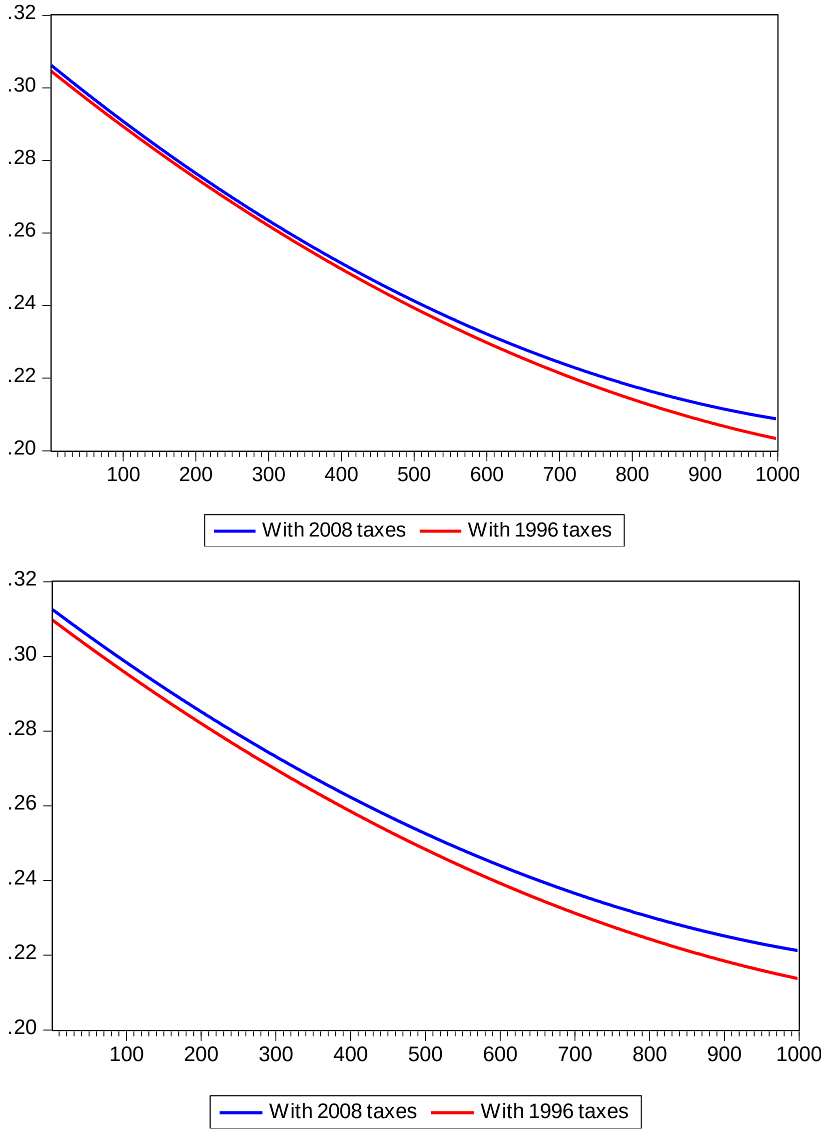
Table 3. Effects of tax policies

Tax policy	K	N	Y	$\bar{n}$	$Gini_l$	$Gini_{ln}$	$Gini_{lna}$	$Gini_w$
Labour taxes in 2008	3.25	0.302	0.711	0.289	0.220	0.175	0.205	0.418
Labour taxes in 1996	3.15	0.298	0.697	0.285	0.219	0.161	0.187	0.409

In order to understand how the tax reforms have affected the behaviour of different type of households, I examine the labour supply effects of each productivity group more carefully. Figure 6 illustrates the labour supply response of productivity-type 2 and 3 to the tax changes; the productivity group 2 denotes to agents in the lowest wage quartile and group 3 to agents in the second lowest wage quartile. The labour supply is plotted on the vertical axis and the wealth of an agent on the horizontal axis while the line shows how labour supply decreases with wealth.[11] As a result of the tax cuts, the labour supply is increased in both groups; however, the increase is greater in the second lowest wage quartile (group 3).

