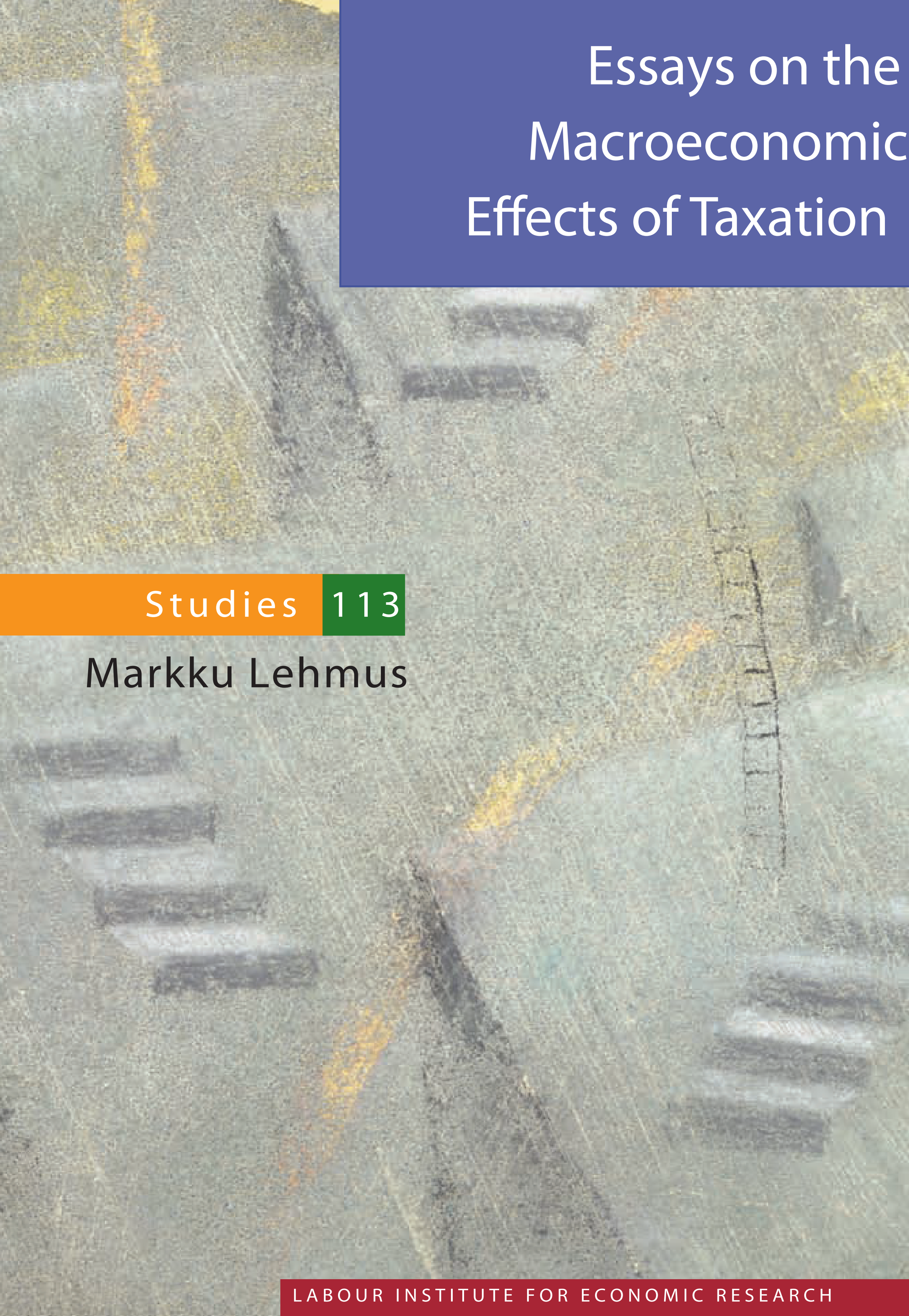


Essays on the Macroeconomic Effects of Taxation

Studies 113

Markku Lehmus

LABOUR INSTITUTE FOR ECONOMIC RESEARCH

Essays on the Macroeconomic Effects of Taxation

Markku Lehmus

Studies 113
Helsinki 2012

Palkansaajien tutkimuslaitos ● Labour Institute for Economic Research
Pitkänsillanranta 3 A, 00530 Helsinki, Finland
www.labour.fi

ISBN 978-952-209-107-9 (Nid.)
ISBN 978-952-209-108-6 (PDF)

ISSN 1236-7176 (Nid.)
ISSN 2242-6922 (PDF)

Kirjapaino Jaarli Oy
2012

Contents

Abstract

This dissertation examines the effect of labour and consumption taxes on economic performance and distributional issues. To study these, I first use a Keynesian-type macroeconometric model whereas in the second and third essay I use a dynamic general equilibrium model with heterogeneous agents.

In the first essay, I examine the effect of labour taxation on employment and growth. I also analyze the effect of other fiscal policy instruments, e.g. the effect of public spending. The focus here is on the fiscal policy shocks that are balanced for the government budget. The analysis will be performed with a macroeconomic model (EMMA) developed at the Labour Institute for Economic Research. The model is Keynesian in the short run but the long-run steady state of the model is determined by the supply side of the economy. The parameters of the model are mostly estimated from the Finnish macro data. The study finds that a one percentage point decrease in the income tax rate which is financed by increasing government debt improves GDP by 0.58 and employment by 0.25 per cent in the long run. Also, a one percentage point decrease in the income tax rate which is neutralized for the government budget by reducing public purchases produces a long-run increase in GDP and employment of a similar magnitude, even though its short-run effect on both variables is negative.

The second essay analyzes the effects of tax reform that shifts tax burden from labour to consumption. This also implies that we need to deal with the issue of progressivity of labour taxes. Even though this kind of tax policy change has recently gained popularity, its positive effects are debatable while the offsetting effect of a consumption tax on labour supply makes the net output change rather ambiguous. In order to examine these issues, I build a dynamic general equilibrium model with heterogeneous agents. The model is calibrated to fit certain characteristics of the Finnish economy, especially labour market features, using both micro and macro data. In addition to output and employment effects, I am particularly interested in the tax reform's effect on income and wealth distribution. First, I find that

eliminating progressivity in labour taxation increases output via increase in capital accumulation that comes, however, in expense of slightly more inequality. Then, tax reform that replaces progressive labour taxes with a flat-rate consumption tax leads to a significant rise in capital accumulation, a negligible change in labour supply and gross labour income distribution, but a relatively considerable increase in wealth concentration.

In the third essay, I examine the distributional and employment effects of the Finnish labour tax changes in the period 1996-2008. The motivation for the topic comes from the following. The labour income taxes in Finland decreased considerably during the period 1996-2008. At the same time the Finnish economy grew rapidly. Nevertheless, there was another coincidental trend in this period: a rapid rise in inequality. The rise in inequality was particularly fast also when compared internationally, as noted by OECD in its two reports. Thus, the study aims to answer to what extent labour income tax reductions between 1996 and 2008 contributed to this trend in inequality. The study also examines how much more employment was achieved owing to the labour tax reforms. To answer these questions, I have built a dynamic general equilibrium model with heterogeneous agents. The model has been calibrated to fit the Finnish economy. The model is based on the similar framework as the model used in the second essay of the dissertation but the progressive taxes are now explicitly included in the model structure. The study finds that the labour income tax cuts fractionally raised the Gini coefficient for net labour income. They also increased the concentration of wealth. The employment gains due to the reforms have been modest, but nevertheless significant.

Tiivistelmä

Väitöskirjassani tarkastelen työn ja kulutuksen verotuksen vaikutusta tuotantoon, työllisyyteen ja tulonjakoon. Ensimmäisen esseen tarkastelu tehdään Keynesiläisellä makroekonometrisella mallilla, kun taas toisen ja kolmannen esseen analyysi perustuu dynaamiseen yleisen tasapainon malliin, jossa agentit ovat heterogeenisia.

Ensimmäinen essee tarkastelee työn verotuksen vaikutusta työllisyyteen ja kasvuun. Lisäksi tarkastellaan julkisen kulutuksen ja muiden finanssipolitiikan instrumenttien vaikutusta. Erityistä huomiota kiinnitetään finanssipolitiikan shokkeihin, jotka tehdään tasapainotetun budjetin oloissa. Analyysi suoritetaan makrotalouden EMMA-mallilla, joka on kehitetty Palkansaajien tutkimuslaitoksessa. Malli on lyhyellä aikavälillä keynesiläinen, mutta talouden pitkän aikavälin tasapaino määrittyy mallissa tarjonnan kautta. Mallin parametrit on estimoitu suomalaisista makroaineistoista. Tutkimuksessa havaitaan, että yhden prosenttiyksikön tuloveron lasku, joka rahoitetaan lisävelanotolla, lisää bruttokansantuotetta 0.58 prosenttia ja työllisyyttä 0.25 prosenttia pitkällä aikavälillä. Kun samansuuruinen veronkevennys tehdään niin, että valtio vähentää julkisia ostojaan budjettinsa tasapainottamiseksi, saadaan pitkällä aikavälillä samansuuruinen vaikutus tuotantoon ja työllisyyteen. Tällaisen politiikkamuutoksen vaikutus työllisyyteen ja tuotantoon on kuitenkin negatiivinen lyhyellä aikavälillä.

Toisessa esseessä tarkastellaan sellaisen veromuutoksen vaikutusta, jossa siirrytään palkkojen verottamisesta kuluttamisen verottamiseen. Tässä yhteydessä käsitellään myös tuloveron progression vaikutusta. Tämänkaltainen veroreformi on saanut viime aikoina osakseen paljon huomiota, mutta sen positiivinen vaikutus on kyseenalainen, sillä kulutusvero vääristää yhtä lailla työn tarjontapäätöstä. Näiden kysymysten tarkastelemiseksi rakennetaan dynaaminen yleisen tasapainon malli, jossa agentit ovat heterogeenisia. Malli kalibroidaan vastaamaan tiettyjä piirteitä Suomen taloudessa hyödyntäen sekä mikro-, että makroaineistoja. Työllisyys- ja tuotantovaikutusten lisäksi tutkimuksessa ollaan erityisen kiinnostuneita veroreformin vaikutuksesta tulojen ja varallisuuden jakaumiin. Tutkimuksen perusteella siirtyminen työn verotuksessa tasaveroon lisää talouden tehokkuutta pääoman kasautumisen kautta, mikä kuitenkin saavutetaan hieman epätasaisemman tulonjaon kustannuksella. Kun korvataan progressiivinen palkkavero pelkästään kulutusveroilla, talouden pääomakanta kasvaa selvästi, työllisyys ja palkkatulojen jakauma eivät juuri muutu, mutta varallisuuden keskittyminen lisääntyy merkittävästi.

Kolmannessa esseessä tarkastellaan Suomessa vuosina 1996-2008 tehtyjen ansiotuloverotuksen muutosten vaikutusta tulonjakoon ja työllisyyteen. Työn verotusta on tarkasteluperiodilla kevennetty tuntuvasti. Samaan aikaan Suomen talous ja työllisyys ovat kasvaneet nopeasti. Samalla ajanjaksolla havaitaan kuitenkin myös toinen, negatiivinen trendi: tuloerot ovat kasvaneet selvästi. Tuloerojen kasvu Suomessa on ollut huomattavan nopeaa myös kansainvälisesti verraten, mikä on noteerattu muun muassa OECD:n taholta. Tutkimuksessani pyritään vastaamaan siihen, missä määrin työn verotuksessa tehdyt kevennykset vuosien 1996 ja 2008 välillä ovat vastuussa tuloerojen kasvusta. Samalla tarkastellaan, kuinka paljon veromuutokset ovat lisänneet työn tarjontaa. Tätä varten tutkimuksessa rakennetaan yleinen tasapainon malli, jossa agentit ovat heterogeenisia. Malli kalibroidaan vastaamaan tiettyjä piirteitä Suomen taloudessa. Malli perustuukin samankaltaiseen kehikkoon kuin toisessa esseessä käyttämäni malli, mutta nyt verotuksen progressio on eksplisiittisesti sisällytetty mallirakenteeseen. Tulosten mukaan tuloveron kevennykset ovat jossain määrin kasvattaneet nettotulojen Gini-kerrointa. Ne ovat myös lisänneet varallisuuden keskittymistä. Verokevennykset ovat siis osittain vastuussa tuloerojen kasvusta Suomessa. Työllisyyttä verokevennykset ovat lisänneet jonkin verran.

Acknowledgements

In 2005, I was given the great opportunity to do my master's thesis as a part of a project at the Labour Institute for Economic Research. Though I had always considered working as a researcher as a possible career, I could not anticipate that this project – building a macro model – would lead me to the path to a PhD degree.

At that time, I knew almost nothing about working as a research economist. However, the collaboration with my supervisor Professor Matti Virén and Research Coordinator Eero Lehto was a jump-start to learning about it. Without exaggeration I can say that in a couple of months I learnt more about economics than during the five years as an undergraduate at the university. In general, Matti Virén's insight on economic modelling and Eero Lehto's intuition of what is happening in the real economy have contributed enormously to my personal development as an economist.

Still most of all, I am indebted to my employer, the Labour Institute for Economic Research. The management has always supported my aim of completing a PhD degree. Hence I am grateful to the directors as well as the research director of the institute: Reija Lilja, Jukka Pekkarinen, Jaakko Kiander, and Seija Ilmakunnas. They have guaranteed the continuation and funding of my dissertation. Most importantly, I wish to thank Employee's Foundation, Yrjö Jahnsson Foundation, and OP-Pohjola Group Research Foundation for the financial support. This support also gave me the chance to spend an academic year at the university of Pompeu Fabra in Barcelona. Accumulating human capital contributes to one's output, as economists know. With regard to this, I thank Prof. Jukka Pirttilä who has often given me invaluable guidance regarding my academic plans.

However, it is not only the management of the institute that deserves a mention. Coffee table discussions mastered by gentlemen such as Ilpo Suoniemi have inspired my writing of this dissertation, as well as other areas of my life. Yet other people ought to be mentioned here too, so I wish to emphasize that I am grateful to the whole personnel of the Labour

Institute for Economic Research. Outside the institute, I owe special thanks to the University of Turku as well as Dr. Tomi Kortela who has helped me to understand what is really happening behind the macro models I am working with.

For me personally, it has always been clear that there is life outside economics. This is where friends come to picture. I am lucky to have as good and supportive friends as I do. They have given me the strength to complete this dissertation. Discussions with them have also contributed to my intellectual development. Nevertheless, behind every achievement, at least for me, there is the family. I have never lacked the support from my parents. It must have been the huge appreciation for education from my father's side of the family that originally inspired me to take this path. However, it was the resilience inherited from my mother that helped me to succeed and finish this project. Finally, I am grateful to Anni who accompanied me all these years.

November 2012
Markku Lehmus

I Introduction to the macroeconomic effects of taxation

1. Introduction

In the following introduction I will provide background for the essays that comprise this dissertation. First I analyze the theoretical effects of (linear) taxes. Then, section 1.2. presents how taxes are imputed to a benchmark macro model and discusses models with heterogeneous agents from both a theoretical and an empirical point of view.

I begin with a description of the household's labour-leisure decision problem with income taxes as generally formulated in the literature. After that, taxation is linked to labour demand issues. The analysis is then extended with an inclusion of a consumption tax in the model. The remainder of the first section considers how the analysis changes when capital is also included in the model. The analysis here uses the tools provided by the Ramsey framework. The approach is based on the assumption of a representative agent and the government that is allowed to use only linear taxes. The government aims at choosing the tax parameters that maximize social welfare. This approach can be contrasted with the Mirrlees approach presented in the second section of the introduction. In the Mirrlees approach – and in the new dynamic public finance framework presented later in the dissertation – agents are, instead, heterogeneous, and the government is also allowed to use nonlinear taxes.

1.1. The theoretical effects of taxation

1.1.1. Labour taxes and employment

I begin by considering a model that will involve a one-period setting in which an individual's only choice variable is their degree of labour effort, and there is a single composite consumption good. In a standard formula, the utility of a representative agent is given by $U(c,l)$, where c denotes consumption and l is labour supply.[1] It is assumed that $U_c > 0$, $U_l < 0$. Thus, the marginal utility of consumption U_c and the marginal disutility of labour, $-U_l$, are positive. The household budget constraint is as follows:

$$c = wl - T(wl), \tag{1}$$

where w is the individual's wage rate and T is a tax function. Thus, taxes are a function of the individual's income (wl); it is this dependence of taxes on income that produces a distortion. Individuals choose the labour effort that maximizes $U(c,l)$ subject to the budget constraint (1). Taking first order conditions gives the following equation:

$$w(1 - T'(wl)) = -\frac{U_l}{U_c} \quad . \tag{2}$$

A prime denotes the derivative with respect to a function's only argument, so $T'(wl)$ indicates the marginal tax rate of an individual earning income of wl . If it is assumed that government taxes households' earnings at a proportional rate, the LHS of (2) becomes more simple: $w(1-T)$. Thus, at the optimum point, the agent chooses labour effort in which post-tax wage equals the ratio between marginal disutility of labour and marginal utility of consumption. So it is easy to see that income tax has a direct effect on households' labour supply.

Nevertheless, income tax does not only affect labour supply, but also labour demand. Following Hamermesh (1993), let L be the homogenous labour input, W the nominal wage and P the product price. Output is

[1] Most of this follows the analysis presented in Kaplow (2008).

produced by a simple production function that transforms labour services into output, $\phi(L)$, with the assumptions that $\phi' > 0$ and $\phi'' < 0$. Hence, there are diminishing returns to the single input that is labour. One can think of this as a short-run production function in which all other inputs are held constant. It is also assumed that the firm is competitive in all markets and that it maximizes profits:

$$\pi = P\phi(L) - WL \ , \tag{3}$$

hence deriving gives:

$$\phi'(L^*) - w = 0 \ , \tag{4}$$

where $w = W / P$ is the real wage and L^* is the demand for labour that maximizes the profit. Thus, at the optimum point the value of the marginal product equals the real wage. It yields the maximum, for $\phi'' < 0$. According to this result, for a firm that is competitive in the product market one only needs to consider changes in real factor prices.

The condition also leads to the assumption of downward-sloping demand curves. Differentiating (4) and rearranging gives the following:

$$\frac{dL^*}{dw} = \frac{1}{\phi''(L^*)} < 0 \ . \tag{5}$$

The negative slope of the demand curve comes from the concavity of the one-factor production function. The more rapidly the returns to labour diminish (the more negative is ϕ''), the steeper is the demand curve for labour.

In order to capture the taxes' effect on labour demand, one also needs to know how wages are formed. For Europe, where either the union density of workers or the coverage of collective bargaining agreements is very high, or both, the wage formation is often analyzed using the union bargaining model (see, for instance, Nickell 2004). In this model, wages are negotiated between the representatives of employees and employers, and after that firms unilaterally determine employment. The unions are interested in the net-of-tax wage rates, so they raise their wage claims as income taxes are increased. As a consequence, taxes indirectly have a negative effect on labour demand. The model setting also assumes that both sides have bargaining power in the wage negotiations and that firms have price-setting power in the goods markets.

Hence, in the union bargaining model, the burden of income taxes is borne by both sides of the labour markets, employees and employers. So, in fact, one is analyzing the tax incidence. The bigger the tax elasticity of wage formation and the wage elasticity of labour demand is, the greater are the effects of taxes on employment. After all, the magnitude of these elasticities is purely an empirical question. Koskela (2001) also derives a theoretical result that when the wage elasticity of labour demand increases, it is harder for the trade union to extract rent from wage negotiations.

1.1.2. Comparison of income and consumption tax

It can be shown that in a simple setting an indirect tax, such as a consumption tax, is equivalent to an income tax. A framework to analyze the problem of direct vs. indirect taxes is provided, for example, by Salanie (2003). He assumes that the government can only use a linear tax on goods and wages, and considers the general equilibrium of a simple production economy. This economy consists of I consumer-workers with utility functions $U_i\left(X^i, L^i\right)$, where X^i is consumption of n goods and L is labour supply. It is assumed that each good is produced from labour alone, hence the production has constant returns of the simplest variety. Now a_j units of labour produce a unit of good j so that the production price is $p_j = a_j w$ in equilibrium. Wages are normalized to one and, also, the units of goods are chosen so that each a_j equals one; hence all production prices satisfy $p_j = 1$.

One must specify how the government intervenes in the economy in this general equilibrium model. The government may be willing to pay civil servants, finance the production of public goods, or purchase private goods. In this simple example it is assumed that it just buys T units of labour. To pay this, the government must collect revenue T. (The wage is normalized to one.) In this problem, the following taxes are considered:

– linear taxes on goods, which raise consumer prices to $(1+t_j)$
– a linear taxes on wages, so that after-tax wages are $(1-\tau)$

Now the budget constraint of consumer i, who rents his labour force, is

$$\sum_{j=1}^{n}(1+t_j)X_j^i = (1-\tau)L^i . \tag{6}$$

With no non-labour income, and no bequest, the tax on wages is equivalent to a uniform tax on goods. To prove this, following Salanie (2003), I define

$$t'_j = \frac{\tau + t_j}{1-\tau} . \tag{7}$$

Because $1+t'_j = (1+t_j)/(1-\tau)$, the budget constraint of consumer i can be rewritten as

$$\sum_{j=1}^{n}(1+t'_j)X_j^i = L^i . \tag{8}$$

The tax system $((t_j),\tau)$ is then equivalent for all consumers to the tax system $((t'_j),0)$, which has no taxes on wages. If the former system is replaced by the latter, it has no effect on consumer choices. With the former tax system, the government collects from consumer i the following:

$$\sum_{j=1}^{n} t_j X_j^i + \tau L^i . \tag{9}$$

Using (8) in (9) the tax revenue can be written

$$\sum_{j=1}^{n}\left(t_j + \tau(1+t'_j)\right)X_j^i = \sum_{j=1}^{n} t'_j X_j^i . \tag{10}$$

But this is exactly the same that the government collects from consumer i in the latter tax system. Thus in this context, taxing wages is absolutely equivalent to a uniform tax on goods. The analogy between consumption and income tax can also be seen if consumption tax is added to the budget constraint (1) so that it looks like this: $c(1+t^c) = wl - T(wl)$, where t^c is consumption tax. Now assuming a linear tax function and maximizing household utility, $U(c,l)$ subject to this new budget constraint gives:

$$\frac{W(1-T)}{1+t^c} = -\frac{U_l}{U_c} \quad . \tag{11}$$

The equation shows that both consumption and income tax affect the optimal labour supply decision of a household, since it is the real purchasing power of the wage that counts for the household decision. Thus, households are indifferent to whether the tax is collected from wages or consumption prices.

Finally, the equivalence between consumption and income taxes is also manifested in the well-known Atkinson and Stiglitz (1976) result, according to which no indirect taxes need be employed ($t^c = 0$) if the utility function is weakly separable between labour and all commodities, and the optimal tax system can rely solely on income taxation. The assumption of separability implies that the utility function can be expressed as follows:

$$U(v(x_1,\ldots,x_n),l) \; , \tag{12}$$

where v is a subutility function. The formulation indicates that, for a given level of after-income-tax income, the individual will allocate his disposable income among all commodities in the same way regardless of the level of labour hours required to generate that level of income. In other words, the ratio of the marginal utility of consumption for any two commodities, at a given level of consumption, is independent of the level of labour effort. Even if the separability condition has been empirically rejected, the assumption may be regarded as a reasonable first approximation and a useful benchmark case.

1.1.3. Extension with capital

If the model is extended to a deterministic discrete-time infinite horizon economy that also includes capital and government spending, the analysis becomes more complicated. Following Coleman (2000) the model now consists of a large number of identical households who own all the factors of production, namely labour and capital, which they rent to firms at perfectly competitive rates. A government imposes flat-rate taxes on income from labour and consumption.[2] In this model, households adjust their consumption and labour supply over time, and firms also adjust their demands for investments and labour.

The government finances a sequence of per-capita spending g_t for each period t, where $g > 0$ in each period. In each period t a government imposes a flat-rate tax τ_t^n on labour income and τ_t^c on consumption. Hence a tax policy is denoted by $\tau = \{\tau_t^n, \tau_t^c\}_{t=0}^{\infty}$. It is assumed that the government issues only one-period debt. The outstanding stock of one-period debt at time t is denoted by b_t, and interest paid to holders of this debt at time t by R_t. The flow budget constraint for the government is then

$$g_t + (1 - R)b_t = \tau_t^n w_t n_t + \tau_t c_t + b_{t+1} \ . \tag{13}$$

I define q_t as

$$q_t = [1 + R_0]\prod_{s=0}^{t} \frac{1}{1 + R_s} \ . \tag{14}$$

I normalize q_t so that $q_0 = 1$ and I rule out any arbitrage between the return of capital and government debt by defining

$$q_t = q_{t+1}[1 + r_{t+1} - \delta] \ . \tag{15}$$

[2] Coleman (2000) also includes capital taxes in his model. I omit it, since I only compare consumption and labour taxes.

Finally, the present value budget constraint for the government can be written as[3]

$$\sum_{t=0}^{\infty} q_t \left[\tau_t^n w_t n_t + \tau_t^c c_t - g_t\right] \geq 0 \ . \tag{16}$$

The government revenue is used to purchase goods and services, and transfer resources among households so that

$$g_t = g_{1t} + g_{2t} \ , \tag{17}$$

where g_{1t} denotes government purchases of goods and services, and g_{2t} is a lump sum rebated to households. As a result, taxation and redistribution of resources create distortion in the model economy.

I continue by assuming that households have an initial capital stock denoted by a_0. Since x_0 units of capital in period 0 can yield $[1 + r_0 - \delta]x_0$ units of consumption in period 0, the following holds:

$$a_0 = [1 + r_0 - \delta]x_0 \ . \tag{18}$$

The households' budget constraint is then (given (15) holds):

$$\sum_{t=0}^{\infty} q_t \left[(1 + \tau_t^c)c_t - (1 - \tau_t^n)w_t n_t - g_{2t}\right] \leq a_0 \ . \tag{19}$$

Now it is possible to consider the Ramsey tax policy, i.e. the policy according to which the allocations from the equilibrium maximize the utility attained by households.[4] I define some constant $\bar{\tau}$, and choose $\tau_t^c = \bar{\tau}$, $\tau_t^n = -\tau_t^c$. From that it follows that I have a constant tax rate on consumption

[3] As well as Coleman (2000) I assume that in the initial period the government has no debt outstanding.

