Estonian Labor Market Institutions within a General Equilibrium Framework

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Abstract

The implications of the Estonian labor market policy reforms, such as changes to the minimum wage, social benefits and tax allowance, will be analysed using a simple applied general equilibrium model. The model used in the paper is from Bovenberg *et al* (2000), with the addition of an efficiency wage section based on Shapiro and Stiglitz (1984). The model integrates union bargaining and efficiency wage theory into a traditional CGE model framework.

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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.)

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).

During recent years, there have been several labor market policy reforms and there are further changes planned, including changes in the minimum wage, social benefits, 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 minimum wages, benefits and taxes. 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.

In the paper the impact of the following policy measures is analysed: the impact of increases in benefit replacement rates, tax allowance and union bargaining power in the wage bargaining process.

Applied general equilibrium models incorporating imperfect labor mar-

kets 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 minimum wages and taxes 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 exercise for observing labor market policies in Estonia in a general equilibrium framework. The results from the model should be interpreted with caution, as the model is a simplification of the Estonian economy and 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 average wage, according to an agreement between unions and employers.

Unemployment benefit in Estonia is very low and households with no other income receive social 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

[1]Unemployment benefit is 400 Estonian kroons, which is less than 30% of the national minimum wage; social benefit guarantees 500 Estonian kroons per person

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) analyses Estonian taxes in comparison to other countries and concludes that tax burden on labor 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

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.

[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)).

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. 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 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, 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 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 2,000 EEK (Statisical Database. Social life: labor market. From Statistical Office of Estonia), which was lower than the minimum wage (2,160 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.[4]

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 1.

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 constraint 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:

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

[4]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.

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 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:[5]

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

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.

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

[5]For derivation of the labor supply function see Appendix 2. For the impact of labor market institutions on the labor supply see Appendix 3.

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:[6]

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

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:[7]

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

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

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

[6]For derivation of the first-order conditions see Appendix 4.

[7]For derivation of the ideal price index see Appendix 5.

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.

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:[8]

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

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.[9] In symmetric equilibrium the mark-up is independent of firms of one type and all firms set the same price.[10] Firms get positive profits

[8] For derivation of the price equation see Appendix 6. For the impact of wages on prices see Appendix 7. For derivation of labor demand see Appendix 8.

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

[10] 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 $a_{ij} \to 0$.

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

3.4.1. 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:[11]

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

3.4.2. 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:

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

[11]For derivation of the wage function see Appendix 9. For the impact of labor market institutions on the low-skilled workers' wage see Appendix 10.

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:[12]

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

where U is the unemployment rate.

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.

[12]For derivation see Appendix 11.

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 in 1997.

Table 1: Data and parameters

National accounts			
$Y = 60,868.004$	$C = 43,206.84$	$G = 17,661.16$	$\Pi = 13,764.00$
$X_y = 17,593.00$	$C_m = 15,588.00$	$G_m = 2,005.00$	
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 on labor supply and demand are in thousands of labor years. Wage and benefit data are in thousands of Estonian kroons.

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 12.)

The marginal income tax rate is set equal to the actual 26 percent and tax allowance to the twelve thousands per worker per year. 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 following simulations were run:

1. An increase in union bargaining power, which increases the wage of low-skilled labor;

2. A benefits increase, which is an increase in the replacement rate for both skill groups by one percentage point;

3. A benefits increase for high-skilled workers, which is an increase in the replacement rate for high-skilled workers by one percentage point;

4. An increase in the tax allowance by 5 percent for both skill groups;

5. An increase in the tax allowance by 5 percent for low-skilled workers.

Simulation 1, increased union bargaining power, can be seen in the Estonian labor market as the higher legal minimum wage, which is the result of higher union bargaining power. The simplifing assumption is made, when calibrating the model, that the bargained wage is the wage for low-skilled workers (see previous section for the discussion of the topic).

Simulation 3, an increased replacement rate for high-skilled workers, describes the reform where the replacement rate is increased only for the workers with a lower initial replacement rate. The starting point for the reform is a situation, where the replacement rate is higher for low-skilled workers and lower for high-skilled workers, which was exactly the situation in Estonia before the introduction of unemployment insurance. The introduction of unemployment insurance benefits increased the replacement rate for high-skilled workers.

Simulation 5, where the tax allowance is increased for low-skilled workers, could be seen as a measure similar to tax credit. Such a reform would be aimed at increasing the employment of low-skilled workers by lowering the costs of employing them.

