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Abstract

In the paper the impact of changes in social benefits and taxes on Estonian labor market will be analysed using a simple computable general equilibrium model. The model used in the paper is from Bovenberg et al. (2000), with the addition of an efficiency wage part based on Shapiro and Stiglitz (1984). The model integrates union bargaining and efficiency wage theory into a traditional CGE model framework.

Keywords: computable general equilibrium models, unemployment, low-skilled labor, benefits, taxes

JEL classification: D58, E62, J32, J50

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1. Introduction

Unemployment is an important problem in the Estonian economy. Estonia encountered especially high unemployment at the end of 1990s. From an unemployment rate of 1 percent in 1990, by 2000 the unemployment rate in Estonia had reached 14 percent. It decreased to its current level of 10 percent by 2003. This is still creating a significant problem for the economy. (See Rõõm and Viilmann (2003) for an overview of unemployment in Estonia.)

During recent years, there have been several labor market policy reforms and there are further changes planned, including changes in the social benefits, income tax rate and tax allowance. The current paper aims at empirically analysing the impact of these changes. An applied general equilibrium model is used for this purpose. The focus of the model is to describe wage formation, labor supply and demand, taking into account the relevant labor market institutions such as benefits, taxes and legally binding minimum wage. The model from Bovenberg et al. (2000) is used with the addition of an efficiency wage section based on Shapiro and Stiglitz (1984).

The model incorporates two imperfect labor market theories: the right to manage union bargaining and the efficiency wage theory. In the right to manage union bargaining model by Nickell and Andrews (1983), the wage rate is determined via a bargaining process between firms and the union and firms set employment. The idea of the efficiency wage theory is that higher wages give an incentive to higher productivity. Therefore, firms prefer to pay wages higher than the market equilibrium because higher wages decrease costs per effective labor unit. This leads to involuntary unemployment because there are unemployed people who would be willing to take a job at a lower wage. In the current paper the shirking model from Shapiro and Stiglitz (1984) is used.

Applied general equilibrium models incorporating imperfect labor markets have often been used to analyse tax reforms. The current paper uses the model by Bovenberg et al. (2000), which introduces the right to manage union bargaining in a general equilibrium framework and is calibrated to Dutch data. Another applied general equilibrium model with union wage bargaining, Böhringer et al. (2002), analyses the effects of taxes and social security payments calibrating the model to German data. The impact of payroll tax has also been analysed using a developing country model with an informal sector by Fortin et al. (1997). To distinguish the impact of tax reforms on different labor groups, models with heterogeneous households which differ in their preferences with respect to labor supply, have been used (see Graafland et al. (2001), Boeters et al. (2004)).

The contribution of the current paper is that it calibrates the general equilibrium model incorporating an imperfect labor market structure to Estonian data, enabling the comparison of the impact of different labor market policies on unemployment and employment. The simulations produced by the model should be considered as the first excersise for observing labor market policies in Estonia in a general equilibrium framework. Therefore, the results from the model should be interpreted with caution, especially as the parameter values of the model are calibrated based on the estimates of other countries, as there are no such estimates available for Estonia.

The model is solved using the General Algebraic Modeling System (GAMS) software.

In the next section of the paper the structure of institutions in the Estonian labor market is summarized. This is followed by a description of the model, which is then followed by an explanation of the data and the calibration. In the fifth section the simulation results are presented, the final section concludes.

2. Wage setting, unemployment benefits and labor taxes in Estonia

The model used in the paper attempts to describe the Estonian labor market in a realistic way, incorporating labor market institutions such as unions, unemployment benefits, taxes. In this section a short overview is given of the wage setting system, unemployment benefits and labor taxes in Estonia.

In Estonia wage setting differs from most European countries, as wages are mostly bargained on an individual basis by workers rather than collectively by unions. Sectoral bargaining is absent except in transportation and in some public sectors such as education. Enterprise level wage negotiations are not very common either, which is reflected in the low union membership: less than 20% of workers belong to unions (for more about unions in Estonia see Kallaste (2003), Eamets and Kallaste (2004)). However, unions and employers' organisations play some role by setting the national minimum wage. The importance of the national minimum wage has been increasing as its relative level compared to the average wage has risen. Currently about 10 percent of the work force are paid a wage equal to or lower than the minimum wage and wages for about a quarter of those employed are close to the national minimum wage Hinnosaar and Rõõm (2003). Therefore it can be concluded that the minimum wage bargained by unions and employers' organisations has a significant impact on the labor market. According to the study by Hinnosaar and Rõõm (2003), increases in the minimum wage in 1995-2000 have decreased employment for those workers whose wage should have been increased by the new agreements between the bargaining parties. The results from the study suggest that increases in the minimum wage have not had a significant impact on overall wage distribution except on the lowest wage being paid. In the future, the minimum wage is supposed to increase in relation to the av-

erage wage, according to an agreement between unions and employers.

Unemployment benefit in Estonia is very low and households with no other income receive social assistance benefit, the size of which depends on the structure of the household and its aggregate income. In a household with no working members and no alternative income, the social assistance payment might exceed the wage potentially earned on the labor market and the replacement rate might be as high as 100 percent.[1] The impact of benefits on labor supply was analysed by Kuddo et al. (2002), but no significant effect could be detected. Although a significant impact from benefits was found on the intensity of job search of the unemployed in the study by Hinnosaar (2004). An unemployment insurance system was introduced in Estonia in 2002 and unemployment insurance benefits have been paid since 2003. The benefits are paid for up to one year depending on the number of the years the worker has paid into the unemployment insurance fund, the replacement rate of the benefits is 0.5 over the first 100 days and 0.4 after that. Unemployment benefit reforms have been proposed, according to which the unemployment benefit, which is paid for an unlimited period, should significantly increase.

Due to tax allowances, the Estonian income tax system is moderately progressive. The income tax rate is 26%.[2] In 2001 the average income tax rate on the average wage was 21.2% and on the minimum wage, 9.5% (Rõõm (2003)). Rõõm (2003) analyses Estonian taxes in comparison to other countries and concludes

[1] Unemployment benefit is 400 Estonian Kroons, which is less than 30% of the nation wide minimum wage; social assistance benefit guarantees 500 Estonian Kroons per person in each household, after the costs related to dwelling are substracted (Kuddo et al. (2002)).

[2] It should be noted that the Estonian tax system is unproportional for production factors, labor and capital. After the corporate income tax reform in 2000, the average effective tax rate of capital is approximately three times lower than of labor (Rõõm (2003)). The average effective tax rate on capital was 13.4% and 10.9% in 2000 and 2001 respectively (Rõõm (2003)). However, in the current paper the role of capital and its taxation is not considered.

that payroll tax in Estonia is somewhat higher than the average in OECD countries and slightly lower than the EU average.[3] There are income tax reforms planned for the future. According to the planned reforms, the income tax rate will be decreased by 6 percentage points to 20 percent and at the same time tax allowance will be increased.

3. Description of the model

3.1. General overview

In this section the main features of the model, used to analyse the impact of labor market reforms on the Estonian economy, are summarized. The complete model is presented in the next section.