[4] The idea stems from the work of Ramsey (1927), who considered the problem of choosing an optimal tax structure in a representative-agent economy when only distorting taxes are available. The results from this tradition and its modern applications are summarized in Chari and Kehoe (1999).

and a subsidy to labour at the tax rate imposed on consumption. In order for this tax policy to be optimal, $\bar{\tau}$ must satisfy the government budget constraint, hence it becomes

$$\bar{\tau}\sum_{t=0}^{\infty} q_t\left[c_t - w_t n_t\right] - \sum_{t=0}^{\infty} q_t g_t = 0\,. \tag{20}$$

Also, with this tax policy I can rewrite the households' budget constraint:

$$(1+\bar{\tau})\sum_{t=0}^{\infty} q_t\left[c_t - w_t n_t\right] - \sum_{t=0}^{\infty} q_t g_{2t} = a_0\,. \tag{21}$$

Combining (20) and (21) and using (17) yields

$$\sum_{t=0}^{\infty} q_t g_t = \bar{\tau}\left(a_0 - \sum_{t=0}^{\infty} q_t g_{1t}\right)\,. \tag{22}$$

From (22) it can be seen that in a dynamic economy in which the government has access to consumption and income tax rates, and in which the government is permitted to subsidy labour income, an optimal tax policy is to impose a positive tax on consumption but a subsidy on labour. This result holds only if the value of initial assets exceeds the value of government consumption, i.e.

$$a_0 > \sum_{t=0}^{\infty} q_t g_{1t}\,. \tag{23}$$

The optimal tax policy reduces the amount the initial assets can purchase, so the consumption tax acts as a one-time lump-sum tax on initial assets less the value of government consumption. This feature is easier to see if all government revenue is lump-sum rebated to households, i.e. when $g_{1t} = 0$, for then (22) becomes

$$\sum_{t=0}^{\infty} q_t g_t = \bar{\tau} a_0\,. \tag{24}$$

However, Auerbach and Kotlikoff (1987) discuss the ability of a consumption tax to tax existing assets. In their analysis, due to the distortive effects on labour supply, the offsetting effect on welfare of implementing only a consumption tax (so that income taxes are set to zero) makes the net welfare change ambiguous. In fact, this is the core of the whole dilemma between labour and consumption taxes.

1.2. Examining the effects of taxation

As stated in the previous section, in equilibrium the real after-tax consumption wage of households must equal the marginal rate of substitution between consumption and leisure, and the firms' real effective wage cost must equal the marginal product of labour. Thus, taxes induce a wedge that distorts the households' consumption-leisure choice on the one side and the firms' demand for labour on the other. Thus, the overall tax wedge can be expressed with the following:

$$\bar{\tau} = 1 - \frac{\left(1 - \tau^{N} - \tau^{W_h}\right)}{\left(1 + \tau^{c}\right)\left(1 + \tau^{Wf}\right)} \approx \tau^{c} + \tau^{N} + \tau^{W_h} + \tau^{W_f}, \tag{25}$$

where τ^{N} is a tax on wages and τ^{c} is a consumption tax, while τ^{W_h} and τ^{Wf} are the contribution rates to social security to be paid by households and firms, respectively. Equation (25) is a typical measure of the total distortions adversely affecting labour utilisation.

Coenen et al. (2008) state that by considering only one static equation such as (25), which is based on the households' intratemporal consumption-leisure margin and the firms' intratemptoral labour-capital margin, the intertemporal aspects associated with capital accumulation and the acquisition of foreign assets will be neglected. Also, a simple one-equation approach disregards the effects of changes in both domestic and international relative prices. As a result, it ignores several important margins and does not provide insights into the transitional dynamics triggered by reductions in the tax wedge. Thus, in order to capture all the important margins of the economy, one needs to build a macroeconomic model that incorporates all the relevant dependencies between economic variables and taxes into its structure.

1.2.1. Taxes in a macro model

In a representative study, Coenen et al. (2008) build a well-articulated dynamic stochastic general equilibrium (DSGE) macro model of the euro area and the United States which they will use for the purpose of evaluating alternative scenarios aimed at reducing the labour-market inefficiencies caused by euro area tax structures.[5] While the paper represents a sort of a benchmark study of the effects of taxation done using macro model, I will use it as a reference to articles of this dissertation. In the following, I write the key equations of the model that aim at capturing the effects of taxation.

In their model, Coenen et al. have two types of households, I and J. Household I maximizes the life time utility subject to the following budget constraint:

$$
\begin{aligned}
&\left(1+\tau^{c}+\Gamma_{v}\left(v_{i,t}\right)\right)P_{C,t}C_{i,t}+P_{I,t}I_{i,t}+R_{t}^{-1}B_{i,t+1}+\\
&\qquad\left(\left(1-\Gamma_{B^F}\left(B_{t}^{F}\right)\right)R_{F,t}\right)^{-1}S_{t}B_{i,t+1}^{F}+M_{i,t}+\Xi_{i,t}+\Phi_{i,t}\\
&=\left(1-\tau_{t}^{N}-\tau_{t}^{W_h}\right)W_{i,t}N_{i,t}+\left(1-\tau_{t}^{K}\right)\left(R_{K,t}u_{i,t}-\Gamma_{u}\left(u_{i,t}\right)P_{I,t}\right)K_{i,t}+\tau_{t}^{K}\delta P_{I,t}K_{i,t}+\left(1-\tau_{t}^{D}\right)D_{i,t}+TR_{i,t}\\
&\qquad-T_{i,t}+B_{i,t}+S_{t}B_{i,t}^{F}+M_{i,t-1}\ ,
\end{aligned}
\tag{26}
$$

where $P_{C,t}$ and $P_{I,t}$ denote the prices of the private consumption good and the investment good, respectively. R_t and $R_{F,t}$ are, respectively, the risk-less returns on domestic government bonds ($B_{i,t+1}$) and on internationally traded bonds ($B_{i,t+1}^{F}$). The domestic value of internationally traded bonds depends on the nominal exchange rate S_t. Firms pay wages $W_{i,t}$ for labour services $N_{i,t}$. $R_{K,t}$ denotes the rental rate for the effective capital services rent to firms, and

[5] Wickens (2008) describes the DSGE model as a dynamic general equilibrium system that consists of the decisions of rational individuals over a range of variables that relate to both the present and the future. The decisions are co-ordinated through markets which constitute the macroeconomy. The economy is in continuous equilibrium in the sense that individuals make decisions that appear to be optimal for them given the information available. The origins of DSGE models lie in the work of Lucas (1975), Kydland and Prescott (1982) and Long and Plosser (1983) on real business cycles.

$M_{i,t}$ describes holdings of money. $D_{i,t}$ and $u_{i,t}K_{i,t}$ indicate the dividends paid by firms that are owned by households. $\Gamma_v\left(v_{i,t}\right)$ and $\Gamma_u\left(u_{i,t}\right)$ denote proportional transaction cost paid in purchases of the consumption goods and capital utilisation, respectively. $\Gamma_{B^F}\left(B_t^F\right)$ is a financial intermediation premium the household must pay from positions in the international bond market; $\Xi_{i,t}$ indicates the incurred premium, which is rebated in a lump-sum manner.

The fiscal authority collects revenues by taxing consumption (τ_t^C) and incomes from wages (τ_t^N), capital (τ_t^K), and dividends (τ_t^D). $\tau_t^{W_h}$ represents the household contribution to social security, while $TR_{i,t}$ and $T_{i,t}$ indicate transfers received and lump-sum taxes paid, respectively. Finally, it is assumed that the household holds state-contingent securities, $\Phi i,t$. The fairly complex structure of the household budget constraint (26) can be associated with the high level of sophistication of the model.

Instead, the other type of households, denoted by symbol J, does not have access to capital and bond markets. They can, however, intertemporally smooth consumption by adjusting their holdings of money. For this household, the budget constraint is simpler:

$$\left(1+\tau^c+\Gamma_v\left(v_{j,t}\right)\right)P_{C,t}C_{j,t}+M_{j,t}=\left(1-\tau_t^N-\tau_t^{W_h}\right)W_{j,t}N_{j,t}+TR_{j,t}-T_{j,t}+M_{j,t-1}+\Phi_{j,t}\,. \quad (27)$$

Defining the Lagrange multipliers associated with the household budget constraint and the capital accumulation, and then maximising the household lifetime utility with respect to consumption, investments, next period capital, the intensity of capital utilisation, domestic and foreign debt, and money holdings gives the equilibrium conditions for the model. The most relevant equation as regard to our analysis is the equilibrium condition for labour supply, which is the same for both types of households and looks quite familiar:

$$\left(1-\tau_t^N-\tau_t^{W_h}\right)\frac{\widetilde{W}_{I,t}}{P_{C,t}}=-\frac{\eta_I}{\eta_I-1}\frac{\Delta_{i,t}}{\Lambda_{i,t}}\,, \quad (28)$$

where $\Delta_{i,t}$ represents the marginal disutility from labour and $\Lambda_{i,t}$ the marginal utility of consumption. $\widetilde{W}$ is the wage rate after re-optimisation of the wage contract. Hence in practice the only new factor is $\eta_I/(\eta_I - 1)$, which denotes the mark-up of the real after-tax wage over the marginal rate of substitution between consumption and leisure, reflecting the degree of monopoly power on the part of the members of the household. This additional factor drives a wedge between the effective consumption wage and the marginal rate of substitution. As before, the tax wedge $1-\tau_t^N-\tau_t^{W_h}$ creates distortion in the household labour supply decision. The consumption tax is now manifested in term $\Lambda_{i,t}$ which also denotes the shadow price of consumption and is the following:[6]

$$\Lambda_{i,t} = \frac{\left(C_{i,t} - \kappa C_{I,t-1}\right)^{-\sigma}}{1+\tau^C + \Gamma_v\left(v_{i,t}\right) + \Gamma_v'\left(v_{i,t}\right)v_{i,t}}\ , \tag{29}$$

where parameter κ measures the degree of external habit formation in consumption and σ is the inverse of the intertemporal elasticity of substitution; other symbols are as in (26).[7] Naturally, the tax parameters also appear in the government's budget constraint:

$$\begin{aligned} &P_{G,t}G_t + TR_t + B_t + M_{t-1} = \\ &\quad \tau_t^C P_{C,t}C_t + \left(\tau_t^N + \tau_t^{W_h}\right)\left(\int_0^{1-\omega} W_{i,t}N_{i,t}di + \int_{1-\omega}^{\omega} W_{j,t}N_{j,t}dj\right) + \tau_t^{W_f}W_tN_t \\ &\qquad + \tau_t^K\left(R_{K,t}u_t - \left(\Gamma_u\left(u_t\right)+\delta\right)P_{I,t}\right)K_t + \tau_t^D D_t + T_t + R_t^{-1}B_{t+1+} + M_t\ . \end{aligned} \tag{30}$$

Hence the government uses tax revenues for public consumption (G_t) and transfers to households (TR_t); the labour services and wages are differentiated across the members of the two households. The model is closed by imposing market-clearing conditions, stating the law of motion for the domestic holdings of international assets, and formulating the aggregate resource constraint. Finally, the model is calibrated for the U.S. and the euro

[6] Again, the equation (29) looks similar for household type j.

[7] Also, the payroll tax drives a wedge between the firm's effective labour cost and the marginal revenue of labour. In addition, the capital tax affects the shadow price of the investment good, i.e. Tobin's Q. However, while these distortions are not in the interest of this analysis, the equations are not written here.

area economies using observed macro data and parameter values found in the related literature.

In the following table, I will replicate the key results by Coenen et al. (2008). The table shows the effects of lowering taxes in Europe to the levels prevailing in the United States.

Table 1. Long-Run Benefits and Spillovers of Lowering Tax Wedges in the Euro Area.

	Components of the overall tax wedge			Overall tax wedge
	$\Delta\tau^{C}=-10.6$	$\Delta\left(\tau^{N}+\tau^{W_h}\right)=-1.5$	$\Delta\tau^{W_f}=-14.8$	$\Delta\bar{\tau}=-26.8$
Euro area				
Output	4.22	0.74	5.38	11.89
Consumption	4.01	0.71	5.12	11.30
Investments	2.77	0.49	3.54	7.74
Exports	3.54	0.63	4.52	9.92
Imports	1.12	0.20	1.42	
Hours worked	4.84	0.85	6.19	13.72
United States				
Output	0.19	0.03	0.24	0.51
Consumption	0.42	0.07	0.53	1.15

Source: Coenen et al. (2008).

The results in Table 1 confirm that lowering taxes has a clearly positive effect on overall economic performance. Both the domestic and the foreign demand increase as a result of the tax changes; the total output increases almost 12 per cent. Also, hours worked in the euro area grow by 13.7 per cent. The first row of the table (above) shows that in order to attain the tax levels prevailing in the U.S. system, the largest reductions need to be targeted at the consumption tax and the firms' contribution rate to social security.

While the above cited study concerned the euro area, there are fewer macro studies of the effects of labour and consumption tax cuts that concern Finland. This is one of the most important factors motivating the essays presented in this dissertation. One reference is, however, Kilponen ja Vilmunen (2007). They examine the effects of different fiscal policies with the Bank of Finland's DSGE macro model (AINO). In their study, an increase in the valued added tax rate is compensated for the government budget by a decrease in the income tax or increase in the government-provided transfers. The results of their experiments are replicated in Table 2.

Table 2. Long-run effects of an increase in Finnish consumption tax.

	Revenue neutral compensation		
	Reduction in income tax	Reduction in indirect labour cost	Increase in income taxes
Output	0.53	0.70	-0.52
Consumption 0.63	0.63	1.05	-0.51
Investments	0.48	0.68	-0.48
Exports	0.20	0.11	-0.27
Imports	0.20	0.45	-0.13
Employment rate (% points)	0.25	0.32	-0.24

Source: Kilponen and Vilmunen (2007).

The results show that a one per cent increase in the value-added tax that is neutralized for the government budget by increasing income transfers reduces output by 0.5 per cent and employment rate by 0.2 percentage points in the long run. The results also indicate that a one percentage point rise in the value added tax that is compensated for the government by decreasing income taxes raises the output more than 0.5 per cent and the employment rate by 0.25 percentage points in the long run. Thus, according to this, lowering income taxes but increasing consumption tax at the same is beneficial for economic outcomes. The positive effects are even greater if the hike in the consumption tax is used to finance a reduction in indirect labour costs.[8] These figures may be compared with the results gained in the first and second essay of this dissertation.

Standard macro models are based on the assumption of a representative agent. However, in the real world agents differ with regard to many properties. Standard models also assume that taxes are linear. Hence

[8] The results are, however, sensitive to the assumptions made about the behaviour of the pensioners that are included in the model.

these models usually operate with the average tax rates. In practice, most developed countries use a progressive income tax. This progressivity is further increased due to different tax deductions. For instance, Finnish employees are allowed for the basic deduction and earned income deduction up to a certain limit in municipal and government taxation. These features lead to the following labour income tax schedule for Finland: for the monthly income of 2000 € the average tax rate is 21.7 with a marginal rate of 34.1; for 4000 € the average tax rate is 33.7 with a marginal rate of 49.2; for 7040 € the average tax rate is 41.4 with a marginal rate of 56.9; for 10 000 € the average tax rate is 45.7 with a marginal rate of 54.8.[9] Thus, Finnish labour income taxes are far from linear.

1.2.2. Optimal taxes with heterogeneous agents

The government uses progressive – and hence nonlinear – taxes to achieve redistributive goals. The study of optimal taxation analyzes the trade-off between equity (the search for a redistribution that implements social views) and efficiency (minimizing distortions induced by the tax system). This has been done formally since Mirrlees (1971).

In the literature of optimal direct taxation it is typical to assume that consumer-workers have heterogeneous, innate earning capacities w. According to Salanie (2003), one may identify w with human capital, productivity, or with the wage that the individual can obtain on the labour market. It is also usually assumed that all consumers have a similar kind of utility function $U(C,L)$ that is defined over a single consumption good C and labour supply L. This assumption plays an important role, since it rules out all differences in individual preferences, and thus all issues that are related to horizontal equity.

The definition for the redistributive objectives of the government has been debated for a long time. In the classical literature it has been argued that a tax should be proportional to the ability to pay, whereas other writers have preferred a tax that would equalize the "sacrifices" between tax-payers.

[9] These are based on the calculations of the Taxpayers' Association of Finland for 2012. The numbers include both the income taxes and the workers' contributions to social security.

These authors can be further split into those who favour equal sacrifice (the same absolute reduction in utility) and those who prefer equiproportional sacrifice (the same proportional reduction in utility). It is quite clear that if the agents did not react to taxation, the optimal taxation should transfer income from the agents with a lower marginal utility of income (the rich) to those with a high marginal utility of income (the poor), and there would be no reason why this process should not continue until marginal utilities of income were equal. Nevertheless, in the real world the reactions of workers who are taxed counter this process of equalization: taxation changes the primary income $Y(w)$, i.e. the income generated before taxes are paid.

The discussion leads us to the model introduced in the literature by Mirrlees (1971). In this model the government chooses the income tax schedule $T(.)$ to maximize welfare:

$$W = \int_0^\infty \psi(U(w))dF(w) \ , \tag{31}$$

where

$$U(w) = u(wL(w) - T(wL(w)), L(w)) \ , \tag{32}$$

and $L(w)$ maximizes over L

$$u(wL - T(wl), L) \ , \tag{33}$$

all of this under the government's budget constraint:

$$\int_0^\infty T(wL(w))dF(w) \geq R \ . \tag{34}$$

This presents the problem at a very general level; hence it is very difficult to characterize the solution. However, under the incentive constraint and the constraint that the utility of the least favoured individual must equal the value of the government's social objective function, the optimal tax can be characterized as shown in Piketty (1998). One also needs to make the assumption that there is no income effect on labour supply. With these assumptions, it is possible to derive a result that the larger the elasticity of labour supply is, the lower the optimal marginal tax rates are. The optimal tax also depends on the distribution of productivities in the population: the optimal marginal tax rate is higher when w is lower in the distribution of productivities and when the concentration of individuals around the productivity under examination is smaller.

Diamond (1998) shows that if one assumes a constant elasticity of labour supply with production, and that above some productivity level w_0 the distribution of productivities is well approximated by a Pareto distribution, the marginal tax rates must be increasing above that productivity level (w_0). This result was followed by Saez (2001), who suggested that with Rawlsian preferences and a constant elasticity of labour supply, marginal rates should decrease for low to middle incomes, but increase for high incomes. Using U.S. data, Saez simulates a U-shaped marginal tax rate curve that slopes upwards at around 75 000 dollars/year, which is a rather high level of earning. This is in contrast to the old result according to which the marginal tax rate should be zero at high incomes.

The deficiency of the Mirrlees model is that it analyzes taxes in the static economy. To tackle this issue, Kocherlakota (2010) extends the Mirrlees model to the dynamic setting. Kochelakota refers to this framework as "New dynamic public finance". It assumes that the agent heterogeneity takes the form of differences in skills that are reflected in labour productivity, and these differences can fluctuate stochastically over time. Taxes are allowed to be nonlinear and the economy is confronted by aggregate shocks. In this setting, a nonlinear taxation problem can be formulated in the following way. In period 0, the government chooses tax system τ that maximizes ex-ante utility:

$$\max_{(c,y,k,\tau)} \sum_{\theta^T \in \Theta^T} \sum_{z^T \in Z^T} \sum_{t=1}^{T} \beta^{t-1} \pi_{\Theta}\left(\theta^T \middle| z^T\right) \pi_Z\left(z^T\right) \left\{ u\left(c_t\left(\theta^T, z^T\right)\right) - v\left(\frac{y_t\left(\theta^T, z^T\right)}{\theta^t}\right) \right\} \tag{35}$$

$s.t.\ (c, y, k) \in EQM_{NL}(\tau, G)$.

In the formula, Z and Θ are assumed to be finite sets. It is assumed that nature draws a T-period sequence z^T of aggregate shocks from the set Z^T according to π_Z. After that, she draws skill θ_t from the set Θ^T for each agent, determined by the p.d.f. $\pi_{\Theta}\left(.\middle|z^{T}\right)$. Function v describes the disutility from working. Other variables in (35) are as usual, so β denotes the discount factor, c, y, k denote consumption, income, and capital, respectively. Finally, (c, y, k) denotes the set of equilibrium allocations for a given τ and G by EQM_{NL}.

It is now possible to characterize the optimal income tax system. Kocherlakota (2010) begins by exploiting the tight restriction on the present value of lifetime taxes imposed by the optimal allocation. If there are no aggregate shocks, the capital tax rate is set so that the ex-post Euler equation holds for all y^T in (domain) DOM_t:

$$u'\left(\hat{c}_t^*\left(y^T\right)\right)=\beta u'\left(\hat{c}_{t+1}^*\left(y^T\right)\right)\left(1-\delta+MPK_{t+1}^*\left(1-\tau_{t+1}^k\left(y^T\right)\right)\right) , \tag{36}$$

where y^T represents the lifetime income, MPK is the marginal product of capital, τ^k is the capital tax rate, and δ is the capital depreciation rate. Also, the flow budget constraint of the economy can be written as follows:

$$\begin{aligned}\hat{c}_t^*\left(y^T,z^T\right)+\hat{k}_{t+1}^*\left(y^T,z^T\right)&=\left(1-\delta+MPK_t^*\left(z^T\right)\left(1-\tau_t^k\left(y^T,z^T\right)\right)\right)\hat{k}_t^*\left(y^T,z^T\right)\\ &+MPL_t^*\left(z^T\right)y_t-\Psi_t^*\left(y^T,z^T\right) ,\end{aligned} \tag{37}$$

where MPL is the marginal product of labour and function ψ^* describes the labour taxes, given that the agent chooses an effective labour sequence in DOM_T. The functions $\hat{c}^*$ and $\hat{k}^*$ describe the agent's consumption and capital holdings that satisfy the flow budget constraint. Now multiply each flow budget constraint (37) by $\beta^{t-1}u'\left(\hat{c}_t^*\left(y^T\right)\right)$, and add them over t. Because of (36), the capital terms cancel, and this gives the following present value restriction:

$$\sum_{t=1}^{T}\beta^{t-1}u'\left(\hat{c}_t^*\left(y^T\right)\right)\psi_t^*\left(y^T\right)=\sum_{t=1}^{T}\beta^{t-1}u'\left(\hat{c}_t^*\left(y^T\right)\right)\left\{MPL_t^*y_t-\hat{c}_t^*\left(y^T\right)\right\} , \tag{38}$$

for all y^T in DOM_T. This present value formula uses the individual's own shadow interest rate that is evaluated at the socially optimal c^*. RHS of (38) describes the present value of the difference between labour income and consumption. The difference depends only on the optimal quantities of (c^*, y^*). LHS of (38) describes the present value of labour income taxes collected. The equation looks similar to the static case, but now the notation is in present value terms: the gap between income and consumption in the optimal allocation is equal to labour income taxes for every y^T in DOM_T.

However, this present value restriction gives little information about the timing of tax collections. In fact, there is a large set of labour income tax schedules and individual capital-holdings (ψ^*, k') such that $(c^*, y^*, k') \in EQM_{NL}(\tau, G)$. Hence it is possible to construct tax schedules with different parameters that satisfy the present value restriction. One only needs to ensure that the present value of the tax burden for each possible income sequence is kept the same. It is only the equilibrium individual-capital holdings that may change. Thus, even though taxes are distortionary, a given optimal allocation is consistent with various processes for government debt. Kocherlakota (2010) states that the main idea is that if taxes in a given period are allowed to be a function of past realizations of individual income, then it is possible to change the timing of tax collections in arbitrary ways without affecting individual choices. Yet, in other words, while the present value of optimal labour income taxes is determined as a function of a person's labour income over his lifetime, the timing of the collection of these taxes (and government debt) is not determined.

The government can exploit this indeterminacy when deciding about the structure of labour income taxes. For instance, there is an optimal tax system in which the government uses a flat tax for labour earnings while people are working. Then, after retirement, people are given transfers that depend on their history of labour incomes. Kocherlakota states that all that matters from the point of view of incentives and insurance is the dependence of the present value of labour income taxes on the history of labour incomes.

1.2.3. Heterogenous-agents models and empirical questions

Of course, it is not possible to examine redistributive problems in the representative-agent macro model. As stated by Heer and Maussner (2009), the model that assumes the representative agent cannot give an answer to how, for instance, fiscal policy affects the distribution of income and wealth. Besides, it does not answer the question how income and wealth dispersions arise in the first place. Thus, to study the distributional issues, we need to use a heterogeneous-agents model.[10] This motivates the use of heterogeneous-agents models in the second and third essay of this dissertation.

Typical general equilibrium models with heterogeneous agents assume incomplete markets without aggregate shocks to the economy. The general equilibrium model structure allows us to jointly analyze aggregate and distributional issues. In a survey of heterogeneous-agents models Guvenen (2011) states that there are three key economic outcomes these kinds of models have been used to address: the cross-sectional distributions of consumption, earnings, and wealth. Next, I describe the basic framework used in the analysis of these issues; most of the presentation follows Guvenen (2011).

In an important benchmark model, Aiygari (1994) analyzed a version of the deterministic growth framework with a neoclassical production function and a large number of consumers (dynasties) that were assumed to live infinitely. The heterogeneity in the model comes from idiosyncratic shocks to labour productivity which are not directly insurable (via insurance contracts). Hence consumers are *ex ante* identical, but *ex post* heterogeneous due to these shocks. However, consumers accumulate a (conditionally) risk-free asset, capital, for self-insurance. They can also borrow in this asset subject to a certain limit. At each point in time, consumers may differ in the amount of accumulated wealth owing to the differences in productivity histories. Thus, the individual maximization problem looks like the following:

$$\begin{aligned} &\max_{\{c_t\}} E_0\left[\sum_{t=0}^{\infty} \delta^t U(c_t)\right] \\ &s.t.\ \ c_t + a_{t+1} = wl_t + (1+r)a_t \qquad (39) \\ &\qquad a_t \geq -B_{\min} \end{aligned}$$

[10] Nevertheless, the model with two types of households as in Coenen et al. (2008) can give some hints of the potential distributional effects.

and l_t follows a finite-state first-order Markov process. There are at least two ways in which to analyze this problem. Aiygari examined a production economy in which the single asset was the capital in the firm, which has a positive net supply. Hence, in this economy aggregate production is determined by the savings of individuals, and both w and r need to be solved in the general equilibrium. On the other hand, in another seminal study, Huggett (1993) assumed that the single asset was a household bond with zero net supply. In this case, the only aggregate variable to be determined is r, while the aggregate production of the economy is exogenous.

The borrowing limit $B_{\min}$ is defined as the loosest possible constraint consistent with a certain repayment of debt: $B_{\min} = wl_{\min} / r$. This can also be seen as a "natural limit"; note that if $l_{\min}$ is set to zero, the natural limit will be zero. In some studies this feature is used to rule out borrowing (see e.g. Carroll (1997)). Alternatively, one can set some ad hoc limit that is stricter than the natural one.

