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A Comparative General Equilibrium Analysis of the Estonian Labour Market

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A COMPARATIVE GENERAL EQUILIBRIUM ANALYSIS OF THE ESTONIAN LABOUR MARKET*

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Abstract: This paper analyses the impact of several tax-benefit reforms on the employment of different skill groups under various wage formation systems. We adapt a general equilibrium model initially developed for the Finnish economy by Alho (2006), combining it with elements from Bovenberg *et al.* (2000) and Hinnosaar (2004a, b). Policy simulations demonstrate the importance of wage setting for the outcome. In the case of Estonia, market determined wages outperform bargained wages, which could imply an important difference between the EU-15 countries and the new member states in general. Additionally, the labour supply of the low-skilled is most effectively increased by lowering the marginal income tax rate, which combined with strategies increasing the overall employment, could potentially improve the labour market position of those with lower skills.

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1. Introduction

The European Union countries are increasingly concerned about their competitiveness in the global market. One of the central issues is related to the functioning of the labour market and social protection systems. In frequent comparisons of the US and the EU labour market, the latter has been considered more regulated and rigid, which again has been associated with higher unemployment rates. On the other hand, labour in Europe enjoys higher social protection standards. Under the pressure of global processes, current trends are towards adjustments in tax-benefit systems, which could increase work incentives and improve flexibility of labour market without scaling back social protection too much (Carone and Salomäki, 2001). Also the re-launched Lisbon Strategy and the underpinning integrated guidelines advocate more employment friendly tax-benefit systems.

The enlargement of the EU in 2004 introduced new member states, which, having relatively decentralised labour markets, also contrast with the EU-15 countries. There are some concerns that this could lead to social dumping. In this context, the new member states have a dilemma as to which way to proceed – continuing the market-oriented flexible approach or shifting to a more centralised bargaining and protective system. There is some empirical evidence that a bell-shaped relationship exists between the centralisation of wage bargaining and the unemployment level (Calmfors and Driffill, 1988), possibly making choices in-between relatively unfavourable.

In this paper we take Estonia as one example of the new member states and try to answer whether it would be beneficial to implement a tax-benefit system more akin to those found in the old EU countries. Estonia is a small open economy conducting liberal economic and tax policy. Recent and on-going tax-benefit reforms aimed at lowering the income tax burden and to increase unemployment and subsistence benefits represent a good opportunity to model the outcome under various wage formation hypotheses.

We adopt a computable general equilibrium (CGE) model initially developed for Finnish economy as a part of the TAXBEN project, see Alho (2006), but also with elements from the models of Bovenberg *et al.* (2000) for Dutch and Hinnosaar (2004a, b) for Estonian economy.

The main features of the model are the following. There are two production factors – capital and labour, the latter divided further into three skill groups based on educational attainment. Firms are symmetric and produce one homogenous good. The goods market is characterised by monopolistic competition, implying positive profits for firms. The foreign sector is not explicitly modelled, domestic firms compete with foreign firms in the international market and it is assumed that the domestic price level of goods equals the international price level. Households earn labour income, receive distributed profits and unemployment benefits. Their utility depends on leisure, private consumption, on which all the income is spent, and public consumption. Government has a passive role of spending all tax income on unemployment benefits and public consumption. Tax revenue is generated by income taxes on labour and capital and employers' social security contributions. Throughout the model, functions with constant elasticity of substitution (CES) have been used (e.g. for production, aggregation of production factors, utility).

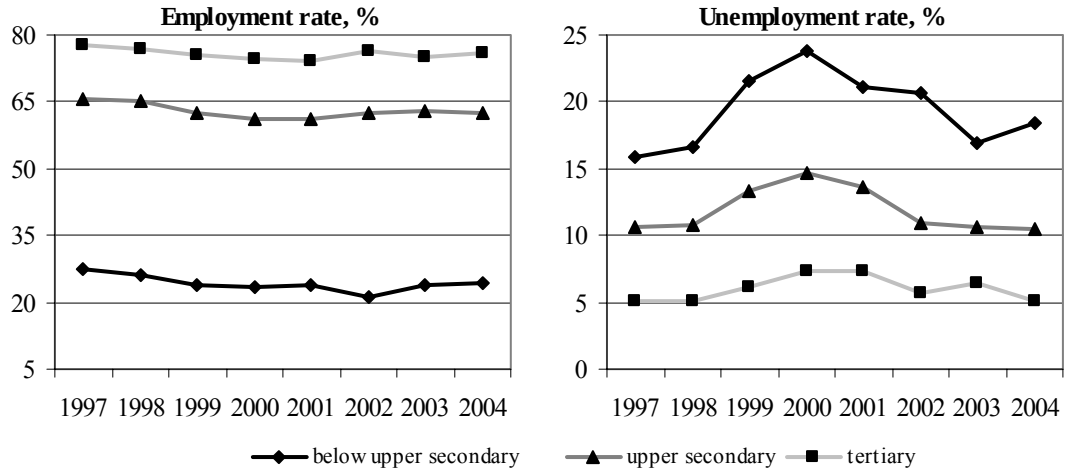
Three different structures of wage formation are modelled. First, fixed wages, which in case of a tax-benefit policy change would reflect the first reaction in the (very) short run. Second, market determined wages, which may correspond to the Estonian case under current circumstances in the medium run. (We do not consider the long run as capital is held fixed.) Third, wage bargaining by each skill group, representing a more EU-oriented hypothetical case.

Overall, labour supply and wage bargaining are modelled in the manner of Bovenberg *et al.* (2000) and Hinnosaar (2004a, b), while the production side and other wage formation schemes (fixed and market determined) are modelled as in Alho (2006). A more detailed comparison of the previous models and the current approach is presented in Appendix 1.

General equilibrium effects of Estonian tax-benefit system have not been extensively researched. To our knowledge, there are no previous studies apart from Hinnosaar (2004a, b). Compared to the latter, we consider several alternative wage formation systems. We also introduce capital as a production factor, although fixed, and employ more recent data. Additionally, having available a similar model to the Finnish case allows to compare tax-benefit effects on employment in an old and a new member state,

where the coverage of wage bargaining differs notably; 90% and 20-30%, respectively, in 2003 (European Industrial Relations Observatory, 2005). Modelling several skill groups allows us also to analyse separately the situation of low-skilled labour, whose employment rate is particularly low (see Figure 1).

