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TIIVISTELMÄ

Tutkimuksessa tarkastellaan sellaisen veroreformin vaikutusta, jossa verotuksen painopiste siirretään palkkojen verottamisesta puhtaasti kulutuksen verottamiseen. Tässä yhteydessä käsitellään myös palkkaverotuksen progression vaikutusta. Vaikka verotuksen painopisteen siirtäminen kulutusveroihin on viime aikoina lisännyt suosiotaan monella taholla, sen positiiviset vaikutukset voidaan kyseenalaistaa sillä perusteella, että kulutuksen verottaminen vaikuttaa työn tarjontaan samaan tapaan kuin palkkatulojen verottaminen. Tässä tutkimuksessa tarkastellaan veroreformin vaikutuksia dynaamisella yleisen tasapainon mallilla, jossa agentit ovat heterogeenisia. Malli kalibroidaan vastaamaan tiettyjä piirteitä Suomen taloudessa. Tehokkuusvaikutusten lisäksi tarkastellaan myös veroreformi(e)n vaikutusta tulonjakoon. 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.

Avainsanat: verotus, yleisen tasapainon mallit, heterogeeniset agentit

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 welfare 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 efficiency effects, I study the tax reform's effect on income and wealth distribution. First, I find that eliminating progressivity in labour taxation increases efficiency 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.

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. 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. 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 income tax with a consumption tax would produce long-run output gains of 3.2 percent to 9.7 percent when compared to the current system in the U.S. Heer & Trede (2003) study the efficiency 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 efficiency, 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 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. 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.[1]

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. 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 het*erogeneous 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, 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 flat-rate labour tax produces a slightly more efficient economy with fractionally more inequality. The efficiency effect is

[1] 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.

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. The sensitivity analysis shows that with less risk averse agents, the contribution of capital to the efficiency effect decreases but wealth concentration increases more when compared to the benchmark results.

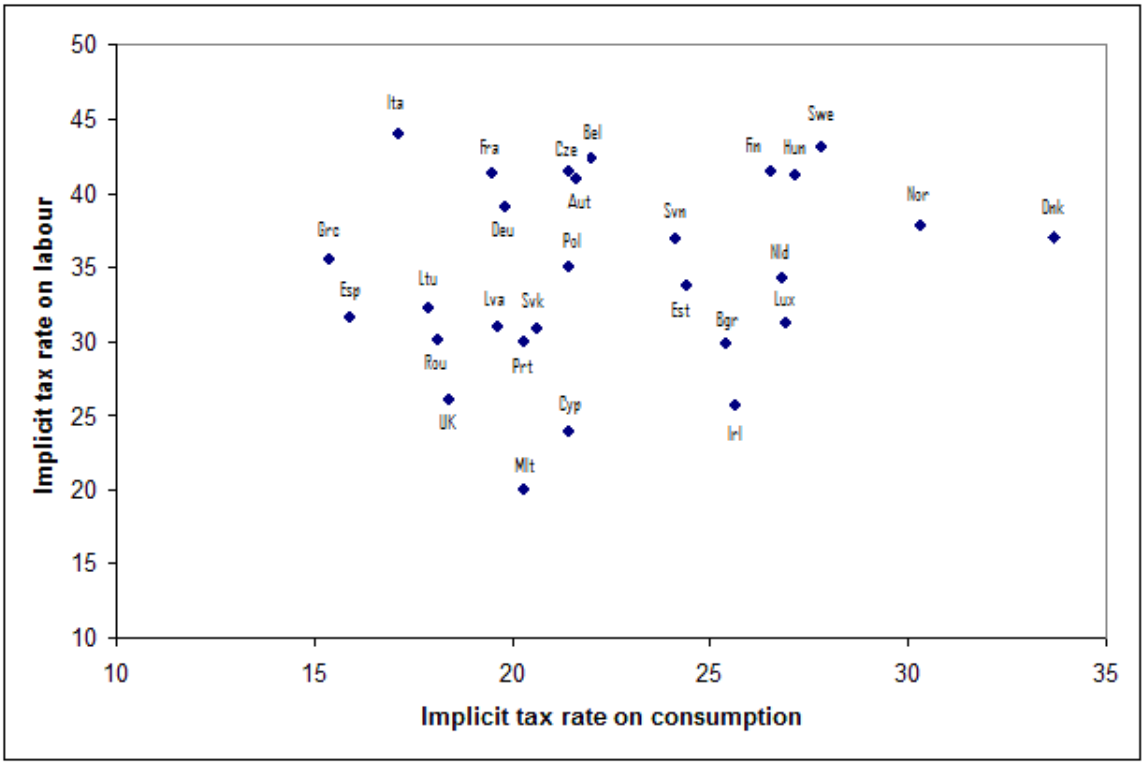
The paper is organized as follows. Section 2 discusses the theoretical aspects of labour and consumption taxes. Section 3 introduces the model I use for simulation, and in section 4 the model parameters are calibrated. In section 5 I discuss the results from different tax policies. Final section concludes.

