The Impact of Minimum Wage on the Labour Market in Estonia: An Empirical Analysis

Marit Hinnosaar
Tairi Rõõm

November 2003

In Estonia, as in several other EU acceding countries, minimum wage has been on an upward trend and in the coming years it will expectedly be raised faster than the average wage. Despite its rapid increase, the impact of the minimum wage on Estonian labour market has not been analysed. The current paper aims to fill this gap. We estimate the effect of the minimum wage on employment and wages in Estonia during the period of 1995–2000, using micro-data from Estonian Labour Force Surveys. The estimation results indicate that a minimum wage increase leads to employment reduction for the group of workers who are directly affected by this change, ie those whose wages have to be raised as a result. Additional negative effect of raising the minimum wage is that the rate of compliance with this regulation diminishes as a result, thereby enlarging the share of workers whose salaries remain below the legally set minimum.

Authors' e-mail addresses: Marit.Hinnosaar@epbe.ee, troom@epbe.ee

Contents

1. Introduction

The purpose of this paper is to analyse the impact of the minimum wage on employment and wages in Estonia. In a competitive labour market a binding minimum wage leads to a decrease in employment, as workers whose marginal product is below the minimum wage level will be fired. Minimum wage affects especially employment possibilities of low-skilled workers, since their wages are more likely to fall in the region where the minimum wage is binding. Also, minimum wage can cause substitution of less productive labour by more productive workers. Thus, according to an orthodox economic theory, setting a binding wage floor will discourage the use of low-skilled labour.

Minimum wage can have an employment increasing impact in the labour market where employers have excess market power, ie in a monopsonistic, oligopsonistic or monopsonistically competitive market. It is often argued that the existence of an employer with monopsonistic power in a particular labour market is irrelevant for the minimum wage discussion, as average wages in a company are usually positively related with the size of the company. This phenomenon (the firm size effect on wages) makes it less likely that an employer paying minimum wages is a large company operating as a monopsony. Rather, minimum wage payers tend to be enterprises in the service sector, where labour market is usually characterised by a large number of relatively small employers and a competitive environment. However, considering the small size of our economy, it is likely that in Estonia some labour markets are not perfectly competitive. This could be the case in the rural areas, where there are not many employers while the regional labour mobility is low. In addition, monopsony power can stem from other factors besides the small number of employers in a particular market. Other often-mentioned sources of excess labour market power are asymmetric information and heterogeneity in workers' preferences. Consequently, there exists a theoretical possibility that a minimum wage increase has an employment increasing impact on at least some sectors of Estonian labour market, which makes it worthwhile to investigate this impact empirically.

The sample used in our empirical analysis covers the period from 1995 to 2000. From January 1996 onward, minimum wages have been raised regularly at the beginning of each year. The relative minimum wage, measured as a percentage of the average wage, stayed more or less stable in the second half of the 1990s, fluctuating in the vicinity of 25%, but started increasing in the turn of the century and reached 31% in 2002. It is expected that the minimum wage will increase significantly within the next few years in Estonia. This increase will take place due to a general agreement signed between employers and workers unions, according to which the minimum wage should form 41% of the average wage by the year 2008. This expected rapid change makes delving into the economic impacts of the minimum wage important in Estonia for the coming years.

Most of the Central and Eastern European (CEE) EU acceding countries have followed the same trend in minimum wage policy as Estonia, significantly increasing the minimum wage levels at the end of 1990s and the beginning of the current decade. An often-stated goal among the acceding countries is to raise the ratio of minimum to average wage to at least 40%. In four CEE economies (Hungary, Lithuania, Slovakia and Slovenia) this ratio already exceeds 40% and it is not much below the level in other acceding countries. Despite its rapid recent increase, the level of the relative minimum

wage in Estonia in 2002 (31%) was the lowest among acceding countries. These developments are initiated by the European Union integration process. The current levels of minimum wage – average wage ratios are in the same range in the acceding countries as in the EU Member States.

Despite significant recent hikes in the level of minimum wages in several CEE countries, the causal effect of these changes on employment has not been much studied. To the authors' knowledge, econometric studies analysing the economic impact of minimum wages have recently been conducted for three CEE countries only: Hungary, the Czech Republic, and Slovakia. The evidence from the studies on Czech Republic and Slovakia (Gottvald et al, 2002; Eriksson and Pytlikova, 2002 suggests that increases in the minimum wage have no significant disemployment effect, but they might have caused a reduction in wage dispersion, with a spike in the wage density function at the minimum wage level becoming more substantial. The evidence from the study on Hungary (Kertesi and Köllö, 2002) suggests that minimum wage hikes had substantial employment decreasing impact in this country. In Estonia, the effects of minimum wage increase have not been analysed before.

This paper aims to fill this gap by examining the link between an increase in the minimum wage and employment outcome in Estonian labour market. The empirical analysis is based on the Estonian Labour Survey dataset, which pools cross-sectional micro-level data across the years 1995–2000. Our empirical approach builds on the methodology used by Neumark, Schweitzer, and Wascher (2000; later referred to as NSW). Following their analytical framework, we divide the sample into several wage groups and investigate the impact of minimum wage increase on work probability at different points in the wage distribution.

Several recent micro-data studies on this subject compare the effects of changes in the minimum wage on employment probabilities of low- and high-wage workers. Most of these studies employ in one form or another the difference-in-difference methodology, comparing the employment experience of those workers who are directly affected by the minimum wage increase with those who are not. NSW in their study analyse the employment effects across several wage groups, and compare the results for other groups with the target group, ie the workers whose wages in year t are between the minimum wages in year t and year $t+1$. For identification purposes, NSW are also able to exploit the fact that minimum wages were raised at different time periods in various US states. This enables them to compare the change in employment probability for the same wage group in the states where the minimum wage was raised with areas where it remained constant. Since in Estonia the minimum wage is set at the centralised level without exceptions, we do not have an analogous control group in our sample. For identification, we use as a control group the target group workers in a time period prior to minimum wage increase. Also, a substantial part of the workers in our sample (8% in an average) are earning wages below the legal minimum. This group can be used as an additional control group, since it can be assumed that their wages are not directly affected by minimum wage increase.[1]

[1] Their wages can be indirectly affected via two channels. First, if minimum wage increase reduces the demand for target group workers' labour, labour supply in informal sector will increase and wages will decrease, *ceteris paribus*. Second, an increase in the minimum wage gives a competitive advantage to informal sector employers, which can increase the wages in this sector; however, this should be a relatively long-term effect.

The study by NSW, similarly to other recent empirical papers, which have been based on micro-level data, estimates a logit model, thus assessing the impact of minimum wage increase on employment probability of those who currently work. The logit or probit estimates used in these studies are based on a sub-sample of the working age population and capture only a partial effect of the minimum wage increase on employment. It is clear, however, that an increase in the minimum wage affects the (re)employment probability of both workers and unemployed. The estimates on the sub-sample of workers would be representative of the whole working age population, if the unobservable individual characteristics affecting the probability of currently working and the probability of being unemployed as a consequence of a minimum wage increase were not correlated. But this is unlikely to be true.

Our analysis improves upon the existing body of research by employing the Heckman selection model, which enables to control for the selection bias that may result from data censoring. The possibility of sample selection bias arises whenever one examines a sub-sample and the unobservable factors determining inclusion in the sub-sample are correlated with the unobservables influencing the variable of primary interest (Vella, 2000). In the minimum wage problem, an unobservable factor that is determining inclusion in the sub-sample and at the same time is influencing the variable of primary interest is the inherent ability of a person that determines his or her success in the labour market. These workers who (due to some unobservable factors) are more likely to be unemployed at any time period are also more likely to be negatively affected by an increase in the minimum wage. Exclusion of the unemployed workers from the sample would therefore cause the probit or logit regression estimates to be downward-biased (in absolute terms).

Approximately 8% of the workers in the sample used in this study earn wages that are below the minimum wage level, although, according to Estonian regulations, the minimum wage is compulsory to everybody without exceptions. This shows that the rate of compliance with the minimum wage regulations is relatively low. The same conclusion can be reached by analysing the effect of the minimum wage increase on the target group workers (ie the employees whose wages in the period prior to the increase remain between the new and the old minimum wage levels). Within three months after each minimum wage hike, 10.1% of the target group workers in the sample were fired. Wages were raised above the new minimum wage level for 34.5% and remained below the new legal minimum for 54.5% of the target group workers. Given that there is a widespread non-compliance with minimum wage law, it is likely that raising the minimum wage would increase the proportion of employees whose salaries are below the minimum wage level. To test this hypothesis, we regress the probability that a worker's wage is below the legal minimum to the natural logarithm of the minimum wage level.

The paper is structured as follows. The second part discusses minimum wage developments in Estonia compared to the European Union countries and the history of minimum wage regulations in the European Union in order to explain some of the recent developments in Estonia as well as to look at future trends. The third part gives an overview of the economic theory on the impact of the minimum wage in the labour market. The fourth part presents an overview of empirical research devoted to this topic. In the fifth section we conduct an empirical analysis to investigate the impact of the minimum wage in Estonian labour market. The last section concludes.

2. The Role of Minimum Wages in the European Union and Estonia

The debate on minimum wages has attained increasing attention in Europe over the recent years. This economic measure has gained a lot of interest since European labour markets have gone through significant changes during the last two decades. Compared with the beginning of the 1980s, the wage distribution has become more unequal. The increasing inequality of labour income has partly been a consequence of workers' diminishing bargaining power as the unemployment rate has been increasing. Other factors behind the widening wage gap have been changes in institutional structure and in the composition of the labour force. Increasing international competition and technological advancements are also often-mentioned factors behind widening disparity of labour income. In the light of increasing income inequality, several political forces support the introduction of higher minimum wages as an equalising measure. On the other hand, the persistently high levels of unemployment in many EU countries have initiated a discussion of the possible disemployment effect of the minimum wage.

2.1. Minimum Wage Levels in the European Union

Statutory minimum wages exist currently in 9 out of 15 EU countries (Belgium, France, Great Britain, Greece, Holland, Ireland, Luxembourg, Portugal and Spain). In some other EU Member States (eg Austria, Germany and Italy), despite the absence of country-level regulations, minimum wages *de facto* exist due to a widespread collective bargaining together with the regulations, which extend the coverage of wage agreements to non-organised workers. Although Nordic countries (Sweden, Denmark and Finland) have no formal system of extending collective agreements, in practice, collective agreements cover almost the entire workforce, making minimum wages mandatory to most of the employers there as well.

Table 2.1. Minimum wages (measured as the percentage of the median wage) in the European Union

Country	1975	1980	1985	1990	1995	2000
Belgium	59.7	52.7	56.8	54.3	51.4	49.2
France	57.9	57.2	62.2	59.4	58.5	60.8
Greece	74.5	58.1	59.5	57.0	52.7	51.3
Ireland						55.5
Luxembourg	42.8	42	46.3	45.8	48.7	48.9
Holland	62.2	61.4	57.2	52.2	48.6	46.7
Portugal	55.8	47.7	47.2	42.0	41.3	38.2
Spain	48.2	41.8	37.9	35.2	32.7	31.8
United Kingdom						41.0

Source: Eurostat.

Table 2.1 presents relative minimum wage levels measured as the percentage of the median wage in these EU Member States where the minimum wages have been centrally set. The data in Table 2.1 indicate that the share of minimum wage to median earnings has decreased in the majority of EU countries over the last 25 years. In 2000, the minimum wage-median wage ratio was the highest in France (61%) and the lowest in Spain (32%).

In most of the EU countries, minimum wages are differentiated across workers. Usually, minimum wage regulations do not cover public sector workers, as their wages are regulated by some other legal act. In several countries, minimum wage regulations do

not cover interns or their minimum wage is set at a lower level. In most of the European Union countries minimum wages are differentiated according to age (see Table 2.2). In some EU countries (for example, in Greece and Luxembourg), minimum wages depend on the number of children in the family and workers' marital status.

Table 2.2. Minimum wage differentiation in case of young workers in the European Union

Country	Belgium	Spain	Holland	Luxembourg	Portugal	France
Age and % of adult minimum wage	20–94% 19–88% 18–82% 17–76% 17–70%	18–89%	22–85% 21–72,5% 20–61,5% 19–52,5% 18–45,5% 17–39,5% 16–34,5%	17–80% 16–70% 15–60%	18–75%	17-18–90% 17–80%

Source: OECD Submission to the Irish National Minimum Wage Commission, 1997.

One of the factors determining the relevance of the minimum wage in the labour market is how many workers are directly influenced by this measure, ie earning minimum wages. The proportion of workers getting the minimum wage varies greatly among the European Union countries starting from 1% in Spain and United Kingdom to almost 16% in Luxembourg.