Figure 1. Employment rate, unemployment rate and educational level in Estonia, 1997-2004



Source: Statistical Office of Estonia

The rest of the paper is structured in the following way. Section 2 discusses the model. Section 3 presents the data and the results of the calibration. Section 4 considers different policy simulations (lowering the marginal income tax rate, increasing the income tax allowance, lowering employers' social security contributions and increasing the unemployment benefit replacement rate). Section 5 concludes.

2. The model

2.1. Households[1]

The workforce consists of three types of households differing in skills based on educational attainment: low-skilled, skilled and high-skilled ($i = 1,2,3$). There are M_i households in each skill category who maximise utility subject to a budget constraint and a time constraint. The utility of household j with skill level i is a function of private consumption C_i^j, leisure V_i^j and public consumption G. The latter enters in an additively separable way, therefore having no effect on labour supply decisions[2]:

$$H_i^j = h(C_i^j, V_i^j) + g(G) \tag{1}$$

The utility sub-function is the CES type:

$$h(C_i^j, V_i^j) = \left[d_i^{\frac{1}{\delta}} \left(C_i^j\right)^{\frac{\delta-1}{\delta}} + (1-d_i)^{\frac{1}{\delta}} \left(V_i^j\right)^{\frac{\delta-1}{\delta}} \right]^{\frac{\delta}{\delta-1}} \tag{2}$$

where δ is the elasticity of substitution between consumption and leisure and d_i is a distribution parameter implying the relative weights which households place on consumption and labour supply. A household's budget constraint is

$$(1-t_i^L) W_i S_i^j = P C_i^j \tag{3}$$

where t_i^L is the average tax rate on labour income (a function of labour income, tax rates and tax free allowance), W_i is the gross wage rate, S_i^j is labour supply and P is the price level. Households also receive capital income from distributed profits, however it is assumed that they are not able to anticipate it *ex ante* and therefore it does not enter the budget constraint here. The time endowment is normalised to unity, $S_i^j = 1 - V_i^j$, i.e. the unit of time endowment (and labour supply) could be considered as a full-time job.

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[1] This section follows Bovenberg *et al.* (2000) and Hinnosaar (2004a, b). However, there is an important difference in the aggregate labour supply equation. See Appendix 2 for the details.

[2] The utility from public consumption for a skill group is derived as $g(G) = d_i^{\frac{1}{\delta-1}} g_i G$, where g_i is the share of the skill group in public consumption. The latter is an exogenous variable.

The total labour supply of skill group i is M_i times the labour supply S_i^j of one household:

$$S_i = \frac{M_i\left(1 - mT^A \frac{1-d_i}{d_i}\frac{1}{P}\left(\frac{(1-m)W_i}{P}\right)^{-\delta}\right)}{1+(1-m)W_i \frac{1-d_i}{d_i}\frac{1}{P}\left(\frac{(1-m)W_i}{P}\right)^{-\delta}} \tag{4}$$

where m is marginal tax rate on labour income and T^A is the tax allowance. Households decide the optimal amount of labour supply, however, the participation decisions are exogenous. Total labour supply S_i of skill group i implies that in the end S_i households from that skill group are supposed to supply all their labour in the model and the rest are considered as inactive.

In this framework firms decide employment E_i, which therefore equals the labour demanded N_i. Some households are unemployed and receive instead of labour earnings unemployment benefits B_i (also taxed). Aggregate (realised) private consumption C is equal to labour income, unemployment benefits and capital income, all net of taxes:

$$PC = \sum_i \left[\left(1-t_i^L\right)W_i E_i + \left(1-t_i^B\right)B_i U_i\right] + (1-m)\Pi \tag{5}$$

where U_i is the number of unemployed (also corresponding to full-time jobs) and Π is aggregate capital income. Note that the marginal tax rate is constant and not dependent on income type or skill group. In fact, all income is taxed in a common framework and tax allowance is in principle applied to total income. However, it is assumed that the tax allowance is assigned to either labour income or unemployment benefits and both exceed that, so that any additional income, i.e. capital income, must be taxed in full extent. The different average tax rates for labour income and unemployment benefits are due to the different underlying amounts.

2.2. Firms

This section is based on Alho (2006). There is monopolistic competition in the economy between identical firms. Firms use two aggregate production inputs – capital and labour – to produce one homogenous good. The aggregate production function is a CES function implying constant returns to scale:

$$Q = A\left[\alpha K^{\sigma} + (1-\alpha)L^{\sigma}\right]^{\frac{1}{\sigma}} \tag{6}$$

where A is total factor productivity, K capital stock, L aggregate effective labour input, α a distribution parameter and $1/(1-\sigma)$ the substitution elasticity between capital and aggregate effective labour.

The aggregate demand Q^* in the international market depends on the international price level P^*, $Q^D = b(P^*)^{-\varepsilon}$, where $\varepsilon > 0$. Firms maximise profits, which assuming Cournot competition leads to the demand for effective labour input:

$$P^*\left(\frac{dP^*}{dQ^*}\frac{Q^*}{P^*}\frac{Q}{Q^*}+1\right)Q_L = C(L) \tag{7}$$

where Q_L is the marginal productivity of aggregate labour, $Q/Q^* = h$ the market share of domestic firms and $C(L)$ is the aggregate unit labour cost. This can be rewritten as:

$$P^*\left(1-h\varepsilon^{-1}\right)Q_L = C(L) \tag{8}$$

where $\left(1-h\varepsilon^{-1}\right)$ is the inverse of the mark-up. This determines the employment. The capital stock remains fixed as we concentrate only on the short-medium run.