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.[2] The common argument is that consumption taxes, unlike income taxes, do not discourage saving**.** The starting position for the reform looks very different across countries. This can be seen from the figure below which shows the implicit tax rates on consumption and labour taxes 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.

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

Figure 1. Implicit tax rates on consumption and labour.[3]



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 analyzed by Coleman (2000). He considers 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.

[3] Source: Eurostat.

Coleman defines some constant $\bar{t}$, and chooses $t_t^c = \bar{t}$, $t_t^l = -t_t^c$, and $t_t^k = 0$. From that follows that he has a constant tax rate on consumption and a subsidy to labour at the tax rate imposed on consumption, and a zero tax rate on capital. In order to this tax policy to be optimal, $\bar{t}$ 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 results holds only if the value of initial assets exceeds the value of government consumption, i.e. if

$$a_0 > \sum_{t=0}^{\infty} q_t g_{1t} \ , \qquad (1)$$

where a_0 denotes the initial assets, q_t is a state price vector, and g_{1t} is government consumption.[4] 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 welfare of implementing only a consumption tax makes the net welfare 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 welfare and efficiency 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 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

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

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 increase efficiency by adding the insurance provided by the tax system.

3. MODELLING THE EFFECTS OF TAX REFORM

Typical macro studies concerning the effects of tax changes are made using the assumption of a representative agent. However, this is a bit of an 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 efficiency effects, but also the distributional effects of tax changes.

In this study I use dynamic general equilibrium model with heterogeneous agents to assess the efficiency 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 which are subject to idiosyncratic shocks. Hence agents are mobile and their productivity and employment status may change between periods. The model and its solution technique utilize the aspects of the framework presented in Heer & Trede (2003).[5] 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

[5] Their model and its solution is also presented in the textbook of Heer & Maussner (2009). The framework is also related to the studies of Ventura (1999) and Castaneda, Diaz-Gimenez and Rios-Rull (1998).

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 e^j and their wealth k^j, $j \in [0,1]$. Productivity is assumed to take a value from the finite set $\mathrm{E} = \{e^1, e^2, ..., e^{ne}\}$, where $e^1 = 0$ is the state of unemployment. The number of productivities in this model is set equal to $ne = 5$.[6] Productivity follows the first-order finite-state Markov chain with transition probabilities given by

$$p(e'|e) = \Pr\{e_{t+1} = e'|e_t = e\} \tag{2}$$

where $e, e' \in \mathrm{E}$. As well as Heer & 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.[7]

Household j with productivity e_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:

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

where b 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 given by the following:

$$u(c_t, 1 - n_t) = \frac{c_t^{1-s}}{1-s} + g_0 \frac{(1-n_t)^{1-g_1}}{1-g_1} \tag{4}$$

[6] In this context, it is worth noting that the model economy does not comprise agents that do not attend in the labour markets, namely 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.

[7] See Shorrocks (1976).

Castañeda, Díaz-Giminénez, and Ríos-Rull (1998) discuss the reasons for choosing this kind of non-standard utility function. They state that this function mimics better the empirical differences in earnings and wealth, and also, that with this function the distribution of working hours varies less than with the standard Cobb-Douglas preferences (and hence the behaviour is more 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:

$$k_{t+1}^j = (1+r_t)k_t^j + (1-t_w^j)w_t n_t^j e_t^j - (1+t_c)c_t^j + 1_{e=e^1} b_t, \tag{5}$$

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

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:

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

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:

$$r_t = a\left(\frac{N_t}{K_t}\right)^{1-a} - d \tag{7}$$

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

where d 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). 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. t_w^1, which characterizes the state of unemployment, is set to zero. The income tax rates for the rest of agents, $\{t_w^2, t_w^3, t_w^4, t_w^5\}$, are taken from the calculations of the Taxpayers' Association of Finland for year 2008. The income tax rate t_w^i relates to the average monthly wage rate of earners in the $(i-1)$-th quartile.[8]

I will compare the employment, saving, and distribution effects of the current labour tax system with the effects of imposing a flat tax on labour or only a consumption tax. In the latter case, wage tax rate is set to zero. In both cases, 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 $V(e,k)$, individual policy rules $c(e,k)$, $n(e,k)$, and $k'(e,k)$ for consumption, labour supply, and next-period capital, respectively, a time-invariant relative prices of labour and capital $\{w,r\}$, time-invariant distribution $F(e,k)$ for the state variable $(e,k) \in \mathrm{E} \times [0,\infty)$, 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:

[8] Heer & 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 more simple but less accurate description of the progressive income tax system. Thus, in our model, the progressive labour taxes only approximate the empirical tax system.