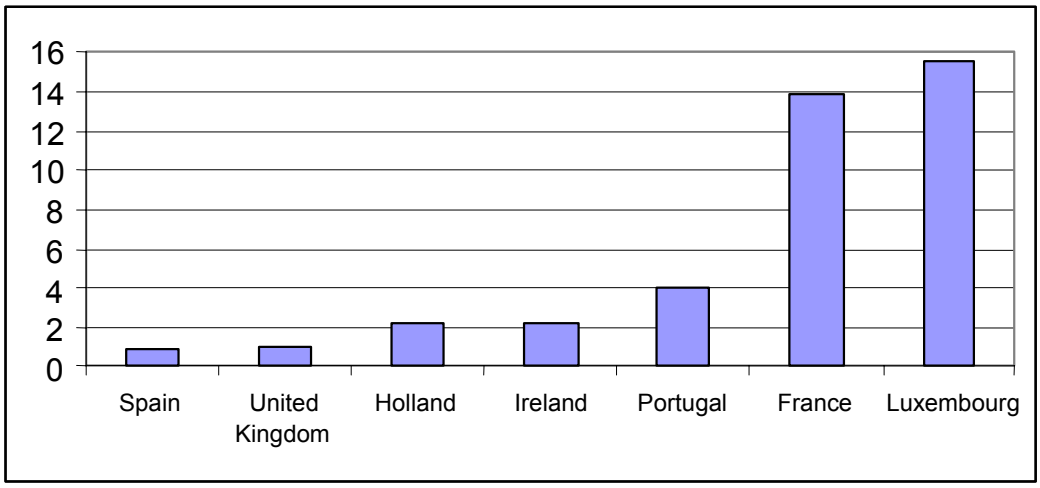

Figure 2.1. Percentage of the employed earning minimum wage
Source: Eurostat.
Notes: Data for Greece and Belgium is not available.

2.2. Debate over Minimum Wages in the European Union

The debate over the minimum wage has received much attention over the recent years. In some countries (for example, in Austria, Denmark, Norway, Greece, Portugal and Spain) the existence of minimum wages is currently not a major issue of debate (Ioakimoglou, Soumeli, 2002), while in others the argument generally opposes the view that wage floors reduce employment. In countries where the question could be more easily analysed because the wage floors were recently set (Ireland and UK), their impact is unclear because the minimum wage was set in the period of economic growth.

In the discussions of the role of minimum wage the Social Charter is often referred to. In 1989, the European Community Social Charter (Charter of Fundamental Social

Rights of Workers) stated the following: “All employment should be fairly remunerated. To this end, in accordance with arrangements applying in each country, workers shall be assured of an equitable wage, i.e. a wage sufficient to enable them to have a decent standard of living.”

Table 2.3. Minimum wage policy: history of thought in the European Union

Year and document	The message
1989 European Community Social Charter	All employment should be fairly remunerated; workers shall be assured of an equitable wage, i.e. a wage sufficient to enable them to have a decent standard of living.
1993 European Commission	The pursuit of an equitable wage must be seen as part of the general drive of achieving higher productivity and employment creation.
2000 European Council, social exclusion strategy	The best way to fight against social exclusion is a job. Ensuring that the take-up of employment results in increased income.

In 1993, in order to implement the Social Charter, European Commission adopted an opinion on an equitable wage, in which it stated that the pursuit of an equitable wage must be seen as part of the general drive to achieve higher productivity and employment creation, and to foster good relations between the two sides of industry.

From the end of the 1990s, the focus has shifted from the low and inequitable pay to poverty reduction, preventing social exclusion and promoting the quality of work (Ioakimoglou, Soumeli, 2002). In 2000, the European Council in the Lisbon Summit launched a social exclusion strategy in response to the EU new objectives. The strategy stresses that the best way to fight against social exclusion is a job. The objectives of the strategy include a “guarantee that everyone has the resources necessary to live in accordance with human dignity” and “ensuring that the take-up of employment results in increased income”.

In 2001, the European Commission issued a Communication on Employment and Social Policies, according to which the aim should be that jobs besides other characteristics “should provide appropriate levels of living”.

A substantial amount of the debate over minimum wages has been focused on the topic of what is the correct measure of poverty. There is no universal definition of low wage in the EU. It is generally considered that low wages should be defined as wages below a certain threshold chosen according to what is the lowest socially acceptable level of remuneration. However, the definition of low wages varies among the EU countries and across time. In 1977, the Council of Europe’s European Social Charter regarding “fair remuneration” suggested the minimum “decency threshold” of 68% of the average national wage. Recently it has been adjusted, stating that the lowest net wage should not fall below 60% of the net average wage. The OECD defines low pay as less than 2/3 of median earnings and this definition is accepted in several countries, including Austria, France, Greece, Ireland, Italy, and Portugal. In some cases 50% of median earnings has been used to define very low wages. Eurostat defines low pay as a monthly wage less than 60% of the median salary (definition mainly used in Denmark). In Germany, a widely used definition of low pay means labour earnings that are below 75% of the national average.

2.3. The Role of the Minimum Wage in Estonia

The nominal level of the minimum wage was steadily increasing during the 1990s in Estonia. In the first half of the last decade, the increase in the minimum wage was slower than the average wage increase, which led to the fall in the ratio of minimum to average wage. This trend turned in the second half of the 1990s: starting from 1996, the minimum wage has been increasing faster than the average. According to the agreement between the central employers' and workers' unions, the minimum wage will be raised gradually until it reaches the level of 41% of the average wage by 2008.

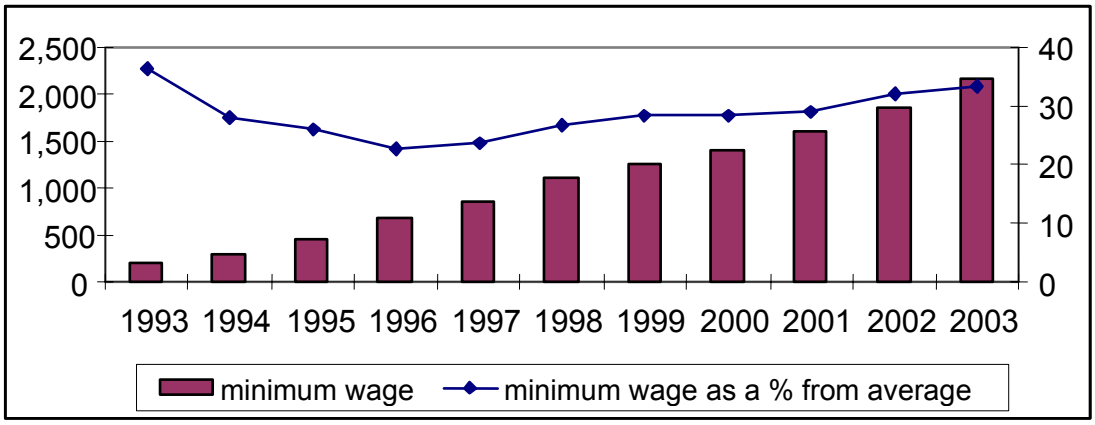

Figure 2.2. Minimum wage in Estonia as percentage from the average wage (right scale)

Note: In 2003, according to the agreement by employers' and labour unions, the minimum wage amounts to 33.5% of the forecasted average wage for the year 2003.

The ratio of minimum to average wage is not the best benchmark if the aim is to analyse the possible impact of minimum wage increase in the labour market. To assess its potential influence on other variables, two measures should be considered. Firstly, the relative magnitude of the increase in the minimum wage, compared to the previous level. Secondly, what proportion of the labour force this change directly affects, ie how large is the share of workers whose wages have to be raised as a result of this change. In the sample of Estonian labour force used in the current study, which covers the years 1995–2000, the labour income of approximately 8% of the workers is below the minimum wage level. This proportion is even larger in the areas where the average wage level is lower, such as agriculture, hotels and restaurants sector, services' sector, and other manual jobs. The relative magnitude of increases in the minimum wage has varied from year to year, ranging from 8 to 23% in real terms during the years 1995–2000.[2]

Comparing the relative minimum wage level in Estonia with the European Union countries implies that it is currently rather low. However, according to the agreement between employers' and labour unions, the minimum wage will increase faster than the average wage and by the year 2008 it should reach a level, which is close to the EU average. The increase in the minimum wage has been initiated by the labour unions in Estonia. Their supportive argument refers to several suggestions by the OECD and the European Union, especially to the EU documents, which have set the goal to maintain income levels of as many people as possible above the poverty threshold. The most commonly stated goal is that no more than 5% of households should earn less than 60%

[2] See Appendix 3 for a detailed description of minimum wage increases in Estonia.

of the median income. However, it should be noted that currently none of the European countries has reached this goal.

3. Impact of the Minimum Wage on the Labour Market: Theoretical Aspects

The purpose of the minimum wage is to ensure a fair income distribution by restraining workers from taking jobs with salaries that are considered unfair in the society. To achieve this aim, government intervenes in the labour market, which can result in labour market distortions, as market agents cannot freely choose the demand and supply prices.

Wages reflect differences in the productivity of workers. In a competitive market, workers are paid the value of their marginal product. When setting the minimum wage affects equilibrium (ie the minimum wage is a binding constraint), these workers whose marginal product is less than the minimum wage lose their jobs. Therefore, minimum wages diminish the incidence of low pay but might not decrease and can in some cases even increase poverty.

3.1. Base Model – Perfectly Competitive Labour Market

The disemployment effect of an increase in the minimum wage can be explained by a simple model, where a uniform minimum wage level is set for all employees, labour force is homogeneous by skills, and labour market is perfectly competitive. The impact of the minimum wage can be formalised as follows. A profit-maximising firm in the competitive labour market with homogeneous labour hires labour up to the point where the addition to the total revenue from an extra unit of labour is equal to its cost for that extra unit. The firm maximises its profit π, the difference between the revenue R and cost of labour E, with the exogenously determined wage w^*:

$$\pi = R(E) - w^* E \tag{3.1}$$

Choosing the profit maximising level of employment leads to the following first-order condition:

$$MR - w^* = 0 \tag{3.2}$$

ie, the firm will pay a wage rate that is equal to the marginal revenue.

Figure 3.1 illustrates the impact of an increase in the minimum wage in case of a perfectly competitive labour market. A competitive firm is facing a decreasing marginal revenue (MR) curve and a horizontal marginal cost (MC) curve. If the minimum wage is instituted at the level above the equilibrium wage, the resulting increase in the marginal cost from MC to MC^* would lead to a new equilibrium at a lower level of employment (E_m).

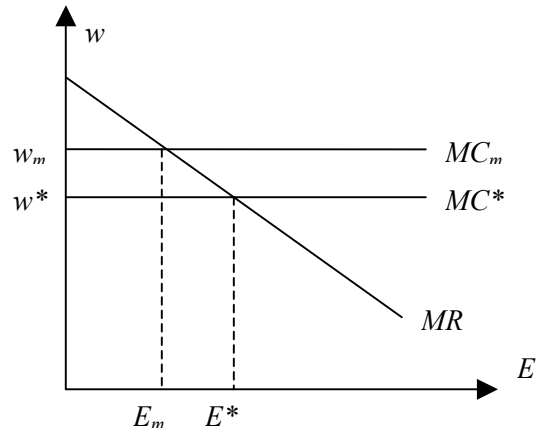

Figure 3.1. Minimum wage in a perfectly competitive labour market

3.2. Two-Sector Model

Often minimum wage regulations do not extend to some sectors. If minimum wage is effective for only a part of the labour market – the covered sector –, then the wage increase directly affects this part, leading to a decrease in the labour demand and employment similarly to the process described in the previous section. In the other part of the labour market – the uncovered sector –, the increase in minimum wage has no direct impact on wages and employment, but there is an indirect effect. Assuming that labour is mobile across sectors, employment will adjust until the expected wage in the two sectors is equal. If a minimum wage increase causes a fall in employment in the covered sector, labour will flow to the uncovered sector. At the same time, more skilled labour would move to the opposite direction, from uncovered to covered sector, seeking higher wages.

Welch (1976) argues that when in the covered sector jobs are distributed randomly (ie each worker has the same probability of being hired) then, as a consequence of an increase in the minimum wage, a part of the labour force will move to the uncovered sector. Therefore, labour supply in the uncovered sector will increase as those who lost their jobs in the covered sector will move to the sector where the wage level can adjust and, therefore, labour demand can increase. Wage in the uncovered sector will fall below the previous equilibrium level. Finally, at the lower wage level, labour demand will go up and employment in the uncovered sector will increase. The effect of an increase in the minimum wage in uncovered sector is characterised by Figure 3.2.