Aggregate effective labour input L is a CES aggregate of labour demanded in each skill group N_i:

$$L = \left[\sum\nolimits_i (e_i N_i)^{\phi}\right]^{\frac{1}{\phi}}, \quad \phi \le 1 \tag{9}$$

Here, e_i is the relative efficiency/productivity parameter of the skill group i with e_1 fixed to unity and $1/(1-\phi)$ is the substitution elasticity of skill groups. The gross wage rate is W_i, but the corresponding cost to the employer, i.e. the producer wage, is $C(N_i) = (1+v)W_i$, where v is the rate of employers' compulsory social security contribution. Setting up and solving a cost minimisation problem gives us the relative demand for the different skill groups (see Appendix 3 for the derivation):

$$\frac{C(N_i)}{C(N_1)} = \left(\frac{e_i}{e_1}\right)^{\phi}\left(\frac{N_i}{N_1}\right)^{\phi-1}, \; i = 2, 3 \tag{10}$$

and the aggregate unit labour cost:

$$C(L) = \left[\sum_i \left(\frac{C(N_i)}{e_i} \right)^{-\frac{\phi}{1-\phi}} \right]^{-\frac{1-\phi}{\phi}} \tag{11}$$

2.3. Wage formation

Similarly to Alho (2006) we consider several wage formation hypotheses. First, fixed wages reflecting the first reactions in the (very) short run after a tax-benefit policy change. Second, market determined wages corresponding to a flexible labour market with market clearing in the medium run (capital still fixed). Third, we consider a case of wage bargaining. The first two settings are perhaps closer to the actual situation in the Estonian labour market within the respective time horizon; the last one is somewhat more hypothetical, reflecting the old EU member states.

The case of fixed wages is the easiest to model, requiring only the relevant constraint in the model. Market determined wages need an additional restriction related to unemployment, which otherwise would not exist in the model. Here, unemployment rates have been fixed under market determined wages. Bargained wages are determined by a right-to-manage model, which is as follows, being a combination of approaches by Hinnosaar (2004a, b) and Alho (2006).

The employers' organisation and three unions each representing workers of one skill group bargain over wages and employers determine employment. This implies maximising the following Nash function:

$$\Omega_i = \Lambda^{\beta_i} \Gamma_i^{1-\beta_i} \tag{12}$$

where

$$\Lambda = PQ(K,L) - \sum_i (1+v) W_i E_i - (\rho + d) K \tag{13}$$

and

$$\Gamma_i = E_i^{0.5} \left[\left(1 - t_i^L\right) W_i - \left(1 - t_i^B\right) B_i \right]^{0.5} \tag{14}$$

Λ stands for the total profit of the employers' organisation and Γ_i represents the utility of the union; ρ denotes the rate of return on capital and d the depreciation rate. It is assumed that the union attaches equal weight to employment and the surplus from

working, i.e. the real consumer wage less the reservation wage what is simply the after-tax unemployment benefit. The parameter β_i denotes the relative bargaining power of the employers. Solving the Nash function gives the following wage equation of skill group *i* (see Appendix 4 for the derivation):

$$W_i = \frac{\beta_i B_i}{0.5(1+\beta_i)} + \frac{(1-\beta_i)\left[P^* Q(K,L) - \sum_{j \neq i}(1+v)W_j E_j - (\rho+d)K\right]}{(1+v)E_i(1+\beta_i)} \tag{15}$$

Note that bargained wages do not depend on the marginal tax rate. This is due to the fact that wages and benefits are taxed in the same manner, applying the same marginal tax rate and tax allowance. This implies that if the employers' organisation dictates the outcome, $\beta_i = 1$, the wage is suppressed down to the reservation wage, i.e. the unemployment benefit, $W_i = B_i$. In case a labour union dominates the bargaining, $\beta_i = 0$, all the production surplus is attributed to wage income:

$$W_i = \frac{P^* Q(K,L) - \sum_{j \neq i}(1+v)W_j E_j - (\rho+d)K}{(1+v)E_i} \tag{16}$$

2.4. Government

The government runs a balanced budget, spending collected tax revenues on unemployment benefits and public consumption. There is a universal income tax applied on all income, including unemployment benefits, with constant marginal tax rate. Yet, income taxation is progressive due to income tax allowance. It is applied to either labour earnings or benefits, depending on which of these a household is receiving, which are assumed to be sufficiently large so that the tax allowance could be utilised fully. Therefore, the rest of the income, namely capital income in the form of distributed corporate profits, is subject to full taxation. The average tax rate on labour earnings could be denoted as

$$t_i^L = \frac{m(W_i - T^A)}{W_i} \tag{17}$$

and the average tax rate on unemployment benefits as

$$t_i^B = \frac{m\left(B_i - T^A\right)}{B_i} \tag{18}$$

where T^A is the amount of tax allowance. Additionally, there is a compulsory social security contribution on employers with a constant rate of v. No value-added tax is used.

Government uses its resources to finance unemployment benefits and the rest is spent on public consumption. Unemployment benefits are indexed to the gross wage rate, $B_i = rW_i$, where r is the pre-tax replacement rate. Overall, the government budget is:

$$\sum_i \left[(v + t_i^L)W_i E_i - (1 - t_i^B)B_i U_i\right] + m\Pi = PG \tag{19}$$

3. Calibration

The model has been calibrated to the Estonian economy in 2004. Input data and parameters are shown in Table 1. Labour market data and gross wage rates have been derived from the Labour Force Survey (Statistical Office of Estonia, 2004). There is a population of 830.1 thousand of persons in working age (16 to pension age). This is divided into three skill groups based on educational level (below upper secondary, upper secondary and tertiary): low-skilled, skilled and high-skilled. Labour force participation rates across the skill groups are, respectively, 42.4%, 76.6% and 88.2%, and unemployment rates 20.8%, 11.0% and 5.4%. The gross wage rate for skilled and high-skilled is higher by respectively 19% and 33% than that of low-skilled workers. Although hourly data would have been preferred, it was not available, therefore labour market data is presented in persons and wage rates are unadjusted for part-time working.

Total production is 141.5 billion of EEK (Statistical Office of Estonia, 2006) and the level of capital stock is 211 billion of EEK, both in nominal values of 2004. The capital stock is estimated using the Perpetual Inventory Method, where the capital stock equals initial capital stock and past investments less the depreciation. It is assumed that the initial capital stock was 1.5 times the residual value of fixed assets on enterprise balance sheets at the end of 1992. The capital stock was then calculated assuming annual depreciation rate of 10% and using fixed investment deflator. The same depreciation rate was also used later for the calculation of aggregate profits. The model is set up for a

small open economy, where domestic price level follows the international price level. The latter has been fixed to unity.