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

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

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

$$T = t_w w N + t_c C \,, \tag{13}$$

$$B = \int_0^{\infty} b \, f(e_1,k) dk \tag{14}$$

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

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

where k' and e' 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:

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

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

6. The distribution of the individual state variable is constant

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

for all $k' \in [0,\infty)$ and $e' \in \mathrm{E}$ and with $k' = k'(e,k)$

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

Prior to solving the model and assessing the effects of different fiscal polices, the model parameters have to be calibrated. The model period corresponds to years and the data is provided by the Confederation of Finnish Industries (EK) and the Statistics Finland. The utility parameters g_0 and g_1 together with productivities e^j, the transition probabilities $p(e'|e)$, and public consumption g_g are chosen to replicate certain features of the Finnish economy, particularly the labour markets. The parameters s, b, a and d are chosen among typically used estimates in the literature and b is a rough approximation.

4.1. Productivity

The productivities $e \in \mathrm{E} = \{e^1, e^2, ..., e^5\}$ are chosen to mimic the discredited distribution of monthly wage rates, i.e. I assume wages to be proportional to productivity. Unemployment is chracterized by e^1 which is set to zero. Productivities $\{e^2, e^3, e^4, e^5\}$ are estimated from the empirical distribution of the monthly wages of the connected Finnish industrial employee and service employer data. Although this data do not cover all the economy, it is considerably large and hence can be said to approximate the Finnish economy. In a similar logic as above with the income tax structure, the productivity e^i corresponds to the average monthly wage rate of earners in the $(i-1)$-th quartile. Following Heer & Trede (2003), I normalize the average of the four nonzero productivities to unity, which gives:

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

The transition probabilities into and out of unemployment, i.e. $p\left(e'=0|e>0\right)$ and $p\left(e'>0|e=0\right)$, are chosen to imply an average unemployment rate of 8.64% and an average duration of unemployment slightly more than one year. It is assumed that the probability to loose one's job depends on individual productivity so that for a higher-productivity worker the risk of loosing job is slightly smaller.[9] The productivity of a worker decreases during unemployment so that he/she can only reach productivity e^2 after unemployment. Hence I set $p\left(e'=e^2|e=0\right)=1-p\left(e'=0|e=0\right)$ and $p\left(e'>e^2|e=0\right)$=0. All the other transition probabilities are calibrated to match the observed quartile transition probabilities of the monthly wage rate from 2007 to 2008 calculated from the connected Finnish industrial employee and service employer data. Unemployment risk is added to each quartile so that the rows in the Markov transition matrix sum to one. Finally, the transition matrix I get is:

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

This matrix describing the mobility of the Finnish workers may be compared to that of Heer & Trede (2003) for the German economy or Castañeda et al. (1998) for the U.S., although the latter uses a slightly different approach. On this basis, German workers look more mobile than their Finnish counterparts.

4.2. Production and utility

The production share of capital is calibrated to 0.36 in the model which is a typical assumption in the literature. Annual rate of capital depreciation d, is set to 0.04. The discount factor is set to 0.96, the preference parameters equal to $s=2$, $g_0=0.15$ and g_1=10. These 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. These two values will be discussed further in chapter 5.1. in which I analyze the results of the benchmark simulation.

[9] By assuming this we make a distinction from Heer & Trede (2003) and Heer & Maussner (2009).

4.3. Government expenditures and taxes

Government consumption is calibrated to imply its share in output equal to 22.6%. This corresponds to its empirical value in 2008. The replacement ratio is assumed to be proportional to the monthly earnings in the lowest quartile. Hence the parameter b, describing the share of the unemployment compensation payment of the lowest quartile monthly earnings, is set equal to 0.52.[10] Progressive labour taxation parameters are set as described in section 3.3. Hence the wage tax rates for each productivity type are the following:

$$\left\{t_w^1, t_w^2, t_w^3, t_w^4, t_w^5\right\} = \{0, 0.22, 0.27, 0.31, 0.38\}.^{11} \quad (20)$$

The consumption taxation parameter, t_c, is endogenously determined in order to balance the government budget. The parameter values are summarized in table 1. Later on, I test the sensitivity of the model results to alternative parameters.

Table 1. Model parameters.[12]

$s = 2$	$g_0 = 0.15$	$g_1 = 10$	$b = 0.96$	$a = 0.36$	$d = 0.04$
$g_g = 0.226$	$b = 0.52$				

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.

[10] This is a rough approximation. The unemployment compensation based on the previous earned salary gives a higher share than 0.52. 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.
[11] These are based on the calculations of the Taxpayers' Association of Finland for year 2008.
[12] Excluding taxation, productivity, and transition parameters.

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 ($e < e^3$) 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.