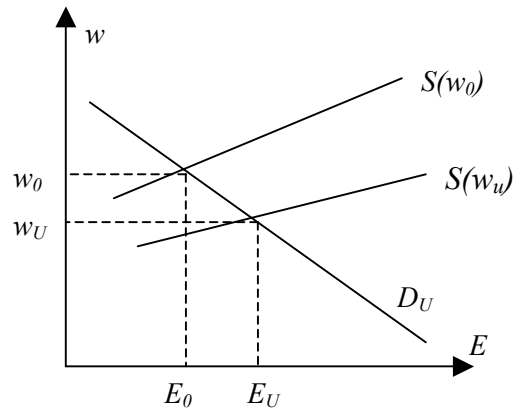

Figure 3.2. The effect of the minimum wage in the uncovered sector

In a developing-country context, the uncovered sector usually refers to the informal economy. The existence of the so-called shadow economy is also evident in Estonia, where, despite universally set minimum wage, a substantial part of workers (8% of the labour force in the sample of the Estonian Labour Force Survey during 1995–2000) earn wages below the current minimum wage level.

Two authors – Gramlich (1976) and Mincer (1976) – develop two-sector models where the minimum wage effect on uncovered sector's labour supply is ambiguous. Both models argue that when the minimum wage is established, employees choose the sector knowing that in the covered sector wage is higher but the probability of finding a job is lower. Gramlich and Mincer show that, depending on certain initial conditions, labour force can move both ways – to the covered sector or out of it. The net effect of labour movements depends on labour demand elasticity in the covered sector and the rate at which the vacancies arise. If labour demand elasticity in the covered sector is low, so that the equilibrium quantity of labour falls by less than the rate at which vacancies arise in this sector, then labour force moves to the covered sector and wage in the uncovered sector increases.

3.3. Heterogeneous Labour Force Models

Until now we described models where the assumption was made that the labour force is homogeneous. Heterogeneous labour force models take into account that employees have different qualifications and the effect of the minimum wage on wage and employment varies across different labour groups. A rise in the minimum wage mostly affects low-qualified labour, whose productivity and labour cost is low. An increase in the minimum wage increases the cost of low-qualified labour and it leads to substitution of their labour for alternative production factors. Low-qualified labour can be substituted by composite non-labour input (mainly capital). This would lead to an overall reduction in employment. Low-qualified labour can also be substituted by marginally more qualified labour, ie by the employees who in a free-market setting would work for a marginally higher wage than the established minimum.

According to Brown (1999), the effect of the minimum wage on heterogeneous labour can be summarised as follows: after establishment of the minimum wage

- some of the employees who worked for a lower wage than the minimum are laid off;
- wages of some employees who worked for a lower wage than the minimum are raised to the established minimum wage level;
- demand for the labour of workers whose wages are somewhat higher than the minimum wage increases;
- minimum wage can indirectly affect employees at even higher wage levels, but it is generally argued that this effect is small and diminishes as the difference becomes larger.

A standard assumption in models that account for labour force heterogeneity is that there are two types of workers – skilled (s) and unskilled (u). In this case, setting a minimum wage for the unskilled workers leads to substitution between skill types and to an increase of skilled workers' wage and employment. The substitution effect of the minimum wage is shown in Figure 3.3. Linear lines *a* and *b* represent the ratio of the relative wages for skilled and unskilled labour before and after an increase in the minimum wage, respectively. A shift in this ratio from *a* to *b*, as a consequence of an

increase in the minimum wage, will lead to the substitution of unskilled labour for skilled labour and a new equilibrium is reached at the point (E_{Um}, E_{Sm}) where less of unskilled and more of skilled labour is employed.

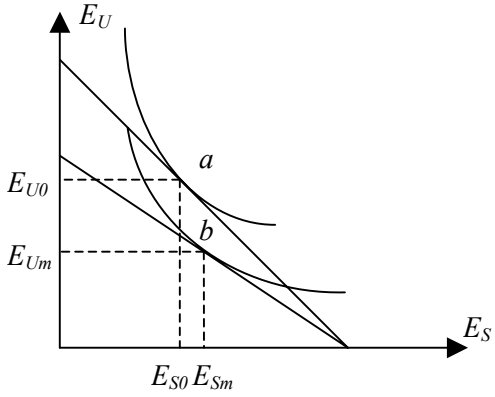

Figure 3.3. Substitution between skilled and unskilled labour

3.4. Monopsony Model

Minimum wage might in certain conditions increase employment. The well-known exception of the minimum wage's disemployment effect is the monopsony case from the paper by Stigler (1946). Consider again a labour market with homogeneous labour as in the base model, but in this case a monopsonistic labour market. In the monopsony model, the employer has enough market power to set the wage. Again, according to the profit maximising behaviour, a firm employs labour at the amount where the marginal revenue from an extra unit of labour is equal to its marginal cost, but in order to get an extra unit of labour, the monopsony must increase the wage level. Therefore, the monopsony hires less workers and pays lower wages compared to an enterprise in a perfectly competitive market. When the minimum wage is set at a level between the profit-maximising wage level of the monopsony and the competitive wage level, the monopsony hires workers at the amount equal to the supply of workers at that price, because the wage is still lower than the marginal revenue of these workers. In this case, setting the minimum wage above the monopsonistic wage level would increase employment.

The above argument can be formalised as follows: the monopsony maximises its profit π:

$$\pi = R(L) - w(E)E \tag{3.3}$$

Choosing the profit-maximising level of employment leads to the following profit maximising condition:

$$MR - w(E) - w'(E)E = 0, \tag{3.4}$$

$$\text{so that: } MR = w\left(1 + \frac{1}{\varepsilon}\right), \tag{3.5}$$

where ε is the elasticity of labour supply.

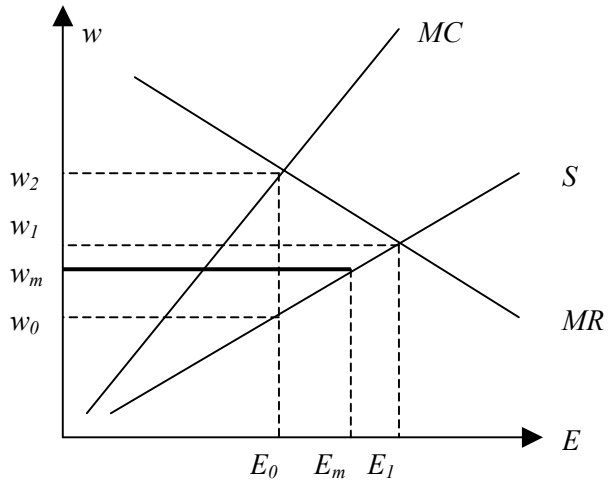

Figure 3.4. The effect of the minimum wage in the monopsonistic market

The monopsony model is depicted in Figure 3.4. Without constraints, a monopsony is choosing an optimal level of production at the point where marginal cost of labour exceeds the supply price and labour is employed at the level (E_0) with price (w_0) where marginal cost and marginal product of labour are equal. Minimum wage causes the supply of labour to be infinitely elastic up to $S(w_m)$. When the minimum wage is set at (w_m), employment increases to the level (E_m). Minimum wage increase up to competitive wage level (w_1) leads to an increase in employment up to the competitive level (E_1). A further minimum wage increase would lead to an employment reduction relative to the competitive level, but employment would still exceed the free-market monopsony level, as long as the minimum wage is set below (w_2).

How much minimum wage can be increased in the monopsonistic market before employment starts to decrease depends on the elasticity of labour supply. The more elastic the labour supply (ie the closer the market structure is to competitive market), the smaller this increase can be.

3.5. Monopsonistic Competition

A model with a single monopsonistic employer is rarely applicable in reality. It is more likely that a monopsonistically competitive market structure would apply in the labour market, where multiple employers compete with one another for workers. Monopsonistic competition in the labour market is similar to the monopsony case, since the labour supply curve facing an individual firm is not perfectly elastic. There are several reasons why a firm in a market with multiple employers may face an upward-sloping supply curve. The absence of perfect information about alternative available jobs is one factor that reduces the elasticity of labour supply. This effect of imperfect information is, among others, modelled in a search model by Burdett and Mortensen (1998). Another possibility is the existence of heterogeneous preferences for different jobs. If a worker has equal productivity in two jobs but prefers the non-wage job characteristics of one job over another, then the elasticity of labour supply is larger than zero. The formation of a monopsonistic market structure as a consequence of heterogeneous preferences for jobs is modelled by Bhaskar, Manning and To (2002).

Consider again the monopsony model set up in the previous section. The difference in the monopsonistic competition case is that minimum wage increase reduces the labour

supply of an individual firm. In particular, if multiple employers compete for workers, raising minimum wage would increase competition in the labour market, since rival employers must also increase their wage level to the minimum. As a consequence, labour supply curve faced by each firm shifts to the left. This effect is illustrated in Figure 3.5. Whether the minimum wage would cause a reduction or an increase in the quantity of labour employed by the firm depends on the relative magnitude of the shift. Figure 3.5 depicts the situation when the shift in labour supply is relatively small, so that the employment effect is positive. However, even if the employment effect is positive, it is smaller in magnitude than in the case of monopsony.

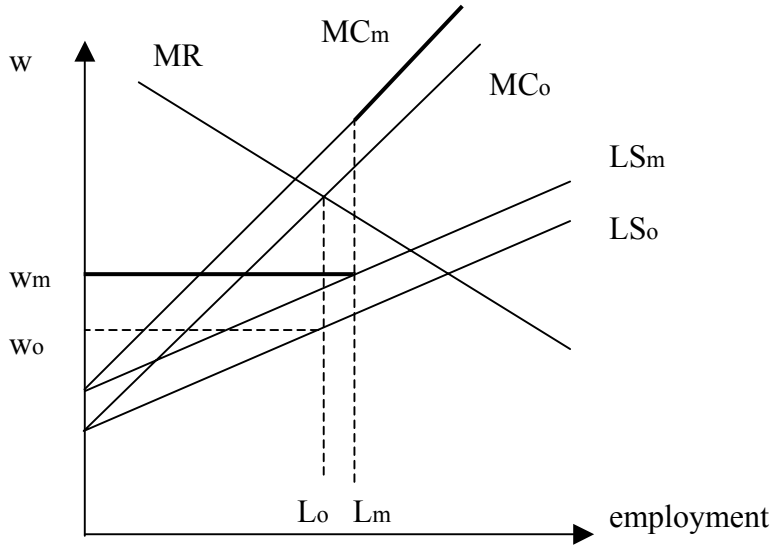

Figure 3.5. The effect of the minimum wage with monopsonistic competition

According to Bhaskar, Manning and To (2002), when firms have market power, minimum wages cause changes in employment through two distinct channels: an employment effect to each individual firm (which they call oligopsony effect) and an aggregate (entry/exit) effect. As explained before, the oligopsony effect can be positive or negative, depending on the relative magnitude of the change in labour supply. The aggregate-level effect occurs because the minimum wage increase also affects the number of firms operating in a market. Since a binding minimum wage reduces employers' profits, some employers will be forced to exit when there is free entry into and exit out of the labour market. Therefore, although individual firms that survive the imposition of the minimum wage may increase their employment, some employers are forced out of business and total employment effect may still be negative.

4. Overview of Empirical Research on Minimum Wage

In empirical works, the most analysed economic consequence of the minimum wage is its effect on employment. Empirical studies on minimum wage impact are often focusing on a specific group of labour, which is more directly affected by the minimum wage, for example teenagers, young adults, low-wage or unskilled workers, or employees in some specific low-wage sector (eg, fast-food restaurants).

Summary of the evidence of the minimum wage impact on employment is well described in several papers with varying conclusions about the dominating results. One

of the early extensive overviews is presented in Brown, Gilroy and Kohen (1982). They reach a conclusion based on the evidence of empirical studies that a 10% increase in minimum wage decreases employment of teenagers by 1–3%. The often-quoted controversial conclusion was made in 1995 by Card and Krueger, who stated that the effect of an increase in the minimum wage on employment is either positive or insignificant. After their widely discussed and much criticised result, many studies have come to the opposite conclusion. The general consensus in the recent overviews (OECD Employment Outlook, 1998; Brown, 1999; the Safety Net Reviews, 1999, 2002, 2003) is that if minimum wages affect a substantial part of the work force, then their increase has a negative impact on employment.

4.1. Research Methods

Time Series Studies

Time series studies regress an employment measure (for example, an employment-population ratio), usually for a specific demographic group (often a specific age group, for example, the young) against a measure of minimum wage.
The basic equation estimated in the time series studies is the following (Brown, 1999):

$$E_t = \alpha X_t + \beta MW_t + \varepsilon_t , \qquad (4.1)$$

where E is the employment, X includes a cyclical indicator and other control variables, and MW is the level of minimum wage. E and MW are often given in the logarithmic form, so that β is the employment elasticity of the minimum wage.