The main finding in Aiyagari (1994) is that with incomplete markets, the aggregate capital stock of the economy is higher than it is with complete markets. This is due to the precautionary savings of households, who consider the idiosyncratic shocks to labour productivity.[11] This also implies that the interest rate must be lower than the time preference rate. This result is also true with Hugget's (1993) economy. The low interest rate can also be associated with the equity premium puzzle, and the finding initially led economists to think that these models could help to understand this puzzle. However, it was subsequently shown that the environment is neither necessary nor sufficient to generate a low interest rate. Another important contribution in Aiyagari is that the model-produced ranking of different types of inequality fits the observations in data: wealth is more dispersed than income, which is more dispersed than consumption.

The models by Aiyagari and Hugget contain the essential structure of a canonical general equilibrium incomplete markets model. However, their work has been followed by a line of studies that have extended the

[11] The role of precautionary savings is profoundly discussed in Carrol (1997). The paper makes the argument that the model with buffer-stock saving behaviour of households fits the essential facts about the behaviour of typical household consumption, income, and wealth better than the standard models typically used to analyze these issues.

framework with the ingredients that are needed for more serious empirical work. Guvenen (2011) lists three main issues that the recent studies have focused on: the nature of idiosyncratic risk, the treatment of borrowing constraint, and the household structure as a source of heterogeneity. The nature of idiosyncratic risk, especially, has intensively been analyzed in the literature while it is often crucial for the implications generated by the model.

Nonetheless, despite many papers about the topic, there is no consensus on the nature of idiosyncratic risk. An important question concerns the persistence of idiosyncratic shocks. While the early papers in the 1970s and 1980s found that individuals were subject to shocks with modest persistence, subsequent papers found just the opposite. However, recent studies, e.g. the study by Guvenen (2009), confirm the old result that shocks have rather low persistence.

As already noted, the studies made with heterogeneous-agents models have concentrated on analyzing the dispersion in consumption, earnings, and wealth. The Aiyagari model – as well as the Krusell-Smith (1998) model, which is augmented with aggregate shocks – assumes that the earnings distribution is exogenous and makes predictions about inequality in household consumption and wealth. While there is literature that follows this assumption, some studies have introduced an endogenous labour supply choice with an assumption that the wage process is exogenous. Thus, in these studies, earnings dispersion is an endogenous outcome of the model. Yet other strand of literature has written models in which wage distribution is also an endogenous outcome of the model.

According to Guvenen (2011), the literature has focused on two different dimensions in consumption inequality. First, it has been asked how much within-cohort consumption inequality increases over the lifecycle. The second dimension concerns how much consumption inequality has risen in the United States since the 1970s. The question was raised since there was a substantial rise in wage inequality at the same time. When it comes to wealth inequality, the main issue has been a cross-sectional one, namely what the reason is for enormous disparities in wealth. In the U.S., for instance, the Gini coefficient for wealth is approximately 0.80.[12] Studies

[12] In Finland, where there are fewer income disparities, the Gini for wealth is less than 0.6.

have developed several models that can generate highly skewed wealth distributions and are then able to produce the Gini coefficients at the same magnitude (see, for instance, Krusell and Smith (1998) and Castaneda et al. (2003)). These models typically use some of the following mechanisms to produce this inequality: 1) dispersion in luck as a consequence of large and persistent shocks to labour productivity (the rich are luckier than the poor); 2) Dispersion in patience (the rich save more than the poor); 3) dispersion in rates of return (the rich gain higher asset returns than the poor).

Virtually every heterogeneous-agents model has implications for consumption and wealth inequality, since a consumption-saving decision is at the core of the incomplete markets model. However, while it is usually assumed that labour supply is inelastic and that the stochastic process for wages is exogenous, these models cannot say anything about the inequality in earnings. Hence to analyze earnings inequality, the labour supply decision must also be endogenized. This has been done, for instance, in Pijoan-Mas(2006), Heathcote et al. (2008), Castaneda et al.(2003) and Heer and Trede (2003). In the second and the third essay of this dissertation, I also aim at contributing to this literature. Still, in order to analyze wage inequality in addition to earnings inequality, the wage process also needs to be endogenized. This further enriches the dynamics of earnings distribution. Nevertheless, despite many studies there is still controversy about what drives inequality in wages. Guvenen (2011) summarizes the previous studies on the topic and states that an important question is whether the variance of idiosyncratic income shocks in the U.S. has increased or not.

In heterogeneous-agents models, one also needs to consider the role of mobility. Heer and Maussner (2009) discuss how it affects the redistribution provided by different economic policies. In their analysis, households move up and down between different earnings and wealth groups. As already stated, this may happen simply due to bad luck (an accident, divorce etc.) or other unanticipated reason. Therefore, a redistribution of income may have multiple effects. An increase in income taxes, for instance, helps to finance a rise in unemployment compensations and redistributes income from the rich to the poor. While utility is a concave function of consumption, this may increase welfare. However, higher income taxes reduce incentives to supply labour and to accumulate savings. As a result, the increased distortions lead to a decrease in total income and welfare. Thus, redistribution comes at the expense of efficiency.

If we also think of income mobility, the welfare effects of such a policy become even more relevant. The reason for this is simple: the poor may move up in the income hierarchy and will then also be harmed by tax increases and a reduction in economic efficiency in the future. To sum up, when one analyzes the redistributive effects of an economic policy using the heterogeneous-agents model, mobility is a crucial ingredient in the model.

One of the influential papers in the literature of heterogeneous-agents models is Krusell and Smith (1998). They added two elements to the basic Aiyagari model. First, they introduced aggregate technology shocks, which is the most important contribution of their paper. Also, they made the assumption that the cumulative discount factor follows a stochastic process $\delta_t = \tilde{\delta}\delta_{t-1}$ where $\tilde{\delta}$ is a finite-state Markov chain. In their model $\tilde{\delta}$ is calibrated so that the average duration of any particular value of the discount factor equals the lifetime of a generation. A key equilibrium object in their model is the law of motion: when forecasting future prices, consumers must forecast only a small set of statistics of the wealth distribution rather than the entire distribution itself. This feature is crucial while it makes it possible to use numerical methods to analyze this class of models.

With only a very few exceptions, there is no analytical solution for dynamic heterogeneous-agents general equilibrium models; neither is it possible to derive analytical results for them. It is only recently that algorithms to solve heterogeneous-agents models with an endogenous distribution have been introduced into the economic literature. Heer and Maussner (2009) discuss the computation of the solution for a standard heterogeneous-agents model and state that it basically consists of two steps: the computation of the policy function(s) and the computation of the invariant distribution. The individual policy functions are solved using numerical methods, for instance projection methods. The second step is the one that differentiates the heterogeneous-agents models from representative-agent models. Also, there are three different kinds of methods to compute the invariant distribution. First, it is possible to compute the distribution function on a discrete number of grid points over the assets. Second, one can use Monte-Carlo simulations by constructing a sample of households and tracking them over time. Third, one can assume a specific functional form of the distribution function and use iterative methods to compute the approximation. In the second and third articles of this dissertation, i.e. in the articles of the dissertation that are based on model with heterogeneous agents, I use the first method.

References

Aiyagari, S. R. (1994): Uninsured Idiosyncratic Risk and Aggregate Saving. *The Quarterly Journal of Economics*, Vol. 109, 659-84.

Atkinson, A. B. and Stiglitz, J. E. (1976): The Design of Tax Structure: Direct versus Indirect Taxation. *Journal of Public Economics*, 6 (1976), 55-75.

Auerbach, A. J. and Kotlikoff, L. J. (1987): *Dynamic Fiscal Policy*. Cambridge University Press, Cambridge, UK.

Carroll, C. D. (1997): Buffer-Stock Saving and the Life Cycle/Permanent Income Hypothesis. *The Quarterly Journal of Economics*, 112 (1), 1–55.

Castañeda, A., Díaz-Giménez, J. and Ríos-Rull, J.-V. (2003): Accounting for the U.S. earnings and wealth inequality. *Journal of Political Economy*, Vol. 111, 818–857.

Chari, V. V. and Kehoe, P. J. (1999): Optimal fiscal and monetary policy. In Taylor, John B. and Michael Woodford (Eds.). *Handbook of Macroeconomics,* Vol. 1C. Amsterdam, North-Holland.

Coenen, G., McAdam, P. & Straub, R. (2008): Tax Reform and Labour-Market Performance in the Euro Area: A Simulation-Based Analysis Using the New Area-Wide Model. *Journal of Economic Dynamics and Control*, 32(8), 2543-2583.

Coleman, W. J. (2000): Welfare and optimum dynamic taxation of consumption and income. *Journal of Public Economics,* 76, 1–39.

Diamond, P. (1998): Optimal income taxation: An example with a U-shaped pattern of optimal marginal tax rates. *American Economic Review,* 88, 83-95.

Guvenen, F. (2009): An Empirical Investigation of Labor Income Processes. *Review of Economic Dynamics,* 12 (1), 58–79.

Guvenen, F. (2011): Macroeconomics with Heterogeneity: A Practical Guide. *Federal Reserve Bank of Richmond's Economic Quarterly*, Vol. 97, No. 3, pp. 255-326.

Hamermesh, D. (1993): *Labour Demand*. Princeton University Press.

Heathcote, J. and Violante, G. L. (2008): The Macroeconomic Implications of Rising Wage Inequality in the United States. *NBER Working Papers,* 14052, June 2008.

Heer, B. and Maussner, A. (2009): *Dynamic General Equilibrium Modeling. Computational Methods and Applications*. Springer-Verlag Berlin Heidelberg. 2nd Edition.

Heer, B. and Trede, M. (2003): Efficiency and Distribution Effects of a Revenue-neutral Income Tax Reform. *Journal of Macroeconomics*, 25, 87-107.

Huggett, M. (1993): The Risk-Free Rate in Heterogeneous-Agent Incomplete-Insurance Economies. *Journal of Economic Dynamics and Control*, 17, 953–969.

Kaplow, L. (2008): *The Theory of Taxation and Public Economics*. Princeton University Press, Princeton and Oxford.

Kilponen, J. & Vilmunen, J. (2007): Revenue neutral shifts in the tax structure: experiments with a dynamic general equilibrium model. *Bank of Finland Bulletin*, 1/2007.

Kocherlakota, N. R. (2010): *The New Dynamic Public Finance.* Princeton University Press.

Koskela, E. (2001): Labour taxation and employment in trade union models: A partial survey. *Bank of Finland discussion papers*, 19/2001.

Krusell, P. and Smith, A. A. (1998): Income and Wealth Heterogeneity in the Macroeconomy. *Journal of Political Economy*, 106 (5), 867–896.

Kydland, F. E. and Prescott, E. C. (1982): Time to build and aggregate fluctuations. *Econometrica,* 50, 1345-70

Long, J. B. and Plosser, C. I. (1983): Real business cycles. *Journal of Political Economy,* 91, 31-69.

Lucas, R. E. (1975): An equilibrium model of the business cycle. *Journal of Political Economy,* 83, 1113-44.

Mirrlees, J. (1971): An exploration in the theory of optimal income taxation. *Review of Economic Studies,* 38, 175-208.

Nickell, S. (2004): Employment and Taxes. *CEP Discussion Paper,* No. 634.

Pijoan-Mas, J. (2006): Precautionary savings or working longer hours? *Review of Economic Dynamics*, 9, 326-352.

Piketty, T. (1997): La redistribution fiscale face au chômage. *Revue Française d'Économie*, Programme National Persée, Vol. 12(1), 157-201.

Ramsey, F. P. (1927): A contribution to the theory of taxation. *Economic Journal,* 37, 47-61.

Saez, E. (2001): Using Elasticities to Derive Optimal Income Tax Rates. *Review of Economic Studies*, 68, 205-229.

Salanié, B. (2003): *The Economics of Taxation*. The MIT Press, Cambridge, Massachusetts.

Wickens, M. (2008): *Macroeconomic Theory. A Dynamic General Equilibrium Approach*. Princeton University Press, Princeton, New Jersey.

2. A summary for the essays

A Labour taxation and employment: An analysis with a macroeconomic model for the Finnish economy

Summary

Until recently, the government of Finland has made major reforms in the income taxes schedule. The income taxes of an average productive worker have decreased by nearly 8 percent since 1997. One of the main arguments for the tax reductions has been to improve employment in Finland. However, there are practically no empirical Finnish study for the subject that captures all the dynamic effects – both demand and supply side – of the tax cuts.

Internationally, the effect of taxes on employment has been examined in several studies. A large number of international studies on the subject have been done with panel data. Nickell (2004) summarizes the results

from different studies and argues that a 10 percentage point rise in the tax wedge reduces labour input by approximately 2 per cent. In Finland, the impact of taxes on employment has typically been examined in times series and labour supply studies. For instance Honkapohja, Koskela and Uusitalo (1999) explain wages by a so-called trade union model that is estimated for each sector separately. Sinko (2002) exploits their estimates and calculates that the tax cuts made from 1997 onwards explain 10% of the employment growth in the Finnish economy in the period 1997-2002.

In a study done with DSGE macro model Coenen et al. (2008) find that lowering European taxes to the levels prevailing in the U.S. has a clearly positive effect on economic performance. Kilponen & Vilmunen (2007) use the same methods but consider the Finnish case. They examine the effect of budget-neutral value-added tax increases with the Bank of Finland's DSGE macro model (AINO). The study finds that one percentage point increase in value-added tax rate that is neutralized for the government budget by decreasing income taxes raises the output more than 0.5 per cent and employment 0.25 per cent in the long run.

In this study the effect of taxes on employment is examined, using the empirical macroeconomic model (EMMA) developed at the Labour Institute for Economic Research. EMMA is a quarterly model that describes the Finnish economy. The model is Keynesian (output is determined by aggregate demand) in the short run, but neoclassical (output is determined by aggregate supply) in the long run. The parameters of the model are estimated from quarterly data that cover the years 1990-2007. The model also contains a Kalman-filtered technological trend variable to control the deep depression in Finland at the beginning of the '90s. This special feature brings the model closer to the new calibrated models. The model is however backward-looking in the sense that it uses historical data.

The model has 77 endogenous and 72 exogenous variables. The core of the model consists of behavioural equations, the number of which is 17. The public sector identities, in particular, enlarge the model. The level of aggregation in the model structure is simple: the economy consists of the private and public sector. The production function is modelled with the standard Cobb-Douglas function. The model also includes the output gap, which is based on the NAIRU rate. The NAIRU rate is formed using data on long-term unemployment. The model equations are estimated with OLS (ordinary least squares). The long-run equilibrium relationships and short-term dynamic corrections of the behavioural equations are estimated using an error correction model (ECM) framework; these are based on the two-stage Engle-Granger (1987) method.

The Keynesian features of the model allow us to study the effects of tax cuts both with and without fiscal policy rules. In other words, the tax cuts are financed either by decreasing government spending or simply increasing government deficit. The possibility to solve the model without closing the government budget constraint, i.e. with an assumption that the government debt is freely determined, is one feature that separates this in some sense traditional model from typical DSGE models. Also, the fiscal policy rule may be bound either to taxes or government spending. All these features together with the detailed description of the public sector make it possible to analyze many different types of fiscal policy shocks.

The main findings of the study are the following. First, a one percentage point decrease in the income tax rate which is financed by increasing government debt improves GDP by 0.58 and employment by 0.25 per cent in the long run. Also, a one percentage point decrease in the income tax rate which is neutralized for the government budget by reducing public purchases produces a long-run increase in GDP and employment of a similar magnitude, even though its short-run effect on both variables is negative. The long-run positive effect is due to the smaller pressures on wages negotiated by the trade unions and increased labour supply. Also, the effects of a reduction in public purchases weaken in the long run when the economy converges to its steady-state path. The results remain consistent if the fiscal policy rule is bound to the income tax rates and public spending is instead shocked. Finally, an experiment with the structure of taxation gives us a long-run zero result for the effects of changing taxation towards higher taxes on consumption but lower on labour.

B Labour or consumption taxes? An application with a dynamic general equilibrium model with heterogeneous agents

Summary

Many western governments are raising consumption taxes while trying to avoid higher labour taxes at the same time. The tendency is actually to lower labour taxes if the government's fiscal situation allows it. Also the Finnish government has many times highlighted the urgent need for this kind of tax reform, i.e. the reform that raises consumption taxes but decreases labour taxes. In addition to a change in the source of taxation, this kind of tax policy switch also contains another aspect: replacing a progressive tax with a flat tax.

Regardless of many theoretical articles comparing labour and consumption taxes, studies with a more empirical approach are harder to find. Nishiyama and Smetters (2005) study a reform for the U.S. economy in which a progressive income tax is replaced by a flat consumption tax using overlapping-generations model with idiosyncratic wage shocks and longevity uncertainty. They find that the efficiency effects of the tax reform crucially depend on the insurability of the wage shocks. In a pure empirical study based on the cross sectional data of 22 OECD countries Kneller et al. (1999) find that by raising consumption taxes and declining labour and other distortionary taxes, considerable efficiency gains would be reached. While we have some international evidence about the effects of tax reforms, there are almost no empirical macro studies of the tax structure changes that use Finnish data. Only Kilponen and Vilmunen (2007) make an exception for this. They find that changing taxation towards higher taxes on consumption but lower on labour produces a significantly positive employment and GDP effect. However, their results are sensitive to the model assumptions. Also, we still know almost nothing about the distributional effects of the reform.

To understand the effects of labour and consumption taxes, I begin by discussing the theoretical aspects of direct and indirect taxation. This part is mostly based on summarizing the results presented in Salanie (2003) and Coleman (2000). Also the issue of flattening progressive taxes is briefly

discussed. Then, in order to assess the effects of consumption and labour taxes quantitatively, I build a general equilibrium model with heterogeneous agents and compare three fiscal regimes: i) progressive labour taxes that correspond to the Finnish system, ii) flat-rate labour tax, iii) only a consumption tax. In the model agents differ with regard to their productivity and employment status which are subject to idiosyncratic shocks. Hence agents are mobile and their productivity and employment status may change between periods. In fact, the model utilizes the aspects of the framework presented in Heer and Trede (2003) and Heer and Maussner (2009).

Still, the model presented has also many unique characteristics. Unlike the previous studies in which income taxes are levied similarly on capital and labour, my framework is the Finnish dual income tax system that treats capital and labour income separately. This allows me to focus purely on the comparison of labour taxes and consumption taxes. Also, I change the theoretical assumptions concerning the risk of unemployment and calibrate the model to fit the stylized facts of the Finnish economy.

The simulations show that flattening labour taxes leads to an economy with some degree larger capital stock, negligibly more employment but slightly more inequality. The main results concern the tax policy reform that replaces progressive labour taxes with a proportional consumption tax. This reform results in a significant rise in capital accumulation, a negligible change in labour supply and gross labour income distribution, but a relatively considerable increase in wealth concentration. To summarize, the tax system that replaces labour taxes with consumption taxes produces a more capital intensive economy with somewhat more wealth inequality.

In order to understand why equivalence between consumption and labour taxes breaks in the model simulations, I also simulated the model with an assumption that the model agents are homogeneous, i.e. I reverted the model to the standard representative agent case. As a result, changing the tax regime produces only a minor increase in aggregate capital and employment. Thus, it is possible to conclude that the main reason for non-equivalence between consumption and labour taxes is the heterogeneity assumption.

The model results are not sensitive to different parameterization, but there are however reasons why the results should be interpreted carefully. First, the study analyzes labour supply only along the intensive margin, i.e. how many labour hours agents choose to work. Also, from empirical point of view, one has to remember that the model economy only consists of labour supplying agents: pensioners and students are not taken into account in this paper. Despite these reservations, the results prove that replacing labour taxes with consumption taxes only slightly improves employment, and even if the reform increases capital accumulation significantly, it contributes negatively on wealth inequality.

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

Summary

Labour income taxes have decreased considerably in Finland in the period 1996-2008. Also the progressiveness of the tax system has changed. 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. 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. This can be seen by looking at the Gini coefficient for household disposable income which has risen from 22.3 to 26.8 between 1996 and 2008. At the same time there is no trend in the Gini coefficient for factor income which represents the market income before taxes and government transfers. Thus, the policy decisions have played an important role on the development.

In this study I examine the role of labour income tax changes on this development. More explicitly, I aim to answer how much labour income tax reductions between 1996 and 2008 have contributed to the rise in inequality in Finland. In this context, changes both in income and wealth distribution are analyzed. The study also examines how much more employment has been attained due to the labour tax reforms, since this was after all the main aim of the Finnish government when lowering taxes.

To answer these questions, I build a dynamic general equilibrium model with heterogeneous agents. 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 build up on the seminal work done by Aiyagari (1994), but the model used here is more closely related to the model presented in Heer and Trede (2003) and Heer and Maussner (2009). As a consequence, the model bears many similarities to the model used in the second article of this dissertation. However, contrary to the previous studies, this study analyzes only particular changes in the level and progressivity of labour taxes. Hence I carefully incorporate the Finnish labour income tax codes of 2008 and 1996 into the model. The model is calibrated to fit the Finnish economy, particularly the Finnish labour markets. This has been done using both micro and macro data.

In addition to the analysis of distributional and employment effects, I also analyze the tax changes' effect on capital stock and output. Also, the study examines how different types of agents have responded to the labour tax changes. Finally, the robustness of the model results is examined by changing the labour supply elasticity with respect to wage rate and the elasticity of substitution.

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 labour hours during this period. Also the capital stock has increased as a result of the tax reductions, and this together with employment change 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; in fact, the labour supply effect increases with productivity. However the differences between productivity groups are small enough to produce only a minor change in the Gini coefficient for gross labour income. The employment effect, and to a modest degree also the distribution effect, is contingent on using labour supply elasticity found in typical micro studies. Also, when interpreting the results one should keep in mind that the model agents adjust their labour supply only along the intensive margin.

The main result from the study is that as a result of the labour income tax cuts, the Gini coefficient for net labour income (including also unemployment compensations) has increased by 1.8 percentage points. Also, the reforms have increased the Gini coefficient for wealth by 0.9 percentage points. This way the labour tax cuts are partly responsible for rising inequality in Finland. The results also implicate that there has been a shift towards a less progressive labour tax system after 1996. Nevertheless, the distributional changes are moderate, and hence one could also conclude that the labour tax cuts may not have been the main driver of rising inequality.

II Essay I:

Labour taxation and employment: An analysis with a macroeconomic model for the Finnish economy*

Abstract

In this study, we examine the effect of labour taxation on employment and growth. We also analyze the effect of other fiscal policy instruments, e.g. the effect of public spending. In this context, our special interest is in the fiscal policy simulations that are neutralized for the government budget. The analysis will be performed with a macroeconomic model (EMMA) developed at the Labour Institute for Economic Research. The study finds that a one percentage point decrease in the income tax rate which is financed by increasing government debt improves GDP by 0.58 and employment by 0.25 per cent in the long run. Also, a one percentage point decrease in the income tax rate which is neutralized for the government budget by reducing public purchases produces a long-run increase in GDP and employment of a similar magnitude, even though its short-run effect on both variables is negative.

Keywords: labour taxation, macro models, fiscal policy.

---

* This paper is published as a Labour Institute for Economic Reseach's working paper. The paper is based on the Licentiate's Thesis approved at the University of Turku in 2009. The model used in the simulations is published in Lehmus, M. (2009): Empirical Macroeconomic Model of the Finnish Economy (EMMA), *Economic Modelling*, Volume 26, Issue 5, September, 926–933. In addition to my supervisor Professor Matti Virén, I would like to thank Eero Lehto and Jukka Pirttilä for their helpful comments. Financial support from the Yrjö Jahnsson Foundation and Employee's Foundation is gratefully acknowledged. Paul A. Dillingham has kindly checked the language.

1. Introduction

The government of Finland has gradually reduced the income tax level from the year 1997 until recently. During this period the income taxes of an average production worker have declined by nearly 8 percentage points. Since short-term tightening at the beginning of the 1990s, the employers' contribution rate to social security has also been reduced by the government. These reforms have produced a major decrease in the level of the tax wedge. One of the main arguments for the tax reductions has been to improve employment in Finland. However, there are practically no empirical Finnish studies for the subject that captures all the dynamic effects – both demand and supply side – of the tax cuts.

In this study for the Finnish economy, we aim to answer the question as to what degree tax reductions improve employment and economic growth. We also analyze the effects of other fiscal policy instruments, e.g. the effects of public spending. The analysis will be performed with the empirical macroeconomic model (EMMA) developed at the Labour Institute of Economic Research. EMMA is a quarterly model for the Finnish economy, which is based on Keynesian behaviour (output determined by aggregate demand) in the short run, but neoclassical (output determined by aggregate supply) in the long run. A substantial feature of the model is that it includes a relatively detailed description of the public sector. The parameters of the model are mostly estimated from data.

The effects of income tax reductions are first compared with those of simply increasing public purchases or working hours. Hence in these simulations fiscal policy changes are financed by increasing government debt. Yet another issue relating to our topic is how to balance the government budget. Thus, in our study, we especially examine budget-neutral changes in labour taxation and public expenditures (namely purchases and working hours). We also do an experiment by changing the structure of taxation. Again, the change in the tax structure is neutralized for the government budget. Finally, we do a sensitivity analysis for the parameter elasticities of the labour demand and wage formation.

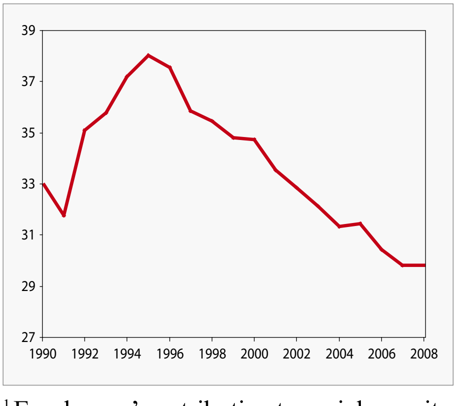
The paper is organized as follows. Section 2 summarizes the empirical evidence from both domestic and international studies with an emphasis on the former. Section 3 presents the structure of our macro model used in the analysis. Section 4 peruses the results gained in this study, and compares the effects of various fiscal policy changes and discusses them. The final section concludes.