The CGE model used in the paper is from Bovenberg et al. (2000), with the main exception of high-skilled workers' wage formation, where the efficiency wage concept is introduced based on Shapiro and Stiglitz (1984). The model used in the current paper is a simplification of the model in Bovenberg et al. (2000) in terms of not including the informal labor market, job matching and hiring costs. The other difference from the Bovenberg et al. (2000) model is the distinguishing of income and social security tax, instead of just payroll tax. The distinction is made in order to describe the impact of tax allowances, which exist for income tax but not for social security tax, in a realistic way.

The model is static. The analysis concentrates on labor market

[3]The average effective tax rate on labor in Estonia in 1996-2001 was 35.8%, the EU average was 36.8% and the OECD countries average was 33.4% (Rõõm (2003)).

policy and therefore capital, investments and savings are not incorporated into the model.

The production process is described by a linear production function, where labor is the only factor used. In order to incorporate large differences in unemployment rates in Estonia by skill groups[4], low-skilled and high-skilled (which differ by productivity), are modelled separately. The assumption is made that labor is not mobile between different skill groups. There is a fixed number of firms and each firm uses only one type of labor. There are two types of goods produced, one by the firms employing low-skilled labor and the other by the firms employing high-skilled labor. There is monopolistic competition in the product market, which creates positive profits. The monopolistic competition provides the incentive for unions to exist and bargain about the profits.

There are three types of households in the economy: two worker households, low-skilled and high-skilled, who receive labor income and unemployment benefits, and capitalists who do not supply labor but receive all the profit. Households consume all their income.

Utility is described by nested CES functions. At the top level, worker households choose between leisure and consumption. Worker households and capitalists share the same consumption pattern. At the next level both worker households and capitalists choose between imported and domestically produced composite good. As mentioned, there are two types of goods produced in the home and foreign country: goods produced by low-skilled workers and by high-skilled workers. At the lower level, households

[4]Unemployment in Estonia is concentrated mainly among people with a poor education. In the period 1997–2003, the unemployment rate for people with secondary and primary education was, respectively, more than 10% and more than 16%, while for people with tertiary education it only ever reached as high as 7% (Statistical Database. Social life: labor market. From Statistical Office of Estonia).

choose between the domestic goods produced by low-skilled and by high-skilled workers. At the lowest level, decisions are made between the products of different firms employing one skill type. Public consumption follows the same consumption pattern as the households have, except for imported and domestic goods consumption. In households' consumption imported goods have a significantly larger share.

Wage setting is described using union bargaining and the efficiency wage concept, which both create involuntary unemployment. For example, when looking at survey data on the unemployed, 16% reported in 2003 that they were willing to take a full time job with a wage of 2000 EEK (Statisical Database. Social life: labor market. From Statistical Office of Estonia), which was lower than the minimum wage (2160 EEK). Therefore, the Estonian labor market cannot be described using a competitive model, with the wage rate equalizing labor supply and demand. In the Estonian labor market the minimum wage, which has legal force, is bargained between unions and employers. The agreed legal minimum wage affects about the quarter of the employed directly (see Hinnosaar and Rõõm (2003)). Therefore, wage setting for low-skilled labor is modelled as a bargaining process between unions and employers, where unions care about both the low-skilled workers' wage income and their employment. In the model, the high-skilled workers' wage is determined as an efficiency wage, it is a wage which is higher than the competitive wage level.

There are two types of taxes: labor income tax and social security tax, and there is a tax allowance in the case of income tax. The government collects tax revenues and uses them to finance unemployment benefits and public consumption. Public consumption has the same structure as private consumption but not in the case

of imports. The government has a balanced budget, which describes the actual situation for Estonia.[5]

Foreign demand is described using a CES function, where the foreign country consumes an aggregate of low-skilled and high-skilled goods. The assumption is made that exports equal imports.

The equations from the model are summarized in appendix A.

3.2. Households

At the top level of the utility maximisation process, worker households observe their state in the labor market, where they are either employed or unemployed. M_i worker households who are employed, maximize utility H_i^m subject to a budget constraints and a time constraint. Utility depends on consumption C_i^m, leisure Z_i^m and public consumption G_i, which enters the utility function in an additively separable way and therefore public consumption does not directly effect private utility maximization choices:

$$H_i^m = u(C_i^m, Z_i^m) + g(G) \tag{1}$$

At the top level, the worker household's CES utility function to be maximized is the following:

$$u(C_i^m, Z_i^m) = \left[d^{1/\theta} C_i^{m(\theta-1)/\theta} + (1-d)^{1/\theta} Z_i^{m(\theta-1)/\theta} \right]^{\theta/(\theta-1)} \tag{2}$$

where d and θ are the parameter and substitution elasticity of the CES function. The utility function is maximised with respect to

[5] According to the law until 1999 the government had to balance the yearly budget, starting from 2000 the government's budget is balanced over an economic cycle.

two constraints. First the budget constraint, which is given by:

$$(1 - TA_i)W_i S_i^m = P_c C_i^m \tag{3}$$

where TA_i is the average income tax rate on gross labor income, W_i is the wage rate, S_i^m is labor supply in hours and P_c is the ideal price index for a consumption bundle. The time constraint, where labor supply equals the time endowment minus leisure, and the total time endowment is normalised to unity $S_i^m = 1 - Z_i^m$. (Some minimal amount of hours are excluded from houshold's total time endowment.)

From utility maximization with respect to budget and time constraints, we get the labor supply S_i, which is M_i times the labor supply of one worker S_i^m:[6]

$$S_i = \frac{M_i}{1 + \frac{1-d}{d}\left(\frac{(1-TA_i)W_i}{P_c}\right)\left(\frac{(1-TM)W_i}{P_c}\right)^{-\theta}} \tag{4}$$

Note that $TA_i = TM - \frac{F_i}{S_i^m W_i} TM$, where TM is the marginal tax rate and F_i is the tax allowance which is a function of wages $F_i = f_i W_i$.

Aggregate household income is the sum of their after tax labor income, unemployment benefits, social benefits and aggregate profits. The aggregate household budget constraint:

$$P_c C = \sum_i \left[(1 - TA_i)W_i L_i + B_i U_i S_i\right] + \Pi \tag{5}$$

where L_i is employment, B_i is unemployment benefit and $U_i = (S_i - L_i)/S_i$ is the unemployment rate of labor type i, unemployment is measured in hours as the difference between labor supply and demand.

[6]For derivation of the labor supply function see appendix B.

At the next level utility maximisation, the choice is made between two aggregate goods: one produced domestically and the other imported. Domestic and foreign commodities are imperfect substitutes. Demand for the two commodities is described by a CES function: $C = c(C_m, C_y)$, where C_m is private demand for foreign good and C_y is private consumption of domestically produced goods. The CES function describing the demand is the following:

$$C = \left[q^{1/\kappa} C_m^{(\kappa-1)/\kappa} + (1-q)^{1/\kappa} C_y^{(\kappa-1)/\kappa} \right]^{\kappa/(\kappa-1)} \tag{6}$$

where q and κ are the CES function parameter and substitution elasticity. From FOC we get the optimal allocation of consumption:

$$\frac{C_m}{C_y} = \frac{q}{1-q} \left(\frac{P_m}{P_y} \right)^{-\kappa} \tag{7}$$

where P_y and P_m denote ideal price indexes for domestic and imported goods. It should be noted that public consumption G has the same structure as private consumption.