Brown (1999) states that the current time series analysis is concentrated mainly on the employment effects, while in the 1970s, the attention was mostly focused on unemployment. Due to the lack of data, there are only a few studies analysing the effect of minimum wage on hours worked. Brown also asserts that with a few exceptions, time series studies investigate the relationship between the minimum wage at time t and employment at time t. Focusing solely on contemporaneous effects differentiates time series studies from employment analysis based on other types of data, which usually find significant lagged effects. The reasons for excluding lags from time series studies have been high turnover rates in low-wage sector and the fact that minimum wage increases are usually known in advance. Still, the short- and long-term responses to the minimum wage have been different, according to the estimates based on other methods.

It is argued that empirical findings from the time-series studies are sensitive to the exact estimation method used and the inclusion of different explanatory variables can alter the results (Safety Net Review, 1999). Another weakness of this approach is the possible endogeneity of the minimum wage-average wage ratio, which might capture the impact of labour demand and supply on the level of wages.

Pooled Cross-Sectional Macro-data Studies

In cross-sectional analysis, the differential impact of changes in the minimum wage is analysed across countries or states. In the case of pooled cross-sectional data, it is possible to compare changes in employment in countries where the minimum wage has increased to the others where it has stayed constant, ie to analyse this impact in a setting that resembles a natural experiment.

The representative equation estimated in the cross-sectional studies is similar to the panel data equation where the fixed effects of region and time are included in order to control for the regional and time-period differences (Brown, 1999):

$$E_{it} = \alpha X_{it} + \beta MW_{it} + \gamma_i + \delta_t + \varepsilon_{it}, \quad (4.2)$$

where γ_i and δ_t are the fixed effects for region and time, respectively. Different from the time-series studies, in case of cross-sectional data the lagged variables are often included in the regression.

Longitudinal Micro-data Studies

Longitudinal datasets of individual workers make it possible to compare dissimilarities in minimum wage impact on employment of different individual workers, for example low or high-wage workers or workers in the covered and uncovered sectors. Longitudinal studies often apply the difference-in-difference methodology, where one group of workers is defined as the group whom minimum wage increase should directly affect, while the other part of the sample is used as a control group.

Brown (1999) points out that when applying the difference-in-difference methodology, one has to control for the general economic trend in order to get the pure response to minimum wage increase from both the target and the control group. Otherwise, such estimation can pick up spurious correlation. For example, spurious correlation would be detected when the change in the minimum wage occurred at the same time with economic downturn, and low-wage workers were more negatively affected by the economic slowdown than high-wage workers.

In the US, the difference-in-difference methodology has often been employed to study the impact of the increase of minimum wage in one state compared to others where the minimum wage was not raised. Again, the main argument against the method is the difficulty to control for factors other than the minimum wage increase, which affect employment (Employment Outlook, June 1998).

4.2. Research in the US

As mentioned before, much of the research on minimum wage impact is conducted in the United States. However, it is generally argued that results from the empirical studies using the US data cannot be applied to other countries where the minimum wage is set at a relatively higher level and is more binding than in the US (Card and Krueger, 1995; Safety Net Review, 1999).

Time Series Studies

Based on the large number of time series studies, by the early 1980s, most labour economists in the US had come to the consensus that minimum wages decrease employment. In the literature overview by Brown, Gilroy and Kohen from 1982, the results of the 25 previous time series studies are presented and the conclusion is made that in time series analysis the typical finding is that a 10% increase in the minimum wage reduces teenage employment by 1–3%. They looked also at the impact on young adult (aged 20–24) employment and found it to be negative but smaller than that of teenagers.

Later studies have found the impact to have much smaller absolute value. In the literature review by Wellington from 1991, she concluded that a 10% increase in minimum wage reduced teenage employment by only 0.6% and had no impact on young adults. Bernstein and Schmitt (1998) found that a 10% minimum wage increase would have led to a 0.95% decrease in teenage employment between 1954 and 1979. However, when the analysis was done using data from 1954 to 1997, the decrease was only 0.66%. It is generally claimed that the decline of the effect of minimum wage on employment in the United States is due to the decline in the real value of the minimum wage (Safety Net Review, 1999).

The by-now famous book by Card and Krueger from 1995, where they state that if anything, minimum wages have had a small positive effect on employment, reactivated the debate on the minimum wage impact. Since the publishing of this book, the argument has found supporters as well as negative responses. During the following years, there have been several studies finding negative impact of minimum wages on employment (Safety Net Review, 1999). It is generally still concluded that most of the time series evidence from the US implies that the minimum wage has a small negative impact on employment.

Cross-Sectional and Pooled Time-Series Studies

In the Safety Net Review (1999), it is argued that evidence from the US pooled cross-sectional studies investigating the relationship between youth minimum wages and employment is also mixed. Brown et al (1982) argued in their survey that most of the results from cross-sectional analysis are similar to time-series studies, indicating that a minimum wage increase by 10% leads to an employment decrease by 1–3%.

In 1992, Card (1992a,b) came to a new result, finding that the increase of the minimum wage in the end of 80s and the beginning of 90s increased or at least did not have any decreasing effect on teenage employment. Similar analysis was conducted by Neumark and Wascher (1992), who reached the opposite conclusion using pooled time-series data from 1973–1989. They found that a 10% increase in the minimum wage leads to a decline in teenagers' employment of 1–2% and to a decline in young adults' employment of 1.5–2%. They also found that the employment impact has a substantial lagged effect, so that negative effect on employment was stronger not in the first year but after two years. Their result of the importance of the lagged effect is confirmed by a later study of Partidge and Partidge (1999), who analyse teenage employment in the low-wage retail sector and find positive effect in the short-run, while much larger negative effect is apparent in the long run, so that raising minimum wage by 10% reduces retail employment by 1% over two years.

Micro-data Studies

Contrary to the time-series analysis, cross-sectional and pooled time-series studies on US micro-data in general provide stronger evidence of minimum wage's negative impact on employment (for example, Neumark and Wascher, 1995, Currie and Fallick, 1996). In a recent study, Neumark (1999) argues that in order to exclude other effects, the analysis should concentrate strictly on the actual target group of the minimum wage increase. Neumark argues that the effect on teenage employment could be misleading, since in the case of a minimum wage increase, labour demand shifts to more qualified teenagers and they leave school, leading to a much smaller aggregate minimum wage disemployment effect for this age group. Due to the shift effect in teenage employment, the analysis that is concentrated on the employment changes among only those most

likely to be affected by the minimum wage increase (non-enrolled individuals in the 16–24 age group) yields a stronger negative impact on their employment.

Using enterprise-level data, Katz and Krueger (1992) and Card and Krueger (1994, 1995) analysed employment in fast-food restaurants. Katz and Krueger (1992) studied the effects of minimum wage increase in Texas. Their results revealed that a raise in the minimum wage led to employment increase in the restaurants, which were affected by the increase. Card and Krueger (1994, 1995) conducted similar analysis on fast food restaurants in New Jersey and Pennsylvania (using the first as a target state and the second as a control state) and found again that minimum wages have no negative impact on employment and perhaps even a positive impact.

The above-named studies by Card and Krueger received much attention and were followed by lively discussion. A number of new studies have been made trying to replicate their results and reaching differing conclusions. The Card and Krueger's data as well as their methodology have been heavily criticised. The arguments against Card and Krueger's results have been the following: they are not taking into account the possible variation of hours worked, as well as that employers might have been able to adjust their behaviour ahead of the minimum wage increase; the impact of the minimum wage is analysed over too short time period and the final impact might be much larger; other possible factors influencing labour demand are not taken into account (Hamermesh, 1995, Kennan, 1995).

The summary of the results of the US minimum wage studies are presented in Appendix 1. The summary is based on the overview articles by Brown (1999) and Safety Net Reviews. From the table in Appendix 1 it can be concluded that majority of the studies find significant negative relationship between minimum wage and employment. As stated in the Safety Net Review (2003), even Card and Krueger – the most prominent opponents of the conventional economic theory on minimum wage impact – acknowledge that there is a point starting from which minimum wage increases cause job losses.

4.3. Research in Other OECD Countries

In other OECD countries, the negative impact of minimum wage seems to be stronger (Safety Net Review, 1999). While differences among countries still persist, the conclusion can be made that the larger the proportion of the labour market affected by an increase in the minimum wage and the higher its relative level, the stronger is the negative impact of minimum wage increase.

Discussion about the minimum wage impact in the European countries has been much weaker, since until recently, minimum wage rates have stayed at a rather stable level and have not given many opportunities for research. Similarly to the cross-state studies conducted for the United States, a more prolific approach would be to study the minimum wage effect across the OECD countries. A cross-country comparison made by the OECD (Employment Outlook, June 1998), done for 9 OECD countries including the US for the period 1975–1996, came to the result that minimum wage rises have significant negative impact on teenage employment.

Micro-data has often been used in the minimum wage studies in the OECD (Abowd, Kramarz and Margolis, 1999), usually finding significant negative impact on

employment. In Europe, United Kingdom is a country where several studies employing micro-data have found no significant negative impact on employment. The first study coming to such a conclusion was conducted by Machin and Manning (1992). They found no significant impact on employment and even positive impact in some sectors. Later study by Dickens, Machin and Manning (1999) arrives at the same conclusion. However, Machin, Manning and Rahman (2002) find a negative impact on employment.

Summary of the results of the minimum wage studies for the OECD countries is presented in Appendix 2. On the basis of this overview, it can be concluded that in Europe, most of the studies have found significant negative impact of minimum wage increases on employment.

4.4. Research in Transition Economies

Although minimum wages have been recently sharply raised in several transition economies, only limited amount of research on the impact of these increases can be found. To the authors' knowledge, this topic is analysed in Hungary and the Czech and Slovak Republics.

In the paper by Kertesi and Köllö (2002) on Hungarian labour market, the labour demand elasticities are calculated based on the firm-level data of Labour Centre's Wage Survey and estimating the translog cost functions. Using the estimated own-wage elasticities of labour, they predicted the change in labour demand in the case of a minimum wage increase. According to their predictions, a minimum wage increase in 2001 and 2002 by 60 and 25% led to a decrease in employment of unskilled workers by 4 and 6%, respectively, and had only negligible impact on the employment of high-skilled workers. The total employment decrease in 2001 and 2002 was equal to 2.5 and 4%, respectively.

A study by Gottvald et al (2002) analyses the impact of minimum wage increases on wage distribution, hours worked, and unemployment in the Czech Republic. Gottvald et al follow the methodology first implemented by Neumark, Schweitzer and Washcer (2000). Estimation results suggest that a minimum wage increase leads to a substantial increase in wage levels for minimum wage workers as well as the workers earning salaries just above this level. The results of effects on hours worked were unstable, indicating that in the short run, after a raise in the minimum wage, employees increase their number of hours worked, but one year lagged effect on hours worked is negative. The results of the effect of minimum wage increase on unemployment are insignificant.

Eriksson and Pytlikovå (2002) study the impact of minimum wage increase on wages and demand of labour in the Czech and Slovak Republics following the strategy by Card (1992b). Using cross-sectional firm-level data, they estimate the impact of minimum wage increase taking into account the distribution of wages in the firm in order to capture the importance of this change. The estimation results are mixed. When independent variable is the minimum wage relative to the wage distribution of the firm[3], estimation results from the Slovak Republic yield mixed results, while in the Czech Republic the impact on employment as well as on hours worked is not significant. When independent variable is the proportion of low-wage workers in the firm, it has a positive impact on employment in the Czech Republic and also in the Slovak Republic in the first period (1998–99) but no effect in the second (1999–2000). The estimated

[3] ((minimum wage-10th decile limit)/minimum wage)

positive impact might reflect the fact that general economic conditions were not taken into account in the regressions.

5. Impact of Minimum Wage on Employment in Estonia: Analysis Based on Micro-Level Data

The methodological approach of the majority of recent empirical studies based on micro-level data has been to estimate a probit or logit model, ie to assess the impact of the minimum wage on the conditional probability of maintaining a job, given that the person has worked before. Estimating the employment elasticity of the minimum wage on the basis of this approach may yield biased results. The possibility of sample selection bias arises whenever one examines a sub-sample and the unobservable factors determining inclusion in the sub-sample are correlated with the unobservables influencing the variable of primary interest (Vella, 2000). In the minimum wage problem, an unobservable factor that is determining inclusion in the sub-sample and at the same time is influencing the variable of primary interest is the inherent ability of a person that determines his or her success in the labour market. These workers who (due to some unobservable factors) are more likely to be unemployed at any time period are also more likely to be negatively affected by an increase in the minimum wage. Exclusion of the unemployed workers from the sample would therefore cause the probit or logit regression estimates to be biased. Our approach differs from the previous empirical studies on this topic by using the Heckman estimation model, which allows us to correct the selection bias that can arise from non-random data censoring.

5.1. Heckman Model and Specification Tests

The Heckman Model

The sample selection model developed by Heckman (1979) provides a methodology to control for the selection bias by first estimating the probability that an observation is not censored (the selection equation) and then using this estimate in the regression equation to correct for the fact that the conditional mean of the residual is not zero.