The impact of these changes will be analysed on the following endogeneous variables: production, consumption, labor supply, employment, unemployment, producer wages, consumer wages and welfare.

5.2. Simulation Results

Simulation results as percentage changes are reported in the following table.

Table 2: Simulation results (percentage changes)

	1	2	3	4	5
Production and welfare					
Production	-0.23	-0.45	-0.06	0.29	0.39
Private consumption	-0.12	-0.20	-0.02	0.30	0.24
Public consumption	-0.44	-0.91	-0.15	0.13	0.63
Exports	-0.13	-0.24	-0.03	0.24	0.24
Welfare	-0.24	-0.40	0.00	-0.01	0.39
Prices and wages					
Production price	0.07	0.12	0.01	-0.12	-0.12
Consumption price	0.04	0.08	0.01	-0.08	-0.08
High-skilled producer wage	-0.15	-0.25	0.01	0.25	0.25
Low-skilled producer wage	1.00	1.71	0.05	-1.70	-1.70
High-skilled consumer wage	-0.15	-0.23	0.01	0.54	0.24
Low-skilled consumer wage	1.06	1.82	0.06	-1.39	-1.40
Labor market					
High-skilled employment	-0.12	-0.26	-0.06	0.10	0.20
Low-skilled employment	-0.69	-1.23	-0.08	1.09	1.19
High-skilled labor supply	-0.07	-0.11	0.00	0.01	0.11
Low-skilled labor supply	0.33	0.55	0.01	-0.70	-0.70
High-skilled unemployment	0.41	1.18	0.48	-0.78	-0.68
Low-skilled unemployment	4.86	8.46	0.43	-8.66	-9.11
Replacement rates and taxes					
High-skilled replacement rate	0.00	1.00	1.00	0.00	0.00
Low-skilled replacement rate	0.00	1.00	0.00	0.00	0.00
High-skilled average tax	-0.03	-0.06	-0.01	-1.08	0.02
Low-skilled average tax	-0.24	-0.42	-0.03	-1.30	-1.27

Notes: Simulation 1: increase in unions bargaining power, which increases wage of low-skilled labor; Simulation 2: benefits increase for both skill groups, which is increase in replacement rate by one percentage point; Simulation 3: benefits increase for high-skilled workers, which is increase in replacement rate for high-skilled workers by one percentage point; Simulation 4: increase in tax allowance for both skill groups; Simulation 5: increase in tax allowance for low-skilled workers.

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.

5.2.1. An Increase in Union Bargaining Power

Increase in union bargaining power leads to increase in low-skilled workers' wage. As firms' pricing decisions depend on the wage, the price of the goods produced by low-skilled workers will increase. The price of the one type of goods has an impact on the general price level, and as the general price level in the home country increases, the demand for home country exports decreases. The decrease of exports translates into a decrease in demand for goods and a decrease in the demand for labor from both skill groups and therefore an increase in unemployment (this is the first impact channel which is described by a bold solid line in Figure 1). There will be a further impact from employment on domestic demand: as employment decreases it influences domestic demand, which decreases production and employment even further and increases unemployment even more (the solid line in the figure).

On the other side, increases in wages increase low-skilled labor supply (dashed-dotted line in the figure). But when employment is lower, then the result is an increase in unemployment of low-skilled workers. Increased unemployment among high-skilled workers has a moderating impact on their wage, which has an impact on the general price level, production and demand for labor (described by the dotted line in the figure). As for low-skilled labor, increased wage increases the supply of high-skilled workers and therefore unemployment (dashed line in the figure).

The final result is an increase in wages for low-skilled workers, which leads to decrease in the high-skilled workers' wage, an increase in unemployment, a decrease in employment for both skill groups and a decrease in production and consumption. The decrease in employment and production was induced by the lower demand caused by a higher price level.

The first stage simulation result could be partly confirmed by the results from a partial equilibrium analysis (Hinnosaar and Rõõm (2003)), which showed that an increase in wages for workers in a low-wage group leads to a decrease in their employment. It is relatively straightforward to suppose that the decrease in employment leads, in the *ceteris paribus* situation, to a lower domestic demand and the higher production price leads to a lower foreign demand.