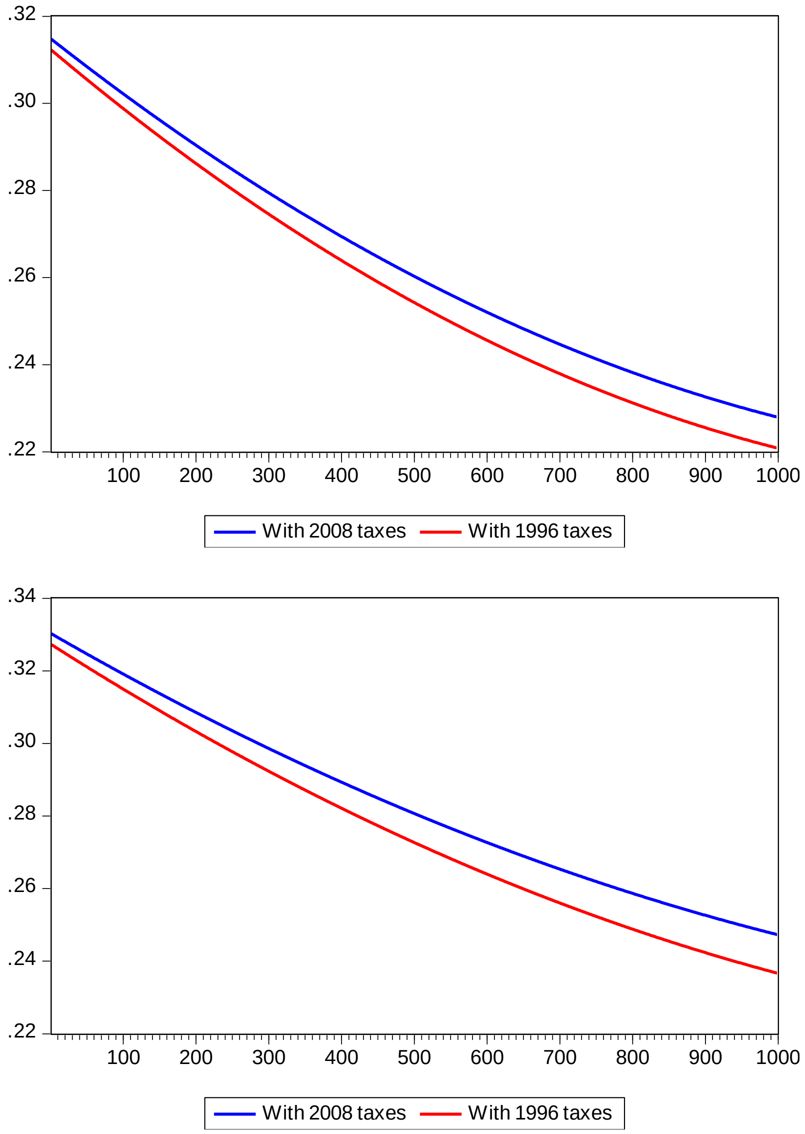
[11] In these figures the model produced numbers are smoothed using second order polynomials.

Figure 6. Labour supply of productivity-type 2 (above) and 3 (below)



On the other hand, the labour supply response of agents in the highest wage quartile (group 5) is greater than the response of agents in productivity group 4 which consist of the agents in the third wage quartile. In fact, the change in the highest productivity group's labour hours is greater than that in all the other productivity groups. Thus, the increase in labour supply produced by the tax cuts grows with productivity. One explanation for this result could be that agents in the lowest wage quartile are more likely to change their behaviour along the extensive margin, i.e. whether they attend in the labour markets, rather than in the intensive margin analyzed in this study. Nonetheless, as can be seen from figures 6 and 7 the differences in labour supply responses are relatively small, and this explains why the Gini coefficient for gross labour income has only slightly changed as a result of the tax cuts.