The selection equation of the Heckman sample selection model can be written as:

$$Y_{1i}^{*} = X_{1i}\beta_1 + \nu_i \quad \text{where} \quad Y_{1i}^{*} \geq 0 \ \text{if} \ Y_{1i} = 1 \quad \text{and} \ Y_{1i}^{*} < 0 \ \text{if} \ Y_{1i} = 0 \tag{5.1}$$

and the regression equation is written as:

$$Y_{2i} = X_{2i}\beta_2 + u_i \qquad \text{where } Y_{2i} \text{ is observed if } Y_{1i} = 1 \tag{5.2}$$

Assume that ν_i and u_i have bivariate normal distribution

$$\phi(\nu_i, u_i) \sim N\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \Sigma \quad \text{where} \quad \Sigma = \begin{bmatrix} \sigma_{11} & \sigma_{12} \\ & \sigma_{22} \end{bmatrix} \tag{5.3}$$

Then in the sample with observed Y_{2i}, the conditional mean of Y_{2i} is equal to

$$E(Y_{2i}/X_{2i}, Y_{1i} = 1) = X_{2i}\beta_{2i} + E(u_i/\nu_i > -X_{1i}\beta_1) = X_{2i}\beta_2 + \theta\lambda(X_{1i}\beta_1) \tag{5.4}$$

where $\theta = \frac{\sigma_{12}}{\sigma_{11}}$ and $\lambda(X_1\beta_1) = \frac{\phi(X_1\beta_1)}{\Phi(X_1\beta_1)}$ is the inverse Mills ratio, with ϕ and Φ being the unit normal pdf and cdf, respectively. A consistent estimate of equation (5.4) can be obtained by either estimating the equations (5.1)–(5.3) by maximum likelihood or by a two-step procedure, where in the first stage equation (5.1) is estimated by probit and in the second stage an estimate of the inverse Mills ratio is formed and equation (5.4) is estimated by WLS or some other analogous method. In the current paper we exploit the maximum likelihood estimation (MLE), since the parameter estimates of the MLE are fully efficient, given that the assumption (5.3.) holds.

Model Specification Tests: The Selection Bias

When $\sigma_{12} = 0$, then the conditional expectation $E(u_i/\nu_i > -X_{1i}\beta_1) = 0$ and the OLS estimates of the second-stage regression equation (5.2) are consistent. This property can be employed to test the significance of the selection bias. It can be carried out by using either the Lagrange-multiplier test or the t-test for testing the significance of the slope coefficient on the inverse Mills ratio.

An alternative way of conducting the selection bias test is to use the likelihood-ratio test, which compares the log likelihood for the estimated selection model with the model estimated under the null hypothesis of no selection bias. We employ both methods of testing the selection bias in the following empirical work.

Model Specification Tests: The Validity of the Joint Normality Assumption

The correct estimation of the above model strongly relies on the assumption that the residuals are jointly normally distributed. If the normality assumption fails, the estimates are inconsistent. To justify the use of the approach described above, we conduct the test of the joint normality of residuals, based on Pagan and Vella (1989). Pagan and Vella construct the normality test by first approximating the unknown density of ν_i and u_i using the following formula:

$$f_{uv} = \left(\sum_{k=0}^{K} \sum_{j=0}^{J} \gamma_{kj} u^k \nu^j \right) \phi_{uv} \qquad (5.5)$$

where ϕ_{uv} is the bivariate normal density of ν_i and u_i and $\gamma_{00} = 1$.

Under the joint normality assumption residuals u_i and ν_i are related as follows:

$u_i = \rho\nu_i + \varepsilon_i$ where $E(\varepsilon_i \nu_i) = 0$

The way to correct for the selection bias in the two-step procedure is to obtain the correction term $E(u_i/Y_{1i} = 1)$, for which a preliminary step is to obtain an estimate of the conditional expectation for the whole population $E(u_i/\nu_i)$. Using the density approximation given in (5.5), the latter term can be calculated as follows:

$$E(u/\nu) = \int u f_{u/v} du = \int u(f_{uv}/f_v) du = \sum_k \sum_j b\gamma_{kj} \left(\int u^{k+1} \phi_{u/v} du \right) \nu^j \qquad (5.6)$$

where $f_{u/v}$ is the conditional density of u given v, $\phi_{u/v}$ is the bivariate normal density and
$b = \phi_v / f_v$.

Under the null hypothesis K = 0 and the above equation can be simplified as follows:

$$E(u/v) = \sum_j b\gamma_{0j}(\int u\phi_{u/v}du)v^j = \sum_j b\gamma_{0j}\rho v^{j+1} \quad (5.7)$$

Thus, under the null hypothesis, which implies $f_v = \phi_v$,

$$E(u_i/Y_{1i} = 1) = \rho\left[E(v_i / Y_{1i} = 1) + \gamma_{01}E(v_i^2 / Y_{1i} = 1) + ... + \gamma_{0J}E(v_i^{J+1} / Y_{1i} = 1)\right] \quad (5.8)$$

Under the null hypothesis $\gamma_{01} = \gamma_{02} = ... = \gamma_{0J} = 0$. Based on the work by Amemiya (1973), Pagan and Vella show that the terms $E(v_i^j / Y_{1i} = 1)$, j=2,3,4 are proportional to $(X_{1i}\beta_1)^{j-1}\left(\frac{\phi_i}{\Phi_i}\right)$. Therefore, a normality test entails obtaining the estimates of these variables from the selection equation, adding the estimated variables to the second-stage regression equation and testing the joint significance of their slope coefficients by an F-test.

5.2. Estimation Technique

The Effect of the Minimum Wage on the Propensity to Work
The first-stage regression is the following equation:

$$W^*_{i,t-1} = \alpha_1 + X_{i,t-1}\theta_1 + v_{i,t-1} \quad (5.9)$$

where W^*_{i1} is the latent variable representing the propensity of working at period *t-1*, and X_{i1} is a vector of individual- and time-specific characteristics of *i-th* individual at period *t-1*. Four variables (the income of other family members, and interactive variable of female dummy * the income of other family members, and interactive variable of female dummy * the number of children, and a dummy for primary earner in the family) are used as exclusionary restrictions (ie included in the selection equation but not in the regression equation).

The second-stage regression equation is analogous to the methodology used by NSW. We estimate the following equation:

$$
\begin{aligned}
Y_{it}^{*} = \alpha + Z_{it}\theta_2 + \left[\sum_{j=1}^{7}\beta_j\left(\frac{mw_t - mw_{t-1}}{mw_{t-1}}\right)G_j(w_{i,t-1}, mw_t, mw_{t+1})\right]\cdot I(mw_t - mw_{t-1} = 0) + \\
+ \left[\sum_{j=1}^{7}\beta_j\left(\frac{mw_t - mw_{t-1}}{mw_{t-1}}\right)G_j(w_{i,t-1}, mw_{t-1}, mw_t)\right]\cdot I(mw_t - mw_{t-1} > 0) + \\
+ \left[\sum_{j=1}^{7}\gamma_j G_j(w_{i,t-1}, mw_t, mw_{t+1})\right]\cdot I(mw_t - mw_{t-1} = 0) + \\
+ \left[\sum_{j=1}^{7}\gamma_j G_j(w_{i,t-1}, mw_{t-1}, mw_t)\right]\cdot I(mw_t - mw_{t-1} > 0) + \varepsilon_{it}
\end{aligned}
\tag{5.10}
$$

In this specification, Y_{it}^{*} is the latent variable representing the propensity of not being fired at period *t*:

$$Y_{it}^{*} \geq 0 \text{ if } Y_{it} = 1 \quad \text{and} \quad Y_{it}^{*} < 0 \text{ if } Y_{it} = 0$$

Y_{it}^{*} is censored since the information on person's wage can be obtained only if this person worked in the previous period (ie period *t-1*). The underlying dummy variable $Y_{it} = 1$ if *i-th* individual works at period *t* and $Y_{it} = 0$ if she is fired or having an involuntary absence from work without pay.

Variables mw_{t-1} , mw_t, and mw_{t+1} are the real minimum wages (net of taxes) at periods *t-1*, *t*, and *t+1*, accordingly.

$I(mw_t - mw_{t-1} > 0)$ is the indicator function, i.e. *I(.) = 1* if the expression in brackets is true and *I(.) = 0* otherwise.

Variable $w_{i,t-1}$ is the net real wage of *i-th* individual in period *t-1*.

Z_i is the vector of control variables, including personal characteristics for each individual, year- and month-specific effects, job characteristics, macro variables, and a second-order polynomial of ln(real wage) defined as of period *t-1* for each individual. The real wage polynomial is included as an additional control because even in the absence of minimum wage, those with lower pay have a lower probability of remaining employed.

G_j (j=1,2,…,8) denotes a set of dummy variables for the worker's position in the wage distribution at period *t-1*, relative to the minimum wages at periods *t* and *t+1* for the time period when $mw_t - mw_{t-1} = 0$ and relative to the minimum wages at periods *t-1* and *t* for the time period when $mw_t - mw_{t-1} > 0$. The exact composition of the group dummies, together with the sample statistics, is given in Appendix 3. Group 2 is defined as a target group, including the set of individuals whose wages remained between the minimum wages at periods *t-1* and *t*, and who, therefore, should be directly affected by the increase in the minimum wage. One group dummy (the highest wage group) is omitted to avoid perfect multicollinearity.

In the regression specification, the parameters of interest are the β_j – the coefficient estimates for the interactive variables of the group dummies and proportionate increase in the minimum wage. The estimates of β_j capture the effects of a change in the minimum wage at each level (or region) in the wage distribution, relative to the omitted region (ie individuals with the highest wages). The highest wage group is the best benchmark for comparison, since it can be expected that workers who belong to this wage group are the least affected by a change in the minimum wage.

The sample covers five years and includes two time periods for each year. (The same individuals are tracked for two consecutive time periods). Each year, within the first period minimum wage stayed constant and within the second period it was raised. This makes it possible to compare workers' employment probability before and after an increase in the minimum wage. The minimum wage ratio $\frac{mw_t - mw_{t-1}}{mw_{t-1}}$ is zero in the first period and positive in the second period. Thus the estimates of β_j capture the net employment effect of the minimum wage raise. The estimate of β_2 for the target group (individuals whose wages were between mw_{t-1} and mw_t in period *t-1*) is similar to a difference-in-difference estimate: it estimates the net employment effect for the target group, relative to all other wage groups and the same group in the previous period.

The Proportion of Workers with Earnings Below the Minimum Wage

Analogously to the employment-minimum wage model, we use the Heckman methodology to assess the impact of minimum wage increase on the propensity of earning a wage below the legal minimum level. The first-stage regression is the following equation:

$$W^*_{i,t-1} = \alpha_1 + X_{i,t-1}\theta_1 + \nu_{i,t-1} \tag{5.11}$$

where $W^*_{i,t-1}$ is the latent variable representing the propensity of working at period *t-1*, and $X_{i,t-1}$ is a vector of individual- and time-specific characteristics of *i-th* individual at period *t-1*. We use the same exclusionary restrictions as in the previous model, with the exception of a dummy for the household's primary earner.

The second-stage regression equation is formulated as follows:

$$Y^*_{it} = \alpha + \beta \ln(mwage)_t + X_{it}\theta_2 + \varepsilon_{it} \tag{5.12}$$

where Y^*_{it} denotes the latent propensity that *i-th* employee's wage is below the legal minimum at period *t*, $\ln(mwage)_t$ is the natural logarithm of the real minimum wage for period *t* and X_{it} denote the individual- and job-specific characteristics for *i-th* employee, toghether with the regional effects and macroeconomic variables. [4]

[4] It was not possible to include the time-specific effects in this model, since the year dummies are highly collinear with the minimum wage variable. Exclusion of the year dummies should not create a problem, since we include controls for the year-specific macroeconomic effects.

5.3. Data

The dataset used – the Estonian Labour Force Survey – consists of four separate files. The last three cover the years 1997–2000, each including three distinct observations per individual. The first file covers a somewhat longer time period over the years 1995–1997 and includes four observations for each individual. Minimum wage was raised once a year during the time period from 1995 to 2000, mostly in January. (See Appendix 3 for the history of minimum wage increases in Estonia.) Given that we have at least three observations for each individual, it is possible to observe the change in the propensity of working for the time period when the minimum wage did not change and to compare it with the time period when the minimum wage was increased. This gives us additional control group in addition to different wage groups for extracting the actual effect of an increase in the minimum wage on the employment probability of the target group.