2. Labour taxation and employment

2.1. Overview

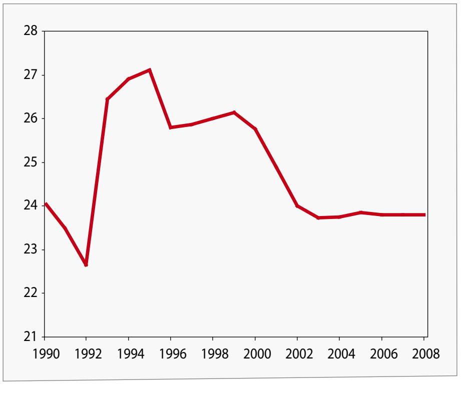
Traditionally, Finland has been among the countries where labour is taxed relatively heavily. However, the government of Finland has gradually reduced the average labour tax rates from the year 1997 until recently. During this period the taxes of an average production worker have declined by nearly 8 percentage points. Since short-term tightening at the beginning of the 1990s, the employers' contribution rate to social security has also been reduced by the government. One of the main arguments for these tax reductions has been to improve employment in Finland.

Figure 1. Income tax rate (%) of an average production worker.[1]



[1] Employees' contribution to social security included.
Source: VATT.

Figure 2. Employers' contribution rate (%) to social security.



Source: VATT.

At the same period, the Finnish economy first confronted a deep depression at the beginning of the 1990s. Since then, the economy has recovered rapidly when the old structures have given room to the new branches of industries. At this period, unemployment first rose from 3% up to 17 % but then has decreased below the average European level. Hence in Finland we can see gradual reductions in the tax wedge and rapid economic growth at the same time.

Figure 3. Employment (1000 persons).

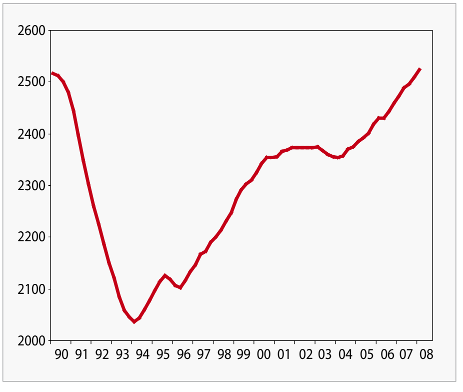
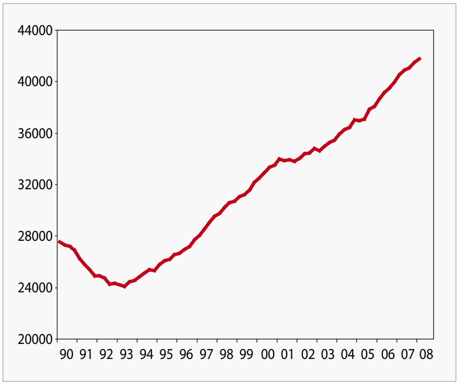


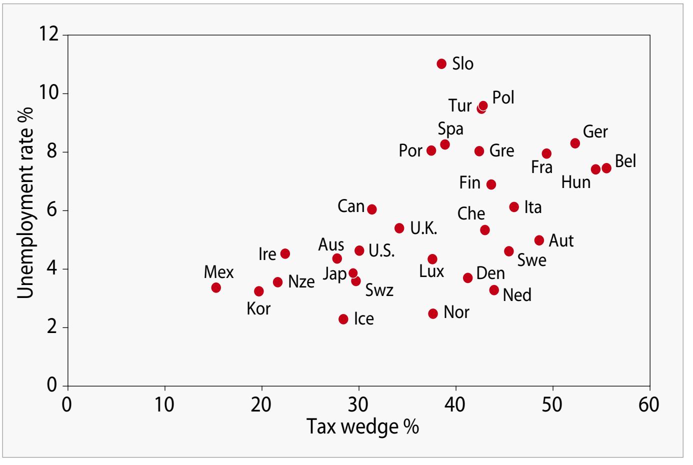
Figure 4. GDP (quarterly, 2005 prices).



In general, we know that there are huge differences in unemployment and labour taxation levels between OECD countries. This can be verified from the following figure, which shows a country's unemployment rate and tax wedge.[13]

[13] Tax wedge = employer's contribution rate + income tax rate of an average production worker. More or less broader definitions for the tax wedge may also be used; for instance, consumption taxes are sometimes included in the wedge.

Figure 5. Unemployment and tax wedge in OECD countries.



Source: OECD database.

Some economists, for instance Prescott (2004), argue that the main reason for high unemployment in Europe is the distortive effects caused by the high tax level. On the basis of the figure(s) 1-5, Prescott's point appears attractive. However, it is more sensible to explain the improvement in Finnish employment by the good international economic trends and some kind of creative destruction caused by the recession. Also, when scrutinizing figure 5 more carefully, one observes countries like Denmark and the Netherlands that have high taxes but low unemployment. The next chapter gives a survey of the empirical evidence of the impacts of the tax cuts. The stress is on the studies for the Finnish economy.

2.2. Empirical evidence

The impact of taxes on employment has been examined in several studies. A large number of international studies about the subject have been done with panel data. The basic idea in these studies is to explain the changes in employment and unemployment by the changes in the tax level. Recent studies have discovered that taxes have an effect on employment in the long run. Nickell (2004) summarizes the results from different studies and argues that a 10 percentage point rise in the tax wedge reduces labour input by somewhere between 1 and 3 per cent. An average point estimate such as 2 per cent is relatively small but by no means insignificant. However, this is no consensus result, and, for instance, Nickell himself (2004) stresses the short-run effects of the tax cuts. Also, one has to remember that considerable differences as regards the level or the structure of taxation make the comparison between countries complicated.

Another outcome from international research is that taxes affect employment more in continental Europe where trade unions are strong but wages are negotiated independently. In these countries, trade unions are able to push taxes into wages. Instead, research finds that taxes affect employment modestly in countries like Finland where wages are negotiated co-ordinately between trade unions and employers' organizations (Koskela, Pirttilä, Uusitalo 2004.).

In Finland, the impact of taxes on employment has typically been examined in times series and labour supply studies. One of the recent time series studies is Honkapohja, Koskela and Uusitalo (1999). In this study the wages are explained by a so-called trade union model estimated for each sector separately. Sinko (2002) exploits the estimates of Honkapohja et al. (1999), and calculates that the tax cuts made from 1997 onwards explain 10% of the employment growth in the Finnish economy in the period 1997-2002. Laine & Uusitalo (2001) concentrate on labour supply in their study. In this study, the effect of incentive reforms on labour supply and the benefits from working are examined. The results are that the effects of incentive reforms are small but distinctly positive.

To capture the dynamic effects of tax cuts, Alho, Kaitila & Kotilainen (2006) construct a computable general equilibrium model of the Finnish labour markets and the economy. The results of the study show that tax policies alone are not a sufficient way to enhance employment because the expansionary and contractionary effects of average tax reductions often neutralize each other. However, in this study, tax cuts do not affect the demand side of the economy.

Kilponen & Vilmunen (2007) examine the effect of budget-neutral income tax cuts with the Bank of Finland's dynamic general equilibrium macro model (AINO). In their study, the income tax cuts are financed by a rise in the value-added tax rate. They find that one percentage point increase in the value-added tax rate raises the output more than 0.5 per cent and employment 0.25 per cent in the long run. They also find that income transfer compensated increase in the value added tax rate decreases output and employment in the long run. In Kilponen & Vilmunen (2007) income tax changes mainly have an effect via labour supply. This is due to the theory-based DSGE model they use.[14]

Although they do not concern Finland, some recent studies are worth mentioning from the point of view of our analysis. Coenen & McAdam (2008) use a dynamic equililibrium macro model (NAWM) to examine the effects of reducing labour-market distortions caused by tax structures in the Euro area. They find that lowering tax wedges in the Euro area to levels prevaling in the United States would lead to a rise in hours worked and output by more than 10 per cent in the long run. Blanchard & Perotti (2002) use a mixed structural VAR/event study approach to characterize the dynamic effects of shocks in government spending and taxes in the United States in the post war period. The study finds that in most cases the (Keynesian) multipliers are small, often close to one. Romer & Romer (2007) use the narrative record to identify the size, timing, and principal motivation for all major postwar tax policy actions. They find that the effects of tax changes are strongly significant, highly robust, and much larger than those obtained using broader measures of tax changes.[15]

Sinko (2002) states that in order to get reliable estimates of the effects of tax cuts in Finland, a large econometric framework that includes the essential causalities should be used. Also, Böckerman & Jäntti (2004) argue that is a mistake to focus the discussion that addresses employment policies on only labour supply. In their study they examine the role of supply and demand factors in individual-level hours of work, using panel data on workers in Finnish manufacturing industries from 1989 to 1995. The result of their study is that demand really matters. They argue that empirical results that

[14] See also Kilponen & Ripatti (2006).

[15] The Joint Committee of Taxation (2006) reports the work they have done to build a macroeconomic model best suitable for the purpose of analyzing tax-level changes. Finally, they estimate the effects of tax reforms with both the standard neoclassical macroeconomic model and the computable equilibrium model. When the simulations are made with the former, in the long run, the amount of growth predicted by a tax cut is crucially dependent on whether the tax cut is debt-financed, or financed by a cut in spending or a future increase in taxes.

neglect variations in labour demand may give biased estimates of the labour supply response to tax reforms. The motivation for our study comes from these arguments: we use a macroecometric model to capture all the dynamic effects of the tax cuts, and, also, our model captures both the demand and the supply-side effects of the tax changes.

3. The methods

3.1. One-equation models vs. macro models

The effect of taxes on employment is examined in most studies in the framework of a one- or two-equation model. For instance, Prescott (2004) captures the effects of taxes on employment by calibrating the parameter values in the labour supply equation derived from the household maximization problem, and then uses it to generate labour supply for seven OECD countries, whereas in a basic time series study Honkapohja, Koskela and Uusitalo (1999) scrutinize the effects of tax cuts on the basis of two equations. First, they express the wage formulation by the following function:

$$w = g(p, q, b, 1-t, 1+s, u) \ , \tag{1}$$

where p is the consumption prices, q is the producer prices, b is the outside option of the unemployed, t and s are tax parameters for employee and employer, and u is unemployment. In the same way, labour demand is a function:

$$L = h\left(\frac{w(1+s)}{q}, \frac{r}{q}, z\right) \ , \tag{2}$$

where z is the exogenous demand variable that is independent of prices, and r symbolizes interest rates. Honkapohja et al. (1999) estimate equations (1) and (2) in a dynamic form for ten sectors of the economy. After one knows the elasticity parameters in these two equations, the effect of the tax change on employment can easily be calculated.

Coenen & Adam (2008) criticize Prescott's approach by stating that it "neglects the intertemporal aspects associated with capital accumulation, the acquisition of foreign assets and the presence of nominal and real rigidities. It also disregards the effects of changes in both domestic and international relative prices. As a result, it ignores several important margins and does not provide insights into the transitional dynamics triggered by reductions in the tax wedge. Moreover, it neglects other important factors that influence labour-market outcomes in reality such as distortions arising from monopolistic competition and other institutional factors that would increase the real wage above the competitive level".

As well as Coenen & Adam (2008), we study the effect of taxes on employment, using a macro-economic model. Unlike the one- or two-equation approaches just described, macromodels try to capture the whole functions of the economy. However, unlike Coenen & Adam, our study uses a macroeconometric model, not a microtheory-based DSGE macromodel. The following section reports the structure of our macromodel. The first-version of the model was also reported in Lehmus (2009), and the next chapter follows the analysis presented there.[16] Because of our topic, extra attention is paid to explain how tax parameters are introduced in the model system.

3.2. The model

The basis of our model structure is Keynesian, although the treatment of the supply side and prices is based on neoclassical economic theory. For this reason the model can be seen to follow the standard routes of neoclassical synthesis. The model is backward-looking in the sense that it uses historical data. The parameters of the equations are mostly estimated.

The model consists of 77 endogenous and 72 exogenous variables. In the core are behavioural equations, the number of which is 17. The public sector identities, in particular, enlarge the model. The level of aggregation in the model structure corresponds to many recently built macromodels: the

[16] Lehmus (2009) also reports the full details and equations of the (EMMA) macro model. See also Lehmus (2007).

economy consists of two blocks, the private and public sector. The equations of the model can be divided into four blocks: production function and factor demand equations, aggregate demand equations, price and wage equations, and public sector identities. The production function is modelled with the conventional Cobb-Douglas function. The model also includes the output gap, which is based on the NAIRU rate. The NAIRU rate is assumed to depend on long-term unemployment.

The model equations are estimated with OLS (ordinary least squares). The long-run equilibrium relationships and short-term dynamic corrections of the behavioural equations are estimated using an error correction model (ECM) framework. From the point of view of time-series analysis, these correspond to the two-stage Engle-Granger (1987) method.

The most demanding part in modelling the Finnish economy in the period 1990-2007 is the deep recession in the years 1991-1994. Owing to the recession, it is difficult to get reasonable estimates for the coefficients of the equations. To solve this problem, we use the Kalman filter to estimate a time-varying parameter included in the scale of the production function. This parameter is used later on as a ”recession dummy” variable in many model equations. In this way the shock caused by the recession is controlled. The solution can be regarded as an indispensable compromise to deal with one of the deepest recessions in western countries during modern times. Other methods, for instance the use of different dummies indicating structural change, would have probably led to impractical and complicated applications. This novel feature also brings this traditional model closer to the new, calibrated macromodels.

The relation of the tax wedge to all the model variables is carefully considered. The income tax rate, which is the main exogenous policy variable in the analysis, directly affects the standard private wage rate index, the households' disposable income, labour supply, and the public sector tax revenues. Thus, all its relevant effects are captured.

3.2.1. The data

The data of the macroeconomic model covers the years 1990-2007. We use quarterly data that is based mainly on the national accounts of Statistics Finland. Other data sources have been the Bank of Finland, VATT (the

Government Institute for Economic Research), Eurostat, and the World Bank. Eurostat and the World Bank have been used to collect the data from foreign countries; the money and interest rate series come from the Bank of Finland. The tax rate data is based on the calculations of VATT. The seasonally unadjusted series have been adjusted with the Tramo/Seats method.

The data not available quarterly but only yearly has been disaggregated with the help of relevant reference series. This has been done with the Ecotrim program developed in Eurostat. The model system operates in the Eviews environment but some calculations, mainly concerning the public sector and the foreign environment, have been done outside the actual model. These ”satellite calculations” are found in Excel. Chapters 3.2.3 and 3.2.5 will illustrate the public sector and foreign sector calculations further.

3.2.2. The production function and potential output

The problem regarding the optimal production function form is widely discussed in the literature. The familiar question is: Should it be the CES or the Cobb-Douglas function?[17] In our case, it turned out to be more convenient to operate with the Cobb-Douglas function. The Cobb-Douglas function is a special case of the CES function in which the elasticity of substitution between labour and capital is unity. It is assumed that the technical development is Hicks-Neutral and the returns to scale are constant. Nevertheless, the deep recession in Finland in the early years of the 1990s causes a fall in production and other volumes. To solve this problem, we estimate a time-varying parameter with the Kalman-Filter in the scale of the production function. In our production function this parameter indicates a negative technological shock. Later on, this parameter is used as a dummy in many model equations to control the deep recession.

The factor shares of the production function have been calibrated so that the share of labour is assumed to be 0.6 and that of capital 0.4.[18] The final form of the production function in our model is then:

---

[17] The explicit form of CD is $Q = A(L^b K^{1-b})$. CES is

$$Q = Ae^{\lambda t}\left[\left(\delta K^{\frac{\sigma-1}{\sigma}} + (1-\delta)L^{\frac{\sigma-1}{\sigma}}\right)\right]^{\frac{\sigma}{\sigma-1}}$$

[18] This is a standard assumption in economic theory.

$$VAQP = Ae^{GF^{*}t}\left((LHP)^{0.6}\,KP^{1-0.6}\right). \tag{3}$$

$VAQP$ is the volume of production in the private sector, LHP denotes private labour (in hours worked), and KP is the net capital stock of the private sector. A is a parameter of scale and t is a trend. GF is the Kalman-filtered coefficient of the trend. GF falls in the recession but is constant during the last years when it obtains the quarterly value of 0.006, which means 2.4% technical progress in a year.

When we consider the CES production function, the first-order conditions with respect to capital and labour lead to the following demand equations:[19]

$$\log(KP) = k_0 + \log(VAQP) - \sigma\log(UCC) + \lambda(\sigma - 1)t\ , \tag{4}$$

$$\log(LHP) = n_0 + \log(VAQP) - \sigma\log(WPQ) + \lambda(\sigma - 1)t\ , \tag{5}$$

where UCC is the user cost of capital and WPQ is the real (product) wage. To formulate explicitly: $k_0 = \sigma\log\left((1-\delta)A^{\frac{\sigma-1}{\sigma}}\right)$ and $n_0 = \sigma\log\left(\delta A^{\frac{\sigma-1}{\sigma}}\right)$. Thus, the constant terms are functions of the parameters of the production function. In the Cobb-Douglas case, the elasticity parameter of σ should be unity.

Defining the user cost of capital (UCC) is ambiguous. The complexity of the definition is studied, for instance, in the pioneering work of Jorgenson (1963).[20] The main issue is that the user cost of capital can be calculated in many ways, depending on how we define the relative price and the real interest rate of capital. Another problem, at least with the Finnish data, is the volatility of the series. In our model, the user cost of capital is as follows:

$$UCC = (pi/pqp)^{*}\left(r10^{*}0.01 - \log(cpi/cpi(-4)) + depr\right)\ , \tag{6}$$

where UCC is the user cost of capital, pi is the investment deflator, pqp is the private sector value added deflator, $r10$ is the interest rate, cpi is the consumer price index and $depr$ symbolizes the depreciation rate of private capital.

[19] See, for instance, Szeto (2001). We derive the factor demand equations from the CES function to illustrate its relation to the Cobb-Douglas function.
[20] See also Chirinko (1993).

To obtain a reasonable estimate for capital formation, we model investments instead of capital stock. Yet the net capital stock is endogenous and depends on investments. We also model the ”real investments”, meaning the domestic investments plus net direct investments abroad. To put it explicitly, the dependent variable in the investment equation is $IPQ + 0.25(DI / PI)$, where IPQ is the private investments, DI the direct investments abroad in current terms, and PI the private investment prices. This formulation implies that the direct investments abroad display the domestic investments, although with a relatively small weight (0.25).[21]

The labour demand equation (5) is important in our analysis of the effects of tax reforms on employment. A tax change affects the total demand and the real wage, at least temporarily. We obtain the elasticity of real (product) wages as a value of 0.21 (parameter σ in equation (5)). Although this estimation result is not fully consistent with the Cobb-Douglas assumption, i.e. $\sigma=1$, we allow this deviation.[22] However, the estimated elasticity for private value added is close to unity. Kiander, Vilmunen & Viren (2005) find slightly bigger estimates in their study that uses micro data, and so do Honkapohja et al. (1999). Later on, we do a sensitivity analysis for the wage elasticity to check the robustness of the results for a different parameterization.

The production function gives the private sector supply. The output gap is also included in the model structure. We assume that potential output is defined by the NAIRU rate; the NAIRU rate is derived from using data on the long-term unemployed. The result is a time-varying series, flatter than the actual unemployment rate series, but a series which is still affected by the economic recession at the beginning of the ’90s. NAIRU is exogenous in our model. Hence, the output gap constructed actually mimics the difference between unemployment and long-term unemployment. The output gap of the private sector also represents the output gap of the whole economy, while the public sector size (working hours) is regarded as an exogenous policy instrument.

We also model the labour supply. Along with the demography variables it is typical that the labour supply equation includes the so-called discouraged

[21] The studies of the relationship between outward foreign direct investment and domestic investment produce various results. Sauramo (2008) finds a one-to-one trade-off in his study with Finnish macro data.

[22] Note also that the elasticity found is typically lower in macro studies.

worker effect in the form of the unemployment rate. In our model, (lagged) employment is used as a proxy for labour market opportunities for a job seeker. The labour supply is also explained by the tax wedge, which has a negative effect on the participation rate in the labour markets. WEDGE consists of the tax rate of an average production worker and the worker's and employer's contribution to social security, and also the consumption tax rate. Hence, we use a broad definition for the wedge variable, in which all the relevant tax rates are included. The broad definition for the wedge variable is motivated by the standard derivation result for the labour supply of a utility-maximizing household (e.g. Prescott (2004)). The labour supply equation resembles the following:

$$\log(LS) = \eta + \beta \log\left(POP1564\right) + \left(1-\beta\right)\log\left(LN\left(-2\right)\right) + \delta\left(WEDGE\right), \qquad (7)$$

where $POP1564$ is population in the age range 15-64, LN is total employment and $WEDGE$ is the wedge variable just discussed. The estimation gives the coefficient for the wedge a value of -0.04, according to which the labour supply is quite inelastic with respect to the tax wedge.

Despite the well defined supply, the basis of the model is Keynesian; demand defines the output in the short run. Nevertheless, because the prices and wages depend on the output gap (the difference between unemployment and long-term unemployment), demand equals supply in the long run.

3.2.3. Aggregate demand

Aggregate demand consists of consumption, investments, and net exports. We begin with household consumption. There are assumed to be two different consumer groups in our model: those who are liquidity constrained and those who are not. The consumption of the former group depends on disposable income, whereas people in the latter group maximize their utility intertemporarily and their consumption follows the predictions of the permanent income life-cycle hypothesis. For the latter group, consumption follows the changes in their wealth, though, for the former group, consumption does not straightforwardly follow their disposable income either, as their consumption depends on the history of their disposable income, too. To put this analysis formally, we have a convex combination of the following kind:

$$CQ = \lambda\left((YHQ_t / PC_t + YHQ_{t-1} / PC_{t-1} + ... + YHQ_{t-6} / PC_{t-6}) / 7\right) + (1-\lambda)HW \ , \quad (8)$$

where CQ is the private consumption, YHQ symbols the disposable income, PC is the deflator of consumption and HW is the real wealth. The estimation results give the parameter λ a value of 0.9. The household wealth is assumed to follow the apartment prices index. We can motivate the use of the apartment price index with the fact that the wealth of Finnish people mainly consists of apartments. Also, compared with other indicators, for instance the stock prices, this indicator is clearly more plausible.[23] The former analysis only concerns the private sector. For public consumption there is no behavioural relation; it is modelled as an identity which sums up real wages paid in the public sector and government purchases (residual term).

For export and import, long-run homogeneity in terms of scale variable(s) has been imposed on the equations. Import is modelled as a convex combination of domestic demand and export volume. The connection from export to import is based on the fact that export industries use a lot of imported inputs. Both export and import are also affected by the price term which measures the price competitiveness of export and import items in their markets. Thus, the import volume is affected by the ratio between the import prices and the domestic value added prices, and, the export volume by the ratio between the export prices and the foreign prices.

Still, there are some special features in our export equation that are worth mentioning. Foreign demand reflects the weighted average of the GDPs in the most important countries for Finnish exports. Respectively, the foreign price level, the determinant of the evaluated price competitiveness, is obtained from the weighted average of the import prices of these countries. In this calculation import prices are converted into euro denomination units. Exports are then modelled:

$$\log(XQ) = \alpha + \log(IMU30) - \gamma \log\left(\frac{PX}{PWI30}\right) + \kappa(GF) \ , \quad (9)$$

where XQ is the export volume, $IMU30$ is the combination of the gross domestic product of 30 countries and $PWI30$ is the combination of the

[23] See Mayes & Virén (2001).

import prices (in euros) of the same countries. *PX* is the domestic export prices and *GF* is the recession dummy described earlier.

3.2.4. Prices and wages

All variables that determine GDP on the demand side are expressed in real and nominal values. For that reason, we also need to model the prices. The price block in our model is based on the law of one price. Thus, static homogeneity has been imposed, which is equivalent to expressing the long-run equations in terms of relative prices.

Prices are usually combinations of (private) value-added prices and foreign/import prices. The weights of individual prices have been estimated from data in all but the investment and consumption price equations. In these equations the weights have been calibrated. It is assumed that *PWI*30 defined in the previous chapter approximates to the foreign prices. Despite the fact that *PWI*30 also explains the export price level, our export price equation's fit in terms of R2 remains rather poor. In the price block, there is a connection from wages to other prices: private value-added prices are assumed to follow private sector wages (positively) and average productivity (negatively). Then, private consumption prices react to the changes in the value added prices. This induces a degree of sluggishness in the response of private consumption prices to changes in the wage rate.

In addition to the private value added and import prices, the private consumption prices are also affected by the (effective) value added tax rate. Thus, a private consumption prices equation is the following:

$$\log(PC) = \lambda + \beta \log(PQP) - (1-\beta)\log(PM) + \delta(ALV) + \gamma t\,, \tag{10}$$

where *PC* is the private consumption prices, *PQP* is the private value added prices, *PM* is the import prices, *ALV* is the value added tax rate, and t is the trend. We calibrate parameter β to the value of 0.7, and thus consumption prices are mainly affected by the domestic price level (PQP). The estimation gives δ a value of 0.9 which, means that consumption prices respond sharply to a change in the value-added tax rate.

Traditionally, wages are modelled with the Phillips curve relationship (1958), in which wages depend on the previous period's inflation and output gap. We notice that wage formation in Finland contains the familiar Scandinavian features: wages are negotiated in a centralized way together with employer and employee organisations and the government.[24] As a result, wages are quite rigid and inelastic. This is why we first model the wage drifts, and the equation for them is as follows:

$$\log(WRP) = \alpha + \log(PWS) + \beta \log(PROD) - \gamma(UGAP) - \mu(D \;\; / IPV(-1)), \quad (11)$$

where WRP is the private wage rate index, PWS is the standard private wage rate index, $PROD$ the productivity of labour, $UGAP$ the unemployment gap, DI the net direct investment abroad (in current prices) and IPV private investments (in current prices). Thus, the unemployment gap, i.e. the difference between unemployment and long-term unemployment, affects wages negatively. The last term, net direct investments abroad as a share of private investments, demands further explanation. Despite the rigidities in Finnish wage formation it has been assumed that direct investments abroad create a negative pressure on domestic wages. According to the data the impact is rather small, but statistically significant.

To capture the labour market effects properly, we also endogenise the standard private (gross) wage rate. It is modelled using a partial adjustment model where the standard private wage rate index is explained by the combination of its lagged value and the private consumption prices, the unemployment gap, and the tax wedge. The equation is as follows:

$$\log(PWS\_Q) = \alpha + \beta * \log(PWS\_Q(-1)) + (1-\beta)\log(PC(-1)) + \gamma(UGAP) + \mu(WEDGE2), (12)$$

where PWS_Q is the standard private (gross) wage rate index, PC the private consumption prices, and $UGAP$ the unemployment gap. As regards the unemployment gap, we use a one-year moving average. The coefficient of the tax wedge obtains an estimate of 0.036. Because the equation includes

[24] However, employer organizations are talking of decentralizing the currect system to decrease rigidities.

a lagged dependent variable with its coefficient calibrated to 0.95, the long-run multiplier of the wedge variable can be calculated by a standard formula: $\mu/(1-0.95)$. This means that, in the long-run, a one percentage point increase in the tax twedge puts the standard private (gross) wage rate index up by approximately 0.7 percent. The elasticity gained is a little higher than that of, for instance, Honkapohja et al. (1999) but because of the partial adjustment model structure it takes time for wages to adjust.