The parameters characterising the tax-benefit system in the model are the following: the marginal income tax rate m is 26%, the annual income tax allowance T^A is 16,800 EEK and the social security contribution rate for employers v is 33%. Under current unemployment insurance, unemployment assistance and social assistance system, the gross replacement rate is 50% for the first 100 days, 40% for the following 80 days and after that about 15% for effectively unlimited duration. Here it is assumed that all unemployed are entitled to the highest replacement rate. Therefore, unemployment benefits gross replacement rate r in the model is 50%.

Table 1. Input data for model calibration

Labour market[a]				
Population	$M_1 = 148.7$	$M_2 = 464.9$	$M_3 = 216.5$	
Employment	$E_1 = 50.0$	$E_2 = 316.9$	$E_3 = 180.7$	
Unemployment	$U_1 = 13.1$	$U_2 = 39.0$	$U_3 = 10.3$	
Gross wage rates[b]	$W_1 = 53.0$	$W_2 = 63.0$	$W_3 = 83.6$	
National accounts[c]	$Q = 141.5$	$K = 211.0$		
Tax-benefit rules	$M = 0.26$	$T^A = 16.8$[b]	$v = 0.33$	$r = 0.5$
Parameters	$\alpha = 0.5$	$\varphi = 2$	$\sigma = 0.8$	$\delta = 2$

[a] Thousands of persons (in working age – 16 to pension age).
[b] Thousands EEK (annually).
[c] Billions EEK

The substitution elasticity between the skill categories, $\phi = 2$, and the substitution elasticity of capital and aggregate labour, $\sigma = 0.8$, are derived from Alho (2006). Although the models and the underlying economies are different, we use those as no estimates for Estonian economy are currently available. The distribution parameter α in the production function is set to 0.4. The substitution elasticity of consumption and leisure δ is set equal to 2, following Hinnosaar (2004a, b).

Calibrated data implies that in the initial equilibrium, total factor productivity is 4.06 and the rate of return on capital is 21.4%. The mark-up factor is 1.92, which is relatively high, on the other hand there is no value-added tax present in the model. Calibrated parameters and some important variables for the skill groups are presented in Table 2.

Table 2. Calibrated parameters and variables by the skill types

	Low-skilled	Skilled	High-skilled
Parameters			
The relative efficiency of a skill group, e_i	1.00	8.96	8.99
The bargaining power of employers, β_i	0.88	0.49	0.56
The distribution parameter in the utility function, $d_i^{1/\delta}$	0.15	0.27	0.34
The share of a skill group in public consumption, g_i	0.18	0.56	0.26
Variables			
The share of a skill group in capital income	0.07	0.53	0.40
Average income tax rate on labour earnings, t_i^L	17.8%	19.1%	20.8%
Average income tax rate on unemployment benefits, t_i^B	9.5%	12.1%	15.6%

There is only a marginal difference between the relative efficiency of skilled and high-skilled labour. The group of skilled has even stronger bargaining power compared to the high-skilled. Each skill group's share in public consumption is assumed to be proportional to the number of respective households and therefore being exogenous. The share in capital income is proportional to the aggregate wage earnings. Finally, the values of the distribution parameter in the utility function reflect that those with higher skills attribute a larger weight to consumption. This is due to higher unemployment among lower skill groups, which in this framework translates (partly) into stronger preferences for leisure.

4. Policy simulations

4.1. Description

There are four policy scenarios evaluated under all three wage systems, altogether up to 9 different simulations (some provide the same results). The following policy changes are considered:

1) lowering the marginal income tax rate,
2) increasing the income tax allowance,
3) lowering employers' social security contributions,
4) increasing the replacement rate.

All policy simulations are financed by an ex-ante reduction in the level of public consumption by 0.5%. In terms of tax-benefit parameters this implies that (a) marginal income tax rate is lowered from 0.26 to 0.222, (b) tax allowance is increased from 16,800 to 17,577 EEK per year, (c) employers' social tax rate is decreased from 0.33 to 0.327, and (d) unemployment benefit replacement rate is increased from 0.5 to 0.541.

The two first policy shifts imitate actual income tax reforms in 2003 and 2005, which will reduce the marginal income tax rate from 26% to 20% and double the annual tax allowance from 12,000 to 24,000 EEK once fully implemented. However, here we do not follow the actual policy changes in their exact magnitude as the different simulations are balanced in fiscal terms in order to retain comparability. The latter two scenarios are more hypothetical, carried out as the main alternatives. No simulation of targeted policy changes in the form of e.g. a higher replacement rate for the low-skilled have been undertaken. The results are presented in Table 3.

Table 3. Simulation results, percentage changes

Policy scenarios / Target variables	(1) Lower marginal income tax rate		(2) Increased income tax allowance		(3) Lower employers' social security contribution			(4) Increased replacement rate	
	F, B	M	F, B	M	F	M	B	F, M	B
Production	0.0	0.9	0.0	-0.1	0.4	0.0	0.0	0.0	-2.7
Private consumption	4.7	6.0	0.2	0.1	0.8	0.2	0.2	0.2	-3.5
Public consumption	-9.6	-7.1	-0.4	-0.6	0.8	-0.2	-0.3	-0.5	-8.4
Social welfare	0.8	1.8	0.0	-0.1	0.5	0.1	0.0	0.0	-2.8
- low-skilled	0.2	0.3	0.0	0.0	0.3	0.0	0.0	0.1	-2.0
- skilled	0.4	1.3	0.0	0.0	0.5	0.1	0.0	0.1	-2.8
- high-skilled	1.3	2.5	0.0	-0.1	0.5	0.1	0.0	0.0	-2.9
Labour supply	1.8	1.5	-0.2	-0.1	0.0	0.1	0.1	0.0	0.4
- low-skilled	5.7	4.3	-0.6	-0.5	0.0	0.1	0.2	0.0	1.3
- skilled	1.7	1.5	-0.1	-0.1	0.0	0.1	0.1	0.0	0.4
- high-skilled	0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Employment	0.0	1.5	0.0	-0.1	0.6	0.1	0.0	0.0	-4.0
- low-skilled	0.0	4.3	0.0	-0.5	0.6	0.1	0.0	0.0	-4.0
- skilled	0.0	1.5	0.0	-0.1	0.6	0.1	0.0	0.0	-4.0
- high-skilled	0.0	0.7	0.0	0.0	0.6	0.0	0.0	0.0	-4.0
Unemployment	17.5	2.0	-1.5	-0.2	-5.4	0.1	0.7	0.0	39.0
- low-skilled	27.6	4.3	-3.0	-0.5	-2.4	0.1	0.9	0.0	21.2
- skilled	15.1	1.5	-1.1	-0.1	-5.0	0.1	0.6	0.0	36.0
- high-skilled	13.7	0.7	-0.8	0.0	-10.9	0.0	0.6	0.0	73.2
Gross wage rate									
- low-skilled		-1.9		0.2		0.2	0.3		1.6
- skilled	fixed	-0.6	fixed	0.0	fixed	0.2	0.3	fixed	1.6
- high-skilled		-0.2		0.0		0.2	0.3		1.6
Unemployment rate[a]	1.6		-0.1		-0.6		0.1	0.0	3.9
- low-skilled	4.3	fixed	-0.5	fixed	-0.5	fixed	0.2	0.0	4.1
- skilled	1.4		-0.1		-0.6		0.1	0.0	3.9
- high-skilled	0.7		0.0		-0.6		0.0	0.0	3.9