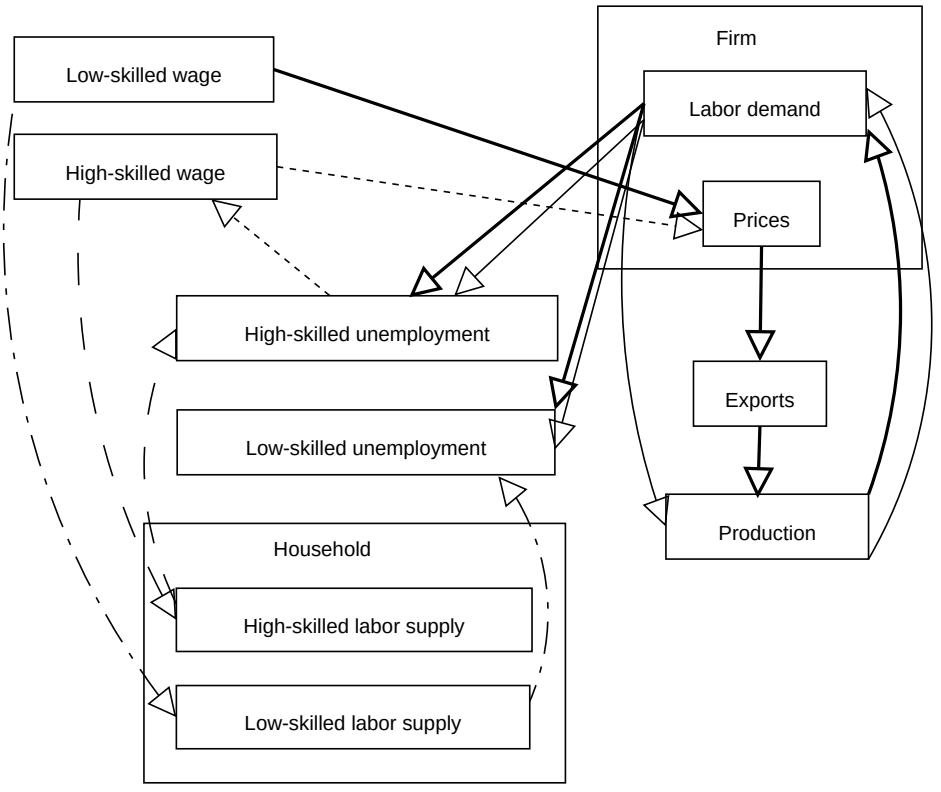

Figure 1: Impact of a wage increase

5.2.2. An Increase in Replacement Rate

An increase in benefits for both skill groups leads to an increase in wages for both skill groups, which leads to similar results to that of the wage increase induced when increasing union bargaining power. There is a decrease in production and employment, and an increase in unemployment. The general results from the simulation are similar to the results from the partial equilibrium analysis (Hinnosaar (2004), Kuddo *et al* (2002)), which also showed either an increase in unemployment or an incentive to decrease labor supply.

In simulation 3, the replacement rate is increased only for high-skilled workers. The increase in the replacement rate for high-skilled workers has a direct impact on their wage. From the wage of high-skilled workers there is a channel to low-skilled wage created by benefits. When the high-skilled wage increases, benefits for low-skilled workers increase and therefore their wage increases. The results are similar to the previous simulations. Although, as the wage increase is much smaller (since the increase in unemployment is taken into account in the high-skilled workers

wage equation), the production price increases less than in the case where both wages were directly increased by replacement rate, and the decrease in production and labor demand is less.

5.2.3. An Increase in Tax Allowance

An increase in tax allowance has a direct impact on wage for low-skilled workers and labor supply in both skill groups. A decrease in wage increases foreign demand and therefore production and demand for labor in both skill groups. An increase in demand for labor and a decrease in labor supply decreases unemployment. There will be additional decrease in labor supply due to a decrease in wages. Due to the increase in demand for labor and the decrease in labor supply, unemployment for both skill groups falls. In the case of high-skilled labor, it has an impact on their wage, which subsequently increases. The increase in wage has an increasing impact on the price level and a decreasing impact on employment.

The overall impact of a tax allowance increase is positive for production, employment and unemployment. The impact is even stronger when the tax allowance is increased only for low-skilled labor. The results of the tax allowance increase are similar to those from Bovenberg *et al* (2000), where the model was used to analyse changes in taxes.

6. Concluding Remarks

Using a general equilibrium framework for analysing the Estonian labor market, has indicated that partial equilibrium is often different from general equilibrium. Partial equilibrium analysis does not take into account secondary effects, which were shown to have a significant impact on the economy. General equilibrium frameworks are useful for policy analysis showing us the impact channels and the final effects, which should be taken into account when making the policy decisions.