Figure 7. Labour supply of productivity-type 4 (above) and 5 (below)



Over the period between 1996 and 2008, the total Finnish employment increased by almost 20 percent. Using the estimates from the simulation results of this paper, it can be calculated that 8.5 per cent of the gains in employment were achieved due to the cuts in labour taxation. Thus, the results are in fact comparable to Sinko (2002) who finds that tax cuts contribute to 10 percent of the increase in the Finnish employment in the period 1997-2002. If compared to other studies done with a general equilibrium model setting, Heer and Trede (2003), Castaneda, Diaz-Gimenez and Rios-Rull (2003), and Ventura (1999) find bigger distributional effects in their studies that analyze tax reforms in Germany and the U.S. However, these studies analyze more comprehensive tax reforms in which tax levels are flattened and also the level of capital taxes is changed, and this explains the differences between results.

The critical parameter affecting the size of employment response produced by the model is, naturally, labour supply elasticity with respect to wage rate. As commented in section 5.1., matching the model with some key features in the Finnish data produces a relatively small elasticity for the average agent. Even if this small elasticity is justified by many micro studies, there is no consensus of the real value for this parameter value and some studies suggest a clearly bigger estimate (see for instance Ohanian et al. 2008). Thus, in order to understand the role of this parameter on the model results, I also examine the effect of tax changes using a considerably larger labour supply elasticity with respect to wage rate. The results are shown in Appendix 3.

As expected, the analysis shows that with a clearly larger labour supply elasticity with respect to wage rate, the employment effect due to the tax change becomes more remarkable. Also the changes in the Gini coefficients are slightly greater. However, with these parameter changes the benchmark model is no longer able to capture the features in the labour income distribution the model aims to match with. In other words, the Gini coefficient for gross labour income produced by the model is far too big relative to the observation in the data.

I also test the sensitivity of the model results to alternative parameter values for the elasticity of substitution. This parameter describes the degree of risk aversion of agents. The results show (see again Appendix 3) that the Gini coefficients for net labour income are not sensitive to changes in the elasticity of substitution parameter. Nevertheless, total employment and the Gini coefficient for wealth are to some extent sensitive to changes in this parameter value, while with less risk averse agents (that is with smaller σ) the effect of tax changes on employment and wealth concentration becomes greater. On this basis, the model results are only to some extent sensitive to different parameter values for the elasticity of substitution.

6. Conclusions

Since 1990s, the rise in inequality has been particularly rapid in Finland. In this study, I examine to what extent labour tax cuts done by the Finnish government over the period between 1996 and 2008 are responsible for this development. Also, the study analyses the reforms' effect on total employment. To answer these, I build a dynamic general equilibrium model with heterogeneous agents. The heterogeneity is based on different productivities of the model agents. The model is calibrated to fit the Finnish economy, particularly the labour markets, using micro data.

The study finds that labour tax reforms between 1996 and 2008 have increased total employment by 1.4 percent which corresponds to 8.5 percent of the total increase in Finnish employment during this period. Thus, even if labour tax cuts have improved employment, their contribution to a good performance has been relatively modest. Also the capital stock has increased as a result of the tax reductions, and this together with employment gains has contributed to a 2.0 percent increase in output. Especially agents in the highest wage quartile have increased their labour supply as a result of the tax cuts. However, the differences in agents' responses are small enough to produce only a minor increase in the Gini coefficient for gross labour incomes.

However, the changes in labour taxation have increased the concentration of net labour incomes and wealth. This way the labour tax reforms are partially responsible for rising inequality in Finland. Nevertheless, the changes in the Gini coefficients due to the labour tax cuts are moderate, and hence one could also conclude that the labour tax cuts have not been the main driver of rising inequality. Yet the results should be interpreted carefully due to some restrictions in the model. First, the model economy consists of agents whose labour supply can only adjust along the intensive margin. Hence the changes along the extensive margin are excluded in the analysis. Also, the employment effect, and to a modest degree also the distribution effect, is contingent on using labour supply elasticity found in typical micro studies. In spite of these facts, the paper gives insights about the effects of the tax policy changes in Finland during last decade and proves that they have produced a moderate but still significant increase in the Finnish employment, but are at the same time partially responsible for rising inequality.