In a stationary model equilibrium the aggregate capital stock amounts to 3.48. That gives the 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 year 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 year 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.[13] Although the model cannot fully replicate the empirical wealth Gini of Finland, the estimates are good enough for the purpose of making comparisons between different fiscal regimes.[14]

In the model equilibrium, the unemployment rate is 8.64, which is slightly lower than its empirical trend rate at the beginning of the 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.[15]

[13] See Jäntti & Sierminska (2007).
[14] The reasons why the simple heterogenous-agent model is unable to fully replicate the empirical wealth distribution is discussed in Heer & Maussner (2009).
[15] The estimates for females are typically higher than those for males.

Table 2. The benchmark simulation and empirical values.

	K/Y	Unemp.	Gini_{l}	Gini_{w}	$s_n / \bar{n}$	$h_{n,w}$
Benchmark case	4.6	8.6	0.218	0.403	0.32	0.208
Empirical value	4.4	9.1	0.224	0.60-0.70	0.24	0.05-0.4

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. From the results can be seen that eliminating progressivity leads to a very minor rise in the aggregate employment. What actually happens is that high-productive workers, whose taxes are now lowered, increase their working 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 capital stock of the economy rises from 3.48 to 3.66. 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 some extent more efficient economy that is however achieved, in expense of slightly more inequality. If we compare these results to those of Heer & 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 & Trede analyze the reform of income taxes that consist both of labour and capital taxes. In addition, Ventura uses slightly different approach in his study.

Table 3. Effects of tax policies.

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

Although the model captures the efficiency 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 a different welfare effect 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 amounts to 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 the opposite ways on labour supply 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. 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 efficiency effect that comes from the character of a consumption tax as an asset tax. Nevertheless, 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 (from 3.48) while the Gini coefficient of wealth gets a value of 0.420. Hence, the new Gini coefficient of wealth is 1.7 percentage point 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, these 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	$s_n / \bar{n}$
Progressive labour taxes	3.48	0.317	0.304	7.77	0.218	0.403	0.320
Consumption tax	3.96	0.321	0.308	7.21	0.214	0.420	0.319

Again, these results may be compared with Heer & 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 similar kind of results for earnings inequality but larger effects for 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 actually 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.[16] 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 the appendix 2. The analysis shows some significant changes in the quantitative results: it is worth noting that with intertemporal elasticity $s = 1$ labour supply is more, but savings less affected by the reforms; with $s = 3$ the opposite holds. Also with $s = 3$, i.e. when the agents are more risk averse, the distributional effects are not so unambiguous. Otherwise, the qualitative assessment of the results remains the same. The results are robust as regards to the disutility from working parameter g_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. Now, 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.

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

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 welfare 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 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 efficiency, is the reform's effect on income and wealth distribution, i.e. on inequality.

In this study, I use dynamic general equilibrium model with heterogeneous agents to assess the efficiency and distributional effects of tax policy reforms. The agents in the model differ with regard to their productivity and employment status which 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 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 & 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.

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Appendix 1

Following Heer & 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 t_c, and the value function $V(e,k)$.
2. Compute the interest rate r, the wage rate w, and unemployment compensation b.
3. Compute the households' decision functions $k'(e,k)$, $c(e,k)$, and $n(e,k)$.
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 t_c that balances the government budget.
7. Update K, N, and t_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 $e^i, i = 1,...,ne$ 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).

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 & Trede 2003). For instance Jones et al. (1993) use values $s \in \{1,2,2.5\}$ for the calibration of the endogenous growth model. Heer & Trede test the model sensitivity using $s = 1$ and $s = 4$. Following these studies, I test the sensitivity of the results using values 1 and 3 for s. The results look the following:

Table 5. Sensitivity analysis of s.

s	Tax policy	K	N	$\bar{n}$	r	Gini_l	Gini_w	$s_n / \bar{n}$
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. $s = 1$, 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 $s = 3$ 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 the 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 point. 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 efficiency 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.

While tax policy changes affect via labour supply, I also test the sensitivity of the results to the disutility from working parameter g_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 g_0.

Table 6. Sensitivity analysis of g_0.

g_0	Tax policy	K	N	$\bar{n}$	r	$Gini_l$	$Gini_w$	$s_n / \bar{n}$
0.10	Progressive labour taxes	3.69	0.337	0.323	7.79	0.216	0.406	0.319
0.10	Flat-rate labour tax	3.90	0.337	.323	7.52	0.219	0.410	0.321
.10	Consumption tax	4.20	0.341	.327	7.22	0.212	0.417	0.319
.20	Progressive labour taxes	3.33	0.303	.290	7.76	0.219	0.398	0.322
.20	Flat-rate labour tax	3.50	0.303	.290	7.53	0.222	0.413	0.325
.20	Consumption tax	3.80	0.307	.294	7.19	0.215	0.423	0.321