Note: F – fixed wages, M – market determined wages, B – wage bargaining.
[a] Absolute changes in percentage points.

4.2. Lowering the marginal income tax rate

We can indeed observe increased private consumption with a lower marginal income tax rate. On the other hand, tax revenues decline and therefore public consumption is smaller. The overall impact on welfare depends on the social welfare function used. In this case private and public consumption share the same distribution parameter and

social welfare also increases. Across the skill groups, more skilled persons gain more as they have higher preference for their consumption (see the comments in Section 3).

In case of fixed (gross) wages only consumer wages decrease, producer wages do not react and therefore production and labour demand will not be affected. Higher consumer wages increase the labour supply. But employment is determined by the firms and constant (as the producer wages are fixed), and the increased labour supply translates one-to-one into higher unemployment.

Market determined wages are more flexible and the gross wage rate must decrease for the unemployment rates to be unchanged. Therefore, the gains from reduced labour taxes are shared between employers and employees. As producer wages decrease, more labour is demanded and higher employment levels are attained. In the new equilibrium, unemployment levels are only slightly higher and unemployment ratios are the same. Yet, production also increases and therefore private consumption and social welfare increase more than under fixed wages.

The wage bargaining case has the same outcome as fixed wages because the bargained wages do not depend on the marginal tax rate. The lower marginal tax rate only increases the labour supply, which has no (direct) effect on employment.

4.3. Increasing the income tax allowance

A larger income tax allowance also increases households' disposable income. However, the effect on the labour supply is exactly the opposite now. Under fixed wages this transforms into lower unemployment as production and employment are not affected. Private consumption increases a little, but the overall effect on social welfare is only marginal. In case of market determined wages the decrease in labour supply is smaller. This in turn requires a decline in employment and a lower gross wage rate. Production also decreases and the overall effect on social welfare remains negative. Wage bargaining yields again the same results as fixed wages.

4.4. Lowering employers' social security contributions

Reducing the labour tax burden by lowering employers' social security contributions has a direct effect on labour demand and employment, but not on labour supply. Lower

labour costs increase production and employment. Again, as there is no mechanism linking labour demand and supply, the latter remains unchanged with fixed wages and unemployment declining. Higher employment and production increase private and public consumption, therefore rising social welfare as well.

Fixed unemployment rates are attained via higher consumer wages and increased labour supply, which makes this policy scenario less favourable under market determined wages. Production increases only marginally, private consumption increases less than under fixed wages and public consumption even decreases. Overall, social welfare is somewhat higher.

This time wage bargaining leads to a different result compared to fixed wages, in fact being closer to the outcome of market determined wages. The initial decrease in producer wages transforms to higher gross wage rates. In the new equilibrium, producer wages, employment and production have returned to initial levels. Higher consumer wages attract additional labour supply causing unemployment levels to rise. Overall, there is a small increase in private consumption, a small decrease in public consumption and only a marginal improvement in social welfare.

4.5. Increasing the replacement rate

The increased replacement rate combined with either fixed wages or market determined wages only implies slightly higher private consumption and social welfare. The reason is that neither firms nor households take into account the extent of unemployment benefits in their optimising behaviour. It does not affect labour costs for the firms and households supply labour without considering the outside option. Unemployed households are exogenously decided and therefore they do not take into account unemployment benefits when choosing optimal labour to supply.

Under wage bargaining, higher unemployment benefits directly increase gross wage rates, which in turn increases labour supply. Higher labour costs lower firms' demand for labour and therefore the employment level. As replacement rate is uniform across the skill groups, the percentage changes in the gross wage rates and employment are also the same. All this results in significantly higher unemployment, decreased production, lower private and public consumption and lower social welfare.

5. Conclusions

The policy simulations considered show that alternative ways to "stimulate" the labour market can lead to very different outcomes, e.g. on labour supply and unemployment. An improvement in terms of households' disposable income might even turn out to be welfare reducing in the new equilibrium. The effects of policy changes also vary under different wage formation schemes – lowering the marginal income tax rate is for example most effective in enhancing private consumption and social welfare under market determined wages while a reduction in the social tax rate works most successfully under fixed wages. A combination of lowering marginal income tax rate and increasing tax allowance, basically the recent tax reform, has a potential to increase production and social welfare without increasing unemployment rates under market determined wages.

Overall, the results are often similar to Hinnosaar (2004b) and Alho (2006) on which our model is based. In comparison with the latter, the main differences occur where our simulations yield identical results under various wage systems, highlighting some limits of our model. However, assuming that different wage formations are relevant for Estonian and Finnish economies (market determined wages and bargained wages, respectively), we can stress the need for different labour market and tax-benefit policies in different EU member states. Comparing the policy scenarios for Estonia under market determined wages and wage bargaining implies that market determined wages outperform bargained wages, the latter representing more EU-like wage formation.

Although no policy scenarios targeted at specific skill groups were carried out, some implications could be still noted. The labour supply of low-skilled is most effectively increased by lowering the marginal income tax rate, valid under every wage scheme. Combining this in turn with strategies improving employment in general, e.g. lowering employers' social security contributions, could potentially improve the labour market position of those with lower skills.