At the next level, the optimal allocation of production over two composite commodity types $i = u, s$, which are produced by either low-skilled or high-skilled labor, demanded by domestic and foreign households and the government, which share the same consumption pattern, is derived from maximising the CES utility function:

$$Y = \left[b^{1/\phi} Y_s^{(\phi-1)/\phi} + (1-b)^{1/\phi} Y_u^{(\phi-1)/\phi} \right]^{\phi/(\phi-1)} \tag{8}$$

where ϕ is the elasticity of substitution between the two composite commodities and b is a share parameter. From first-order

conditons we arrive at the following optimal allociation:[7]

$$\frac{Y_s}{Y_u} = \frac{b}{1-b}\left(\frac{P_s}{P_u}\right)^{-\phi} \tag{9}$$

where P_s and P_u are the prices of skilled and unskilled goods. The parameter ϕ can be considered as the substitution elasticity between low and high-skilled labor. The aggregate ideal price index P is:[8]

$$P_y = \left[bP_s^{1-\phi} + (1-b)P_u^{1-\phi}\right]^{1/(1-\phi)} \tag{10}$$

Commoditities produced by different firms $j = 1, ..., N_i$ of one type are substitutable with each other according to the following CES function:

$$Y_i = \left[\sum_j^{N_i} a_{ij}^{1/\eta} Y_i^{j(\eta-1)/\eta}\right]^{\eta/(\eta-1)} \tag{11}$$

where α_{ij} is the share parameter and η is the substititution elasticity between commodities produced by different firms of one type. The substitution elasticity is independent of firm. Ideal price index (a unit cost function) P_i is the following:

$$P_i = \left[\sum_j^{N_i} a_{ij} P_i^{j(1-\eta)}\right]^{1/(1-\eta)} \tag{12}$$

where P_i^j is the firm dependent price of goods.

[7] For derivation of the first-order conditions see appendix C.

[8] For derivation of the ideal price index see appendix D.

3.3. Firms

There are two types of firms, which differ according to the skill of the labor they employ. For each skill group, low-skilled and high-skilled $i = u, s$, there is a fixed number of firms N_i. Firm's produce output Y_i^j using labor L_i^j as the only input. Production takes place according to the linear production function, where h_i describes labor productivity of skill type:

$$Y_i^j = h_i L_i^j \tag{13}$$

Firms act in monopolistic competition, maximizing their profits Π_i^j, where they have impact on prices P_i^j:

$$\Pi_i^j = P_i^j Y_i^j - W_i(1 + T_s)L_i^j \tag{14}$$

The costs of the firm are determined by the wage rate W_i, social security tax rate T_s and the amount of labor employed L_i^j. From the FOC of profit maximisation, their optimal strategy is to set prices as a mark-up over marginal cost:[9]

$$P_i^j = \frac{1}{1-\epsilon}\frac{W_i(1+T_s)}{h_i} \tag{15}$$

where $\epsilon = -\frac{\partial P_i^j}{\partial Y_i^j}\frac{Y_i^j}{P_i^j}$ denotes the inverse price elasticity of product demand.[10] In symmetric equilibrium the mark-up is independent of firms of one type and all firms set the same price.[11] Firms get

[9] For derivation of the price equation see appendix E.

[10] It follows the standard monopolistic competition model introduced by Dixit and Stiglitz (1977).

[11] The price elasticity of product demand equals the substitution elasticity of goods $\epsilon = 1/\eta$ and therefore the mark-up is smaller the closer substitutes are the goods. To show that mark-up is independent of firm type, take the derivative from $Y_i^j = \frac{a_{ij}Y}{P_i^{j(\eta)}}\left(\sum_j^{N_i} a_{ij}P_i^{j(1-\eta)}\right)^{\eta/(1-\eta)}$ with respect to P_i^j and assume $a_{ij} \to 0$.

positive profits due to the mark-up. The aggregate profits Π of all firms are given by the following:

$$\Pi = \sum_i \sum_j^{N_i} \Pi_i^j \tag{16}$$

3.4. Labor market

Wage bargaining

For low-skilled workers wages are determined by a right to manage, unions bargaining model, where the union and the employers' organisation bargain over wages and employers determine employment. In the bargaining process the following Nash function is maximised:

$$\Omega_u = \Lambda_u^{\alpha} \Gamma_u^{1-\alpha} \tag{17}$$

subject to the optimal labor demand chosen by firms, where $\Lambda_u = P_u Y_u - W_u(1+T_S)L_u$ is the utility of the employers' organisation and $\Gamma_u = L^{1/2}\left[W_u(1-TA_u) - B_u\right]^{1/2}$ is the utility of the union. The utility of the union depends on labor demand and the wage over the reservation wage. It is assumed that the union gives equal weight to employment and wage.

From FOC for the Nash bargaining solution, we get the following wage equation:[12]

$$W_u = \frac{\frac{\alpha B_u}{1-TM}}{\alpha\frac{1-TA}{1-TM} - \frac{1}{2}(1-\alpha)\frac{\epsilon}{1-\epsilon}} \tag{18}$$

[12] For derivation of the wage function see appendix F.

Efficiency wage for high-skilled workers

High-skilled workers, based on the Shapiro and Stiglitz (1984) model, receive an efficiency wage. Working takes some effort, which gives disutility to workers. The workers who do not provide effort do not produce anything, therefore firms want to give motive to provide effort. For the firms it is optimal to pay a wage, which is higher than the competitive wage. A worker who is employed but does not provide effort – a shirking worker – takes into account that he might become unemployed, his expected utility is:

$$rV_S = W - (\rho + \upsilon)(V_S - V_U) \tag{19}$$

where r is the discount rate, W is wage, ρ is the probability of getting caught of shirking, υ is the exogeneous probability of quitting the job and V_U is the utility of the unemployed worker. The worker who provides effort e – a non-shirker – might also become unemployed for exogeneous reasons, his expected utility is:

$$rV_N = W - e - \upsilon(V_N - V_U) \tag{20}$$

The utility of the unemployed worker is:

$$rV_U = B + \psi(V_N - V_U) \tag{21}$$

where ψ is the probability of finding a job.

Firms would like to pay a wage where $V_N \geq V_S$, the assumption is made that when a worker is indifferent between the two states, he chooses to provide effort. The wage that corresponds to this non-shirking condition is the following:[13]

$$W = B + e + \left(r + \frac{\upsilon}{U}\right)\frac{e}{\rho} \tag{22}$$

where U is the unemployment rate.

[13]For derivation see appendix G.

3.5. Government

The government collects revenues using a labor income tax and finances unemployment benefits and public consumption. As mentioned, public consumption G has the same structure as private consumption and therefore also the same ideal price index P_c. The government has a balanced budget with the following budget constraint:

$$P_c G = \sum_i \left[TA_i W_i L_i + T_s W_i L_i - B_i U_i S_i \right] \tag{23}$$

The assumption is made that the marginal tax rate and unemployment benefits are uniform for low-skilled and high-skilled workers. Unemployment benefits are indexed to wages in the following way:

$$B_i = R_i \left(\frac{W_u + W_s}{2} \right) \tag{24}$$

where R_i is the replacement rate.