The table in Appendix 4 conveys descriptive sample statistics across all wage groups and for the full sample. Nearly 8% of the workers are earning wages that are below the minimum wage level, although, according to Estonian regulations, minimum wages are compulsory to everybody without exceptions. This shows that the rate of compliance with minimum wage regulations is relatively low. Possible reasons why such a large proportion of workers report wages below the legal minimum are statistical errors in the reported work hours or reported salaries. Since the data is based on the questionnaires of workers without the employer's verification of its accuracy, workers can mistakenly report that they work full hours, although their work contract stipulates part-time work. In such a case, part-time salaries are reported as a full-time pay, and may fall in the region below the legal minimum level, while employers are actually breaking no laws. The fact that workers actually work longer hours than is written in their contract is quite likely to be the case in Estonia, where labour unions are relatively weak.

Another possible explanation to why the proportion of workers getting paid less than the legal minimum is so large is the ample share of informal economy in Estonia. According to the official estimates by Statistical Office of Estonia, the size of the informal sector in the labour market has been 10–15% of the total.

Other figures in the table in Appendix 4 are largely as expected. Women are over-represented in the lowest wage categories and their proportion diminishes monotonically as the relative wage level increases. A similar pattern can be observed for individuals with lower than secondary education, and young low-educated persons (aged 16–19). These characteristics of the data are in accordance with the evidence from previous empirical studies on minimum wage impact, indicating that the minimum wage usually has the strongest impact on women and young less educated workers. The sample statistics reveal that elderly people (aged 50 or more) are also over-represented in the lowest wage categories. This characteristic of our labour market is a result of the transition process. Adjustment to changing economic environment was harder for the elderly people and this disadvantage is reflected in their lower than average wage levels.

Sample statistics reveal that foreign-owned enterprises in Estonia pay above-average salaries. The often-observed positive firm size effect on wages is also evident in Estonian labour market: larger than average proportion of workers in small firms earn low wages and this proportion decreases monotonically across the increasing wage groups. If minimum wages in Estonia are mainly paid in small companies, it indicates

that increase in the minimum wage should decrease employment, since small companies usually work in a competitive environment. Still, taking into account the small size of sectoral labour markets in Estonia and low mobility of workers in the rural areas, it can be expected that in several rural regions enterprises have excess market power. Thus, the possibility of an opposite (employment increasing) effect cannot be excluded.

5.4. Estimation Results

Minimum Wage and Employment

The regression estimates for the selection model, where the minimum wage-employment relationship is investigated, are presented in the first two columns of the table in Appendix 6, the second column reporting the heteroscedasticity-robust standard errors. The slope estimate of the beta for the target group is negative and statistically significant at 5% confidence level. This implies a significant disemployment effect of an increase in the minimum wage for the target group (ie these workers whose wages in period 1 were between the minimum wages in periods 1 and 2). The slope estimates for all other wage groups are not significantly different from zero. The selection equation estimates are reported in columns 3 and 4. All variables used as exclusionary restrictions are highly significant individually and as a group.

We tested the assumption that the residuals of equations (5.9) and (5.10) are jointly normally distributed, using the methodology of Pagan and Vella outlined in section 5.1. To test the normality assumption, we included the terms $(X_{1i}\hat{\beta}_1)^{j-1}\left(\frac{\hat{\phi}_i}{\hat{\Phi}_i}\right)$ where j=2,3,4 in the second-stage regression equation and tested the joint significance of these variables. The value of the Chi-square statistic in the F-test was 5 and the null hypothesis of normality could not be rejected. We concluded from the test that the Heckman selection model is correctly specified.

Testing the significance of the selection bias yielded weakly significant results. The correlation coefficient between the error terms of equations (5.9) and (5.10) was significantly different from zero at 10% confidence level. Also, the Wald test of independent equations had a Chi-square statistic of 3.02 and the null hypothesis of no significance could be rejected at 10% confidence level. Neither of the tests rejected the null hypothesis at 5% confidence level.

Given the weak test results, we also estimated the second-stage regression equation (5.9) by probit, which yields consistent estimates under the null hypothesis of no selection bias. The regression estimates are given in columns 5 and 6 of the table in Appendix 6. The estimates of interest – betas for the target group and other wage groups – are similar in magnitude to the estimates of the Heckman model. The slope coefficient for the target group is smaller in the absolute value, but the difference is small. In probit specification, the slope coefficient for the first wage group (those with wages below the legal minimum) is negative and marginally significant at the 10% level. The slope coefficients for all other wage groups are insignificant.

The estimated effect of a unit change in the minimum wage on the employment probability of an *i-th* worker belonging to the target group can be calculated using the following formula:

$$\frac{\partial Y_{it}}{\partial(\%\Delta mw * g2)} = \varphi(\hat{Y}_{it}^{*})\hat{\beta}_2 \qquad (5.13)$$

where g2 is the dummy for the target group, $\hat{Y}_{it}^{*}$ is the estimated employment propensity in period *t*, and φ is the standard normal pdf.

The average estimated change in probability in response to a unit change in the minimum wage was -0.06624 in the Heckman model and -0.0426 in the case of probit specification. This implies that a 10% increase in the minimum wage caused an employment reduction in the range of 0.43% …0.66% among the workers who were directly affected by this change. Considering that minimum wage increases affected a significant proportion of the labour force (5% in average), it is surprising that the estimated employment elasticity is below 1% (ie the level that is most often reported in the studies for the US, where minimum wage has a direct effect to a much smaller proportion of the labour market). One possible explanation to this is the low compliance with minimum wage regulations in Estonia. As already stated, three months after each minimum wage hike the salaries remained below the new legal minimum for approximately half of the target group workers in our sample.

Minimum Wage and the Size of the Informal Sector

Given that there is a widespread non-compliance with minimum wage law, it is likely that raising the minimum wage would increase the proportion of employees whose salaries are below the minimum wage level. To test this hypothesis, we regressed the probability that a worker's wage is below the legal minimum on the natural logarithm of the minimum wage level and a set of control variables. The estimation methodology was analogous to the one used in the previous section: we estimated the Heckman two-step model and the probit model for comparison.

The regression results estimating the minimum wage impact on the probability that a worker's wage is below the legal minimum in the time period following an increase in the minimum wage are given in Appendix 7. The results of the Heckman second-stage regression equation are given in the first two columns of the table. The slope coefficient on the minimum wage variable is positive and significant at 1% level, indicating that an increase in the real value of the minimum wage enlarges the proportion of workers who earn salaries below the legal minimum level. Women and non-Estonians are more likely to earn below-minimum wages. Workers in private sector and small firms (with less than 50 employees) are more likely to fall in the group of below-minimum wage earners, whereas these who work in the companies owned by foreigners are less likely to belong to this group. Coefficients for all profession dummies are significantly negative. Since the comparison group is low-skilled workers, this implies that low-skilled workers are the most likely to earn below-minimum wages. Regions, where people are more likely to earn below-minimum salaries include Hiiumaa, Ida-Virumaa, Jõgevamaa, Põlvamaa, Tartumaa, Viljandimaa ja Võrumaa. In order to better estimate the sectoral effects, we ran a different regression (not reported here), where *dsector1* (agriculture) was left out. In this configuration, all other sectors had either significantly negative or insignificant slope coefficients. This implies that the largest proportion of below-minimum wage earners works in the agricultural sector – a result that is in accordance with the evidence from other sources implying that the share of informal economy is the largest in the agricultural sector in Estonia.

In addition to regression estimation, we conducted the model specification tests outlined in section 5.1. The likelihood ratio test on the selection bias strongly rejected the null of no correlation between the two residuals, implying that the Heckman model was correctly specified. However, the test on the joint normality of the residuals yielded a Chi-square statistic of 15.66, thus rejecting the normality assumption at 1% confidence level. Although the test statistics were separately all insignificant, the joint significance could not be rejected.

Given the latter test result, we also estimated the second-stage regression equation of the Heckman model by probit. Probit-type regression estimations are not very sensitive to deviations from normality. To obtain a major change in the magnitude of the slope coefficients from this source requires that the error term be distributed very differently from normal, eg to be bimodal rather than unimodal (Moffitt, 1999). The estimates of the probit model and the heteroscedasticity-robust standard errors are reported in the last two columns of the table in Appendix 7. The estimated slope coefficients are in general very close to Heckman model estimates, implying that the selection bias is not large in magnitude.

We used formula (5.13) to assess the magnitude of the minimum wage impact on informal economy. The relevant elasticities for Heckman and probit models were 0.001986 and 0.002124, accordingly. This implies that a 10% increase in the real value of the minimum wage increases the proportion of people whose salaries are below the legal minimum level by approximately 2%.

Minimum Wage and Income Distribution

We evaluated the effect of the minimum wage on the wage distribution by observing how the shape of the nonparametric wage distribution changes in response. Figure 5.1 presents the kernel estimations of the wage distribution in Estonian labour market at the first half of 1995 (the first time period in the sample we use) and at the first half of 2000 (the last time period in our sample). The kernel density functions of the two periods are nearly identical. Although it is possible to detect a small shift of the probability distribution in the rightward direction, the maximum point has not changed and the skewness of the distribution is also practically the same.

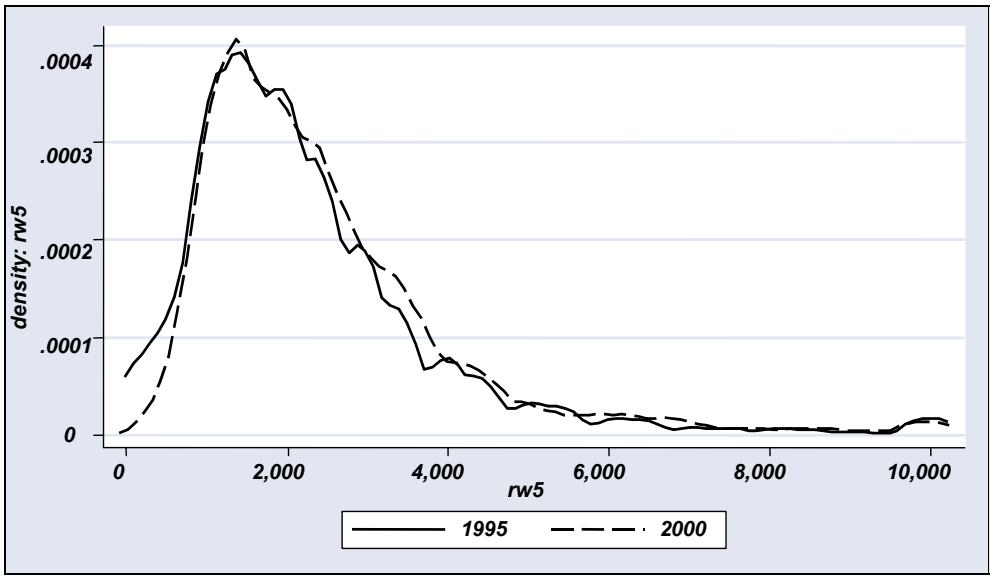

Figure 5.1. Kernel density estimates for real wage in Estonia in 1995 and 2000

The estimated probability distributions in Figure 5.1 both exhibit a strong vertical spike at the minimum wage level. This gives further support to the argument that the minimum wage is a binding constraint in Estonia, as it is evident on the basis of this graph that it affects the wage setting for a substantial part of the labour force.

In addition to the comparison given in Figure 5.1, we also compared the wage distributions within each year in the periods before and after an increase in the minimum wage. As the shapes of the estimated density functions were even more similar in the within-one-year comparisons, the results are not reported here. The fact that increases in the minimum wage have not much altered the shape of the probability distribution of wages during 1995–2000 could indicate that the labour market adjustment mechanism in Estonia in response to an increase in the minimum wage takes place mainly through the alteration of the number of people employed, rather than through the adjustment of wages.

Conclusion

In Estonia, the importance of minimum wages has been steadily increasing during the 90s, although, compared to the European Union countries, the level of the relative minimum wage (minimum wage compared to the average wage) is still low. According to the agreement between the central employers' and labour unions, the minimum wage will be considerably increased in the coming years in Estonia. The initiative for this has come from the labour unions' side, who support the use of the minimum wage as an income-equalising measure. However, the impact of the minimum wage on labour market efficiency has not been considered in labour unions' policy proposals.

We examined the link between an increase in the minimum wage and employment outcome in Estonian labour market. The empirical analysis was based on the Estonian Labour Force Survey dataset, which pools cross-sectional micro-level data across the years 1995–2000. Our empirical approach was similar to the methodology used by Neumark, Schweitzer, and Wascher (2000). Following their analytical methods, we investigated the impact of minimum wage increase on work probability separately for different income groups. Our analysis improved upon the methodology used in the NSW study by employing the Heckman two-level selection model, which enabled us to control for the selection bias that may result from data censoring.

The empirical results of the study were consistent with the competitive labour market model, according to which an increase in the minimum wage reduces employment. The disemployment effect of the minimum wage was significant only for the group of workers directly affected by its change. As the slope estimates for other wage groups were insignificant, we could not detect any substitution effects between different skill-levels of labour. The estimate of the slope coefficient was, among others, also insignificant for the group of workers earning wages below the legally set level. On the basis of this finding, we could not detect an outflow from the formal sector jobs to the informal sector in Estonia.