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Appendix 1. A comparison of CGE models

Model	**Bovenberg *et al.* (2000)** *Tax reform and the Dutch labor market: an applied general equilibrium approach*, Journal of Public Economics, No 78, 2000, pp. 193-214.	**Hinnosaar, M. (2004)** a) *Estonian Labor Market Institutions within a General Equilibrium Framework*, Eesti Pank, No 5, 2004. b) *The Impact of Benefit and Tax Reforms on Estonian Labor Market in a General Equilibrium Framework*, University of Tartu, Working Paper, No 31, 2004.	**Alho, K. (2006)** *Labour market institutions and the effectiveness of tax and benefit policies in enhancing employment: a general equilibrium analysis*. ETLA Discussion paper, No 1008.	**The current paper** *A Comparative General Equilibrium Analysis of the Estonian Labour Market*. PRAXIS, Working Paper.
Back-ground	A simplification of MIMIC (a larger applied general equilibrium model for the Dutch economy).	Based largely on Bovenberg *et al.* (2000), without informal labour market, job matching and hiring costs. The wage formation for high-skilled workers is based on the efficiency wage concept.	Some similar elements with Bovenberg *et al.* (2000) (job matching and hiring costs). Additional input in production – capital.	Based on Hinnosaar (2004a, b) and Alho (2006).
House-holds	Three types of households: capitalists, unskilled and skilled households. Capitalists do not supply labour and receive all profit income. *Participation decisions are exogenous, households choose the number of working hours.* Households of each skill type maximise utility, subject to a budget and a time constraint (public consumption additively separable).	As in Bovenberg *et al.* (2000), except no hiring costs and tax progressivity due to tax allowance, not tax credit.	Three types of skill groups (low-skilled, skilled and high-skilled), each divided further as employed on market-based terms, employed on subsidised terms, unemployed and those outside the labour force. Individuals maximise utility subject to a budget and a time constraint:	As in Hinnosaar (2004a, b). Three skill groups instead of two. Workers receive distributed corporate profits, although it is not considered in labour supply (not anticipated).

	$H_i = u(C_i, V_i) + h(G), \quad s.t.$ $(1-TA_i)(1-D_i)W_i S_i = P_c C_i$ $S_i = 1 - V_i$ which yields the **labour supply** (in terms of hours).	$H_i^m = u(C_i^m, Z_i^m) + g(G), \quad s.t.$ $u(C_i^m, Z_i^m) =$ $\left[d^{\frac{1}{\theta}} (C_i^m)^{\frac{\theta-1}{\theta}} + (1-d)^{\frac{1}{\theta}} (Z_i^m)^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}$ $(1-TA_i)W_i S_i^m = P_c C_i^m$ $S_i^m = 1 - Z_i^m$	$H_i = H(C_i, 1-L_i^S, G_i), \quad s.t.$ $P^* C_i^F = (1-t_i^L)W_i L_i^S + (1-t_i^B)b_i U_i + O_i + Tr_i$ $U_i = 1 - L_i^S$ **Decisions to participate in the labour market and to supply labour are considered simultaneously.** Unemployment benefits are means-tested.	
Firms	Two types of domestic firms, according to the type of labour employed (unskilled, skilled). The number of firms is fixed. A linear production function, $Y_i^j = h_i L_i^j$. Profit maximisation implies under monopolistic competition **output prices** (mark-up over marginal costs): $P_i^j = \frac{1}{1-\varepsilon_i^j} \frac{W_i}{h_i}, \quad i = u,s \quad j = 1...N_i$ Commodities produced by identical firms are aggregated into two composite commodities and those are aggregated further into overall production. The optimal allocation of two composite commodities is an **implicit demand function for skilled and unskilled labour**.	As in Bovenberg *et al.* (2000), except producer wage includes employer's compulsory social security contributions. $P_i^j = \frac{1}{1-\varepsilon} \frac{W_i(1+T_s)}{h_i}$	Identical monopolistic firms. CES aggregate production function is $Q = A\left[\alpha K^\sigma + (1-\alpha)L^\sigma\right]^{1/\sigma}$. Profit maximisation under Cournot competition implies **aggregate labour demand**: $(1-h\varepsilon^{-1})Q_L(1-t_Q)P^* = C$. In the long run capital stock also adjusts: $P_Q Q - CL = \bar{\rho} K^*$. **Labour input in each skill group**: $N_i = \left[L_i^\chi + a_i M_i^\chi\right]^{1/\chi}$. The **relative demand** for two components (trough cost minimisation): $\frac{M_i}{L_i} = a_i^{\frac{1}{1-\chi}} \left[\frac{(1+v_i^M)(1-s_i)}{(1+u_i^L)} \right]^{-\frac{1}{1-\chi}}$. **Aggregate labour input** is $L = \left[\sum_1^I (e_i N_i)^\phi\right]^{1/\phi}$ and the	As in Alho (2006), except no subsidised labour.

			relative demand for each skill group is $C(N_i)/C(N_1) = (e_i/e_1)^{\phi}(N_i/N_1)^{\phi-1}$	
Goods market	There are two aggregate goods on the highest level: (a) a CES aggregate of domestic composite commodities produced by skilled and unskilled workers, (b) a composite of imported commodities.	As in Bovenberg *et al.* (2000).	A single tradable good, both in private and in public consumption.	As in Alho (2006).
Labour market	Realised employment equals to labour demanded and unemployment is the difference between labour supply and labour demand (both in terms of hours). Wage bargaining for both skill type labour (a right-to manage model). The reservation wage is a weighted average of opportunity wages in formal and informal sector, introducing some **real wage resistance**, i.e. higher tax rates or hiring costs only partly borne by workers. Additionally, job matching with hiring costs.	Determination of employment and unemployment as in Bovenberg *et al.* (2000). Wage bargaining for low-skilled workers as in Bovenberg *et al.* (2000), except no informal labour market, job matching or hiring costs. The reservation wage is simply unemployment benefit. High-skilled workers receive an efficiency wage depending (among others) on unemployment benefit and unemployment.	Job matching similar to Bovenberg *et al.* (2000), establishing a link between labour demand and labour supply. Firms decide employment. Several wage formations considered: a) fixed wages, b) market determined wages, c) wage bargaining in each skill group, d) nation-wide wage bargaining.	Three wage structures considered: a) fixed wages, b) market determined wages, c) wage bargaining as in Hinnosaar (2004a, b).
Govern-ment	Government runs a balanced budget with revenue from taxing labour incomes and expenditure on unemployment benefits and public consumption. The latter featuring the same composition	As in Bovenberg *et al.* (2000), except government revenues include also employers' compul-sory social security contributions. Tax progressivity due to tax allowance not tax credit.	Balanced budget. Tax revenues from income tax (with progressive rates) on labour income, unemployment benefits and capital income, social security tax and value-added tax. Government	Balanced budget. Government revenues from labour and capital taxation (income and social tax). No value-added tax. Government expenditures on unemployment benefits and public consumption.