3.6. Foreign trade

Exports X_y are described by a CES function, which determines the consumption in the foreign country of imported goods from home country and domestically produced goods in the foreign country. The FOC of the CES function is:

$$X_y = \frac{z}{1-z} \left(\frac{P_y}{P_m} \right)^{-\xi} C_f \tag{25}$$

where z is the share parameter, ξ the elasticity of substitution, P_y and P_m are the prices of goods produced in the home and foreign country and C_f is private and public consumption in the foreign country of locally produced goods.

3.7. Equilibrium

There is equilibrium in the goods market. Aggregate supply of domestic goods Y is equal to domestic private demand C_y plus government demand G_y and foreign demand X_y:

$$Y = C_y + G_y + X_y \tag{26}$$

Also, total imported goods equal exported goods. Balance of payments equilibrium:

$$P_m(C_m + G_m) = P_y X_y \tag{27}$$

4. Data and calibration

The data used in the simulations is from the year 2001. In the data, labor supply is actual labor force, while labor demand is employment, both come from Labor Force Survey data. People with less than basic education and those with basic education, vocational secondary education subsequent to basic education and together with secondary education are considered as low-skilled labor. Other groups on the basis of education are considered to be high-skilled labor.

The data about the relative wages by skill groups is from the Labor Force Survey. Based on the relative wages, wage income from national accounts data is divided between low and high-skilled workers. The data about profits is taken from the national accounts, and reduced by the share of interest rate income for the owners of the capital.

The data about imports is calibrated based on proportion of private and government consumption of imported goods in total imports

Table 1: Data and parameters

National accounts			
$Y = 60868.004$	$C = 43206.84$	$G = 17661.16$	$\Pi = 13764.00$
$X_y = 17593.00$	$C_m = 15588.00$	$G_m = 2005.00$	
Labor market			
$L_u = 142.10$	$S_u = 175.00$	$u_u = 0.19$	$W_u = 47.41$
$L_s = 435.60$	$S_s = 485.80$	$u_s = 0.10$	$W_s = 66.36$
Institutional data			
$B = 15.20$	$F = 12.00$	$TM = 0.2600$	$T_s = 0.3215$
Parameters			
$\phi = 0.5$	$\kappa = 2.0$	$\theta = 2.0$	$\xi = 2.0$
$\alpha = 0.1822$	$\epsilon = 0.2261$	$\rho = 0.2$	$r = 0.1$
$\nu = 0.05$			

Notes: Data from national accounts are in millions of Estonian Kroons. Data of labor supply and demand are in thousands of labor years. Wage and benefit data are in thousands of Estonian Kroons.

in 1997. The other variables are calculated as residuals. In the model, prices in the base simulation are normalised to unity. (For further discussion of the data compilation see appendix H.)

The marginal income tax rate is set equal to the actual 26 percent and tax allowance to the twelve thousands per worker per year. While the social security tax rate is calculated based on the actual data on wages and social security payments and is 32.2 percent. The replacement rate of benefits for low-skilled workers is 32 percent and for skilled is 23 percent.

The substitution elasticity of high-skilled and low-skilled is set equal to a rather low value 0.5, based on Hamermesh (1993). The substitution elasticity of leisure and consumption is set equal to 2 (Bovenberg et al. (2000) have the elasticity equal to 4 for both

skill groups). The Armington elasticity and transformation elasticity are both set equal to 2 based on Bovenberg et al. (2000) and Böhringer et al. (2002) (see also Hertel (1997) for estimates of Armington and de Melo and Tarr (1992) for transformation elasticities). Employers bargaining power is calibrated to match the wage data.

5. Simulations

5.1. Description

The simulations that are run include changes in tax rates and benefits, which describe either the recently passed reforms or current reform proposals. The changes in the policy are financed by ex ante decrease in public consumption by 0.5%. The impact of the changes are analysed on the following endogeneous variables: production, consumption, labor supply, employment, unemployment, producer wages, consumer wages and welfare.

The simulation 1 of an increase of benefits by a same amount for both skill groups, characterizes an increase in the flat rate unemployment benefits by a same amount for both skill groups. The reform proposal is raised due to the current small flat rate unemployment assistance benefits. The simulation 2 of the replacement rate increase for high-skilled workers, describes the reform, where the replacement rate is increased only for the workers with the lower initial replacement rate. The starting point for the reform is the situation, where replacement rate is higher for low-skilled workers and lower for high-skilled workers, which was the situation in Estonia before the introduction of the unemployment insurance system. The introduction of the unemployment insurance benefits increased replacement rate for high-skilled workers.

The simulation 3 of the tax allowance increase by a same amount for both skill groups illustrates tax allowance increase which took place in 2004 and there is a proposal to increase the tax allowance further. The simulation 4 of the tax allowance increase for low-skilled workers, can be considered as a measure similar to tax credit. The reform would be aimed at increasing the employment of low-skilled workers by lowering the costs of employing them. The last simulation of a decrease of the marginal tax rate is describing the reform, which is planned to take place in Estonia in 2005 and according to the law the marginal tax rate will be decreased further in the coming years.

5.2. Simulation results

Simulation results as percentage changes are reported in table 2. The aggregate welfare measure is calculated based on equation 1, in order to create one aggregate measure to compare the simulations. Aggregate welfare depends on the sum of the utility of the three household types plus government consumption. Therefore, it depends on leisure and production.

In the following, some of the main impact channels of the simulations are described. An important channel works via demand for goods and labor. The marginal tax rate, tax allowance and benefits have direct impact on producer wage, which affects labor demand. Higher wage costs increase prices, which have impact on exports. Due to the higher domestic price level exports decrease. When domestic demand decreases, then demand for labor decreases. The decrease in employment decreases the demand for labor further as the domestic demand for goods decreases too. This leads to lower employment and higher unemployment.

The model is specified in a way that high-skilled labor takes into account a probability of becoming unemployed. Therefore, when

Table 2: Simulation results

	1	2	3	4	5
Production and welfare					
Production	-3.17	-0.64	0.29	1.56	0.16
Private consumption	-1.42	-0.19	0.30	0.93	0.32
Public consumption	-6.60	-1.59	0.14	2.59	-0.33
Exports	-1.73	-0.30	0.24	0.96	0.21
Welfare	-2.76	0.07	0.00	1.59	0.67
Prices and wages					
Production price	0.87	0.15	-0.12	-0.48	-0.11
Consumption price	0.56	0.10	-0.08	-0.31	-0.07
High-skilled producer wage	-1.69	0.15	0.25	1.01	-0.09
Low-skilled producer wage	12.21	0.16	-1.70	-6.71	-0.18
High-skilled consumer wage	-1.58	0.19	0.54	0.97	0.22
Low-skilled consumer wage	13.03	0.21	-1.40	-5.62	0.09
Labor market					
High-skilled employment	-1.91	-0.63	0.10	0.80	0.15
Low-skilled employment	-8.19	-0.64	1.09	4.89	0.20
High-skilled labor supply	-0.77	0.02	0.01	0.45	0.17
Low-skilled labor supply	3.68	0.02	-0.70	-2.89	0.15
High-skilled unemployment	9.10	5.68	-0.79	-2.66	0.29
Low-skilled unemployment	56.41	2.96	-8.68	-37.46	-0.09
Replacement rates and taxes					
High-skilled replacement rate	7.01	11.60	0.00	0.00	0.00
Low-skilled replacement rate	7.01	0.00	0.00	0.00	0.00
High-skilled average tax	-0.43	-0.14	-1.06	0.17	-1.15
Low-skilled average tax	-3.00	-0.22	-1.27	-4.83	-1.12
Marginal tax	0.00	0.00	0.00	0.00	-1.19