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Appendix 1

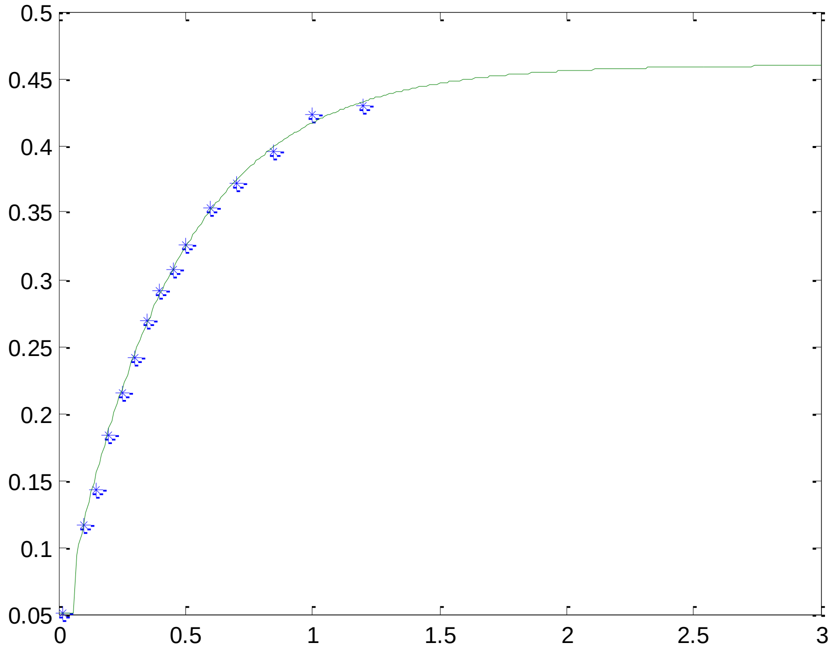
The basics of the solution algorithm follow Heer & Maussner (2009, p. 379-381). The benchmark case of the paper is described by the following steps.

1. Make initial guesses of the aggregate capital stock K, aggregate employment N, and the value function $V(\varepsilon, k)$.
2. Compute the interest rate r, the wage rate w, and unemployment compensation b.
3. Compute the households' decision functions $k'(\varepsilon, k)$, $c(\varepsilon, k)$, and $n(\varepsilon, k)$.
4. Compute the steady-state distribution of assets.
5. Compute K, N, and taxes T that solve the aggregate consistency conditions.
6. Compute the government expenditures G that balance the government budget.
7. Update K, N, and G, and return to step 2 if necessary.

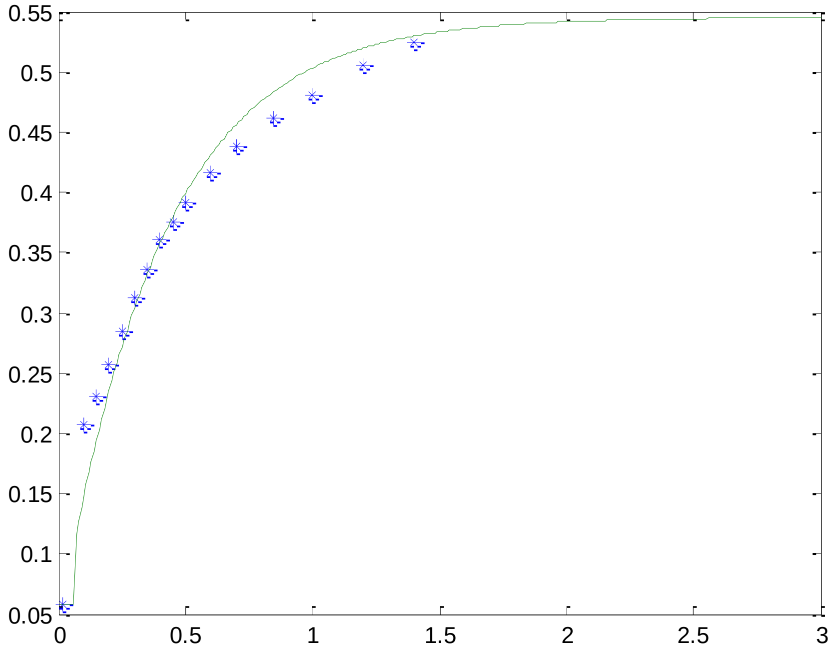
Household optimization problem is solved with value function iteration. The value function is discretized using an equispaced grid K of 1,000 points on the interval $[0, k^{max}]$. The value function is initialized with an assumption that agents use 20 percent of their time for working and that each agent consumes his current-period income infinitely. It is assumed that the labour supply can only take discrete values from the interval $[0,1]$ with an equispaced grid N of 100 points. The iteration is done with help of the monotonicity conditions. The wealth density is discretized and its invariant distribution is computed as described in Heer and Maussner (2009, p. 351).