Although, 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.

There are other drawbacks to the current analysis. The static model used in the paper does not take into account the potentially important dynamic effects created by the labor market policies. For example, it would be especially useful to analyse labor market policies in relation to changes in schooling and human capital creation. The other extentions to the current model would be to include capital and savings.

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Appendix 1. 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:

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

Government consumption of imports:

$$P_m(C_m + G_m) = P_y X_y$$

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:

$$TA_i = TM - \frac{F_i}{S_i^m W_i} TM$$

Tax allowance:

$$F_i = f_i W_i$$

Export demand:

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

Domestic production:

$$Y = C_y + G_y + X_y$$

Appendix 2. Labor supply

CES utility function to be maximized is the following:

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

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 $\left(TA_i = TM - \frac{TMF_i}{W_i S_i^m} \right)$[13], is:

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

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

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:

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

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

Appendix 3. The impact of labor market institutions on labor supply

In the following the first-stage impact of labor market institutions on labor supply is described.

As $TA_i = TM - \frac{f_i TM}{S_i^m} = TM - \frac{f_i TMM_i}{S_i}$, the labor supply can also be written in the form:

$$S_i = \frac{M_i - \frac{1-d}{d}\frac{fTMM_iW_i}{P_c}\left(\frac{(1-TM)W_i}{P_c}\right)^{-\theta}}{1 + \frac{1-d}{d}\left(\frac{(1-TM)W_i}{P_c}\right)^{1-\theta}} \tag{35}$$

The impact of the tax allowance parameter f on labor supply:

$$\frac{\partial S_i}{\partial f_i} = -\frac{\frac{1-d}{d}\frac{TMM_iW_i}{P_c}\left(\frac{(1-TM)W_i}{P_c}\right)^{-\theta}}{1 + \frac{1-d}{d}\left(\frac{(1-TM)W_i}{P_c}\right)^{1-\theta}} < 0 \tag{36}$$

is negative. When the tax allowance increases proportionally to the wage rate, then labor supply will decrease (again, it is the first stage impact: wage is kept constant).

When finding marginal tax rate's impact on labor supply, it is useful to first denote the numerator in (35) as A and denominator as B.

$$\frac{\partial A}{\partial TM} = -\frac{1-d}{d}\frac{f_iM_iW_i}{P_c}\left(\frac{(1-TM)W}{P_c}\right)^{-\theta} \cdot \left[1 + \theta\frac{TMW}{P_c}\left(\frac{(1-TM)W}{P_c}\right)^{-1}\right] < 0 \tag{37}$$

$$\frac{\partial B}{\partial TM} = -\frac{1-d}{d}\frac{W}{P_c}(1-\theta)\left(\frac{(1-TM)W}{P_c}\right)^{-\theta} > 0 \tag{38}$$

as $\theta > 1$. The impact of the marginal tax rate on labor supply is:

$$\frac{\partial S_i}{\partial TM} = \frac{\overbrace{\frac{\partial A}{\partial TM}}^{-}\overbrace{B}^{+} - \overbrace{A}^{+}\overbrace{\frac{\partial B}{\partial TM}}^{+}}{B^2} < 0 \tag{39}$$

as $A, B > 0$.

Appendix 4. First order conditions of CES function

CES function

$$Y = \left[b^{1/\phi} Y_s^{(\phi-1)/\phi} + (1-b)^{1/\phi} Y_u^{(\phi-1)/\phi}\right]^{\phi/(\phi-1)} \tag{40}$$

Ideal price index:

$$P_y = \left[bP_s^{1-\phi} + (1-b)P_u^{1-\phi}\right]^{1/(1-\phi)} \tag{41}$$

The cost minimization problem is the following:

$$\min P_s Y_s + P_u Y_u \tag{42}$$

st

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

Lagrangian:

$$\mathcal{L} = P_s Y_s + P_u Y_u$$
$$-\lambda \left[Y - \left[b^{1/\phi} Y_s^{(\phi-1)/\phi} + (1-b)^{1/\phi} Y_u^{(\phi-1)/\phi}\right]^{\phi/(\phi-1)}\right] \tag{44}$$