Notes: Simulation 1: a benefits increase by the same amount for both skill groups, which is an increase in the replacement rate for both skill groups; Simulation 2: a benefits increase for high-skilled workers, which is an increase in the replacement rate for high-skilled workers; Simulation 3: an increase in the tax allowance by the same amount for both skill groups; Simulation 4: an increase in the tax allowance for low-skilled workers; Simulation 5: a decrease in the marginal tax rate.

unemployment is high then high-skilled labor in the model is willing to accept a lower wage. Wage for low-skilled workers is bargained by a union, on whose objective function a decrease in em-

ployment has less impact. This has important consequences on the results, as a decrease in employment has moderating impact on high-skilled workers' wage while not on low-skilled workers wage. The specification describes the Estonian situation in a quite realistic way, because in the model the share of the wages, which are bargained by union, is about equal to the share of the wages, which are close to minimum wage in reality.

It should be noted that an increase in the wage of one skill group has impact on the wage of the other skill group, through a link between average wage level and benefits: benefits of one skill group depend on the wages of both skill groups. The assumption is especially appropriate in case of flat rate benefits, as it is realistic to assume that flat rate benefits depend on the wages of both skill groups.

An increase in replacement rate

An increase in replacement rates for both skill groups leads to a decrease in production and employment, and an increase in unemployment. The reason of the decrease in production and employment is the one described, where an increase in wages increases prices and therefore leads to lower demand. The general results from the simulation are similar to the results from the partial equilibrium analysis (Hinnosaar (2004), Kuddo et al. (2002)), which also have showed either an increase in unemployment or an incentive to decrease labor supply.

When the replacement rate is increased only for high-skilled workers, the increase in wages is much smaller. The reason is that the increase in unemployment is taken into account, when deciding the high-skilled workers' wage. The smaller increase in wage leads to a situation where production price increases less compared to the case where both wages were directly increased by replacement rate. Therefore, when the replacement rate increases

only for high-skilled workes, the decrease in production and labor demand is lower.

Changes in taxes

An increase in tax allowance and a decrease in marginal tax rate (see the last three columns in table 2) has a decreasing impact on wages, this increases foreign and domestic demand, which leads to an increase in production and employment. The positive impact is the strongest when the tax allowance is increased only for low-skilled labor (the fourth column in table 2).

When the tax allowance is increased, then labor supply of both skill groups decreases due to an income effect. The overall impact of tax allowance increase is positive on labor supply of high-skilled workers. This is due to the positive impact of tax allowance on wage; the tax allowance affects wage via lowering unemployment. A decrease in marginal tax rate increases labor supply through a substitution effect.

Unemployment of low-skilled workers decreases in all the cases. High-skilled workers' unemployment decreases when tax allowance is increased. However, a decrease in marginal tax rate increases unemployment of high-skilled workers. The increase in high-skilled workers' unemployment takes place despite that a decrease in marginal tax rate increases employment. The unemployment increases as labor supply of high-skilled workers increases.

It has to be concluded that the increase in tax allowance only for low skilled workers leads to the best results in terms of employment, unemployment and production.

6. Concluding remarks

The purpose of the paper was to describe changes to the benefits and labor income tax in Estonia in a general equilibrium framework. The results of the analysis indicated that from the tax burden decreases, an increase in tax allowance only for low-skilled workers has the most favorable impact on the labor market. An increase in benefits had negative impact in the model. However, the negative impact was much smaller when the replacement rate was increased only for high-skilled workers.

It should be noted that the results from the current analysis should be interpreted with caution for several reasons. First, the simulation results from the model are highly dependent on the elasticity values. Unfortunately there are no available estimates based on Estonian data for these elasticities, and in the current analysis the estimates are taken from research based on other countries. An extention to the current project would be to estimate the elasticity values for Estonia and conduct the robustness analysis of the model.

The model used in the current paper is, of course, a simplification of Estonian economy. The model could be extended to include capital, savings and investments. Addititionally, a dynamic framework would give valuable information in the analysis. For example, it would be especially useful to analyse labor market policies in relation to changes in human capital creation.

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SISUKOKKUVÕTE

Sotsiaaltoetuste ja maksude mõju Eesti tööturule: analüüs üldise tasakaalu raamistikus

Käesolevas artiklis analüüsitakse toetuste ja maksude muutmise mõju Eesti tööturule lihtsa arvutusliku üldise tasakaalu mudeli abil. Töös kasutatakse Bovenberg et al. (2000) mudelit, mida on täiendatud efektiivsuspalga osaga, tuginedes Shapiro and Stiglitz (1984) artiklile.

Käesolevas töös kasutatud mudel ühendab ametiühingu kauplemise ja efektiivsuspalga teooriad. Mudel on staatiline. Keskendumaks tööturule ei kaasata mudelisse kapitali, säästmist ja investeeringuid. Mudelis eristatakse kahte tüüpi tööjõudu, kirjeldamaks erineva kvalifikatsiooniga inimeste erinevat olukorda Eesti tööturul.

Mudeliga viiakse läbi viis simulatsiooni uurimaks toetuste ja üksikisiku tulumaksumäära vähendamise ning tulumaksuvaba miinimumi suurendamise üldise tasakaalu efekte. Igas simulatsioonis varieeritakse erinevat majanduspoliitika instrumenti või rakendatakse seda erinevale osale tööjõust. Toetuste suurendamisel on mudelis negatiivne mõju tööturule ja kogutoodangule, kuid negatiivne mõju on suhteliselt väike, kui toetused suurenevad vaid kõrge kvalifikatsiooniga tööjõul. Maksukoormust vähendavatest simulatsioonidest on madala kvalifikatsiooniga tööjõu tulumaksuvaba miinimumi suurendamisel kõige positiivsem mõju tööturule ning kogutoodangule.

Käesolev töö on esimene katse uurida Eesti tööturureforme üldise tasakaalu raamistikus. Selles töös kasutatud mudel on Eesti majanduse lihtsustatud kujutis ja töö tulemuste konkreetsel tõlgendamisel tuleb olla ettevaatlik ning arvestada, et tulemused sõltuvad oluliselt mudeli kujust ja parameetritest. Käesolevas töös

tehtud simulatsioonid näitavad, et üldise tasakaalu efektid võivad erineda osalisest tasakaalust, mistõttu peaks üldise tasakaalu mudelitel olema oluline koht majanduspoliitika analüüsis.