The analysis also showed that, as the real value of the minimum wage increased, the proportion of workers with earnings below the legal minimum level increased as well. This implies that the substitution between the formal and informal sectors took place via a different mechanism in Estonia: employers, rather than workers, seemed to be moving

from one sector to another in response to an increase in the minimum wage. However, it is questionable if the results can be interpreted in such a manner. It is ambiguous to draw a borderline between formal and informal sectors on the basis of wage information only. As already indicated earlier, it is possible that workers in low-wage jobs report longer hours than their work contract stipulates. This is quite likely to be the case, considering that in Estonia labour unions are relatively weak and the unemployment rate among workers competing for low-wage jobs is high. In this case, their salaries can remain below the legally set minimum level, although the employers are formally breaking no laws and therefore do not classify as belonging to an informal part of the economy.

The results of our empirical analysis imply that the minimum wage had a negative impact on employment in Estonia during the time period 1995–2000. This result is noteworthy, considering that a significant increase in the minimum wage is expected to take place within the next few years. While in the period from 1995 to 2000 the minimum wage was less than 30% of the average wage, this ratio is expected to reach 41% by the year 2008. The relative rise in the minimum wage compared to the average might lead to a stronger negative impact of the minimum wage in the labour market.

Considering a significant disemployment effect of the minimum wage on low-wage workers in the light of current high unemployment rate in Estonia, two questions arise. First, how can the negative impact of minimum wage increase be minimised, ie which labour market policy measures would increase the productivity of workers? Second, is setting a high wage floor the right method to increase welfare? Welfare effects of this policy measure are ambiguous, given that it will likely result in excluding a significant proportion of low-productivity workers from the labour market and moving them to the social beneficiaries' list. Then, should alternative policies be applied to reduce poverty? An example of an alternative policy, which increases low-earning workers' welfare without generating a disemployment effect, is a reduction in the tax burden of low-earning workers. Considering this, the expected tax reform (according to which the income tax is reduced to 20% from the current level of 26% and the tax-exempt minimum is raised from 12,000 kroons a year to 24,000 kroons within the next three years) is a better measure for fighting poverty than increasing the minimum wage. A disadvantage of a reduction in the low-earners tax burden, compared with the minimum wage measure, is that the resulting increase in the net wage will be financed by government, not by the private sector, which will reduce state revenues.

References

Abowd, J.M., Kramarz, F., Lemieux, T., Margolis, D. (1997), 'Minimum Wages and Youth Employment in France and the United States', *NBER Working Paper No 6111*.

Bhaskar, V., Manning, A., To, T. (2002), 'Oligopsony and Monopsonistic Competition in Labor Markets', *Journal of Economic Perspectives*, Vol 16, No 2, pp 155–174.

Brown, C. (1999), 'Minimum Wages, Employment and the Distribution of Income', *Handbook of Labor Economics*, Vol 3B, pp 2101–2164.

Brown, C., Gilroy, C., Kohen, A**.** (1982), 'Time-Series Evidence of the Effect of the Minimum Wage on Youth Employment and Unemployment', *Report of US minimum wage study commission*, Vol 5, Washington.

Burdett, K., Mortensen, D. (1998), 'Wage Differentials, Employer Size, and Unemployment', *International Economic Review*, Vol 39:2, pp 257–73.

Card, D. (1992a), 'Do Minimum Wages Reduce Employment? A Case Study of California, 1987–89', *Industrial and Labour Relations Review*, Vol 46:1, pp 38–54.

Card, D. (1992b), 'Using Regional Variations in Wages to Measure the Effect of the Federal Minimum Wage', *Industrial and Labor Relations Review*, Vol 46, No 1.

Card, D., Krueger, A. (1994), 'Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania', *American Economic Review*, Vol 84, Is 4, pp 772–793.

Card, D., Krueger, A. (1995), 'Myth and Measurement: The New Economics of the Minimum Wage', Princeton: Princeton University Press.

Clare, R., Paternoster, A. (2003), 'Minimum Wages. EU Member States and Candidate Countries', Eurostat, *Statistics in Focus*, 8, January.

Currie, J., Fallick, B.C. (1996), 'The Minimum Wage and the Employment of Youth: Evidence from the NLSY', *The Journal of Human Resources*, Vol 31, No 2.

Dickens, R., Machin, S., Manning, A. (1999), 'The Effects of Minimum Wages on Employment: Theory and Evidence from Britain', *Journal of Labor Economics*, Vol 17, No 1, pp 1–23.

Employment Outlook, (1998), June, OECD, Paris.

Eriksson, T., Pytliková, M. (2002), 'Consequences of Minimum Wage Increases: Empirical Evidence from Czech and Slovak Republic. Determinants of Individual Pay and Firm's Pay Structures in the Czech and Slovak Republic', Eds Jaromir Gottvald, Ostrava: Vysoká Škola Báňská, Technická Univerzita Ostrava, Ekonomická Fakulta.

Gottvald, J., Hančlová, J., Pytlikova, M., Stanek, V. (2002), Minimum Wage in the Wage Structures of the Czech and Slovak Republics. – Determinants of Individual Pay and Firm's Pay Structures in the Czech and Slovak Republic, Ed. By Jaromir Gottvald, Ostrava: Vysoká Škola Báňská – Technická Univerzita Ostrava, Ekonomická Fakulta.

Gramlich, E.M. (1976), 'Impact of Minimum Wages on Other Wages, Employment and Family Incomes', *Brookings Papers on Economic Activity*, Vol 1976, Is 2.

Hamermesh, D. (1995), 'What a Wonderful World this Would Be', in Review symposium on Card and Krueger's Myth and Measurement: The New Economics of the Minimum Wage. *Industrial And Labor Relations Review*, Vol 48, pp 835–838.

Ioakimoglou, E., Soumeli, E. (2002), 'Low-Wage Workers and the 'Working Poor', *European Industrial Relations Observatory*.

Katz, L., Krueger, A.B. (1992), 'The Effect of the Minimum Wage on the Fast-Food Industry', *Industrial and Labor Relations Review*, Vol 46, Is 1.

Kennan, J. (1995), 'The Elusive Effects of Minimum Wages', *Journal of Economic Literature*, Vol 33, Is 4, pp 1950–1965.

Kertesi, G., Köllö, J. (2002), 'Labor Demand with Heterogeneous Labor Inputs after the Transition in Hungary 1992–1999 – and the Potential Consequences of the Increase of Minimum Wage in 2001 and 2002', Budapest Working Papers on the Labor Market No 5, p 44.

Machin, S., Manning, A. (1994), 'The Effects of Minimum Wages on Wage Dispersion and Employment: Evidence from UK Wage Councils', *Industrial And Labor Relations Review*, Vol 47.

Machin, S., Manning, A., Rahman, L. (2002), 'Where the Minimum Wage Bites Hard: the Introduction of the UK National Minimum Wage to a Low Wage Sector', Centre for Economic Performance, *Discussion Paper No. 544*.

Mincer, J. (1976), 'Unemployment Effects of Minimum Wages', *Journal of Political Economy*, Vol 84, Is 4.

Neumark, D. (1999), 'The Employment Effects of Recent Minimum Wage Increases: Evidence from a Pre-Specified Research Design', *NBER Working Paper No 7171*.

Neumark, D., Wascher, W. (1992), 'Employment Effects of Minimum and Subminimum Wages: Panel Data on State Minimum Wages', *Industrial and Labor Relations Review*, Vol 46, pp 55–81.

Neumark, D., Wascher, W. (1995), 'The Effects on Minimum Wages on Teenage Employment and Enrolment: Evidence from Matched CPS Survey's', *NBER Working Paper No 5092*.

Neumark, D., Schweitzer, M., Washcer, W. (2000), 'The Effects of Minimum Wages Throughout the Wage distribution', *NBER Working Paper No 7519*.

Pagan, A., Vella, F. (1989), 'Diagnostic Tests for Models Based on Individual Data: A Survey', *Journal of Applied Econometrics*, Vol 4, pp 29–59.

Partidge, D., Partidge, J. (1999), 'Do Minimum Wage Hikes Reduce Employment? State-level evidence', *Journal of Labor Research*, Vol 20, No 3.

Safety Net Review – Wages 1998–1999. (1999), Commonwealth Submission.

Safety Net Review – Wages 2002–2003. (2003), Commonwealth Submission.

Safety Net Review – Wages 2001–2002. (2002), Commonwealth Submission.

Stigler, G. (1946), 'The Economics of Minimum Wage Legislation', *American Economic Review*, Vol 36.

Submission to the Irish National Minimum Wage Commission. (1997), *OECD Labor Market and Social Policy Occasional Papers No 28*.

Vella, F. (2000), 'Estimating Models with Sample Selection Bias: A Survey', *The Journal of Human Resources*, Vol 33:1, pp 127–169.

Welch, F. (1976), 'Minimum Wage Legislation in the United States', in O. Ashenfelter and J. Blum eds *Evaluating the Labor Market Effects of Social Programs*. Princeton University Press, Princeton.

Wellington, A.J. (1991), 'Effects of the Minimum Wages on the Employment Status of Youths: An Update', *The Journal of Human Resources*, Vol 26, Winter.

Appendix 1. Summary results of the US minimum wage studies

Authors (year published)	Findings
Bazen and Marimoutou (1997)	**Significant negative** relationship.
Belman and Wolfson (1999)	No evidence of a negative relationship.
Bernstein and Schmitt (1998)	Mixed results.
Burkhauser, Couch and Wittenburg (2000)	**Significant negative** relationship.
Card (1992)	Positive relationship.
Card and Krueger (1995)	No negative relationship, possibly positive relationship.
Card and Krueger (1999)	Little evidence of a negative relationship.
Currie and Fallick (1996)	**Significant negative** relationship on probability of remaining employed.
Hsing (2000)	**Significant negative** relationship on ratio of part-time to full-time employment.
Katz and Krueger (1992)	Significant positive relationship
Keil, Robertson and Symons (2001)	**Significant negative** relationship.
Klerman (1992)	**Significant negative** relationship.
Mills, Roy and Williams (1999)	No significant evidence using natural experiments but **a significant, large and negative** effect using time series analysis.
Neumark (1999)	**Significant negative** relationship.
Neumark and Wascher (1992)	**Significant negative** relationship.
Neumark and Wascher (1995)	**Significant negative** relationship.
Neumark, Schweitzer and Wascher (2000)	**Significant negative** relationship.
Partridge and Partridge (1999)	**Significant negative** long-term relationship.
Wellington (1991)	**Significant negative** relationship.
Williams and Mills (2001)	**Significant negative** relationship on teenage employment.

Sources: Safety Net Review – Wages 2001–2002, 2002.

Appendix 2. Summary results of minimum wage studies in other countries

Authors (year published)	Country	Findings
Abowd, Kramarz and Margolis (1997)	US and France	**Significant negative** relationship for France, insignificant relationship for the US.
Abowd, Kramarz, Lemieux and Margolis (1997)	France	**Significant negative** relationship.
Bazen (1990)	UK	**Significant negative** relationship.
Bazen and Martin (1991)	France	**Significant negative** relationship.
Bazen and Skourias (1997)	France	**Significant negative** relationship.
Bell (1997)	Columbia	**Significant negative** relationship.
Bell (1997)	Mexico	No clear relationship.
Benhayoun (1994)	France	**Significant negative** relationship.
Chapple (1997)	NZ	Inconclusive results.
Dolado, Fergueroso and Jimeno (1998)	Spain	**Significant negative** relationship.
Dolado, Kramarz, Machin, Manning, Margolis and Tuelings (1996)	France	**Negative relationship** with qualification that analysis could be affected by different business cycles.
Dolado, Kramarz, Machin, Manning, Margolis and Tuelings (1996)	Spain	**Significant negative** relationship.
Kan and Sharir (1996)	Canada	Small or negligibly negative relationship.
Koutsogeorpoulou (1994)	Greece	**Significant negative** relationship.
Kramarz and Philippon (1999)	France	**Significant negative** relationship.
Machin and Manning (1996)	UK	No negative relationship.
Maloney (1994)	NZ	**Significant negative** relationship.
Neumark and Wascher (1999)	Cross-Country	Results varied but were generally consistent with the view that minimum wages cause employment losses among youth.
OECD (1997)	France	**Significant negative** relationship.
OECD (1998)	Cross-Country	**Significant negative** relationship.
Saget (2001)	Selected Developing Countries	No significant effect.
Stewart (2002)	UK	Positive relationship for adult male and young workers.
van Soest (1994)	Netherlands	**Significant negative** relationship.
van Soest and Kapteyn (1990)	Netherlands	**Significant negative** relationship.