	and price index as private consumption.	Unemployment benefits combine subsistence benefit and universal unemployment benefit.	expenditures on unemployment benefits, wage subsidies and public consumption.	Unemployment benefit is a fixed proportion of gross wage.
Foreign sector	The allocation of foreign consumption over domestic and foreign goods depends on the terms of trade. The market of domestic goods is in equilibrium.	As in Bovenberg *et al.* (2000).	Demand for domestic products depends on the international price level (given for a small open economy). Otherwise not explicitly modelled.	As in Alho (2006).
Data and the key para-meters	Dutch economy in 2018. Substitution elasticity between skill groups 1.5, substitution elasticity of consumption and leisure 4, uncompensated wage elasticity 0.15, income elasticity -0.05, export elasticity -2.	Estonian economy in 2001, import structure from 1997. Substitution elasticity between skill groups 0.5, substitution elasticity of consumption and leisure 2, Armington elasticity and transformation elasticity 2.	Finnish economy in 2002. Substitution elasticity between skill groups 2, substitution elasticity of capital and aggregate labour 0.8, distribution parameter in production function 0.4, substitution elasticity of consumption and leisure 0.5.	Estonian economy in 2004. Substitution elasticity between skill groups 2, substitution elasticity of capital and aggregate labour 0.8, distribution parameter in production function 0.5, substitution elasticity of consumption and leisure 2.
Simula-tions	1) Lowering marginal tax rate (benefits indexed to consumer wages) 2) Higher tax credit for all households (benefits indexed to consumer wages) 3) Higher tax credit for all households (benefits indexed to producer wages) 4) Higher tax credit for unskilled workers (benefits indexed to producer wages) 5) Higher tax credit for all workers, higher marginal tax rate, skilled workers break	Hinnosaar 2004a: 1) Higher union bargaining power, i.e. higher wage for low-skilled workers 2) Higher unemployment benefits replacement rate for all workers 3) Higher unemployment benefits replacement rate for high-skilled workers 4) Increasing tax allowance for all workers 5) Increasing tax allowance for low-skilled workers	1) Lowering income tax rate a) average (and marginal) b) marginal (only) 2) Lowering employers' social security contributions for a) all skill groups b) low-skilled workers 3) Higher wage subsidy rates 4) Lower unemployment benefit replacement rates 5) Reducing unemployment in a fully flexible labour market Financed by ex ante decrease in public consumption by 0.5% in 1)	1) Lowering marginal income tax rate 2) Increasing tax allowance 3) Lowering employers' social security contributions 4) Increasing replacement rate. Financed *ex ante* decrease in public consumption by 0.5%.

	even ex ante (benefits indexed to producer wages) Financed by *ex ante* reduction in public consumption (0.5% GDP).	Hinnosaar (2004b), reforms financed by *ex ante* decrease in public consumption by 0.5%: 1) Lowering marginal tax rate 2)-5) As in Hinnosaar (2004a).	and 2), 0.07% in 3), 0.18% in 4).	
Results	Paper demonstrates various trade-offs facing tax reforms. Simulations highlight in-work benefits as an effective instrument against unemployment.	Reducing tax burden via targeted increase in tax allowance has the most favourable impact on the labour market.	Simulations show that wage formation is an important factor for employment enhancing policies. In some cases the expansionary effects are even the largest under wage bargaining.	Simulations show that market determined wages outperform bargained wages. The labour market position of the low-skilled could be improved most effectively by lowering the marginal tax rate and employers' social security contributions.

Appendix 2. Labour supply

Individuals maximise the CES sub-utility function

$$h(C_i^j, V_i^j) = \left[d_i^{\frac{1}{\delta}} \left(C_i^j\right)^{\frac{\delta-1}{\delta}} + (1-d_i)^{\frac{1}{\delta}} \left(V_i^j\right)^{\frac{\delta-1}{\delta}} \right]^{\frac{\delta}{\delta-1}} \tag{20}$$

subject to the time constraint $S_i^j = 1 - V_i^j$ and the budget constraint

$$(1-t_i^L) W_i S_i^j = P C_i^j \tag{21}$$

Substituting constraints into the utility function:

$$\max_{S_i^j} h = \left[d_i^{\frac{1}{\delta}} \left((1-t_i^L) W_i S_i^j P^{-1}\right)^{\frac{\delta-1}{\delta}} + (1-d_i)^{\frac{1}{\delta}} \left(1-S_i^j\right)^{\frac{\delta-1}{\delta}} \right]^{\frac{\delta}{\delta-1}} \tag{22}$$

FOC, note that $(1-t_i^L) W_i S_i^j = (1-m) W_i S_i^j + m T^A$:

$$\begin{aligned} &\left[d_i^{\frac{1}{\delta}} \left(\left((1-m) W_i S_i^j + m T^A\right) P^{-1}\right)^{\frac{\delta-1}{\delta}} + (1-d_i)^{\frac{1}{\delta}} \left(1-S_i^j\right)^{\frac{\delta-1}{\delta}} \right]^{\frac{1}{\delta-1}} \cdot \\ &\left[d_i^{\frac{1}{\delta}} \left(\left((1-m) W_i S_i^j + m T^A\right) P^{-1}\right)^{-\frac{1}{\delta}} (1-m) W_i P^{-1} + (1-d_i)^{\frac{1}{\delta}} \left(1-S_i^j\right)^{-\frac{1}{\delta}} (-1) \right] = 0 \end{aligned} \tag{23}$$