In equation (12) we have a wedge variable which includes the tax rate of an average production worker and the employer's and employee's contribution to social security. Hence, it has to be noted that the wedge variable is narrower than that in (7) because it does not consist of the consumption taxes. Nevertheless, the consumption taxes are also included in the model system through the consumption price equation (10).

3.2.5. Income accounting and the public sector

The public sector, its revenues and expenditures, is mainly modelled with identities. The same applies to the income accounting of households. To avoid making the model system too complicated, some identities have been constructed outside the model. For instance, employers' contributions to social security were originally calculated in Excel by adding up the employer's actual and imputed social contributions.

When the public sector and income accounting identities were being constructed, the main aim was to make them consistent with the national accounts data. The identities also describe the legal and institutional framework of the public sector. Public sector linkages are important in all policy simulations. In the public sector, behavioural equations are estimated only for value added, wages, and consumption prices. Still, this is not the whole truth, since the parameters in the public sector identities are usually estimated from the data. The residual terms received from the estimations are added to the public sector identities. The typical form of a public sector identity then is

$$\log(TAXQM) = \alpha + \beta \log\left(ALV * CV\right) + RESID, \tag{13}$$

where $TAXQM$ denotes the production and import taxes collected by the public sector. They depend on current private consumption (CV) and the value added tax rate (ALV); the parameter β has been estimated from the data. $RESID$ is the residual term which makes the right side of the equation consistent with the left side.

Several items constitute the income accounting of households. When analyzing the labour tax effects, our interest is in particular in the instant taxes paid by households. Through this link the direct taxes affect the private consumption, and also the total demand in the economy. The income taxes paid by households are modelled as an identity-type equation that combines both the property income and the earned income. The equation is as follows:

$$(TAX\_IN) = \alpha + \beta(TAX\_APW * EARN) + TAX\_K * PROP + RESID\,, \quad (14)$$

where TAX_IN denotes the income taxes paid by households, TAX_APW the earned income tax parameter, $EARN$ the earned income tax base, TAX_K the capital tax parameter, and $PROP$ the property income. The estimation results give the parameter β a value of 1.19 because of the progressive income tax system.

4. The effects of the tax cuts[25]

4.1. Debt-financed fiscal policy changes

We begin by analyzing the effects of various fiscal policy shocks with no policy rules. First, we simulate one percentage point permanent decrease in the income taxes of an average production worker. The shock affects the economy through the following path. First, it decreases the wage pressures in the wage negotiations because the trade unions notice the cut in the income tax. The labour supply also increases, which raises the potential output in the

[25] We make a *permanent* change to an exogenous variable in all the simulations.

economy and reduces the wage claims of the trade unions. As a consequence, the domestic price level declines, which improves the competitiveness of the export sector. The tax reduction also has a pure consumer demand effect while it increases the real disposable income of households and in that way boosts private consumption. The demand effect has an opposite, namely inflationary, effect on prices, but this effect is dominated by the supply side effects. Hence, in the long run, employment is 0.25 and GDP 0.58 per cent higher when compared with the baseline solution. On the other hand, the tax reduction increases the government deficit and raises the government 10-year bond to some extent.

We also simulate a five per cent shock to government purchases.[26] The shock has a standard demand effect on the economy: it increases employment and GDP sharply in the short run. However, this leads to inflationary pressures which make the prices rise in the long run. As a result, the shock's positive effect decreases in the long run. The government deficit also grows and the government ten-year bond rises as a result of the shock.

Then, we simulate a five per cent shock to the public sector working hours.[27] It tightens the labour markets, and then puts pressures on wages in the wage negotiations and leads to inflation. This weakens the competitiveness of the export sector and crowds out activity in the private sector. Nevertheless, even if private employment decreases, the shock's effect on total employment stays positive. Also, the public sector deficit is not so adversely affected in response to the shock in the short run. However, the shock has quite harmful effects on GDP (and also the budget deficit) in the long run.

Table 1. Long-run effects of fiscal policy shocks.

	Income tax cut	Increase in public purchases	Increase in public hours
Employment	+0.25 %	+0.03 %	+1.06 %
GDP	+0.58 %	+0.04 %	-1.13 %
Prices	-0.48 %	+0.29 %	+3.90 %
Government deficit	-0.79 % (unit)	-0.92 % (unit)	-1.06 % (unit)

[26] Five per cent permanent increase in the level of the public purchases.
[27] Five per cent permanent increase in the level of the public sector working hours.

Fiscal policy shocks

Figure 6. GDP effects.

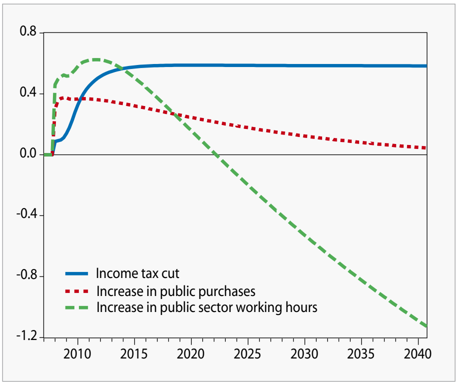


Figure 7. Employment effects.

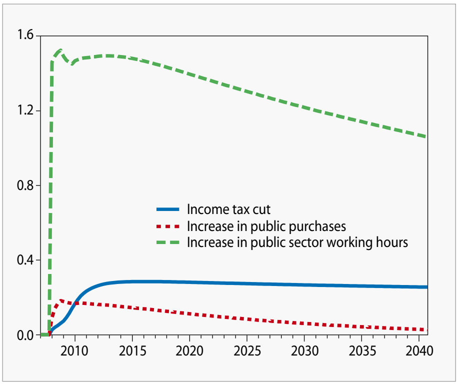


Figure 8. Price effects.

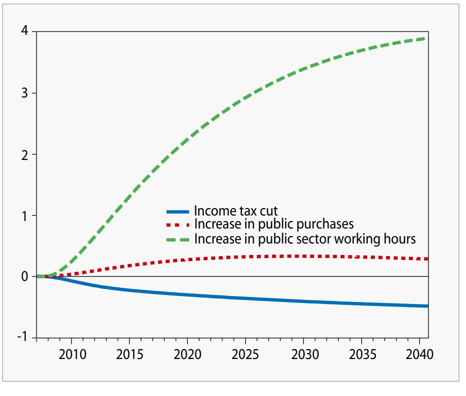
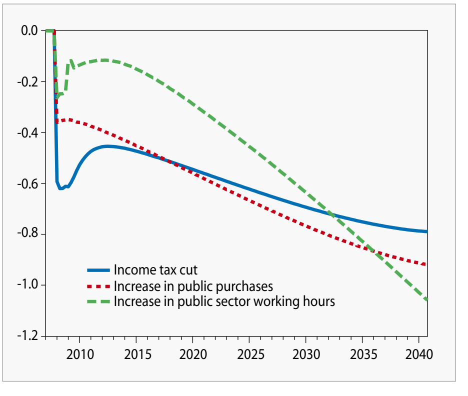


Figure 9. Government deficit effects.



4.2. Budget-neutral changes

4.2.1. Fiscal policy shocks with policy rules

In the previous simulations we did not consider how to finance the fiscal policy changes. Thus we had no policy rule; the government deficit was allowed to alter freely. Next, we examine the effect of an income tax cut when the government deficit has been bound to a simple public spending rule which makes the changes in taxation budget neutral. Thus the fiscal rule is the following:

$$GQP * PG = GQP(-1) * PG(-1) + T14(-1) \ , \tag{15}$$

where GQP denotes the real public purchases, PG is the public consumption prices, and $T14$ is the public sector budget deficit (a positive value means a surplus) in current terms.

Now, a one per cent permanent reduction in the income tax rate which is neutral for the government budget due to the reduction in public spending has both the effects just described above. The effect of the decrease in public purchases is sharper in the short run and thus employment and GDP first decrease as a result of the shock. However, as seen above, the demand effect decreases in the long run and the effect of the tax reduction that improves the potential output of the economy starts to dominate. As a result, both employment and GDP increase, 0.24% and 0.57% each in the long run, in response to the cut in income tax (compensated by a reduction in public purchases). Both the income tax cut and the reduction in public purchases affect prices and wages negatively; this is first due to the looser labour markets and, later on, when employment is improved, due to the fact that the trade unions are interested in employees' post-tax wages.

Budget-neutral income tax cut

Figure 10. GDP effect.

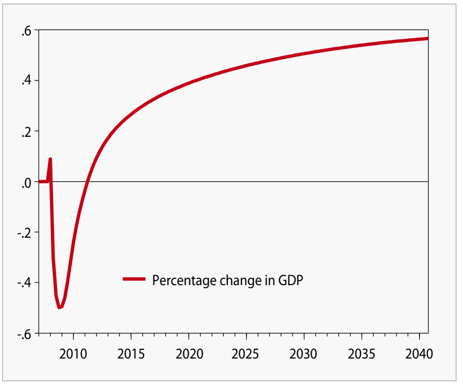


Figure 11. Employment effect.

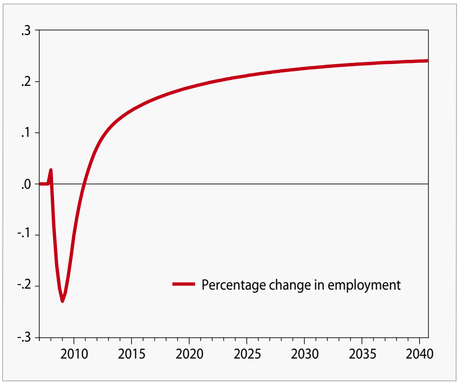


Figure 12. Price effect.

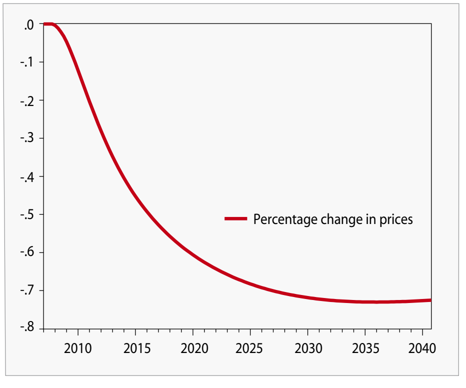
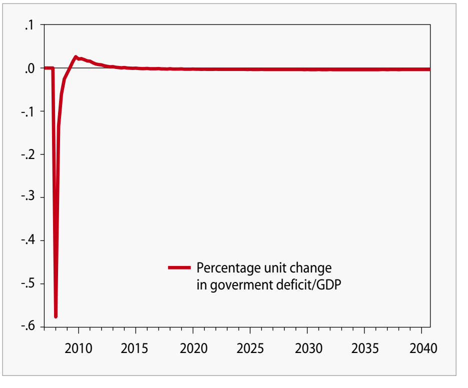


Figure 13. Government deficit effect.



Alternatively, fiscal policy rule may be bound to a tax rule, in contrast to the public spending rule above. Thus, we formulate a simple tax rule which looks like the following:

$$TAX\_APW = TAX\_APW(-1) - (T14/GDPV)*100 \, , \tag{16}$$

where *TAX_APW* denotes the income tax rate of an average production worker, *T*14 is the public sector budget deficit (a positive value means a surplus), and *GDPV* is gross domestic product in current terms. Now we simulate a 5 per cent[28] decrease in public purchases. A decrease in public purchases allows the government to lower income taxes. Although we have a different fiscal policy rule, the effect of the shock looks similar to that seen above. Again, a reduction in public spending affects the economy more sharply in the short run. But in the long run, the income tax cuts lower the wage pressure in the wage negotiations and increase the labour supply, which produces a long-lasting supply side effect. Thus, the effects are similar regardless of the type of fiscal policy rule, i.e. whether it is bound to public spending or taxes.

We also introduce a 5 per cent[29] decrease in public sector working hours, which is compensated by lowering income taxes. This slows inflation as the pressures on wages in the wage negotiations decrease. The competitiveness of the export sector is improved, and the effect of the shock on GDP is beneficial in the long run. However, the decrease in the public sector working hours is not totally compensated by the positive effects in the private sector labour hours. This is why employment (also) decreases in the long run in response to the shock.

Table 2. Long-run effects of fiscal policy shocks (with fiscal policy rules).

	Income tax cut (p. spending rule)	Decrease in public purchases (tax rule)	Decrease in public hours (tax rule)
Employment	+0.24 %	+0.27 %	-0.66 %
GDP	+0.57 %	+0.63 %	+1.9 %
Prices	-0.73 %	-0.88 %	-4.38 %

[28] Of total public purchases.
[29] Of the total public sector working hours.

Fiscal policy shocks (with fiscal policy rules)

Figure 14. GDP effects.

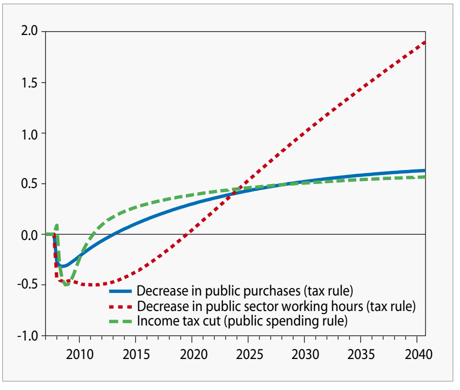


Figure 15. Employment effects.

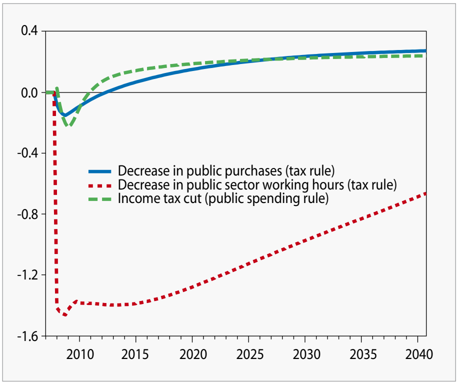


Figure 16. Price effects.

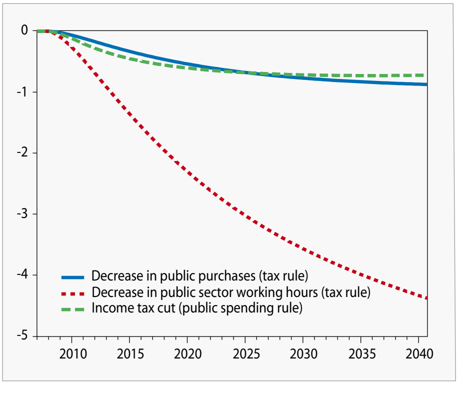
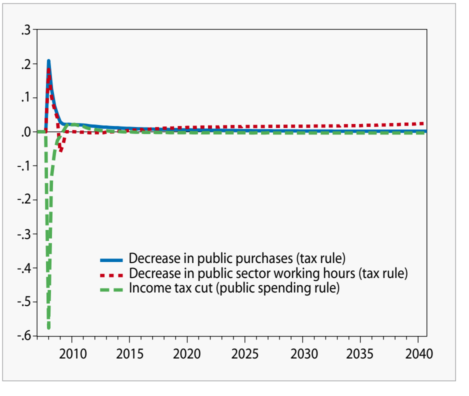


Figure 17. Government deficit effects.



On the basis of these results, income tax cuts that are neutral for the government budget due to the reductions in public purchases or public sector working hours improve GDP, at least in the long run. However, when income tax cuts are compensated by reductions in public sector working hours, employment of the economy decreases, but this is naturally due to the fact that the shock is directly directed at public employment. Finally, we have to keep in mind that we only operated with public purchases and working hours and not, for instance, public investments that may have technology-augmenting effects in the long run.

4.2.2. The structure of taxation

We also experiment with the impact of a change in the structure of the tax system, namely we shock the value added tax rate.[30] When compared internationally, the value added tax rate is relatively high in Finland, approx. 20 per cent when measured as an effective rate.[31] Notwithstanding, we simulate one percentage point increase in the (effective) value added tax rate, which is again compensated by reducing income taxes. In this simulation, we again use the tax rule (16) to make the tax changes neutral for the government budget. The effects of the value added tax change crucially depend on how the consumer prices react in response to the shock.

Table 3. Long-run effects of increasing the value-added tax rate (with tax rule).

	Value added tax rise (tax rule)
Employment	+0.02 %
GDP	+0.01 %
Prices	+1.33 %

Even though the rise in the value added tax rate pushes consumption prices up, the income tax cut's impact dominates in the short run. However, the dominance weakens in the long run, and hence the effect of the tax structure change converges to zero. As a result, the long-run values of GDP and employment are not affected by the shock. In Kilponen & Vilmunen's study (2007) for the Finnish economy, the effects of a similar shock are 0.53 for GDP and 0.25 for employment, and thus our zero result does not support the policy implications presented there.

4.3. Sensitivity analysis

How robust is our analysis? To do a sensitivity analysis for the results gained, we first alter the elasticity of the real wage in the labour demand equation. The estimations gave us the elasticity of real wages -0.21 (see section 3.2.2.);

[30] Of course, another relevant issue is the legitimate tax rates for labour and capital. Our model also allows us to study this issue, but when we are simulating capital tax changes some problems may arise.
[31] See, for instance, Coenen, McAdam, and Straub (2008).

we calibrate it to a value of -0.5, which is closer to the results gained from the previous Finnish studies (Kiander, Vilmunen, Virén (2005) , Honkapohja et al. (1999)). One percentage point reduction in the income tax rate is now compared with the previous results. The reductions are financed by increasing government debt, and hence the budget deficit is allowed to alter freely.

The sensitivity of results to the wage elasticity of labour demand

Figure 18. The sensitivity of employment.

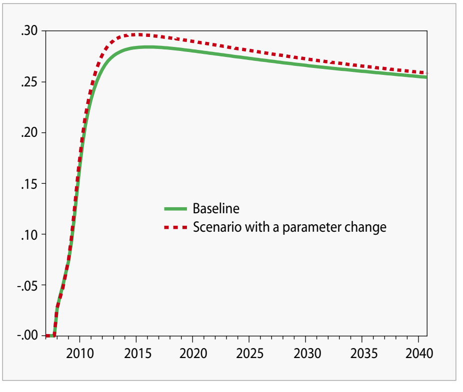


Figure 19. The sensitivity of GDP.

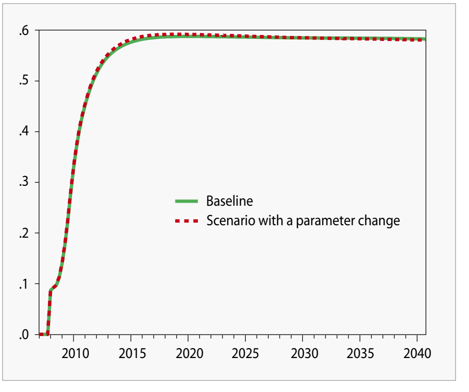
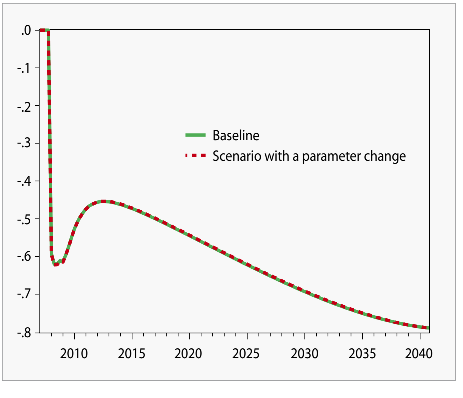


Figure 20. The sensitivity of the budget deficit.



The figures show that the government deficit and GDP are not sensitive to the wage elasticity of labour demand. One can notice some sensitivity in employment; however, this does not seem significant. One may assume that the results are sensitive to the changes of the wedge parameter in the wage formation equation. Hence, we calibrate the elasticity parameter in the standard private wage rate equation to the value of 0.028, which is, to some degree, smaller than the estimated elasticity (0.036). When we again use the formula $\mu/(1-0.95)$, calibration means that the long-run estimate for the wedge is now 0.56. Thus, we use the elasticity gained in Honkapohja et al. (1999).

The sensitivity of results to the wedge parameter of wage formation

Figure 21. The sensitivity of employment.

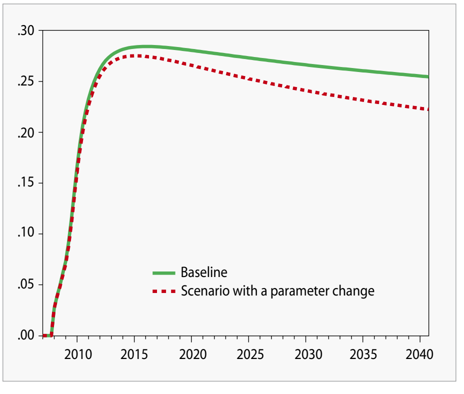


Figure 22. The sensitivity of GDP.

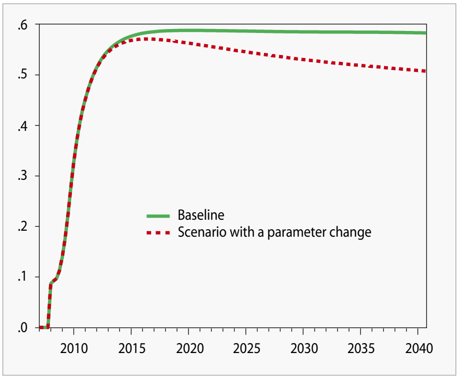
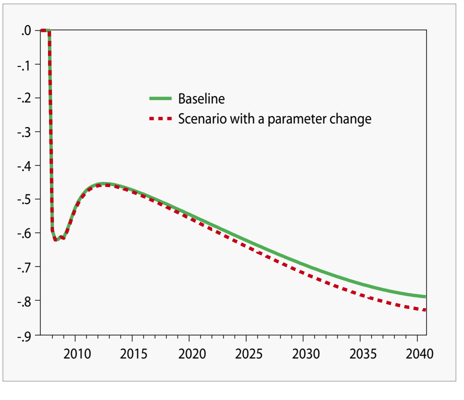


Figure 23. The sensitivity of budget deficit.



From the results it can be seen that employment is affected so that the effect of a one percentage point income tax cut on employment is now close to the average result of international studies, 0.2 per cent.[32] GDP is also, to some degree, sensitive to the wedge parameter change. As regards the budget deficit, the sensitivity is slightly smaller. However, one must notice that the long-run multiplier for the wedge was changed by just 0.16 points, which is a relatively small change. To summarize our sensitivity analysis, we can say that employment, GDP, and the government budget deficit are, to some degree, sensitive to the changes in the wedge parameter of the wage formation equation, a conlusion which is by no means surprising. However, the sensitivity of the results for the wage elasticity of labour demand is minor.

5. Concluding remarks

We found that a one percentage point decrease in the income tax rate which is financed by increasing government debt improves GDP by approx. 0.58 and employment approx. 0.25 per cent in the long run. We also found that a one percentage point decrease in the income tax rate which is compensated by reducing public purchases produces a long-run increase of GDP and employment of similar magnitude. In the short run, the negative effects of cutting public expenditures are stronger, and GDP even decreases, but in the long run the positive effects of income tax cuts start to dominate. This is due to the smaller pressures on wages negotiated by the trade unions and increased labour supply. The result is also due to the fact that the effects of a reduction in public purchases weaken in the long run when the economy converges to its steady-state path.

We also simulated policy shocks with an alternative fiscal policy rule which is bound to the income tax rates – not to public purchases as analyzed above. This modification of the fiscal policy rule produces consistent results

[32] See Nickell (2004). However, these and our results are not fully comparable because of different model frameworks.

for the effects of lowering the income tax rate and reducing public purchases at the same time. A decrease in public sector working hours also has a clearly positive effect on GDP in the long run. However, in this case the positive effects in private sector employment due to income tax cuts do not cover all the reductions in public sector employment, and this is why employment of the economy decreases in response to this shock.

One observes some sensitivity in our results to the changes of a wedge parameter in the wage formation equation. Decreasing the coefficient for the wedge brings our simulation results close to the (average) estimates gained from international studies. The results are only slightly sensitive to the changes in the wage elasticity of labour demand. An expirement with the structure of taxation gives us a (long-run) zero result for the effects of changing taxation towards higher taxes on consumption but lower on labour. Hence in this case the results gained using a macroeconometric model seem somewhat different to those gained using a theory-based DSGE model (see Kilponen & Vilmunen (2007)).

References

Alho, K., Kaitila, V. & Kotilainen, M. (2006): Työllisyys ja tuottavuus – analyysi talous- ja työllisyyspoliittisten toimien vaikutuksista (in Finnish). *Työpoliittinen tutkimus 317*. Ministry of Labour.

Blanchard, O. & Perotti R. (2002): An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output. *Quarterly Journal of Economics,* 1329-1368.

Böckerman, P. & Jäntti, M. (2004): Is Variation in Hours of Work Driven by Supply or Demand? Evidence from Finnish Manufacturing Industries. *Labour Institute for Economic Research, Discussion papers 196.*

Chirinko, R. S. (1993): Business Fixed Investment Spending: Modeling Strategies, Empirical Results, and Policy Implications. *Journal of Economic Literature,* Vol. 31, No. 4, 1875–1911.

Coenen, G., McAdam, P. & Sraub, R. (2008): Tax Reform and Labour-Market Performance in the Euro Area: A Simulation-Based Analysis Using the New Area-Wide Model. *Journal of Economic Dynamics and Control*, 32(8), 2543-2583.

Engle, R. F. & Granger, C. W. J. (1987): Co-Integration and Error Correction: Representation, Estimation, and Testing. *Econometrica,* Vol. 55, No. 2, 251–276.

Honkapohja, S., Koskela E. & Uusitalo, R. (1999): Työllisyys, työn verotus ja julkisen talouden tasapaino (in Finnish). *Kansantaloudellinen aikakauskirja*, 95(1), 74-95.

Joint Committee of Taxation (2006): Exploring Issues in the Development of Macroeconomic Models for Use in Tax Policy Analysis. JCX-19-06, June 16.

Jorgenson, D. W. (1963): Capital Theory and Investment Behavior. *American Economic Review*, 53:2 (May), 247–259.

Kiander, J. , Vilmunen, J. & Virén, M. (2005): Miksi työ ei käy kaupaksi? Analyysejä VATT:n yrityspaneeliaineistolla 1994–2002 (in Finnish). Unpublished manuscript.

Kilponen, J. & Ripatti, A. (2006): Labour and Product Market Reforms in General Equilibrium – Simulation Results Using a DGE Model of the Finnish Economy. *Bank of Finland Discussion Paper Series*, 5/2006.