FOC:

$$Y_s = -\frac{bY\lambda^\phi}{P_s^\phi} \tag{45}$$

$$Y_u = -\frac{(1-b)Y\lambda^\phi}{P_u^\phi} \tag{46}$$

Dividing them gives:

$$\frac{Y_s}{Y_u} = \frac{b}{1-b}\left(\frac{P_s}{P_u}\right)^{-\phi} \tag{47}$$

Appendix 5. Ideal price index in case of CES function

The ideal price index of the CES function:

$$Y = \left[b^{1/\phi} Y_s^{(\phi-1)/\phi} + (1-b)^{1/\phi} Y_u^{(\phi-1)/\phi}\right]^{\phi/(\phi-1)} \tag{48}$$

is the following:

$$P_y = \left[bP_s^{1-\phi} + (1-b)P_u^{1-\phi}\right]^{1/(1-\phi)} \tag{49}$$

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

$$\min P_s Y_s + P_u Y_u \tag{50}$$

st

$$Y = \left[b^{1/\phi} Y_s^{(\phi-1)/\phi} + (1-b)^{1/\phi} Y_u^{(\phi-1)/\phi}\right]^{\phi/(\phi-1)} \tag{51}$$

Forming the Lagrangian gives:

$$\mathcal{L} = P_s Y_s + P_u Y_u$$
$$-\lambda \left[Y - \left[b^{1/\phi} Y_s^{(\phi-1)/\phi} + (1-b)^{1/\phi} Y_u^{(\phi-1)/\phi}\right]^{\phi/(\phi-1)}\right] \tag{52}$$

FOC:

$$Y_s = -\frac{bY\lambda^{\phi}}{P_s^{\phi}} \tag{53}$$

$$Y_u = -\frac{(1-b)Y\lambda^{\phi}}{P_u^{\phi}} \tag{54}$$

$$Y = \left[b^{1/\phi} Y_s^{(\phi-1)/\phi} + (1-b)^{1/\phi} Y_u^{(\phi-1)/\phi}\right]^{\phi/(\phi-1)} \tag{55}$$

Substituting first two FOC (53) and (54) into the third one (55), it is possible to get λ:

$$\lambda = -\left(bP_s^{1-\phi} + (1-b)P_u^{1-\phi}\right)^{1/(1-\phi)} \tag{56}$$

Substituting λ from (56) into FOCs (53) and (54) we get Y_s and Y_u as functions of Y and prices:

$$Y_s = \frac{bY}{P_s^{\phi}} \left(bP_s^{1-\phi} + (1-b)P_u^{1-\phi}\right)^{\phi/(1-\phi)} \tag{57}$$

$$Y_u = \frac{(1-b)Y}{P_u^{\phi}} \left(bP_s^{1-\phi} + (1-b)P_u^{1-\phi}\right)^{\phi/(1-\phi)} \tag{58}$$

Finally substituting (57) and (58) into the cost function:

$$PY = P_s Y_s + P_u Y_u \tag{59}$$

we arrive at the ideal price index presented by (49).

Appendix 6. Profit maximisation

Firms maximise the following profit function:

$$\Pi_i^j = P_i^j Y_i^j - W_i(1+T_s)L_i^j \tag{60}$$

choosing labor demand. FOC:

$$\frac{\partial \Pi_i^j}{\partial L_i^j} = P_i^j h_i + \frac{\partial P_i}{\partial Y_i^j} h_i Y_i^j - W_i(1+T_s) = 0 \tag{61}$$

$$\implies P_i^j h_i + \frac{\partial P_i}{\partial Y_i^j} h_i Y_i^j - W_i(1+T_s) = \tag{62}$$

$$\implies P_i^j h_i + \frac{\partial P_i}{\partial Y_i^j} h_i Y_i^j \frac{P_i}{P_i} - W_i(1+T_s) = 0 \tag{63}$$

$$\implies P_i^j h_i - \epsilon h_i P_i - W_i(1+T_s) = 0 \tag{64}$$

From which firm's optimal pricing decision is:

$$\implies P_i = \frac{W_i(1+T_s)}{(1-\epsilon)h_i} \tag{65}$$

Appendix 7. The impact of wages on prices

Wages have an impact on prices and through prices on the demand for goods. The impact works through the following mechanism: the wage level of each specific labor group has an impact on the price of the goods they produce $P_i = \frac{1}{1-\epsilon}\frac{W_i(1+T_s)}{h_i}$ for $i = u, s$ which has an impact on the aggregate price level of domestic goods $P_y = \left[bP_s^{1-\phi} + (1-b)P_u^{1-\phi}\right]^{1/(1-\phi)}$ which has an impact on the consumption price level: $P_c = \left[qP_m^{1-\kappa} + (1-q)P_y^{1-\kappa}\right]^{1/(1-\kappa)}$. This is also described in figure 2, where wu is the wage of low-skilled workers and ws is the wage of high-skilled workers.