A Main equations of the model

HOUSEHOLD
Labor supply:
$S_i = \frac{M_i}{1+\frac{1-d}{d}\left(\frac{(1-TA_i)W_i}{P_c}\right)\left(\frac{(1-TM)W_i}{P_c}\right)^{-\theta}}$
Private consumption:
$p_c C = \sum_i \left[(1-TA_i)W_i L_i + B_i U_i S_i\right] + \Pi$
Demand for home produced goods:
$C = \left[q^{1/\kappa} C_m^{(\kappa-1)/\kappa} + (1-q)^{1/\kappa} C_y^{(\kappa-1)/\kappa}\right]^{\kappa/(\kappa-1)}$
Demand for imports:
$\frac{C_m}{C_y} = \frac{q}{1-q}\left(\frac{P_m}{P_y}\right)^{-\kappa}$
Demand for high-skilled labor goods:
$Y = \left[b^{1/\phi} Y_s^{(\phi-1)/\phi} + (1-b)^{1/\phi} Y_u^{(\phi-1)/\phi}\right]^{\phi/(\phi-1)}$
Demand for low-skilled labor goods:
$\frac{Y_s}{Y_u} = \frac{b}{1-b}\left(\frac{P_s}{P_u}\right)^{-\phi}$

FIRM
Labor demand:
$Y_i^j = h_i L_i^j$
Price:
$P_i^j = \frac{1}{1-\epsilon}\frac{W_i(1+T_s)}{h_i}$
Profit:
$\Pi_i^j = P_i^j Y_i^j - W_i(1+T_s)L_i^j$
Aggregate profits:
$\Pi = \sum_i \sum_j^{N_i} \Pi_i^j$

LABOR MARKET
Low-skilled wage:
$W_u = \frac{\alpha B_u/(1-TM)}{\alpha\frac{1-TA}{1-TM} - \frac{1}{2}(1-\alpha)\epsilon/(1-\epsilon)}$
High-skilled wage:
$W_s = B_s + e + \left(r + \frac{\upsilon}{U_s}\right)\frac{e}{\rho}$
Unemployment:
$U_i = (S_i - L_i)/S_i$

PRICES
Domestic aggregate price:
$P_y = \left[bP_s^{1-\phi} + (1-b)P_u^{1-\phi}\right]^{1/(1-\phi)}$
Aggregate consumption price (2):
$P_c = \left[qP_m^{1-\kappa} + (1-q)P_y^{1-\kappa}\right]^{1/(1-\kappa)}$

GOVERNMENT
Government consumption:
$P_cG = \sum_i \left[TA_iW_iL_i + T_sW_iL_i - B_iU_iS_i\right]$
Government consumption of imports:
$P_m(C_m + G_m) = P_yX_y$
Government consumption of domestic goods:
$G = \left[q^{1/\kappa}G_m^{(\kappa-1)/\kappa} + (1-q)^{1/\kappa}G_y^{(\kappa-1)/\kappa}\right]^{\kappa/(\kappa-1)}$

EXOGENOUS FACTORS
Benefits: $B_i = R_i\left(\frac{W_u+W_s}{2}\right)$
Average tax: $TA_i = TM - \frac{F_i}{S_i^mW_i}TM$
Tax allowance: $F_i = f_iW_i$
Export demand: $X_y = \frac{z}{1-z}\left(\frac{P_y}{P_m}\right)^{-\xi}C_f$

Domestic production: $Y = C_y + G_y + X_y$

B Labor supply

CES utility function to be maximized is the following:

$$u(C_i^m, Z_i^m) = \left[d_i^{\frac{1}{\theta}} C_i^{m\,\frac{\theta-1}{\theta}} + (1-d_i)^{\frac{1}{\theta}} Z_i^{m\,\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}} \tag{28}$$

The household's budget constraint is the following:

$$(1-TA_i)W_i S_i^m = P_c C_i^m \tag{29}$$

Substituting the budget constraint into the utility function and taking into account that $Z = 1 - S$, the household problem becomes the following:

$$\max_{S_i^m} \left[d_i^{1/\theta} \left(\frac{(1-TA_i)W_i S_i^m}{P_c} \right)^{\frac{\theta-1}{\theta}} + (1-d_i)^{1/\theta} (1-S_i)^{m\,\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}} \tag{30}$$

The FOC, taking into account that $\left(TA_i = TM - \frac{TMF_i}{W_i S_i^m} \right)$[14], is:

$$0 = \left[d_i^{1/\theta} \left(\frac{(1-TA_i)W_i S_i^m}{P_c} \right)^{\frac{\theta-1}{\theta}} + (1-d_i)^{1/\theta} (1-S_i)^{m(\theta-1)/\theta} \right]^{\frac{1}{\theta-1}} \cdot \left[d_i^{\frac{1}{\theta}} \left(\frac{(1-TA_i)W_i S_i^m}{P_c} \right)^{-\frac{1}{\theta}} \frac{(1-TM)W_i}{P_c} - (1-d_i)^{\frac{1}{\theta}} (1-S_i^m)^{-\frac{1}{\theta}} \right] \tag{31}$$

$$S_i^m \frac{1-d_i}{d_i} \left(\frac{(1-TA_i)W_i}{P_c} \right) \left(\frac{(1-TM_i)W_i}{P_c} \right)^{-\theta} - (1-S_i^m) = 0 \tag{32}$$

[14] In the optimisation process, the worker does not take into account that tax allowance depends on wage.

From which it is easily seen that labor supply is given by the following formula:

$$S_i^m = \frac{1}{1 + \frac{1-d}{d}\left(\frac{(1-TA_i)W_i}{P_c}\right)\left(\frac{(1-TM_i)W_i}{P_c}\right)^{-\theta}} \tag{33}$$

and multiplying by M_i gives:

$$S_i = \frac{M_i}{1 + \frac{1-d}{d}\left(\frac{(1-TA_i)W_i}{P_c}\right)\left(\frac{(1-TM_i)W_i}{P_c}\right)^{-\theta}} \tag{34}$$

C First order conditions of CES function

CES function

$$Y = \left[b^{1/\phi} Y_s^{(\phi-1)/\phi} + (1-b)^{1/\phi} Y_u^{(\phi-1)/\phi}\right]^{\phi/(\phi-1)} \tag{35}$$

Ideal price index:

$$P_y = \left[bP_s^{1-\phi} + (1-b)P_u^{1-\phi}\right]^{1/(1-\phi)} \tag{36}$$

The cost minimization problem is the following:

$$\min P_s Y_s + P_u Y_u \tag{37}$$

st

$$Y = \left[b^{1/\phi} Y_s^{(\phi-1)/\phi} + (1-b)^{1/\phi} Y_u^{(\phi-1)/\phi}\right]^{\phi/(\phi-1)} \tag{38}$$

Lagrangian:

$$\mathcal{L} = P_s Y_s + P_u Y_u$$
$$-\lambda \left[Y - \left[b^{1/\phi} Y_s^{(\phi-1)/\phi} + (1-b)^{1/\phi} Y_u^{(\phi-1)/\phi} \right]^{\phi/(\phi-1)} \right] \quad (39)$$

FOC:

$$Y_s = -\frac{bY\lambda^{\phi}}{P_s^{\phi}} \quad (40)$$

$$Y_u = -\frac{(1-b)Y\lambda^{\phi}}{P_u^{\phi}} \quad (41)$$

Dividing them gives:

$$\frac{Y_s}{Y_u} = \frac{b}{1-b} \left(\frac{P_s}{P_u} \right)^{-\phi} \quad (42)$$