Kilponen, J. & Vilmunen, J. (2007): Revenue neutral shifts in the tax structure: experiments with a dynamic general equilibrium model. *Bank of Finland Bulletin*, 1/2007.

Koskela, E., Pirttilä, J. & Uusitalo, R. (2004): Kuinka verotus vaikuttaa työllisyyteen? Katsaus taloustieteelliseen tutkimukseen (in Finnish). *Valtioneuvoston kanslian julkaisusarja*, 13/2004.

Laine, V. & Uusitalo, R. (2001): Kannustinloukku-uudistuksen vaikutus työvoiman tarjontaan (in Finnish). *VATT-studies 74.*

Lehmus, M. (2009): Empirical Macroeconomic Model of the Finnish Economy (EMMA). *Economic Modelling*, Vol. 26, Issue 5, September 2009, 926–933.

Lehmus, M. (2007): Empirical Macroeconomic Model of the Finnish Economy (EMMA). *Labour Institute for Economic Research, Discussion papers 225.*

Mayes, D. & Virén, M. (2002): Financial Condition Indices. *International Economics,* LV:4, 521–550.

Nickell, S. (2004): Employment and Taxes. *CEP Discussion Paper*, No. 634.

Phillips, A. W. (1958): The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861–1957. *Economica,* NS. 25, No. 2, 283–299.

Prescott, E. (2004): Why Do Americans Work So Much More Than Europeans? *Federal Reserve Bank of Minneapolis Quarterly Review,* Vol. 28, No. 1, July 2004, 2–13

Romer D. H. & Romer C. (2007): The Macroeconomic Effects of Tax Changes: Estimates Based On a New Measure of Fiscal Shock. *NBER Working Paper*, No. 13264.

Sauramo, P. (2008): Does outward foreign direct investment reduce domestic investment? Macro-evidence from Finland. *Labour Institute for Economic Research, Discussion papers 239*.

Sinko, P. (2002): Labour tax reforms and labour demand in Finland 1997-2001. *VATT-discussion papers 273*.

Szeto, K. L. (2001): An Econometric Analysis of a Production Function for New Zealand. *Treasury Working Paper,* 01/31.

III Essay II:

Labour or consumption taxes? An application with a dynamic general equilibrium model with heterogeneous agents*

Abstract

This study analyzes the effects of tax reform that shifts tax burden from labour to consumption. In this context, I also deal with the issue of progressivity. Even though this kind of tax policy change has recently gained popularity, its positive effects are debatable while the offsetting effect of a consumption tax on labour supply makes the net output change rather ambiguous. I examine these effects using a dynamic general equilibrium model with heterogeneous agents. The model is calibrated to fit certain characteristics of the Finnish economy. In addition to output and employment effects, I study the tax reform's effect on income and wealth distribution. First, I find that eliminating progressivity in labour taxation increases output via increase in capital accumulation that comes, however, in expense of slightly more inequality. Then, tax reform that replaces progressive labour taxes with a flat-rate consumption tax leads to a significant rise in capital accumulation, a negligible change in labour supply and gross labour income distribution, but a relatively considerable increase in wealth concentration.

Key words: taxation, general equilibrium models, heterogeneous agents.

* This paper is published in Economic Modelling, Volume 28, Issue 4, July 2011, 1984-1992, 2011. I would like to thank Petri Böckerman for assistance with micro data. I would also like to thank my supervisor Professor Matti Virén, Professor Martin Ellison, Tomi Kortela, and Juha Tervala for their helpful comments. Financial support from the Yrjö Jahnsson Foundation and Employee's Foundation is gratefully acknowledged.

1. Introduction

In response to the long-run structural challenges and deficits accumulated by the current crisis, many western governments are intending to raise consumption taxes but trying to avoid higher labour taxes at the same time. In fact, the tendency is to lower labour taxes if the government's fiscal situation allows it. Also the Finnish government has many times highlighted the urgent need for this kind of tax reform, i.e. the reform that raises consumption taxes but decreases labour taxes. In addition to a change in the source of taxation, this kind of tax policy switch also contains another aspect: replacing a progressive tax with a flat tax. From the theoretical point of view, changing the structure of taxes can be seen as part of a larger issue, the design of optimal tax system. The theoretical underpinnings of the topic can be found e.g. in Mirrlees (2006), Salanié (2003) or Kaplow (2008). In macro context, tax structure changes have been analyzed using a variety of approaches. The important work has been done by Auerbach and Kotlikoff (1987) who consider changes in taxes in an overlapping generations setting with exogenous growth. Jones, Manuelli and Rossi (1993) study the issue in an infinite-horizon representative-agent framework with endogenous growth and Coleman (2000) in the context of optimal Ramsey tax policy.

Regardless of many theoretical articles concerning the topic, studies with a more empirical approach are harder to find. Auerbach (1996) estimates that various proposals to replace the current income tax system in the U.S. with a consumption tax would produce long-run output gains of 3.2 percent to 9.7 percent. Heer and Trede (2003) study the output and distribution effects of tax reforms in a general equilibrium model calibrated to fit the stylized facts of the German economy. In their study income taxes are replaced with a flat-rate tax or consumption taxes. Their results show a significant rise in output, negligible effects on labour income distribution, but quite considerable (negative) effects on wealth distribution. Nishiyama and Smetters (2005) also study a similar kind of tax reform, i.e. a reform in which a progressive income tax is replaced by a flat consumption tax. They use an overlapping-generations model in which agents face idiosyncratic wage shocks and longevity uncertainty. They find that the effects of the tax reform crucially depend on the insurability of the wage shocks. In a pure empirical study based on the cross sectional data of 22 OECD countries Kneller et al. (1999) find that by raising consumption taxes and declining labour and other distortionary taxes, considerable output and employment gains would be reached. Bleany et al. (2001) use the same data and end up with the same conclusions. Unlike the previous investigation, they also try to eschew biases associated with incomplete specification of the government budget constraint and endogeneity of fiscal or investment variables. Tervala and Ganelli (2008) study the effects of a tax structure reform with an open economy DSGE (dynamic stochastic general equilibrium) model. They find modestly positive effects on growth in the long run when labour taxes are replaced with consumption taxes. However, the model they use does not include capital, and its calibration does not represent any particular country.[33]

While we have some international evidence of the effects of tax reforms, there are almost no empirical macro studies of the tax structure changes that use *Finnish data*. Only Kilponen and Vilmunen (2007) make an exception for this. They find that shifting taxes from labour towards consumption produces a significantly positive employment and GDP effect. Their study uses DSGE macromodel that also tries to capture the behaviour of the pensioners. For this reason, the results are very sensitive to the assumptions made for labour supply. Hence we still know very little how a tax structure reform would affect the output and employment in Finland. And we know almost nothing about the distributional effects of the reform.

To understand the effects of labour and consumption taxes, I first discuss the theoretical aspects of direct and indirect taxation. Then, in order to assess these effects quantitatively, I apply a general equilibrium model with heterogeneous agents to compare three fiscal regimes: i) progressive labour taxes that correspond to the Finnish system, ii) flat-rate labour tax, iii) only a consumption tax. That said, I utilize the aspects of the framework presented in Heer and Trede (2003) and Heer and Maussner (2009). Nevertheless,

[33] Also recent macro model simulation studies provide estimates for the effects of changing consumption or labour taxation, e.g. Forni, Monteforte & Sessa (2009) and Coenen, McAdam & Sraub (2008) estimate a DSGE model for the Euro area and find that decreases in labour and consumption tax rates have sizeable effects on consumption and output. However these simulation studies are concerned with lowering tax rates in general, but not reforming their structure.

the model presented in this paper has many unique characteristics. Unlike these previous studies in which income taxes are levied similarly on capital and labour, my framework is the Finnish dual income tax system that treats capital and labour income separately. This allows me to focus purely on the comparison of labour taxes and consumption taxes. Also, I change the theoretical assumptions concerning the risk of unemployment and calibrate the model to fit the stylized facts of the Finnish economy.

The results show that replacing progressive labour taxes with a flat-rate labour tax produces a slightly larger economy with fractionally more inequality. The output effect is almost totally due to the increase in capital stock. In the second and main experiment I find that the tax reform that replaces progressive labour taxes with a flat consumption tax has only minor effects on labour supply and gross labour income distribution, a positive effect on capital stock, but a negative effect on wealth distribution (i.e. wealth concentration increases). The sensitivity analysis shows that with less risk averse agents, the contribution of capital to output effect decreases but wealth concentration increases more when compared to the benchmark results.

The paper is organized as follows. Section 2 discusses the theoretical aspects of labour and consumption taxes. Section 3 introduces the model I use for simulation, and in section 4 the model parameters are calibrated. In section 5 I discuss the results from different tax policies. Final section concludes.

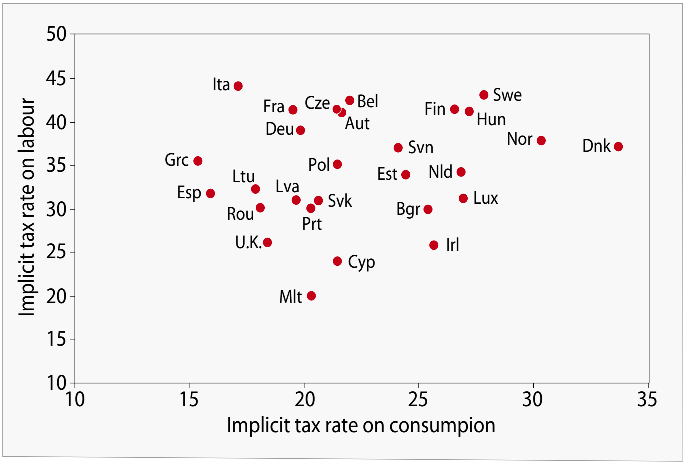
2. Direct vs. indirect taxation

In recent years, tax reform that replaces labour taxes with consumption taxes has gained popularity among many politicians and economists. Consumption tax is regarded as the least distortionary instrument to collect more tax revenues or even as a ”money machine” for government.[34] The common argument is that consumption taxes, unlike income taxes, do not discourage saving. The starting position for the reform looks very different

[34] For instance the discussion in the U.S. is surveyed by Carrol and Viard (2010).

across countries. This can be seen from the figure below, which shows the implicit tax rates on consumption and labour for 28 countries. For instance, one can find countries like Denmark and Italy that both have a high tax rate on labour but a totally different tax rate on consumption.

Figure 1. Implicit tax rates on consumption and labour.



Source: Eurostat.

A useful and simple framework to analyze the problem of direct vs. indirect taxes is provided for instance by Salanié (2003). He assumes that government can only use a linear tax on goods and wages, and considers the general equilibrium of a simple production economy. In this framework, it is possible to show that with no non-labour income, and no bequest, the tax on wages is completely equivalent to a uniform tax on goods.

However, if we extend the model to a deterministic discrete-time infinite horizon economy that also includes capital and government spending, the analysis gets more complicated. This kind of economy is studied by Coleman (2000). He analyzes Ramsey tax policy, i.e. the policy in which the allocations from the equilibrium maximize the utility attained by households. The model now consists of a large number of identical households who own all the factors of production, namely labour and capital, that they rent to firms at perfectly competitive rates. A government imposes flat-rate taxes on income from labour, consumption, and capital. In this model, households adjust their consumption and labour supply over time, as well as firms adjust their demands for investments and labour.

Coleman defines some constant $\bar{\tau}$, and chooses $\tau_t^c = \bar{\tau}$, $\tau_t^l = -\tau_t^c$, and $\tau_t^k = 0$. From that follows that he has a constant tax rate on consumption and a subsidy to labour at the rate imposed on consumption, and a zero tax rate on capital. In order to this tax policy to be optimal, $\bar{\tau}$ must satisfy the government budget constraint. Now it is possible to derive the result that in a dynamic economy in which the government has access to consumption and income tax rates, and in which the government is permitted to subsidy labour income, an optimal tax policy is indeed to impose a positive tax on consumption but a subsidy on labour, and no tax on capital income. Nevertheless, this result holds only if the value of initial assets exceeds the value of government consumption, i.e. if

$$a_0 > \sum_{t=0}^{\infty} q_t g_{1t} \quad , \tag{1}$$

where a_0 denotes the initial assets, q_t is a state price vector, and g_{1t} is government consumption.[35] The optimal tax policy reduces the amount the initial assets can purchase, so the consumption tax acts like a one-time lump-sum tax on initial assets less the value of government consumption. However, Auerbach and Kotlikoff (1987) discuss the ability of a consumption tax to tax existing assets. In their analysis, due to the distortive effects on labour supply, the offsetting effect on output of implementing only a consumption tax makes the net output change ambiguous. In fact, this is the core of the whole dilemma.

There is still one thing that makes the comparison of labour taxes and consumption taxes complicated: the fact that consumption tax is usually proportional but labour taxes progressive in the Western countries. Nishiyama and Smetters (2005) state that flattening tax rates tend to produce sizable long-run output gains across a range of models with deterministic wages. Salanié (2003) states that a proportional tax would also have obvious administrative advantages. It would simplify the tax returns and eliminate the situation in

[35] In Coleman's analysis q_t is needed to rule out the arbitrage possibilities.

which a taxpayer pays more tax when his income varies over time compared to the situation when it is constant. It would also make pay-as-you-earn withholding systems simpler when the taxpayer has several income sources.

However, despite all these advantages, Salanié argues that most voters estimate that taxes should be progressive. This is mainly due to the equality enhancing effects of progressive taxation. Nishiyama and Smetters (2005) stress the importance of risk-sharing aspects of progressive taxation. They state that even if flat-rate tax would eliminate numerous distortions contained within the progressive tax system, it would also reduce the amount of risk sharing provided by the tax system when wages are stochastic. Thus progressive taxes may in fact increase efficiency by adding the insurance provided by the tax system.[36]

3. Modelling the effects of tax reform

Typical macro studies concerning the effects of tax changes have been made using the assumption of a representative agent. However, this is a slightly unrealistic assumption, while people differ with regard to many characteristics, e.g. their age, education, productivity, and wealth holdings. This calls for replacing the standard representative agent framework with the assumption of heterogeneous agents. This is also a starting point in this analysis. In addition, this feature allows me to assess not only the output effects, but also the distributional effects of tax changes.

In this study I use dynamic general equilibrium model with heterogeneous agents to assess the employment, output, and distributional effects of tax reforms in which progressive labour taxes are first flattened and then replaced with consumption taxes. The model agents differ with regard to their productivity and employment status that are subject to idiosyncratic shocks. Hence agents are mobile and their productivity and employment status may

[36] In Nishiyama and Smetters (2005) the efficiency is determined by the amount of extra resources tax reform produces after the expected remaining lifetime utility of each household has been restored to its prereform level.

change between periods. The model and its solution technique utilize the aspects of the framework presented in Heer and Trede (2003).[37] The major difference in this paper comes from the fact that I am only interested in the comparison of labour and consumption taxes. This allows me to drop capital taxes out of the model structure. From empirical point of view, the different treatment between labour and capital income is also consistent with the Finnish dual income tax system that indeed treats labour and capital income separately. Also, I assume that the risk of unemployment is little higher for low-productive workers whereas Heer et al. (2003) assume it to be equal among all workers. Finally, I calibrate the model to fit the stylized facts of the Finnish economy.

The model consists of three sectors: households, firms, and the government. It assumes the typical optimization behaviour of households and firms, the former maximizing their discounted life-time utility and the latter maximizing their profits with respect to their labour and capital demand. The government taxes households' wages and consumption and uses the revenues gained for public consumption and unemployment compensation.

3.1. Households

Households live infinitely and are of measure one. Households differ with regard to their employment status, their productivity ε^j, and their wealth k^j, $j \in [0,1]$. Productivity is assumed to take a value from the finite set $\mathrm{E} = \{\varepsilon^1, \varepsilon^2, ..., \varepsilon^{n\varepsilon}\}$, where $\varepsilon^1 = 0$ is the state of unemployment. The number of productivities in this model is set equal to $n\varepsilon = 5$.[38] Productivity follows the first-order finite-state Markov chain with transition probabilities given by

$$\pi(\varepsilon' | \varepsilon) = \Pr\{\varepsilon_{t+1} = \varepsilon' | \varepsilon_t = \varepsilon\}, \tag{2}$$

[37] Their model and its solution are also presented in the textbook of Heer and Maussner (2009). The framework is also related to the studies of Ventura (1999) and Castañeda, Díaz-Giménez, and Ríos-Rull (1998, 2003).

[38] In this context, it is worth noting that the model economy does not comprise agents that do not attend in the labour markets, for instance pensioners and students. Thus, it is assumed that there are only labour supplying agents in the economy. For this reason, the model may underestimate the effects of consumption tax changes on income and wealth distribution.

where $\varepsilon, \varepsilon' \in \mathrm{E}$. As well as Heer and Trede (2003), I do not model the dynamics of productivity with second-order Markov chain since it improves accuracy rather little but increases the model's complexity considerably.[39]

Household j with productivity ε_t^j and wealth k_t^j in period t, maximizes his intertemporal utility with regard to consumption c_t^j and labour supply n_t^j:

$$E_0 \sum_{t=0}^{\infty} \beta^t u\left(c_t^j, 1-n_t^j\right), \tag{3}$$

where β is a discount factor and expectations are conditional on the information set of the household at time 0. I assume that the utility function is additively separable between consumption and leisure and is the following:

$$u\left(c_t, 1-n_t\right) = \frac{c_t^{1-\sigma}}{1-\sigma} + \gamma_0 \frac{\left(1-n_t\right)^{1-\gamma_1}}{1-\gamma_1} . \tag{4}$$

Castañeda, Díaz-Giménez, and Ríos-Rull (1998, 2003) discuss the reasons for choosing this kind of utility function instead of, for instance, the more standard Cobb-Douglas function with nonseparable preferences. 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.

I assume that borrowing is not possible for agents, $k^j \geq 0$. Household receives income from labour n_t and capital k_t, which he uses for consumption c_t and next-period wealth k_{t+1}. Hence the budget constraint for household is:

$$k_{t+1}^j = \left(1+r_t\right)k_t^j + \left(1-\tau_w^j\right)w_t n_t^j \varepsilon_t^j - \left(1+\tau_c\right)c_t^j + 1_{\varepsilon=\varepsilon^1} b_t , \tag{5}$$

where r_t, τ_w^j, w_t, and τ_c denote the interest rate, the wage tax rate, the wage rate, and the consumption tax rate, respectively. $1_{\varepsilon=\varepsilon^1}$ is a symbol for an indicator function, which takes the value one if the household is unemployed $\left(\varepsilon = \varepsilon^1\right)$ and zero otherwise. The unemployed agent is allowed for unemployment compensation b_t.

[39] See Shorrocks (1976).

3.2. Production

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

$$Y_t = N_t^{1-\alpha} K_t^{\alpha} , \tag{6}$$

where N_t denotes labour input and K_t capital input. In the model equilibrium profits are zero and factor prices equal to their marginal productivities:

$$r_t = \alpha \left(\frac{N_t}{K_t} \right)^{1-\alpha} - \delta , \tag{7}$$

$$w_t = (1-\alpha) \left(\frac{K_t}{N_t} \right)^{\alpha} , \tag{8}$$

where δ is the capital depreciation rate.

3.3. Government

Government raises revenues by taxing wages and consumption. These revenues are used for government consumption (G) and unemployment compensation payments (B).[40] Consumption tax is proportional to consumption, but wage tax is progressive. The progressivity is modelled by setting individual income tax rate for each five productivity type, since the productivities are in this model proportional to earnings. τ_w^1, which relates to the state of unemployment, is set to zero. The income tax rates for the rest of agents, $\{\tau_w^2, \tau_w^3, \tau_w^4, \tau_w^5\}$, are taken from the calculations of the Taxpayers'

[40] In this paper, government consumption does not enter the utility function nor has any effect on production. However, this limiting has a slightly moderate effect here, since the share of government consumption in total output is held fixed in the analysis, i.e. it stays constant in each tax policy regime. The government budget is balanced by the consumption tax, which is computed endogenously in the model. Nevertheless, the government consumption is needed to keep the fiscal block of the model consistent: without that, the consumption tax rate would be arbitrarily low (or even negative in some simulations).

Association of Finland for year 2008. The income tax rate τ_w^i relates to the average monthly wage rate of earners in the ($i-1$)-th quartile.[41] While the share of government consumption in output is held fixed in the analysis, the government budget is balanced by consumption tax which is computed endogenously in the model.

I will analyze the employment, saving, and distribution effects of replacing the current labour tax system with a flat tax on labour or only a consumption tax. In the latter case, wage tax rate is set to zero. In each case, the government balances its budget every period so that government expenditures are financed by tax revenues T_t:

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

3.4. Stationary equilibrium

I analyze a stationary equilibrium for a given government tax policy with constant prices and the invariant distribution of both income and wealth. Hence a stationary equilibrium for a given set of government policy parameters is defined as a value function $V(\varepsilon,k)$, individual policy rules $c(\varepsilon,k)$, $n(\varepsilon,k)$, and $k'(\varepsilon,k)$ for consumption, labour supply, 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, labour, consumption, tax revenues, and unemployment compensation payments are aggregated over households:

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

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

[41] Heer and Treede (2003) choose income tax structure to match the German system most closely. Our model aims at the same for Finland but we use a simpler but less accurate description of the progressive income tax system. Thus, in our model, the progressive labour taxes only approximate the empirical tax system.

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

$$T = \tau_w wN + \tau_c C \ , \tag{13}$$

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

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 this is subject to the budget constraint (5), the tax policy, and the Markov-type stochastic mechanism determining the productivity level (2).

3. Factor prices equal their marginal productivities as expressed in (7) and (8).

4. The goods market clears:

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

5. The government balances its budget (as in (9)): $G + B = T$.

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 $\varepsilon' \in \mathrm{E}$ and with $k' = k'(\varepsilon, k)$

The definition of the equilibrium concept used is further analyzed in Heer and Maussner (2009). The solution algorithm for the benchmark case is described in Appendix 1.

4. Calibration

Before solving the model and assessing the effects of different fiscal policies, the model parameters have to be calibrated. The model period corresponds to years and the data are provided by the Confederation of Finnish Industries (EK), the Statistics Finland, and Taxpayers' Association of Finland. The utility parameters γ_0 and γ_1 together with the productivities ε^j and the transition probabilities $\pi(\varepsilon'|\varepsilon)$ are chosen to replicate certain features of the Finnish economy, particularly the 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 unemployment payment compensation parameter b is an approximation and γ_g, the share of government consumption in output, is imposed to its real value in the Finnish data. In the next three subsections I aim to clarify the calibration of these parameters carefully.

4.1. Productivity

The productivities $\varepsilon \in \mathrm{E} = \{\varepsilon^1, \varepsilon^2, ..., \varepsilon^5\}$ are chosen to correspond to the discretized distribution of monthly wage rates, i.e. the productivities are assumed to be proportional to wages. Unemployment is characterized by ε^1, which is set to zero. Productivities $\{\varepsilon^2, \varepsilon^3, \varepsilon^4, \varepsilon^5\}$ are estimated from the empirical distribution of the monthly wages of the connected Finnish industrial employee and service employer data. The data are for year 2008 and are provided by the Confederation of Finnish Industries (EK). Although the data do not cover all the economy, they are considerably large, covering more than 400 000 workers, and hence can be said to approximate the Finnish economy. In a similar logic to the one used with the income tax structure (see section 3.3.), the productivity ε^i corresponds to the average monthly wage rate of earners in the $(i-1)$-th quartile. Following Heer and Trede (2003), I normalize the average of the four nonzero productivities to unity, which finally gives me:

$$\{\varepsilon^2, \varepsilon^3, \varepsilon^4, \varepsilon^5\} = \{0.5701, 0.7938, 1.0367, 1.5994\}\ . \tag{18}$$

The transition probabilities into and out of unemployment, i.e. $\pi(\varepsilon' = 0|\varepsilon > 0)$ and $\pi(\varepsilon' > 0|\varepsilon = 0)$, are chosen to imply an average unemployment rate of 8.64%, which is close to the current unemployment rate in Finland (to be discussed further in section 5.1).[42] Also, they imply an average duration of unemployment to be slightly more than one year. I assume that the probability to lose one's job depends negatively on individual productivity. In other words, 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). By assuming this I make a distinction from Heer and Trede (2003) and Heer and Maussner (2009). Nevertheless, the assumption seems realistic. It is also assumed that the productivity of a worker depreciates during unemployment so that he/she can only reach productivity ε^2 after unemployment. Hence I set $\pi(\varepsilon' = \varepsilon^2|\varepsilon = 0) = 1 - \pi(\varepsilon' = 0|\varepsilon = 0)$ and $\pi(\varepsilon' > \varepsilon^2|\varepsilon = 0)$=0.

All the other transition probabilities, comprising the rest 4 x 4 part of the transition matrix, are calibrated to match the observed quartile transition probabilities in the Finnish micro data. So these are based on the observed transition probabilities of the monthly wage rate from 2007 to 2008 in the connected Finnish industrial employee and service employer data. The transition probabilities are finally imposed so that the rows in the Markov transition matrix sum to one. The transition matrix finally looks the following:

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

This matrix describing the mobility of the Finnish workers may be compared to that of Heer and Trede (2003) for the German economy or

[42] To find out the average unemployment rate, we must solve for the stationary distribution of employment. In this case, it is done by solving the eigenvalue problem for the matrix (19).

Díaz-Giménez et al. (1997) for the U.S., although the mobility properties in the latter correspond to a five-year span. On this basis, German workers seem more mobile than their Finnish counterparts. One can also see from (19) that the persistence in the highest quartile is very high.

4.2. Production and utility

The production share of capital is calibrated to 0.36, which is very close to a typical assumption found in the literature, where it usually is around 1/3. For instance Lehmus (2009) uses value 0.4 in the Cobb-Douglas production function for the Finnish economy, and therefore the estimate seems very reasonable. The annual rate of capital depreciation δ is set to 0.04, which is also a relatively standard assumption and used for instance by Heer and Trede (2003) for the German economy. The discount factor is set to 0.96 and the intertemporal elasticity of substitution, σ, is set to 2. There is no consensus of the magnitude of σ; but since there are estimates ranging from 1 to 4 in the literature, $\sigma = 2$ used here is by no means contradictory. The preference parameters in the utility function are set to $\gamma_0 = 0.15$ and $\gamma_1 = 10$. These, along with the other parameters in the utility function, are chosen to imply an average working time of approximately 30% and a coefficient of variation for hours worked close enough to its empirical value in the Finnish data. In fact, the benchmark simulation produces an average working time equal to 0.304 and the coefficient of variation for working hours equal to 0.32. These two values will be discussed further in section 5.1. in which I analyze the results of the benchmark simulation.