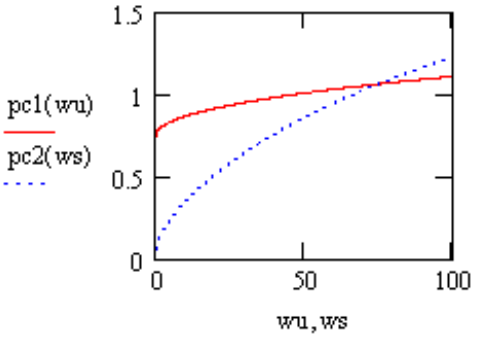


Figure 2: Impact of wages on prices

Appendix 8. Labor demand

There is no first stage impact from the wage rate on labor demand. The secondary effects take place through the dependence of price on demand. Demand for goods depends on income, while income depends on labor demand. In the following, the lowest level of utility maximisation is looked

at. An assumption is made that income at this level is constant, although in the model it depends on the relative prices of next stage aggregate goods and labor demand.

Assume that the income of a household is I, which is the sum of expenditure on goods produced by different firms.

$$I = \sum_j Y_i^j P \tag{66}$$

Therefore we can write the sum of the goods as a function of income and price (all the goods are sold at the same price).

$$\sum_j Y_i^j = \frac{I}{P} \tag{67}$$

Commodities produced by different firms $j = 1, ..., N_i$ of one type are substitutable with each other according to the following CES function: $Y_i = \left[\sum_j^{N_i} a_{ij}^{1/\eta} Y_i^{j(\eta-1)/\eta}\right]^{\eta/(\eta-1)}$ and $P_i = \left[\sum_j^{N_i} a_{ij} P_i^{j(1-\eta)}\right]^{1/(1-\eta)}$ where P_i^j is the firm dependent price of good.

When prices are the same for all goods then the production from firm i is a constant share of total production:

$$Y_i^j = a_i \left(\sum a_i\right)^{\eta/1-\eta} Y_i = c_i Y_i \tag{68}$$

As $\sum Y_i^j = \left(\sum c_i\right) Y_i$ and $Y_i = \frac{I}{P \sum c_i}$ we get that

$$Y_i^j = c_i Y_i = \frac{I c_i}{P \sum c_i} \tag{69}$$

Using the production function: $Y_i^j = h_i L_i^j$ and that $P = \frac{W_i(1+T_s)}{h_i(1-\epsilon)}$

$$h_i L_i = \frac{I c_i}{\sum c_i \frac{1}{1-\epsilon} \frac{W(1+T_s)}{h_i}} = \frac{I c_i h_i (1-\epsilon)}{W(1+T_s) \sum c_i} \tag{70}$$

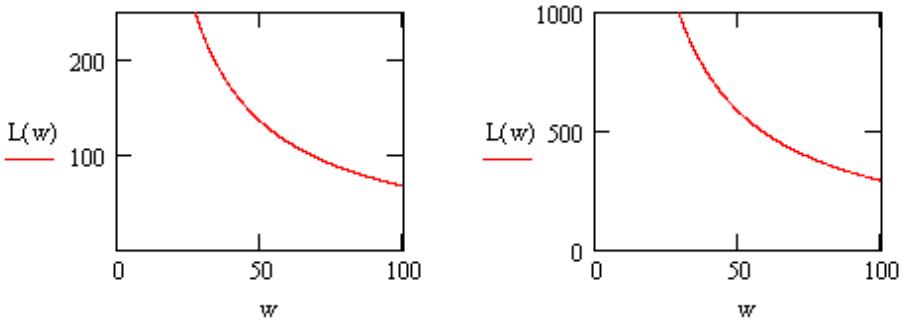
we can write the labor demand function for a specific firm:

$$L_i^j = \frac{I c_i (1-\epsilon)}{W(1+T_s) \sum c_i} \tag{71}$$

and labor demand for low-skilled and high-skilled labor:

$$L_i = \frac{Y_i (1-\epsilon)}{W_i (1+T_s)} \tag{72}$$

The dependence of labor demand on wage is described as the second stage impact in figure 3.