D Ideal price index in case of CES function

The ideal price index of the CES function:

$$Y = \left[b^{1/\phi} Y_s^{(\phi-1)/\phi} + (1-b)^{1/\phi} Y_u^{(\phi-1)/\phi} \right]^{\phi/(\phi-1)} \quad (43)$$

is the following:

$$P_y = \left[b P_s^{1-\phi} + (1-b) P_u^{1-\phi} \right]^{1/(1-\phi)} \quad (44)$$

The ideal price index is the optimal cost. The cost minimization problem:

$$\min P_s Y_s + P_u Y_u \tag{45}$$

st

$$Y = \left[b^{1/\phi} Y_s^{(\phi-1)/\phi} + (1-b)^{1/\phi} Y_u^{(\phi-1)/\phi} \right]^{\phi/(\phi-1)} \tag{46}$$

Forming the Lagrangian gives:

$$\mathcal{L} = P_s Y_s + P_u Y_u$$
$$-\lambda \left[Y - \left[b^{1/\phi} Y_s^{(\phi-1)/\phi} + (1-b)^{1/\phi} Y_u^{(\phi-1)/\phi} \right]^{\phi/(\phi-1)} \right] \tag{47}$$

FOC:

$$Y_s = -\frac{bY\lambda^{\phi}}{P_s^{\phi}} \tag{48}$$

$$Y_u = -\frac{(1-b)Y\lambda^{\phi}}{P_u^{\phi}} \tag{49}$$

$$Y = \left[b^{1/\phi} Y_s^{(\phi-1)/\phi} + (1-b)^{1/\phi} Y_u^{(\phi-1)/\phi} \right]^{\phi/(\phi-1)} \tag{50}$$

Substituting first two FOC (48) and (49) into the third one (50), it is possible to get λ:

$$\lambda = -\left(bP_s^{1-\phi} + (1-b)P_u^{1-\phi} \right)^{1/(1-\phi)} \tag{51}$$

Substituting λ from (51) into FOCs (48) and (49) we get Y_s and Y_u as functions of Y and prices:

$$Y_s = \frac{bY}{P_s^{\phi}} \left(bP_s^{1-\phi} + (1-b)P_u^{1-\phi} \right)^{\phi/(1-\phi)} \tag{52}$$

$$Y_u = \frac{(1-b)Y}{P_u^{\phi}} \left(bP_s^{1-\phi} + (1-b)P_u^{1-\phi} \right)^{\phi/(1-\phi)} \tag{53}$$

Finally substituting (52) and (53) into the cost function:

$$PY = P_s Y_s + P_u Y_u \tag{54}$$

we arrive at the ideal price index presented by (44).

E Profit maximisation

Firms maximise the following profit function:

$$\Pi_i^j = P_i^j Y_i^j - W_i(1+T_s)L_i^j \tag{55}$$

choosing labor demand. FOC:

$$\frac{\partial \Pi_i^j}{\partial L_i^j} = P_i^j h_i + \frac{\partial P_i}{\partial Y_i^j} h_i Y_i^j - W_i(1+T_s) = 0 \tag{56}$$

$$\implies P_i^j h_i + \frac{\partial P_i}{\partial Y_i^j} h_i Y_i^j - W_i(1+T_s) = \tag{57}$$

$$\implies P_i^j h_i + \frac{\partial P_i}{\partial Y_i^j} h_i Y_i^j \frac{P_i}{P_i} - W_i(1+T_s) = 0 \tag{58}$$

$$\implies P_i^j h_i - \epsilon h_i P_i - W_i(1+T_s) = 0 \tag{59}$$

From which firm's optimal pricing decision is:

$$\implies P_i = \frac{W_i(1+T_s)}{(1-\epsilon)h_i} \tag{60}$$

F Maximisation of Nash function

The Nash function to be maximised is:

$$\begin{aligned}\Omega_u = \Lambda_u^{\alpha}\Gamma_u^{1-\alpha} = \\ (P_u Y_u - W_u(1+T_s)L_u)^{\alpha} \cdot \\ \left(L^{1/2}\left[W_u(1-TA_u) - B_u\right]^{1/2}\right)^{1-\alpha}\end{aligned} \tag{61}$$

Where the average tax equals the marginal tax minus the tax allowance $TA = TM - \frac{F \cdot TM}{W \cdot S}$. FOC[15]:

$$\begin{aligned}\frac{\partial \Omega_u}{\partial W_u} = -\alpha\left(P_u Y_u - W_u(1+T_s)L_u\right)^{\alpha-1} L(1+T_s) \cdot \\ \left(L^{1/2}\left[W_u(1-TA_u) - B_u\right]^{1/2}\right)^{1-\alpha} + \\ \left(P_u Y_u - W_u(1+T_s)L_u\right)^{\alpha}(1-\alpha) \cdot \\ \left(L^{1/2}\left[W_u(1-TA_u) - B_u\right]^{1/2}\right)^{-\alpha} \cdot \\ L_u^{1/2}\frac{1}{2}\left[W_u(1-TA_u) - B_u\right]^{-1/2}(1-TM) = 0\end{aligned} \tag{62}$$

From which we can get

$$\begin{aligned}-\alpha\left(L_u^{1/2}\left[W_u(1-TA_u) - B_u\right]^{1/2}\right) L_u(1+T_s) + \\ \left(P_u Y_u - W_u(1+T_s)L_u\right)(1-\alpha) \cdot \\ L_u^{1/2}\frac{1}{2}\left[W_u(1-TA_u) - B_u\right]^{-1/2}(1-TM) = 0\end{aligned} \tag{63}$$

[15] In the optimisation process, the union does not take into account that benefits and tax allowances depend on the wage. The firms' pricing decision is also not taken into account.

$$\implies -\alpha(W_u(1-TA_u)-B_u)L_u(1+T_s)+$$
$$(\frac{1}{1-\epsilon}-1)(1+T_s)W_uL_u(1-\alpha)\frac{1}{2}(1-TM)=0 \quad (64)$$

After some manipulation we arrive at

$$W_u\left[\frac{1}{2}(1-\alpha)\frac{\epsilon}{1-\epsilon}(1-TM)-\alpha(1-TA_u)\right]=-\alpha B_u \quad (65)$$

From which it is directly seen, that the wage equals:

$$W_u=\frac{\frac{\alpha B_u}{1-TM}}{\alpha\frac{1-TA_u}{1-TM}-\frac{1}{2}(1-\alpha)\frac{\epsilon}{1-\epsilon}} \quad (66)$$

When $\alpha=1$ then:

$$W_u=\frac{B_u}{1-TA_u} \quad (67)$$

G Efficiency wage

The utility of a shirker is:

$$rV_S=W-(\rho+\upsilon)(V_S-V_U) \quad (68)$$

The utility of a non-shirker is:

$$rV_N=W-e-\upsilon(V_N-V_U) \quad (69)$$

The utility of an unemployed worker is:

$$rV_U=B+\psi(V_N-V_U) \quad (70)$$

The condition of working is $V_N = V_S$. Subtract 69 from 68 and assume $V_N = V_S$:

$$r(V_S - V_N) = e - \rho(V_N - V_U) \tag{71}$$

$$\Longrightarrow V_N - V_U = \frac{e}{\rho} \tag{72}$$

From 69:

$$W = e + rV_N + \upsilon(V_N - V_U) = e + rV_U + (r+\upsilon)(V_N - V_U) \tag{73}$$