4.3. Government expenditures and taxes

Government consumption as a share of total output is calibrated to its empirical value in Finland in 2008. This gives γ_g a value of 0.226. In the simulations, the share of government consumption remains constant in each policy regime. The replacement ratio is assumed to be proportional to the monthly earnings, net of taxes, in the lowest quartile. In the model, its value is a rough approximation. In Finland, the unemployment compensation based on the previous earned salary is well above 50 percent of the salary. However, the labour market subsidy paid on long-term unemployed or job seekers who enter the labour market for the first time is considerably smaller. Hence the parameter b, describing the share of the unemployment compensation payment in the lowest quartile monthly net earnings, is set to 0.52.

Progressive labour taxation parameters are set as described in section 3.3. Hence the wage tax rates for each productivity type (for each wage bracket) are the following:

$$\left\{\tau_w^1, \tau_w^2, \tau_w^3, \tau_w^4, \tau_w^5\right\} = \{0, 0.22, 0.27, 0.31, 0.38\}\,. \tag{20}$$

The values in (20) are based on the calculations of the Taxpayers' Association of Finland for year 2008. As said before, (20) only approximates the Finnish progressive labour tax system. The consumption taxation parameter, τ_c, is endogenously determined in order to balance the government budget. The parameter values (excluding the taxation, productivity, and transition probability parameter values that are given by (20), (18), and (19), respectively) are summarized in table 1. Later on, I will test the sensitivity of the results to alternative parameters.

Table 1. Model parameters.

$\sigma = 2$	$\gamma_0 = 0.15$	$\gamma_1 = 10$	$\beta = 0.96$	$\alpha = 0.36$	$\delta = 0.04$
$\gamma_g = 0.226$	$b = 0.52$				

Thus, parameter γ_g is estimated from the Finnish macro data while the other parameter values in Table 1 are imputed with the help of the previous literature. The productivities and transition probabilities are estimated from the Finnish micro data and the labour tax data uses the calculations of the Taxpayers' Association of Finland.

5. Results

This section studies the quantitative effects of tax reform that i) eliminates progressivity in labour taxes and finally, ii) shifts tax burden from labour to consumption. I especially scrutinize the effect of the reforms on employment, savings, and income and wealth distribution. Prior to comparison of fiscal regimes, equilibrium properties of the benchmark case with progressive labour taxes are discussed.

5.1. Benchmark case with progressive labour taxes

Optimal consumption of the employed worker increases with both productivity and wealth. Agents with low wealth and productivity ($\varepsilon < \varepsilon^3$) are liquidity constrained. Labour supply is an increasing function of productivity since the substitution effect dominates the income effect. Instead, labour supply is a decreasing function of wealth as higher wealth makes the marginal utility of income decline.

Table 2 compares the properties of the benchmark model and the Finnish data. In a stationary model equilibrium the aggregate capital stock gets a value of 3.48, which is associated with a capital-output ratio equal to 4.6. This is slightly more than its empirical value for the Finnish economy in recent years but equals to its empirical value in 2005. In the benchmark simulation, I get the Gini coefficient of gross labour income a value of 0.218. This is close to its empirical value, 0.224, calculated from the earnings of full-time employees in 2006 by the Statistics Finland (2008). For the Gini coefficient of wealth, I get a value of 0.403. This is smaller than its empirical counterpart that is typically between 0.60 and 0.75 in the Western countries Finland being in the lower range of the interval (see for instance Jäntti and Sieminska 2007). Although the model cannot fully replicate the wealth Gini of Finland, the estimates are good enough for the purpose of making comparisons between different fiscal regimes.[43]

[43] The reasons why the simple heterogenous-agent model is unable to fully replicate the empirical wealth distribution are discussed in Heer and Maussner (2009).

In the model equilibrium, the unemployment rate is 8.64, which is slightly lower than its empirical trend rate at the beginning of 2010. However, the current unemployment rate is strongly affected by the global economic downturn, and it is assumed to decrease in the near future; the average rate in 2008 was 6.4. For aggregate effective labour supply the model gives N=0.317 with an average working time equal to 0.304. The coefficient of variation for working hours amounts to 0.32 in the model equilibrium. 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, this empirical estimate refers to the regular working time that is rather a legal concept than the true estimate for working hours variation and hence it is probably downwards biased. In the benchmark simulation, the labour supply elasticity with respect to wages is 0.208 for the average worker, which is consistent with the empirical estimates that are typically in the range of 0.05 and 0.4.[44]

Table 2. The benchmark model and empirical values.[1]

	K/Y	Unemp.	$Gini_1$	$Gini_w$	$\sigma_n / \bar{n}$	$\eta_{n,w}$
Benchmark case	4.6	8.6	0.218	0.403	0.32	0.208
Empirical value	4.4	9.1	0.224	0.60-0.65	0.24	0.05-0.4

[1] The model produces consumption tax rate equal to 7.2 in the benchmark simulation. This is clearly smaller than its empirical counterpart in Finland. The difference is due to the fact that the model only abstracts the Finnish public sector while it excludes many components on the public expenditure side. With all the components (e.g. all the transfers, subsidies, interest payments etc.) included on the expenditure side, the model would naturally produce much higher consumption tax rate (in order the budget to balance). However, the focus of this analysis is on the change of the consumption tax rate, not to produce its real level in the data.

5.2. Eliminating progressivity of labour taxes

I begin by eliminating the progressivity of labour taxes: the progressivity is replaced with a flat-rate tax. The level of the flat tax equals to the average tax rate on labour. The results are summarized in Table 3 where

[44] The estimates for females are typically higher than those for males.

“Progressive labour taxes” represents the benchmark case and hence the current steady state of the economy. As a result of the reform, the economy moves to a new steady sate. Thus, for instance, K and N are aggregate units of capital and labour, respectively, in each steady state. From the results can be seen that eliminating progressivity leads to a very minor rise in the aggregate employment (from 0.317 to 0.318, which equals a 0.3 percent change). What actually happens is that high-productive workers, whose taxes are now lowered, increase their work effort due to the substitution effect. On the other hand, low-productive workers are met with a higher tax rate, which results in a decline of their work input. Nevertheless, wealth effect, that affects the opposite way, dampens both these changes. The joint effect of these changes can be seen in the Gini coefficient of gross labour income, which increases slightly, from 0.218 to 0.221. The variation coefficient of working hours also increases slightly (from 0.320 to 0.323). However, these changes in labour markets are fairly small in magnitude.

As a result of the tax policy change, the high-productive agents are now faced with higher disposable incomes. Part of this higher net income is used for savings. The increase in savings is partly due to the precautionary motives of agents, since the elimination of progressivity increases the losses in disposable income if one falls to a lower wage bracket. In other words, eliminating progressivity decreases the insurance provided by the tax system. Hence, the aggregate capital stock of the economy rises from 3.48 to 3.66, which equals a 5.2 percent change. Together with the employment change this gives a 2.0 percent increase in total output when compared to the current steady state.

The reform also leads to the more concentrated wealth distribution. This can be seen from the Gini coefficient of wealth that increases from 0.403 to 0.411. In general, the switch from progressive to flat-rate labour taxes leads to a somewhat larger economy that is however achieved, in expense of slightly more inequality. If we compare these results to those of Heer and Trede (2003) or Ventura (1999) who analyze the effects of a switch to a flat tax system, it can be seen that both these previous studies find slightly larger employment effects both as regards to aggregate employment and distribution of labour income. Nevertheless, this is mainly due to the reason that I only flatten the labour taxes whereas Ventura deals with a more complete tax reform and Heer and Trede analyze the reform of income taxes that consist both of labour and capital taxes. In addition, Ventura uses a slightly different approach in his study.

Table 3. Effects of tax policies.

Tax policy	K	N	$\overline{n}$	r	$Gini_l$	$Gini_w$	$\sigma_n / \overline{n}$
Progressive labour taxes	3.48	0.317	0.304	7.77	0.218	0.403	0.320
Flat-rate labour tax	3.66	0.318	0.303	7.52	0.221	0.411	0.323

Although the model captures the output and distributional effects of the tax reform, the aspects of risk sharing are not profoundly covered in our experiment; we only capture the reform's effects on savings that come from precautionary motives of households perceiving stochastic wages. If the insurance provided by progressive taxes could be explicitly modelled, e.g. that could somehow be included in the household's utility function, eliminating progressivity would probably lead to different output and employment effects in general.

5.3. A switch to consumption taxation

In the following experiment, I replace the progressive labour taxes with a flat-rate consumption tax. The consumption tax is endogenously set to the level that balances the government budget. In the model simulation this results in the consumption tax equal to 46.2%. As a result of the tax reform, the distortionary effect of taxation shifts from labour to consumption. The effective tax rates of high productive workers decrease, which increases their incentives to supply labour. At the same time, their wealth increases considerably due to not taxing their labour income that is not used for consumption, i.e. the income that is used for saving. These two effects, substitution and wealth effect, affect labour supply in opposite ways nearly neutralizing each other. On the other hand, low-productive workers are met with higher taxes. However, while these agents are liquidity constrained, they have to work harder to maintain their level of consumption. Again, the net effect on labour supply is almost neutral. As a result, the aggregate labour in the economy is almost unaffected and gets a value of 0.321 (in fact 0.321/0.317 implies a 1.3 percent change). Also the Gini coefficient of labour income changes only a little, from 0.218 to 0.214. The variation coefficient of labour hours also remains close to its previous level (changing from 0.320 to 0.319).

The saving behaviour of households is clearly more affected by the tax reform. The high-productive workers consume only part of their labour income, hence the pure consumption tax system makes their tax burden smaller and gives them incentives to accumulate capital. The increase in savings is also due to the precautionary motives that appear when insurance against the risk of falling to a lower wage bracket provided by the progressive labour taxes is abolished. There is also a small role for the output effect that comes from the ability of a consumption tax to tax initial assets. Nevertheless, the magnitude of this effect diminishes in time in the infinite-horizon economy of the model.

As a result of the tax reform, the aggregate wealth of the economy increases but also gets more concentrated. In the new steady state, the aggregate capital amounts to 3.96, which implies a 13.8 percent change from the current steady state. Together with the employment change this produces a 5.6 percent increase in output. The Gini coefficient of wealth gets a value of 0.420. Hence the new Gini coefficient of wealth is 1.7 percentage points higher than in the regime of progressive labour taxes. The magnitude of this change is not large, but it is by no means insignificant. To conclude, the results show that the switch to the consumption tax produces a significant rise in the aggregate capital of the economy, while the effects on labour supply remain minor. So the change is actually towards a more capital intensive economy. Also, the inequality measured by the distribution of gross labour incomes remains almost unaffected, but the wealth inequality measured by the distribution of assets rises fairly considerably.

Table 4. Effects of tax policies.

Tax policy	K	N	$\bar{n}$	r	$Gini_l$	$Gini_w$	$\sigma_n / \bar{n}$
Progressive labour taxes	3.48	0.317	0.304	7.77	0.218	0.403	0.320
Flat-rate labour tax	3.96	0.321	0.308	7.21	0.214	0.420	0.319

Again, these results may be compared with Heer and Trede (2003), even though they model a slightly different kind of tax reform. In general, their results show larger effects on capital stock and inequality. Castañeda et al. (1998) find effects of similar magnitude on earnings inequality but larger effects on wealth inequality as a result of changing the current U.S. tax system towards proportional tax system. My results concerning output gains (5.6%) are in fact in the same magnitude as Auerbach's (1996) who however analyzes the effects of a more complete tax reform that consists of replacing the income tax system with consumption tax in the U.S.[45] On the other hand, output gains from the tax policy change that shifts tax burden towards consumption are much bigger in Kilponen & Vilmunen (2007) who also use Finnish data in their model. Thus, even though it is useful to compare the results provided by this paper with previous studies, the differences in tax policy changes make exact comparisons little difficult. One should keep in mind that, in this study, only labour taxes are compared with consumption taxes. This makes the biggest distinction from most of the previous studies.

Sensitivity of the results to alternative parameterization of intertemporal elasticity of substitution and disutility from working is examined in Appendix 2. The analysis shows some significant changes in the quantitative results: it is worth noting that with intertemporal elasticity $\sigma = 1$ labour supply is more, but savings less affected by the reforms; with $\sigma = 3$ the opposite holds. Also with $\sigma = 3$, i.e. when the agents are more risk averse, the distributional effects are not so unambiguous. Otherwise, the qualitative

[45] As already said in the introduction section, Auerbach gets output gains from 3.2 to 9.7 percent depending on the model assumptions.

assessment of the results remains the same. The results are robust as regards to the disutility from working parameter γ_0.

In order to understand why equivalence between consumption and labour taxes breaks in the model simulations, I also simulated the model with an assumption that the productivity of each agent equals to one, i.e. I reverted the model to the standard representative agent case. For this theoretical experiment, I also assumed that labour tax as well as consumption tax is proportional. In addition, I slightly modified the transition probabilities in the transition matrix. Nevertheless, this should play no role here when each agent has the same productivity and there is no unemployment in the model. As a consequence, the simulation results show that there are only minor differences in aggregate capital and employment in different tax regimes (the results are not shown in the paper). The sizes of the differences depend on the parameters for intertemporal elasticity of substitution and disutility from working but also initial value for capital stock. Nevertheless, since the differences are very small in magnitude, I can conclude that the main reason for non-equivalence between consumption and labour taxes is the heterogeneity assumption.[46]

6. Conclusions

A tax reform that puts more weight on consumption taxes but reduces labour taxes has been vividly discussed in the Western countries during recent years. Economists and politicians generally see consumption taxes as the least distortionary way to increase tax revenues collected by the government. However, the positive effects of consumption tax are debatable while its offsetting effect on labour supply makes the net output change rather ambiguous. Consumption tax may be justified on the grounds that it is also a tax on existing assets, which does not affect labour supply decision

[46] Also, one could consider the role of unemployed agents and the compensations they are allowed on the model results. However they should play no role here while the compensation payment is determined as a share of earnings net of income taxes.

of households. Still, the significance of this effect is uncertain, at least in the long run. The efficiency of the consumption tax is also much dependent on whether a price level change due to the consumption tax increase is compensated to pensioners and other non-working groups. Another, even a bigger issue than the output effects, is the reform's effect on income and wealth distribution, i.e. on inequality.

In this study, I use a dynamic general equilibrium model with heterogeneous agents to assess the output and distributional effects of tax policy reforms. The agents in the model differ with regard to their productivity and employment status that are subject to idiosyncratic shocks; hence the agents are mobile and their productivity and employment status may change between periods.

In order to differentiate the effects of progressivity from the source of taxation, I begin by simulating a switch from progressive to a flat-rate labour tax. This results in an economy with some degree larger capital stock, negligibly more employment but slightly more inequality. The main results concern the tax policy reform that replaces progressive labour taxes with a proportional consumption tax. According to the simulations this reform results in a significant rise in capital accumulation, a negligible change in labour supply and gross labour income distribution, but a relatively considerable increase in wealth concentration. To summarize, the tax system that replaces labour taxes with consumption taxes produces a more capital intensive economy with somewhat more wealth inequality.

Even if the model simulations prove to be relatively robust on the basis of the sensitivity analysis, there are also reasons why the results should be interpreted carefully. The reasons are discussed in Heer and Trede (2003) who use modelling technique similar to mine. These include the possible transition effect after the tax policy change and the strong assumption about the exogeneity of workers' productivities, which is also independent of the tax policy regime. It is also worth noting that this study analyzes labour supply only along the intensive margin; tax structure change may naturally have an effect along the extensive margin, i.e. whether people attend in the labour markets. From empirical point of view, one has to also remember that the model economy only consists of labour supplying agents: pensioners and students are not taken into account in this paper.

Hence it is probable that the model experiment underestimates the distributional effects of the tax reforms. Despite these reservations, I argue that the results prove that replacing labour taxes with consumption taxes only slightly improves employment, and albeit the reform increases capital accumulation significantly, it contributes negatively on wealth inequality.

References

Aiyagari, S. R. (1993): Uninsured idiosyncratic risk and aggregate saving. *Working Papers 502*, Federal Reserve Bank of Minneapolis.

Auerbach, A.J. (1996): Tax Reform, Capital Allocation, Efficiency and Growth. In Aaron, H.J. and Gale, W.G. (edit.): *Economic Effects of Fundamental Tax Reform*. Brookings Institution Press.

Auerbach, A. J. and Kotlikoff, L. J. (1987): *Dynamic Fiscal Policy*. Cambridge University Press, Cambridge, UK.

Bleaney, M., Gemmell, N. and Kneller, R. (2001), Testing the endogenous growth model: public expenditure, taxation, and growth over the long run. *The Canadian Journal of Economics,* 34(1), 36-57.

Carrol, B. and Viard, A. (2010): Value Added Tax: Basic Concepts And Unresolved Issues. *Tax Notes,* March 1, 1117-1126.

Castañeda, A., Díaz-Giménez, J. and Ríos-Rull, J.-V. (1998): Earnings and wealth inequality and income taxation: Quantifying the trade-offs of switching to a proportional tax in the US. *Working Paper 9814*, Federal Reserve Bank of Cleveland.

Castañeda, A., Díaz-Giménez, J. and Ríos-Rull, J.-V. (2003): Accounting for the U.S. Earnings and Wealth Inequality. *Journal of Political Economy*, Vol. 111, 818-57.

Coenen, G., McAdam, P. and Sraub, R. (2008): Tax Reform and Labour-Market Performance in the Euro Area: A Simulation-Based Analysis Using the New Area-Wide Model. *Journal of Economic Dynamics and Control*, 32(8), 2543-2583.

Coleman, W. J. (2000): Welfare and optimum dynamic taxation of consumption and income. *Journal of Public Economics,* 76, 1–39.

Díaz-Giménez, J., Quadrini, V. and Ríos-Rull, J.-V. (1997): Dimensions of Inequality: Facts of the US Distributions of Earnings, Income, and Wealth. *Federal Reserve Bank of Minneapolis Quarterly Review,* Vol. 21, 3-21.

Forni, L., Monteforte, L. and Sessa, L. (2009): The general equilibrium effects of fiscal policy: Estimates for the Euro area. *Journal of Public Economics,* 93, 559–585.

Heer, B. and Maussner, A. (2009): *Dynamic General Equilibrium Modeling. Computational Methods and Applications*. Springer-Verlag Berlin Heidelberg. 2nd Edition.

Heer, B. and Trede, M. (2003): Efficiency and Distribution Effects of a Revenue-neutral Income Tax Reform. *Journal of Macroeconomics*, 25, 87-107.

Jones, L.E., Manuelli, R.E. and Rossi, P.E. (1993): Optimal taxation in models of endogenous growth. *Journal of Political Economy,* 101 (Fall), 485–517.

Jäntti, M. and Sierminska, E. (2007): Survey Estimates of Wealth Holdings in OECD Countries. Evidence on the Level and Distribution across Selected Countries. *UNU-WIDER, Research Paper,* No. 2007/17.

Kaplow, L. (2008): *The Theory of Taxation and Public Economics*. Princeton University Press, Princeton and Oxford.

Kilponen, J. and Vilmunen, J. (2007): Revenue neutral shifts in the tax structure: experiments with a dynamic general equilibrium model. *Bank of Finland Bulletin*, 1/2007.

Kneller, R., Bleaney, M. and Gemmell, N. (1999), Fiscal policy and growth: evidence from OECD countries. *Journal of Public Economics*, 74, 171-190.

Lehmus, M. (2009): Empirical Macroeconomic Model of the Finnish Economy (EMMA). *Economic Modelling*, Vol. 26, Issue 5, September, 926–933.

Mirrlees, J. A. (2006): *Welfare, Incentives, and Taxation*. Oxford University Press, Oxford.

Nishiyama S. and Smetters K. (2005). Consumption taxes and economic efficiency with idiosyncratic wage shocks. *Journal of Political Economy,* 113(5), 1088-1115.

Salanié, B. (2003): *The Economics of Taxation*. The MIT Press, Cambridge, Massachusetts.

Shorrocks, A.F. (1976): Income mobility and the Markov assumption. *Economic Journal,* 86 (3), 566–578.

Tervala, J. and Ganelli, G. (2008): Tax Reforms, ”Free Lunches”, and ”Cheap Lunches” in Open Economies. *IMF Working Paper/08/227.*

Ventura, G. (1999): Flat-rate tax reform: A quantitative exploration. *Journal of Economic Dynamics and Control,* 23 (9–10), 1425–1458.

Appendix 1

Following Heer and Maussner (2009, p. 379-381), the solution algorithm for the benchmark case with progressive labour income taxation is described by the following steps:

1. Make initial guesses of the aggregate capital stock K, aggregate employment N, the consumption tax τ_c, 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 consumption tax τ_c that balances the government budget.
7. Update K, N, and τ_c, and return to step 2 if necessary.

The optimization problem for household (step 3) is solved with value function iteration. Due to this reason, 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 working agents supply 0.2 units of time as labour and that each agent consumes his current-period income infinitely. It is assumed that agents supply labour by choosing only discrete values from the interval $[0,1]$. I use an equispaced grid N of 100 points. In order to find the maximum of right hand side of the Bellman equation (15), iteration over the next-period capital stock $k' \in \mathrm{K}$ and the optimal labour supply $n \in N$ for every $k \in \mathrm{K}$ and $\varepsilon^i, i = 1,...,n\varepsilon$ is needed. This amounts to a very large sum of iterations, but their number is reduced substantially by the exploitation of the monotonicity conditions. For the computation of invariant distribution, I discretize the wealth density and compute it as described in Heer and Maussner (2009, p. 351).

The accuracy of the computations may be checked by computing the residual functions for the two first order conditions, the other describing the intertemporal and the other intratemporal margin. It is then possible to calculate, for instance, the mean absolute deviations for these residuals. The magnitude of the deviations produced by the model used here is moderate, and hence the fit of the model seems reasonable. For further discussion of the stability of this kind of model, see Heer and Maussner (2009). The stability properties of the heterogeneous-agents models are also discussed in the seminal paper by Aiyagari (1993).

Appendix 2

I test the model sensitivity to alternative parameters of intertemporal elasticity of substitution and disutility from working. In typical studies the intertemporal elasticity parameter varies from 1 to 4 (see Jones et al. 1993 or Heer and Trede 2003). For instance Jones et al. (1993) use values $\sigma \in \{1,2,2.5\}$ for the calibration of the endogenous growth model. Heer and Trede test the model sensitivity using $\sigma = 1$ and $\sigma = 4$. Following these studies, I test the sensitivity of the results using values 1 and 3 for σ. The results look the following:

Table 5. Sensitivity analysis of σ .

σ	Tax policy	K	N	$\overline{n}$	r	Gini_l	Gini_w	$\sigma_n / \overline{n}$
1	Progressive labour taxes	2.91	0.268	0.254	7.85	0.225	0.281	0.315
1	Flat-rate labour tax	2.98	0.270	0.254	7.71	0.232	0.349	0.320
1	Consumption tax	2.93	0.276	0.261	7.51	0.228	0.486	0.318
3	Progressive labour taxes	4.00	0.352	0.339	7.59	0.212	0.379	0.323
3	Flat-rate labour tax	4.31	0.352	0.339	7.25	0.213	0.386	0.326
3	Consumption tax	4.73	0.354	0.342	6.85	0.206	0.384	0.30

With logarithmic utility, i.e. $\sigma = 1$, agents become less risk averse and decrease precautionary savings. Now the effects of the tax reforms on capital are much smaller: the aggregate capital stock rises either from 2.91 to 2.98 or to 2.93. On the other hand, agents increase their labour supply more than in the benchmark case(s). The Gini coefficient of wealth rises from 0.281 to 0.349 as a result of the tax reform that flattens the labour taxes, and even to 0.486 with the consumption tax system. Thus, the increase in the concentration of wealth is much more dramatic with logarithmic utility. Instead, with $\sigma = 3$ agents become more risk averse; as a result of the tax policy switch from progressive labour taxes to flat-rate or consumption tax, the capital stock increases significantly more when compared to the results above. However, the increase in labour supply is only marginal. With the tax policy shift to consumption tax the distributional effects are not unambiguous since the Gini coefficient of gross labour income decreases, but that of wealth rises approximately 0.5 percentage points. To conclude the sensitivity analysis of the intertemporal elasticity of substitution, one could argue that even if the results show some significant changes in quantitative effects, the qualitative assessment of the results is relatively robust. It seems that the reforms increase output but the contribution of capital decreases when agents are less risk averse; also, the reforms increase wealth inequality but less if agents are more risk averse by assumption.

Since tax policy changes affect via labour supply, I also test the sensitivity of the results to the disutility from working parameter γ_0 by using values 0.10 and 0.20 instead of 0.15 used in the benchmark simulation. Table 6 shows some small changes in quantities, but in general, the results are relatively robust as regards to the disutility from working parameter γ_0 .

Table 6. Sensitivity analysis of γ_0 .

γ_0	Tax policy	K	N	$\overline{n}$	r	$Gini_l$	$Gini_w$	$\sigma_n / \overline{n}$
1	Progressive labour taxes	3.69	0.337	0.323	7.79	0.216	0.406	0.319
1	Flat-rate labour tax	3.90	0.337	0.323	7.52	0.219	0.410	0.321
1	Consumption tax	4.20	0.341	0.327	7.22	0.212	0.417	0.319
2	Progressive labour taxes	3.33	0.303	0.290	7.76	0.219	0.398	0.322
2	Flat-rate labour tax	3.50	0.303	0.290	7.53	0.222	0.413	0.325
2	Consumption tax	3.80	0.307	0.294	7.19	0.215	0.423	0.321

IV Essay III:

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

Abstract

Labour income taxes in Finland decreased considerably during the period 1996-2008. At the same time the Finnish economy grew rapidly. Nevertheless, there was another coincidental 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 contributed to this trend in inequality. The study also examines how much more employment was achieved owing to the labour tax reforms. To answer these questions, I have built a dynamic general equilibrium model with heterogeneous agents. The model has been calibrated to fit the Finnish economy. The study finds that the labour income tax cuts fractionally raised the Gini coefficient for net labour income. They 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

* I would like to thank Svante Henriksson and Mikael Kirkko-Jaakkola for assistance with tax data. I would also like to thank my supervisor Professor Matti Virén, Tomi Kortela, and participants of several seminars for their helpful comments. Financial support from the Employee's Foundation and OP-Pohjola Group Research Foundation is gratefully acknowledged.

1. Introduction

Since the middle of the 1990s Finnish labour income taxes have decreased considerably. Many other Western countries have also seen major tax reforms during the last few decades. Not only the level but also the progressivity of the tax systems has been changed. The shift in many countries has been towards a less progressive tax system, at least when all the forms of taxation are taken into account. This result holds, for instance, for the United States or the United Kingdom, as has been examined in Piketty and Saez (2007).[47] However, when one examines 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.