Solving for labour supply[3]:

$$\frac{1-d_i}{d_i} \left(\left((1-m) W_i S_i^j + m T^A\right) P^{-1}\right) \left((1-m) W_i P^{-1}\right)^{-\delta} = \left(1-S_i^j\right) \Rightarrow \tag{24}$$

$$S_i^j = \frac{1 - m T^A \frac{1-d_i}{d_i} P^{-1} \left((1-m) W_i P^{-1}\right)^{-\delta}}{1 + (1-m) W_i \frac{1-d_i}{d_i} P^{-1} \left((1-m) W_i P^{-1}\right)^{-\delta}} \tag{25}$$

Total labour supply is

$$S_i = M_i S_i^j = \frac{M_i \left(1 - m T^A \mu\right)}{1 + (1-m) W_i \mu}, \quad \mu = \frac{1-d_i}{d_i} \frac{1}{P} \left(\frac{(1-m) W_i}{P} \right)^{-\delta} \tag{26}$$

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[3] Note that this is different compared to Bovenberg *et al.* (2000) and Hinnosaar (2004a, b). There a household's labour supply was also expressed in terms of average tax rate, which in return depends on household's labour supply.

Appendix 3. Labour cost

The aggregate labour cost minimisation problem:

$$C = \min_{N_i} \sum_i C(N_i) N_i \tag{27}$$

subject to

$$\left[\sum_i (e_i N_i)^{\phi}\right]^{\frac{1}{\phi}} = L \tag{28}$$

The Lagrangian function is:

$$\min_{N_i} \hat{L} = \sum_i C(N_i) N_i - \lambda\left\{\left[\sum_i (e_i N_i)^{\phi}\right]^{\frac{1}{\phi}} - L\right\} \tag{29}$$

FOC:

$$\frac{\partial \hat{L}}{\partial N_i} = C(N_i) - \lambda\left[\sum_i (e_i N_i)^{\phi}\right]^{\frac{(1-\phi)}{\phi}} (e_i N_i)^{\phi-1} e_i = 0 \tag{30}$$

Divide by $\partial \hat{L} / \partial N_j$, $j \neq i$:

$$\frac{C(N_i) N_i}{C(N_j) N_j} = \left(\frac{e_i N_i}{e_j N_j}\right)^{\phi} \tag{31}$$

Sum over $i = 1...n\ (i \neq j)$ and add one to both side for $i = j$:

$$\frac{\sum_i C(N_i) N_i}{C(N_j) N_j} = \frac{\sum_i (e_i N_i)^{\phi}}{(e_j N_j)^{\phi}} \tag{32}$$

Substitute (27) and (28) into (32), solve for N_j:

$$N_j = \left(\frac{C}{L^{\phi}}\right)^{\frac{1}{1-\phi}} \left(\frac{e_j^{\phi}}{C(N_j)}\right)^{\frac{1}{1-\phi}} \tag{33}$$

Multiply by $C(N_j)$ and sum over $j = 1...n$

$$C = \sum_j C(N_j) N_j = \left(\frac{C}{L^{\phi}}\right)^{\frac{1}{1-\phi}} \sum_j \left(\frac{e_j}{C(N_j)}\right)^{\frac{\phi}{1-\phi}} \tag{34}$$

Solve for aggregate labour cost, C:

$$C = L\left(\sum_j \left(\frac{C(N_j)}{e_j}\right)^{-\frac{\phi}{1-\phi}}\right)^{-\frac{1-\phi}{\phi}} \tag{35}$$

Aggregate unit labour cost ($L=1$):

$$C(L)=\left(\sum_i\left(\frac{C(N_i)}{e_i}\right)^{-\frac{\phi}{1-\phi}}\right)^{-\frac{1-\phi}{\phi}} \tag{36}$$

Appendix 4. Wage bargaining

The Nash function to be maximised is

$$\Omega_i=\Lambda^{\beta_i}\Gamma_i^{1-\beta_i} \tag{37}$$

where

$$\Lambda=P^*Q(K,L)-\sum_i(1+v)W_iE_i-(\rho+d)K \tag{38}$$

and

$$\Gamma_i=E_i^{0.5}\left[\left(1-t_i^L\right)W_i-\left(1-t_i^B\right)B_i\right]^{0.5} \tag{39}$$

FOC:

$$\begin{aligned}&\frac{\partial\Omega_i}{\partial W_i}=\beta_i\Lambda^{\beta_i-1}\left[-(1+v)E_i\right]\Gamma_i^{1-\beta_i}\\&+(1-\beta_i)\Lambda^{\beta_i}\Gamma_i^{-\beta_i}\,0.5E_i^{0.5}\left[\left(1-t_i^L\right)W_i-\left(1-t_i^B\right)B_i\right]^{-0.5}(1-m)=0\end{aligned} \tag{40}$$

Note that $t_i^L=m\left(1-T^A/W_i\right)\Rightarrow\left(1-t_i^L\right)W_i=(1-m)W_i+mT^A$. The unions do not take into account that benefits depend on wage (otherwise employees would claim very high wage and be unemployed).

Simplifying yields:

$$\beta_i(1+v)E_i\left[\left(1-t_i^L\right)W_i-\left(1-t_i^B\right)B_i\right]=0.5(1-\beta_i)(1-m)\Lambda\Rightarrow \tag{41}$$

$$\begin{aligned}&\beta_i(1+v)W_iE_i+0.5(1-\beta_i)(1+v)W_iE_i\\&=\beta_i(1+v)B_iE_i+0.5(1-\beta_i)\left[P^*Q(K,L)-\sum_{j\neq i}(1+v)W_jE_j-(\rho+d)K\right]\Rightarrow\end{aligned} \tag{42}$$

$$W_i=\frac{\beta_iB_i}{0.5(1+\beta_i)}+\frac{(1-\beta_i)\left[P^*Q(K,L)-\sum_{j\neq i}(1+v)W_jE_j-(\rho+d)K\right]}{(1+v)E_i(1+\beta_i)} \tag{43}$$

In case $\beta_i=1$ then $W_i=B_i$, if $\beta_i=0$ then

$$W_i=\frac{P^*Q(K,L)-\sum_{j\neq i}(1+v)W_jE_j-(\rho+d)K}{(1+v)E_i} \tag{44}$$