From 70:

$$W = B + e + (\psi + r + \upsilon)(V_N - V_U) = B + e + (\psi + r + \upsilon)\frac{e}{\rho} \tag{74}$$

In equilibrium:

$$\upsilon L = \psi(S - L) \tag{75}$$

Substract υS from both sides:

$$\upsilon L - \upsilon S = \psi(S - L) - \upsilon S \tag{76}$$

$$\Longrightarrow \upsilon + \psi = \frac{\upsilon S}{S - L} \tag{77}$$

From which we get the wage equation:

$$W = B + e + \left(r + \frac{\upsilon}{U}\right)\frac{e}{\rho} \tag{78}$$

It is easily seen that the wage is higher, when the benefit is higher, and the wage is lower, when the unemployment is higher.

H Data description

Labor income is divided between skill groups using hourly wage according to education level from the labor force survey data. Labor is divided into low-skilled and high-skilled according to data about the education levels of the labor force. People with less than basic education and those with basic education, vocational secondary education subsequent to basic education and together with secondary education are considered to be low-skilled labor. All other people are considered as being high-skilled labor.

Data about hourly wages according to level of education is obtained from labor force surveys, but this data does not match the wage data from enterprises and national accounts. However, data about wages according to levels of education should give some information about the proportional divisions of wage income between low-skilled and high-skilled labor. According to the labor force survey data, the high-skilled workers wage is 1.4 times higher than the low-skilled workers wage (including income taxes). An assumption is made that the same proportion holds for the total wage income.

The income approach is used to calculate national income (production), in order to have as correct data as possible to describe the labor market. Using the income approach, GDP is formed using wages and employers' social security contributions plus operating surplus and mixed income. The data is obtained from the cost components of value added by the institutional sector from national accounts statistics.

Table 3: Wage and unemployment by skill groups

Education	Monthly wage, weighted	Monthly wage	Unempl. r., 2001	Aver. unempl. r., 1999-2003
1	16.49	15.72	21.1	20.8
2	19.16	19.64	15.9	14.8
3	22.89	21.14	13.3	12.74
4	21.86	21.14	17.9	16.26
5	19.63	20.99	11.1	10.6
6	23.77	22.97	11.5	9.52
7	32.04	30.13	7.4	6.6
Low-skilled	19.38	18.38		
High-skilled	27.36	25.54		

Notes on education groups: 1 – No primary education, primary education, basic education; 2 – Vocational secondary education after basic education; 3 – Secondary education; 4 – Vocational education together with secondary education; 5 – Vocational secondary education after secondary education; 6 – Post-secondary technical education based on basic education; 7 – Higher education and post-secondary technical education based on secondary education; Low-skilled – Basic education and lower, vocational secondary education after basic education and together with secondary education; High-skilled – Other.

Table 4: National accounts data by institutional sector and income approach

	Wages	Soc. security	Capital	Tax on prod.	Surplus	Value added
Non-financial corporations	26511.7	8451	…	…	17698.1	52660.8
Financial corporations	1090.7	365.1	…	…	1683.3	3139.1
General government	8042.6	2643.1	…	…	0	10685.7
NPISH	…	…	…	…	…	…
Households	…	…	…	…	…	…
Value added total	35645	11459.2	…	…	19381.4	66485.6
Payments to shareholders					5617.472	
Capitalists					13764.0	13764.0
Low-skilled	6737.0	2166.0				8903.0
High-skilled	28908.0	9293.0				38201.0
Value added total	35645.0	11459.0	…	…	13764.0	60868.0

Data from national account statistics on profits is reduced by interest rate payments to shareholders. The interest rate payments to shareholders are calculated based on the enterprise data on equity and assuming that the average interest rate is 8 percent. According to financial statistics of enterprises, equity at the end of 2001 was 70218.4 altogether in non-financial corporations with more than 20 employees. Therefore, interest rate income would be 5617.5 assuming that interest rate is 8 percent.

All the national income is either consumed by private agents or by the government. Private consumption in the model is not equal to private consumption in the national accounts statistics, but is calculated as a residual from the wage income and profits. Wage income reduced by income tax is calculated from wages including taxes using data on tax allowances and marginal tax rates.

The government's budget is constructed from the actual revenue from income and social security tax. The data about tax incomes comes from general government receipts and disbursements from national accounts statistics. (The sum of income and social security tax income is close to the actual government budget minus the production taxes, which are excluded from the GDP, minus the current transfers within general government.) In the model economy, with no other taxes than social security and income tax, there are no other income sources for the government, i.e. all the other income sources for the current government budget do not exist in the equilibrium.

The government pays benefits. The size of the benefits is calculated based on the replacement rate for the representative worker in that skill group. The total sum of benefits in the government budget is calculated based on data on unemployment and the size of the benefits. There is a significant difference between the actual benefits paid according to the government budget and the calculated data. The difference has no impact on the results from the consumption side, due to the fact that higher benefits payments

reduce government consumpiton, and in the model, government consumption is similar to private consumption. However, the size of the benefits has an impact on labor supply. Therefore, to be able to describe the actual impact, it has to be assumed that all unemployed receive the potential benefit for an average person.

The unemployed in 2001 received unemployment assistance of 400 EEK per month and social assistance benefits, which covered expenditure on housing plus additional 500 EEK per month per household member. The data on expenditure on housing comes from Household Living Niveau 2001. In 2001 expenditure on housing was 4152 EEK per household member per year. Making the assumption that there are 0.5 non-working members in the household per average person in the labor force (the average size of the household altogether is 2.4 according to the household living niveau), then benefits amount to 15.2 thousands Estonian Kroons per year.

Table 5: Government budget

	High-skilled	Low-skilled	Total
Income tax	6157	1308	7465
Social security tax	9293	2166	11459
Total government income	15450	3474	18924
Benefits	763	500	1263
Government consumption			17661
Total government expenditure			18924

Government consumption is a residual of tax income and benefits.

It is assumed that the model describes the equilibrium process, therefore the assumption is made that exports and imports in 2001 were the same (in reality in 2001 imports were larger than exports by four percent according to expenditure side national accounts data). Intermediate consumption and investments are excluded from the actual imports. Data about the use of imports is obtained from the 1997 input-output tables. The assumption is made that

the same shares of imports' use existed then as for 2001. The imports figures used in the model are 19 percent of the actual, and from the imports used in the model 88 percent is consumed by households and 12 by government. Exports are calculated as being equal to imports.

Table 6: Use of imports by institutional sector

	1997	percent	2001
Intermediate consumption	34647.3		
Households	9688.0	0.171	15588
Government	1262.0	0.022	2005
Final consumption	10950.0	0.193	17593
Capital	9430.0		
Exports	1693.0		
Total use	56720.3		91157.3