Finnish governments have been motivated to change tax rates in order to improve employment and to lower the marginal tax rates that have historically been relatively high in Finland. How much employment has improved owing to the reforms is still a matter of debate. For instance, Sinko (2002) finds rather modest estimates for the gains. However, 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).[48] OECD (2011) also reports the rapid rise in inequality from the mid-1990s to the 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 the 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 by a dual system that treats capital and labour income with a different tax code. Riihelä et al. (2001, 2010) stress the changes in the capital incomes of households, and

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

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 in both income and wealth distribution are examined. The study also contributes to the question of how much more employment has been attained owing to the labour tax reforms. To answer these questions the paper builds a dynamic 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 have been explicitly incorporated into the model structure.

The basic features of the model build upon 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 also has 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 with the conclusion that efficiency gains from flattening taxes come at the 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.

The heterogeneous agent framework allows us to look at the way in which different types of agents respond to labour tax changes. The 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, owing 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 types of agents in order to understand the employment and distributional effects of tax changes.

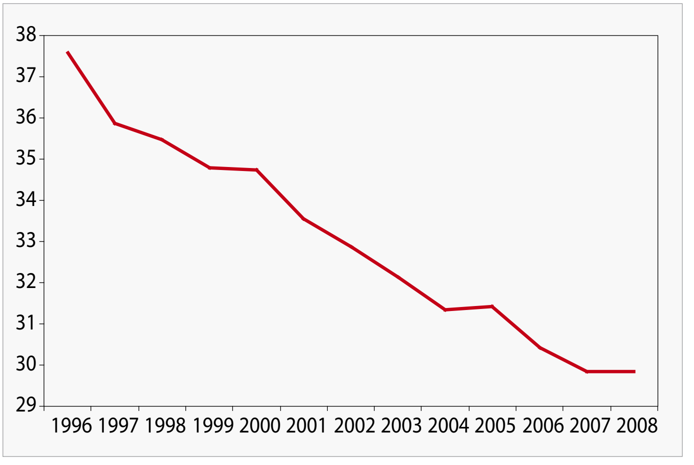
The paper finds that changes in Finnish labour taxation in the period 1996 – 2008 have improved employment by 1.4 per cent. Hence the reforms have produced gains in employment, but these are relatively modest in magnitude. Also, as a result of the tax cuts, the capital stock of the economy has increased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

The paper is organized as follows. Section 2 summarizes the main changes in Finnish labour taxation and inequality in the period 1996-2008. Section 3 presents the model used in the analysis, and the parameters of the model are calibrated in section 4. Section 5 analyzes the results of the paper carefully. The 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 per cent in 1996 to less than 30 per cent in 2008, which is depicted in Figure 1.

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



[1] The data is from the Government Institute for Economic Research and the Labour Institute for Economic Research.

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 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 the progressivity of the tax system has also been changed. This is depicted in Figure 2, which shows the average tax rates for each (nominal) wage rate in 2008 and 1996, and in Figure 3, which shows the change in the average tax rate for each nominal wage.

Figure 2. Average wage income tax and nominal incomes.

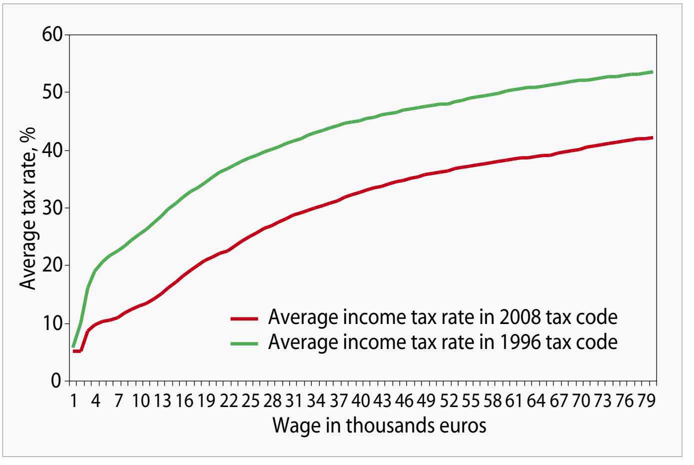
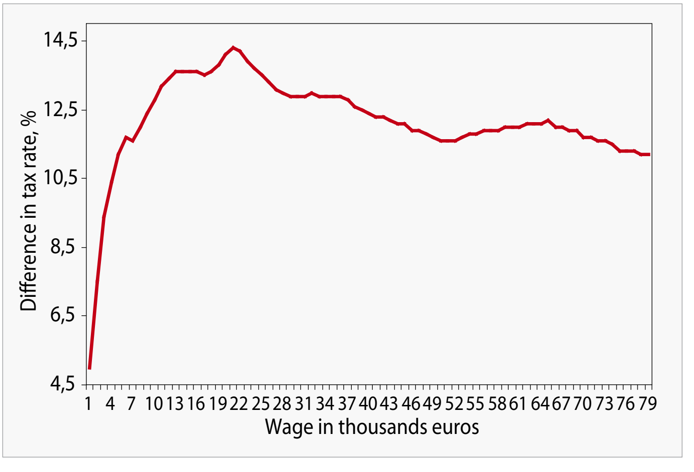
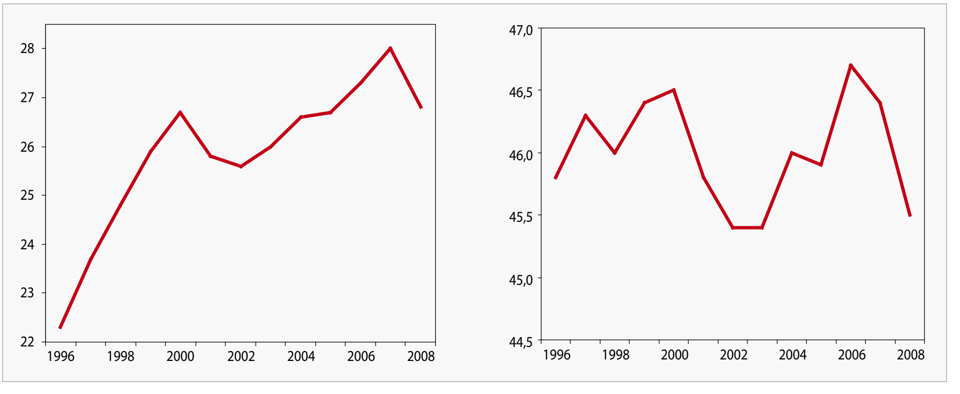


Figure 3. The differences between 2008 and 1997 tax codes.



At the same time the Finnish economy has grown rapidly, at an average rate of 3.7 per cent per year. Employment has also improved considerably. Nevertheless, the contribution of tax cuts to an improvement in employment is debatable, whereas the outcome is more likely to be due to a good global economic performance in this period. This 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 if one looks at the Gini coefficient of household disposable income in Finland in the period 1996-2008 (to the left in Figure 4). The coefficient was 22.3 in 1996, but amounted to 26.8 in 2008 and has continued rising after that. During the same period there is no trend in the Gini coefficient of factor income, which is the market income before taxes and transfers. Thus, policy decisions have played an important role in determining 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 few 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, tax changes have also 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 of 1993. In this reform the comprehensive income tax system was replaced by a dual income tax system that treats capital and labour income differently. Labour income is now taxed progressively, but capital income is taxed at a proportional rate. Riihelä et al. associate the reform with the rapid increase in capital income at the top of the income distribution.

Thus, there have been changes in both 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. The study also examines how much more employment is attained owing to the tax reforms, since, after all, that was the government's main aim when it changed 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 us 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 the idiosyncratic risk of unemployment. The basic features of the model structure build upon 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 carried out in the Finnish labour tax system during the last few decades. So the paper carefully incorporates the changes made in the Finnish labour income tax system and calibrates the model to fit the Finnish data. When compared with the paper by Heer and Trede, I also assume that the risk of unemployment is a little lower among high-income workers, whereas Heer & Trede assume it to be equal among all workers. In general, the model has many similarities to Lehmus (2011), but in this paper consumption taxes have been excluded from the analysis, and it is the level of government expenditures that balances the government budget. An even more relevant difference is that the progressive income taxes have now been 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 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 compensation.

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:[49]

[49] 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.

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

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:

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

Here r_t denotes the interest rate and w_t is the wage rate. The progressive tax rate τ_w is a function of labour hours (n_t) and the 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 $\left(\varepsilon=\varepsilon^1\right)$ and zero otherwise. The unemployed agent is allowed for unemployment compensation b_t, which is defined relative to the net 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:

$$Y_t=N_t^{1-\alpha} K_t^\alpha \quad . \tag{5}$$

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:

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

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

where δ is the capital depreciation rate.

3.3. Government

Government raises revenues by taxing the 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 it 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, have been 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 like the following:

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

where x denotes the labour income, i.e. the effective wage rate multiplied by the 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 have been collected with the help of the Taxpayers' Association of Finland (TAF). The wages in 1996 have been 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 the following hold:

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

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

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

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

$$T=\tau_w wN \ , \tag{13}$$

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

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 $\varepsilon' \in \mathrm{E}$ 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 the calibration of progressive taxes. Also, consumption taxes have been excluded from this analysis. The model period corresponds to years. The data have been 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 have been chosen to replicate certain features in the Finnish labour markets. The parameters σ, β, α, and δ have been chosen from among typically used estimates in the literature with the aim of fitting the stylized facts of the

Finnish economy to the model. 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 $\{\varepsilon^2, \varepsilon^3, \varepsilon^4, \varepsilon^5\}$ have been chosen to match the discretized distribution of monthly wages. These have been estimated from the empirical distribution of the monthly wages of the connected Finnish industrial employee and service employer data. The data have been provided by the Confederation of Finnish Industries (EK) and refer to the 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 the following:

$$\{\varepsilon^2, \varepsilon^3, \varepsilon^4, \varepsilon^5\} = \{0.5701, 0.7938, 1.0367, 1.5994\} . \tag{18}$$

This can be compared with Heer & Trede (2003) for the German economy. The transition probabilities into and out of unemployment, i.e. $\pi(\varepsilon' = 0 | \varepsilon > 0)$ and $\pi(\varepsilon' > 0 | \varepsilon = 0)$, have been 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 that the average duration of unemployment is slightly more than one year. I also assume that the unemployment risk gradually decreases with productivity; the way in which this is imposed can be seen in the first column of the transition probability matrix (19). This assumption differs 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 a lower unemployment risk than their low-productive counterparts.

It is also assumed that after unemployment the agent can only reach productivity ε^2, so workers' skills 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 remaining 4×4 part of the transition matrix, have been calibrated to match the observed quartile transition probabilities in the Finnish micro-data. The transition probabilities refer to sequential years and they have been estimated from the connected Finnish industrial employee and service employer data for the years 2007 and 2008. The transition matrix I obtain looks like the following:

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

Lehmus (2011) discusses the way in which 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 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 the value of 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 typically gets 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 have been 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 have been 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.

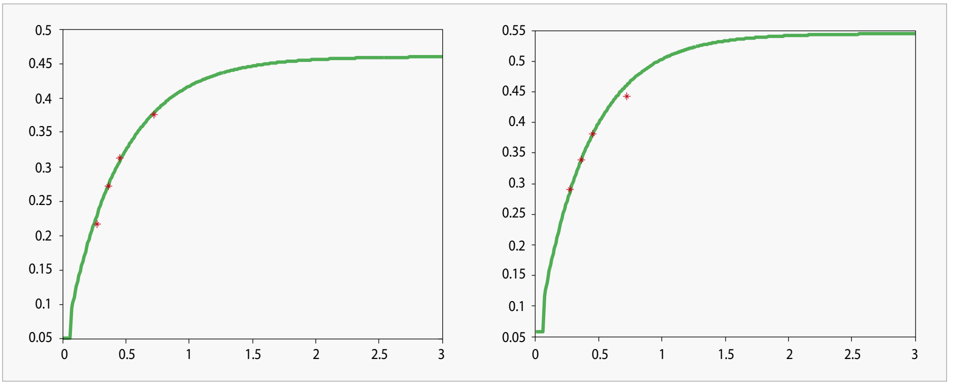
4.3. Government and progressive taxes

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, net of taxes, 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 to the long-term unemployed or job seekers who enter the labour market for the first time is considerably smaller. Thus, the replacement ratio has been calibrated to 0.52 in the model economy.

The progressive labour income tax schedules of 2008 and 1996 have been imposed by parameterization of tax function equation (8). The parameters in (8) have been set so that the function produces the average income tax rates that are consistent with the real tax rates observed in the data. The parameters have been found by minimizing the squared sum of the difference between real observations and model projections. So the parameters I obtain for (8) are $\phi_{08} = 0.46$, $\varphi_{08} = 0.43$, and $\eta_{08} = -2.3$ for the year 2008 and $\phi_{96} = 0.545$, $\varphi_{96} = 0.51$, and $\eta_{96} = -2.5$ for the year 1996.The fit of the resulting tax functions can be seen from Figure 5, which plots the real tax rates of the agents in each wage quartile and the average tax rates (for each set of earnings) produced by the model.[50] The average tax rate is plotted on the vertical axis and the labour income on the horizontal axis.

[50] 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 the figures it 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.[51] 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.

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

[51] There is only a 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 which 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 types of agents. I begin with a 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. The labour supply is an increasing function of productivity; this is due to the fact that the substitution effect is stronger than the income effect. On the other hand, the 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 the average of the empirical capital-output ratio in Finland in the period 2006-2010.[52] The model produces the Gini coefficient for gross wages (Gini_1) 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).[53] In the benchmark simulation, the Gini coefficient for net wage income equals 17.5, while the progressive labour taxes dampen 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.

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

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 with the empirical Gini coefficient for household disposable income in 2008, which was 26.8, which is then greater than the model coefficient. Nevertheless, the gap between these figures is explained by the fact that the net incomes calculated in the model coefficient do not include capital gains and dividends paid to households. In addition, the model economy excludes some low-income groups such as students and retired persons who are not included in the labour markets, which sets the model Gini coefficient lower than in the data. In the model steady state, the Gini coefficient for wealth ($Gini_w$) equals 41.8. This is somewhat smaller than its empirical counterpart, which amounted to 57.9 in 2009.[54] Even if the model cannot fully replicate the empirical distribution of wealth, the estimates in general are consistent enough for a comparison of the 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 of 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 0.318. This is somewhat larger than its empirical estimate (0.24) calculated from the connected Finnish industrial employee and service employer data for the year 2008. However, the calculated empirical estimate may be downwards biased owing to the reasons discussed in Lehmus (2011). In the model equilibrium, the labour supply elasticity with respect to the 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 were between 0.1 and 0.2.[55]

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

Table 2. The benchmark simulation and empirical values.

	K/Y	Unemp.	Gini_1	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 per cent above the level of 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 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 the 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 made over the period between 1996 and 2008, the total employment of the economy has increased by 1.4 per cent (0.302/0.298). Hence the increase is relatively modest, but yet 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, the capital stock of the economy has also risen by 3.2 per cent (3.25/3.15). Using the Cobb-Douglas production function of the model this contributes to a 2.0 per cent increase in the total output of the economy.

The increase in the labour supply is shared by all the model agents, but there are some differences in the size of the responses between agents. As a result, the Gini coefficient for gross labour income amounts to 21.9 with the 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 the labour taxes of 1996.

This suggests that there has been a shift towards a less progressive labour tax system since 1996. Thus, the results show that the labour tax system has become less progressive even if low-income workers have benefited 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 to a rise in inequality, although the magnitude of the change is moderate.

In addition, the tax cuts have led to an 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 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 point higher owing to the tax cuts made after 1996.

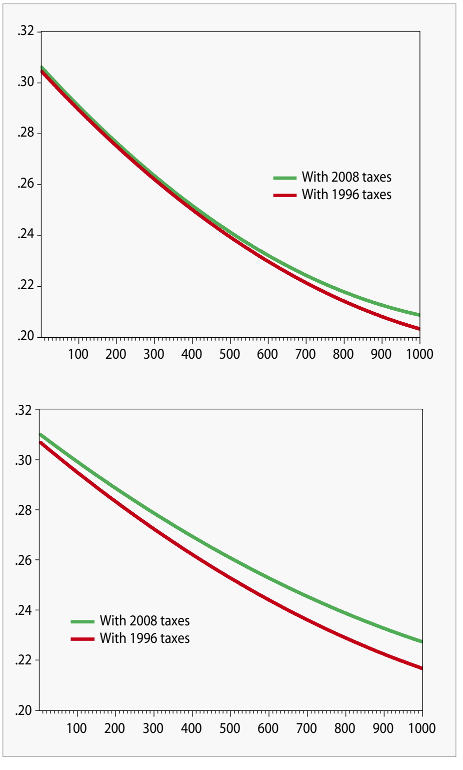
Table 3. Effects of tax policies.

Tax policy	K	N	Y	$\overline{n}$	$Gini_l$	$Gini_{ln}$	$Gini_{lna}$	$Gini_w$
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 types of households, I examine the labour supply effects of each productivity group more carefully. Figure 6 illustrates the labour supply response of productivity types 2 and 3 to the tax changes; productivity group 2 denotes agents in the lowest wage quartile, and group 3 denotes agents in the second lowest wage quartile. The labour supply is plotted on the vertical axis, and an agent's wealth is plotted on the horizontal axis, while the line shows how the labour supply decreases with wealth.[56] 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).

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

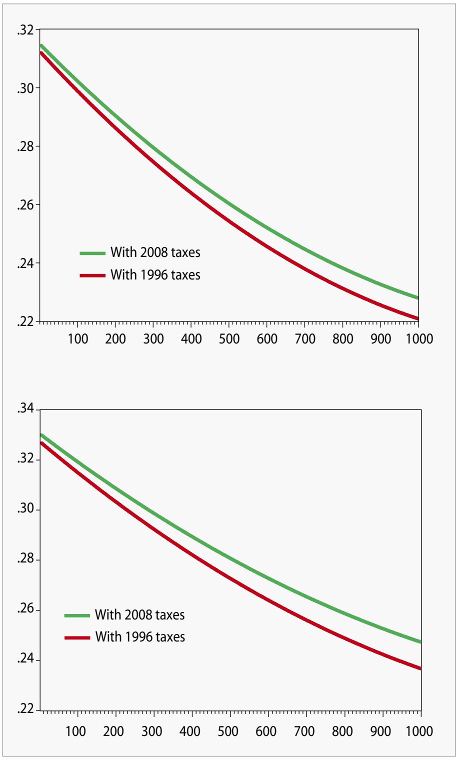
Figure 6. Labour supply of productivity-type 2 (above) and 3 (below).



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 consists 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 the 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 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.

Over the period between 1996 and 2008, the total Finnish employment increased by almost 20 per cent. 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 owing to the cuts in labour taxation. Thus, the results are, in fact, comparable to Sinko (2002), who finds that tax cuts contribute to 10 per cent of the increase in Finnish employment in the period 1997-2002. If compared with 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

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



flattened and the level of capital taxes is also changed, and this explains the differences between the results.

The critical parameter affecting the size of the employment response produced by the model is, naturally, labour supply elasticity with respect to the 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 the 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 the 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 that 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 the 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 the 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 the 1990s, the rise in inequality has been particularly rapid in Finland. In this study, I examine to what extent labour tax cuts made by the Finnish government over the period between 1996 and 2008 are responsible for this development. The study also analyzes 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 per cent which corresponds to 8.5 per cent 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. The capital stock has also increased as a result of the tax cuts, and this together with employment gains has contributed to a 2.0 per cent increase in output. Agents, especially those 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. In 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, owing to some restrictions in the model. First, the model economy consists of agents whose labour supply can only be adjusted along the intensive margin. Hence, the changes along the extensive margin have been excluded from the analysis. In addition, 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 the last decade and proves that they have produced a moderate, but still significant, increase in Finnish employment, but are at the same time partially responsible for the rising inequality.

References

Aiyagari, S. R. (1994): Uninsured Idiosyncratic Risk and Aggregate Saving. *Quarterly Journal of Economics*, Vol. 109, 659-84.

Castañeda, A., Díaz-Giménez, J. and Ríos-Rull, J.-V. (2003): Accounting for the U.S. earnings and wealth inequality. *Journal of Political Economy*, Vol. 111, 818–857.

Heer, B. and Maussner, A. (2009): *Dynamic General Equilibrium Modeling. Computational Methods and Applications*. Springer-Verlag Berlin Heidelberg. 2nd Edition.

Heer, B. and Trede, M. (2003): Efficiency and Distribution Effects of a Revenue-neutral Income Tax Reform. *Journal of Macroeconomics*, 25, 87-107.

Ilmakunnas, S. (1997): Female Labour Supply and Work Incentives. *Labour Institute for Economic Research, Studies 68.*

Lehmus, M. (2009): Empirical Macroeconomic Model of the Finnish Economy (EMMA). *Economic Modelling*, Vol. 26, Issue 5, 926–933.

Lehmus, M. (2011): Labour or consumption taxes? An application with a dynamic general equilibrium model with heterogenous agents. *Economic Modelling*, Vol. 28, Issue 4, 1984–1992.

Nishiyama, S. and Smetters, K. (2005). Consumption taxes and economic efficiency with idiosyncratic wage shocks. *Journal of Political Economy,*113(5), 1088-1115.

OECD (2008): Growing Unequal? Income Distribution and Poverty in OECD Countries. OECD Publishing.

OECD (2011): Divided We Stand: Why Inequality Keeps Rising. OECD Publishing. *http://dx.doi.org/10.1787/9789264119536-en.*

Ohanian, L., Raffo, A. and Rogerson, R. (2008): Long-term changes in labor supply and taxes: Evidence from OECD countries, 1956–2004. *Journal of Monetary Economics*, Vol. 55, Issue 8, 1353-1362.

Pijoan-Mas, J. (2006): Precautionary savings or working longer hours? *Review of Economic Dynamics*, 9, 326-352.

Piketty, T. and Saez, E. (2007): How Progressive is the U.S. Federal Tax System? A Historical and International Perspective. *Journal of Economic Perspectives*, 21(1), 3-24.

Riihelä, M., Sullström, R. and Tuomala, M. (2001): What Lies Behind the Unprecedented Increase in Income Inequality in Finland During the 1990's. *VATT Discussion Papers 247.*

Riihelä, M., Sullström, R. and Tuomala, M. (2010): Trends in top income shares in Finland 1966-2007. *VATT Research Reports 157.*

Sinko, P. (2002): Labour tax reforms and labour demand in Finland 1997-2001. *VATT Discussion Papers 273*.

Turkkila, J. (2011): Real Changes in Personal Income Taxation in Finland. Dissertation (*ETLA A 46*).

Ventura, G. (1999): Flat-rate tax reform: A quantitative exploration. *Journal of Economic Dynamics and Control,* 23(9-10), 1425-1458.

Appendix 1

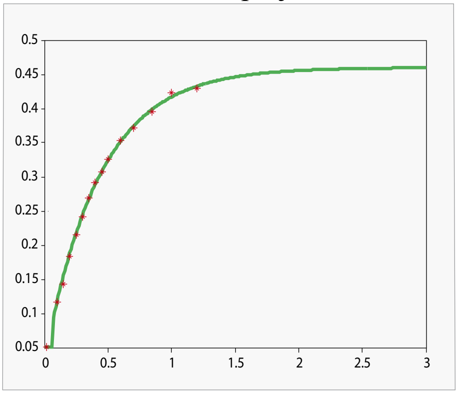
The basics of the solution algorithm follow Heer & Maussner (2009, p. 379-381). The benchmark case of the paper is described in the following steps.

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.

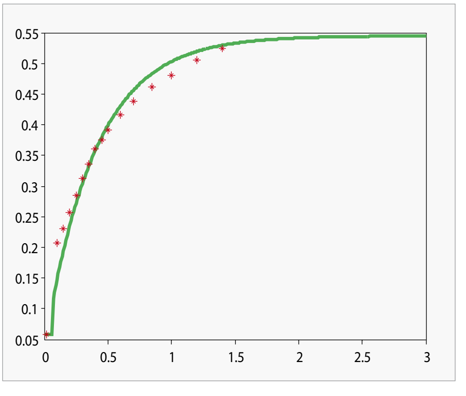
The household optimization problem is solved with value function iteration. The value function is discretized using an equispaced grid K of 1,000 points on the interval $[0, k^{\max}]$. The value function is initialized with an assumption that agents use 20 per cent of their time for working and that 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 the 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_1, γ_0	Tax policy	K	N	Y	$\overline{n}$	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 the 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 per cent increase found using benchmark parameterization. Also, the capital stock rises by 5.5 per cent, and this, together with the employment change, produces a 4.0 per cent increase in output. The distributional effects also become slightly larger compared with 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 0.271 with 2008 taxes, while its value in the data 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. But with $\sigma=2$, agents are more risk-averse, and precautionary motives dominate their behaviour. Thus, agents prefer to save the marginal increase in their net incomes, and the 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 of 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

PALKANSAAJIEN TUTKIMUSLAITOS

LABOUR INSTITUTE FOR ECONOMIC RESEARCH

Pitkänsillanranta 3A, 6.krs 00530 Helsinki Finland

p. 09-2535 7330 (Tel. +358-9-2535 7330)
fax 09-2535 7332 (Fax +358-9-2535 7332)
www.labour.fi

Palkansaajien tutkimuslaitos harjoittaa kansantaloudellista tutkimusta, seuraa taloudellista kehitystä ja laatii sitä koskevia ennusteita. Laitos on perustettu vuonna 1971 Työväen taloudellisen tutkimuslaitoksen nimellä ja on toiminut nykyisellä nimellä vuodesta 1993 lähtien. Tutkimuksen pääalueita ovat työmarkkinat, julkinen talous, makrotalous ja talouspolitiikka. Palkansaajien tutkimuslaitosta ylläpitää kannatusyhdistys, johon kuuluvat kaikki Suomen ammatilliset keskusjärjestöt, SAK, STTK ja AKAVA sekä suurin osa näiden jäsenliitoista.

The Labour Institute for Economic Research carries out economic research, monitors economic development and publishes macroeconomic forecasts. The Institute was founded in 1971. The main areas of research are labour market issues, public sector economics, macroeconomic issues and economic policy. The Labour Institute for Economic Research is sponsored by an association whose members are the Finnish central labour confederations like the Central Organisation of Finnish Trade Unions (SAK), Finnish Confederation of Salaried Employees (STTK) and the Confederation of Unions for Academic Professionals in Finland (AKAVA), and many of their member unions.

Hinta 13,50 e
ISBN 978-952-209-107-9 (Nid.) ISSN 1236-7176 (Nid.)
ISBN 978-952-209-108-6 (PDF) ISSN 2242-6922 (PDF)