Low-skilled **High-skilled**

Figure 3: Labor demand

Appendix 9. Maximisation of Nash function

The Nash function to be maximised is:

$$\Omega_u = \Lambda_u^{\alpha}\Gamma_u^{1-\alpha} = (P_uY_u - W_u(1+T_s)L_u)^{\alpha}\left(L^{1/2}\left[W_u(1-TA_u)-B_u\right]^{1/2}\right)^{1-\alpha} \quad (73)$$

Where the average tax equals the marginal tax minus the tax allowance $TA = TM - \frac{F \cdot TM}{W \cdot S}$. FOC[14]:

$$\frac{\partial \Omega_u}{\partial W_u} = -\alpha\left(P_uY_u - W_u(1+T_s)L_u\right)^{\alpha-1} L(1+T_s)\cdot \left(L^{1/2}\left[W_u(1-TA_u)-B_u\right]^{1/2}\right)^{1-\alpha} + \left(P_uY_u - W_u(1+T_s)L_u\right)^{\alpha}(1-\alpha)\left(L^{1/2}\left[W_u(1-TA_u)-B_u\right]^{1/2}\right)^{-\alpha}\cdot L_u^{1/2}\frac{1}{2}\left[W_u(1-TA_u)-B_u\right]^{-1/2}(1-TM) = 0 \quad (74)$$

From which we can get

$$-\alpha\left(L_u^{1/2}\left[W_u(1-TA_u)-B_u\right]^{1/2}\right)L_u(1+T_s) + \left(P_uY_u - W_u(1+T_s)L_u\right)(1-\alpha)\cdot L_u^{1/2}\frac{1}{2}\left[W_u(1-TA_u)-B_u\right]^{-1/2}(1-TM) = 0 \quad (75)$$

$$\Longrightarrow -\alpha(W_u(1-TA_u)-B_u)L_u(1+T_s) + (\frac{1}{1-\epsilon}-1)(1+T_s)W_uL_u(1-\alpha)\frac{1}{2}(1-TM) = 0 \quad (76)$$

[14]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.

After some manipulation we arrive at

$$W_u \left[\frac{1}{2}(1-\alpha)\frac{\epsilon}{1-\epsilon}(1-TM) - \alpha(1-TA_u) \right] = -\alpha B_u \tag{77}$$

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

$$W_u = \frac{\frac{\alpha B_u}{1-TM}}{\alpha\frac{1-TA_u}{1-TM} - \frac{1}{2}(1-\alpha)\frac{\epsilon}{1-\epsilon}} \tag{78}$$

When $\alpha = 1$ then:

$$W_u = \frac{B_u}{1-TA_u} \tag{79}$$

Appendix 10. The impact of labor market institutions on the low-skilled workers' wage

In the following, the first stage impact of the labor market institutions on the low-skilled workers' wage is described. Taking into account that $B_u = \frac{R_u}{2}(W_u + W_s)$ and $TA_u = TM - \frac{f_u TMM_u}{S_u}$, we can write the wage function as:

$$W_u = \frac{\frac{\alpha R_u W_s}{2(1-TM)}}{\alpha\left(1 + \frac{f_u TMM_u}{S_u(1-TM)}\right) - \frac{1}{2}(1-\alpha)\frac{\epsilon}{1-\epsilon} - \frac{R_u\alpha}{2(1-TM)}} \tag{80}$$

Holding S_u constant we can write the impact of the tax allowance parameter on the wage:

$$\frac{\partial W_u}{\partial f_u} = \frac{-\frac{\alpha R_u W_s}{2(1-TM)}\alpha\frac{TMM_u}{S_u(1-TM)}}{\left[\alpha\left(1 + \frac{f_u TMM_u}{S_u(1-TM)}\right) - \frac{1}{2}(1-\alpha)\frac{\epsilon}{1-\epsilon} - \frac{R_u\alpha}{2(1-TM)}\right]^2} < 0 \tag{81}$$

and the impact of the marginal tax rate on the wage:

$$\frac{\partial W}{\partial TM} = \frac{\frac{\alpha R_u W_s}{2(1-TM)^2}\left[\alpha\left(1 - \frac{f_u M_u}{S_u}\right) - \frac{1}{2}\frac{(1-\alpha)\epsilon}{1-\epsilon}\right]}{\left[\alpha\left(1 + \frac{f_u TMM_u}{S_u(1-TM)}\right) - \frac{1}{2}(1-\alpha)\frac{\epsilon}{1-\epsilon} - \frac{R_u\alpha}{2(1-TM)}\right]^2} < 0 \tag{82}$$

Appendix 11. Efficiency wage

The utility of a shirker is:

$$rV_S = W - (\rho + \upsilon)(V_S - V_U) \tag{83}$$

The utility of a non-shirker is:

$$rV_N = W - e - \upsilon(V_N - V_U) \tag{84}$$

The utility of an unemployed worker is:

$$rV_U = B + \psi(V_N - V_U) \tag{85}$$

The condition of working is $V_N = V_S$.