Appendix 2

Observed tax rates for each wage rate in 2008 and the model projection



Observed tax rates for each wage rate in 1996 and the model projection



Appendix 3

To test the sensitivity of the results, the model is simulated with a fairly greater value for the labour supply elasticity with respect to wages. This is done by increasing the disutility from working parameter γ_0 from 0.1 to 1.5 while decreasing parameter γ_1 from 10 to 2.5.

Table 4. Simulation results with a larger labour supply elasticity with respect to wages

γ_0, γ_1	Tax policy	K	N	Y	$\bar{n}$	$Gini_l$	$Gini_{ln}$	$Gini_{lna}$	$Gini_w$
1.5 2.5	Labour taxes in 2008	3.15	0.289	0.683	0.270	0.271	0.221	0.251	0.414
1.5 2.5	Labour taxes in 1996	2.99	0.280	0.657	0.262	0.268	0.201	0.228	0.400

With these disutility parameters, the labour supply elasticity with respect to wage rate amounts to 0.9 for the *average* agent. Now the aggregate employment increases by 3.1 per cent due to the tax change, which is clearly more than the 1.4 percent increase found using benchmark parameterization. Also the capital stock rises by 5.5 percent, and this together with the employment change produces a 4.0 percent increase in output. The distributional effects also become slightly larger compared to the benchmark simulation, although here the differences are more modest. For instance the change in the Gini coefficient for gross labour income is 0.2 percentage points larger than that gained in the benchmark simulation. However, with these parameter changes, the Gini coefficient for gross labour income produced by the model is far too big relative to its empirical value: in the model it equals to 0.271 with 2008 taxes while in the data its value is 0.224. The experiment shows that increasing labour supply elasticity with respect to wages leads to a decline in the model's ability to fit the Finnish labour market facts.

In the literature, the elasticity of substitution parameter σ gets values ranging from 1 to 4. I test the sensitivity of the results using σ=1 or σ=2 instead of σ=1.5 used in the benchmark simulation. With less risk averse agents, i.e. with σ=1, both labour supply and capital stock rise clearly more than in the benchmark simulation. Also the change in the concentration of wealth is more dramatic. However, the changes in the Gini coefficients for net labour income are comparable to the results from the benchmark simulation. Instead with σ=2, agents are more risk averse and the precautionary motives dominate their behaviour. Thus, agents prefer to save the marginal increase in their net incomes and labour supply is only marginally increased. This, however, leads to a modest change in the Gini coefficient for wealth. The changes in the Gini coefficients for net labour income are again at the same magnitude as those in the benchmark results. In general, the differences in the Gini coefficient for gross labour income are small even though the sign of the change seems ambiguous.

Table 5. Sensitivity analysis of σ

σ	Tax policy	K	N	Y	$\bar{n}$	$Gini_l$	$Gini_{ln}$	$Gini_{lna}$	$Gini_w$
1	Labour taxes in 2008	2.96	0.279	0.652	0.265	0.222	0.178	0.209	0.334
1	Labour taxes in 1996	2.84	0.270	0.631	0.258	0.220	0.162	0.191	0.295
2	Labour taxes in 2008	3.54	0.322	0.763	0.309	0.217	0.173	0.202	0.401
2	Labour taxes in 1996	3.43	0.321	0.753	0.307	0.218	0.159	0.184	0.395