Subtract 84 from 83 and assume $V_N = V_S$:

$$r(V_S - V_N) = e - \rho(V_N - V_U) \tag{86}$$

$$\implies V_N - V_U = \frac{e}{\rho} \tag{87}$$

From 84:

$$W = e + rV_N + \upsilon(V_N - V_U) = e + rV_U + (r + \upsilon)(V_N - V_U) \tag{88}$$

From 85:

$$W = B + e + (\psi + r + \upsilon)(V_N - V_U) = B + e + (\psi + r + \upsilon)\frac{e}{\rho} \tag{89}$$

In equilibrium:

$$\upsilon L = \psi(S - L) \tag{90}$$

Substract υS from both sides:

$$\upsilon L - \upsilon S = \psi(S - L) - \upsilon S \tag{91}$$

$$\implies \upsilon + \psi = \frac{\upsilon S}{S - L} \tag{92}$$

From which we get the wage equation:

$$W = B + e + \left(r + \frac{\upsilon}{U}\right)\frac{e}{\rho} \tag{93}$$

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

Appendix 12. 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 the 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.

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 70,218.4 altogether in non-financial corporations with more than 20 employees. Therefore, interest rate income would be 5,617.5 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.

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: 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 educ. and lower, voc. second. educ. after basic educ. and together with second. educ.
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	26,511.7	8,451	...	...	17,698.1	52,660.8
Financial corporations	1,090.7	365.1	...	...	1,683.3	3,139.1
General government	8,042.6	2,643.1	...	...	0	10,685.7
NPISH	...	...	...	...	...	...
Households	...	...	...	...	...	...
Value added total	35,645	11,459.2	...	...	19,381.4	66,485.6
Payments to shareholders					5,617.472	
Capitalists					13,764.0	13,764.0
Low-skilled	6,737.0	2,166.0				8,903.0
High-skilled	28,908.0	9,293.0				38,201.0
Value added total	35,645.0	11,459.0	...	...	13,764.0	60,868.0

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 benefit, 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 4,152 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	6,157	1,308	7,465
Social security tax	9,293	2,166	11,459
Total government income	15,450	3,474	18,924
Benefits	763	500	1,263
Government consumption			17,661
Total government expenditure			18,924

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	34,647.3		
Households	9,688.0	0.171	15,588
Government	1,262.0	0.022	2,005
Final consumption	10,950.0	0.193	17,593
Capital	9,430.0		
Exports	1,693.0		
Total use	56,720.3		91,157.3

The SAM matrix is constructed from the data described. Table 7 describes the basic SAM structure, based on Lofgren *et al* (2002).

Table 7: Basic SAM structure

	Activities	Commodities	Factors	Households	Government	Social security	Income tax	Rest of the World	Total Receipts
Activities		Marketed outputs							Gross output
Commodities				Private consumption	Government consumption				Demand
Factors	Value added								Factor income
Households			Factor income to households		Transfers to households				Household income
Government						Social security to government	Income tax to government		Government income
Social security				Social security to government					Social security tax revenue
Income tax				Income tax to government					Income tax revenue
Rest of the world	Imports								Foreign exchange outflow
Total expenditure	Activity	Supply expenditure	Factor expenditure	Household expenditure	Government expenditure	Social security to government	Income tax to government	Foreign exchange inflow	

Source: Lofgren *et al* (2002)

Table 8: SAM

	Activitites	Commodities	Factors	Household	Government	Social security tax	Income tax	Rest of the world	Total
Activitites	0	60,868	0	0	0	0	0	0	60,868
Commodities	0	0	0	43,209	17,659	0	0	17,598	78,466
Factors	60,868	0	0	0	0	0	0	0	60,868
Household	0	0	60,868	0	1,265	0	0	0	62,134
Government	0	0	0	0	0	11,459	7,465	0	18,925
Social security tax	0	0	0	11,459	0	0	0	0	11,459
Income tax	0	0	0	7,465	0	0	0	0	7,465
Rest of the world	0	17,598	0	0	0	0	0	0	17,598
Total	60,868	78,466	60,868	62,134	18,924	11,459	7,465	17,598	