Sources: Safety Net Review – Wages 2001–2002, 2002.

Appendix 3. Minimum wage development in Estonia

Time of minimum wage increase	1/07/92	1/10/93	1/09/94	1/01/96	1/02/97	1/01/98	1/01/99	1/01/00	0/01/01	1/01/02	1/01/03
New minimum wage level	200	300	450	680	845	1100	1250	1400	1600	1850	2160
Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Average Wage	549	1066	1734	2985	3573	4125	4418	4907	5510	5781	6448
Minimum wage as % of average wage	36,4	28,1	26	22,8	23,6	26,7	28,3	28,5	29,0	32,0	33,5
Increase of nominal minimum wage, %		50,0	50,0	51,1	24,3	30,2	13,6	12,0	14,3	15,6	16,8
Increase of real minimum wage, %		1,6	16,3	22,8	11,7	20,3	10,0	7,7	8.0	12,3	13,4

Appendix 4. Subset proportions for the whole sample and the wage groups

		Total Proportion	*Women*	*Age 16-19*	*Age >50*	*Education < secondary*	*Educ.> secondary*	*Foreign Enterprise*	*Enterprise size < 50*	*Public Enterprise*
	Full sample	100.0%	50.5%	1.7%	23.3%	30.6%	26.1%	6.6%	51.4%	30.5%
Group1	**wage<MW1**	8.1%	61.2%	3.9%	36.0%	39.3%	19.0%	2.5%	64.6%	20.1%
Group2 (target)	**MW1<wage <MW2**	5.0%	63.8%	1.7%	30.4%	43.3%	14.1%	2.4%	68.3%	25.9%
Group3	**MW2<wage <MW2*1.4**	12.2%	63.4%	2.2%	26.9%	39.1%	14.6%	3.5%	61.9%	28.7%
Group4	**MW2*1.4<wage <MW2*1.8**	14.6%	59.2%	1.6%	23.0%	35.1%	16.6%	5.6%	54.9%	29.2%
Group5	**MW2*1.8<wage <MW2*2.2**	12.7%	54.6%	1.5%	22.2%	30.9%	22.2%	6.8%	50.5%	33.0%
Group6	**MW2*2.2<wage <MW2*2.8**	15.9%	48.4%	1.4%	20.5%	28.9%	27.3%	7.2%	47.7%	32.9%
Group7	**MW2*2.8<wage <MW2*3.7**	15.9%	41.1%	1.0%	22.1%	24.5%	32.3%	8.2%	45.7%	36.5%
Group8	**MW2*3.7<wage**	16.4%	31.1%	0.8%	19.4%	19.8%	45.1%	11.7%	44.6%	29.2%

Total sample size is 99,890 observations. The number of uncensored observations (for which wages are observed) is 41,891. Observations with wages below 100 Estonian kroons (50 Estonian kroons for years 1995 and 1996) are excluded from the sample, so as observations with wages above 100,000 Estonian kroons (the proportion of excluded observations is less than 0.5% of uncensored observations).

Appendix 5. Model variables

mwdgroupj (j = 1,2,...,8) the interactive variables of the proportional change in the minimum wage times the dummy of the j-th wage group

groupj (j = 1,2, ... , 8) wage group dummies (see also appendix 4)

rwage	natural logarithm of the real wage net of taxes
rwagesquare	rwage squared
male	dummy variable, equals 1 if male
age	age (years)
agesquare	age squared
nationality	dummy variable, equals 1 if Estonian
language	dummy variable, equals 1 if a person speaks more than one language
education1	dummy variable, equals 1 if a person has primary education (8 years of schooling or less)
education2	dummy variable, equals 1 if a person has secondary education
children	the number of children less than 16 years old
dgdp	percentage change in real GDP for a given year
infl	inflation rate for a given year
private	dummy variable, equals 1 if a person works in a privately owned company
foreign	dummy variable, equals 1 if a person works in a company owned by foreigners
dsize1	dummy variable, equals 1 if a person works in an enterprise with less than 50 workers
dsize2	dummy variable, equals 1 if a person works in an enterprise with more than 50 and less than 500 workers
primaryearner	dummy variable, equals 1 if a person is a primary earner in his/her household
oincome	the combined per capita income of other household members
oincfem	female dummy times the combined per capita income of other household members
childfemale	female dummy times *children*

Profession Dummies:

dprof1	legislature, higher officials, managers
dprof2	high-level specialists
dprof3	medium-level specialists, technicians
dprof4	office clerks
dprof5	service and sales workers
dprof6	skilled specialists, agriculture and fishing
dprof7	skilled specialists
dprof8	operators of equipment and machinery
dprof9	low-skilled workers
dprof10	armed forces

Sector Dummies:

dsector1	agriculture
dsector2	fishing
dsector3	mining

dsector4	manufacturing
dsector5	energy and water supplies
dsector6	construction
dsector7	whole- and retail sales
dsector8	hotels and restaurants
dsector9	transport and logistics
dsector10	financial intermediation
dsector11	real estate
dsector12	public sector and defense
dsector13	education
dsector14	healthcare and social work
dsector15	other

Regional Dummies:

dregion1	Harjumaa, excluding Tallinn
dregion2	Hiiumaa
dregion3	Ida-Virumaa
dregion4	Jõgevamaa
dregion5	Järvamaa
dregion6	Läänemaa
dregion7	Lääne-Virumaa
dregion8	Põlvamaa
dregion9	Pärnumaa
dregion10	Raplamaa
dregion11	Saaremaa
dregion12	Tartumaa
dregion13	Valgamaa
dregion14	Viljandimaa
dregion15	Võrumaa
dregion16	Tallinn

Appendix 6. Employment effect of the minimum wage

	Heckman Regression Equation		Heckman Selection Equation		Probit Equation	
	Dep. Var. = P(notfired)		Dep. Var. = P(empl.)		Dep. Var. = P(notfired)	
	Coefficient	Robust Std. Error	Coefficient	Robust Std. Error	Coefficient	Robust Std. Error
mwd*group1	-1.293	0.914			-1.556*	0.863
mwd*group2 (target)	-2.145**	1.012			-1.988**	0.978
mwd*group3	0.45	0.892			0.295	0.871
mwd*group4	0.538	0.830			0.868	0.838
mwd*group5	0.354	0.959			0.112	0.912
mwd*group6	-0.842	0.809			-0.622	0.808
mwd*group7	-0.328	0.805			-0.223	0.805
group1	-0.260	0.257			-0.27	0.252
group2 (target)	-0.283	0.222			-0.317	0.217
group3	-0.232	0.188			-0.228	0.186
group4	-0.144	0.165			-0.156	0.162
group5	-0.045	0.150			-0.058	0.149
group6	0.085	0.137			0.070	0.136
group7	0.034	0.115			0.023	0.115
rwage	0.009***	0.003			0.010***	0.003
rwagesquare	0.005	0.007			0.006	0.006
male	-0.067	0.058	0.058***	0.011	-0.103**	0.049
age	0.040	0.029	0.264***	0.002	-0.005	0.011
agesquare	-0.0003	0.000	-0.003***	0.000	0.000	0.000
nationality	0.051	0.059	0.099***	0.010	0.032	0.057
language	0.048	0.061	0.228***	0.010	0.033	0.057
children	0.025	0.026	0.112***	0.005	0.024	0.026
education1	-0.315***	0.086	-0.524***	0.010	-0.207***	0.072
education2	-0.254***	0.070	-0.185***	0.009	-0.205***	0.067
dgdp	0.042	0.026	-0.007**	0.003	0.037	0.026
infl	-0.168**	0.073	0.023***	0.007	-0.173**	0.071
private	-0.017**	0.008			-0.019**	0.008
foreign	-0.037	0.091			-0.035	0.092
dsize1	-0.060	0.082			-0.078	0.082
dsize2	0.038	0.078			0.036	0.078
primaryear~r			0.416***	0.008		
oincome			0.0003***	0.000		
oincfem			-0.0001***	0.000		
childfemale			-0.261***	0.007		
dprof1	0.343***	0.112			0.306	0.110
dprof2	0.518***	0.155			0.441	0.144
dprof3	0.195**	0.088			0.166	0.088
dprof4	0.343***	0.131			0.350	0.132
dprof5	0.252***	0.091			0.199	0.088
dprof6	-0.081	0.133			-0.121	0.133
dprof7	0.031	0.071			-0.006	0.071
dprof8	0.109	0.076			0.061	0.076
dsector1	0.060	0.135			0.083	0.135
dsector2	-0.277	0.274			-0.201	0.276

dsector3	-0.180	0.221			-0.203	0.223
dsector4	-0.078	0.111			-0.087	0.111
dsector5	0.231	0.222			0.255	0.225
dsector6	-0.304**	0.124			-0.363***	0.122
dsector7	-0.142	0.113			-0.160	0.111
dsector8	-0.384***	0.137			-0.341**	0.136
dsector9	-0.104	0.123			-0.103	0.122
dsector10	-0.088	0.286			-0.089	0.288
dsector11	-0.195	0.150			-0.227	0.145
dsector12	-0.036	0.156			-0.017	0.157
dsector13	-0.066	0.126			-0.054	0.126
dsector14	0.182	0.169			0.213	0.170
dregion1	-0.001	0.085	0.028*	0.016	-0.028	0.083
dregion2	0.403	0.259	-0.109***	0.031	0.210	0.202
dregion3	0.156**	0.078	-0.010	0.014	0.183**	0.079
dregion4	0.333**	0.135	-0.226***	0.020	0.363***	0.129
dregion5	0.166	0.126	-0.062***	0.019	0.148	0.121
dregion6	0.240	0.153	-0.085***	0.021	0.205	0.142
dregion7	0.201**	0.095	-0.052***	0.016	0.237**	0.097
dregion8	0.040	0.137	-0.354***	0.022	0.035	0.128
dregion9	0.411***	0.126	-0.079***	0.018	0.383***	0.115
dregion10	0.182	0.124	-0.104***	0.019	0.233*	0.124
dregion11	0.306**	0.144	-0.093***	0.020	0.363**	0.145
dregion12	0.236***	0.090	-0.160***	0.015	0.237***	0.085
dregion13	0.149	0.134	-0.137***	0.020	0.130	0.127
dregion14	0.071	0.106	-0.204***	0.018	0.102	0.102
dregion15	0.305**	0.134	-0.301***	0.019	0.384***	0.129
dmarch	-0.031	0.091			-0.071	0.090
djan	-1.265***	0.453			-1.334***	0.440
djan2			0.003	0.014		
year1996			0.149***	0.041		
year1997	-2.943**	1.393	0.357**	0.150	-3.020**	1.353
year1998	-3.602**	1.469	0.242	0.165	-3.671***	1.428
year1999	-4.128**	1.737	0.027	0.185	-4.221**	1.691
_cons	5.367**	2.362	-5.263***	0.200	6.588***	2.122

Notes: *** significant at 1% level, ** significant at 5% level, and * significant at 10% level. The explanation of model variables is presented in appendix 5. Year1996 dropped from the model due to high collinearity.

Appendix 7. Minimum wage and the propensity of earning a below-minimum wage

	Heckman regression equation		Selection equation		Probit equation	
	Dep. Var. = P(wage<mw)		Dep. var. = P(empl.)		Dep. Var. = P(wage<mw)	
	Coefficient	Robust Std. Error	Coefficient	Robust Std. Error	Coefficient	Robust Std. Error
lnmwage	2.1618***	0.5798			2.1356***	0.5506
male	-0.1784***	0.0407	0.0933***	0.0154	-0.2376***	0.0359
age	-0.0172	0.0161	0.2615***	0.0024	-0.0499***	0.0071
agesquare	0.0003*	0.0002	-0.0031***	0.0000	0.0007***	0.0001
nationality	-0.1213***	0.0445	0.1011***	0.0142	-0.1416***	0.0421
language	-0.0372	0.0450	0.2015***	0.0149	-0.0733*	0.0412
primaryearner	0.0008	0.0363	0.3177***	0.0112	-0.0312	0.0331
children	0.0154	0.0179	0.1093***	0.0072	0.0162	0.0165
education1	-0.0316	0.0492	-0.4739***	0.0139	0.0594	0.0419
education2	-0.0528	0.0414	-0.1364***	0.0129	-0.0098	0.0384
dgdp	0.0005	0.0079	0.0224***	0.0016	-0.0034	0.0074
infl	0.0343***	0.0103	0.0108***	0.0006	0.0354***	0.0098
childfemale			-0.2366***	0.0101		
oincome			0.0002***	0.0000		
oincfem			-0.0001***	0.0000		
private	0.1850***	0.0524			0.1296***	0.0497
foreign	-0.4338***	0.0895			-0.4027***	0.0843
dsize1	0.2818***	0.0717			0.2783***	0.0705
dsize2	0.0003	0.0719			0.0358	0.0705
dprof1	-0.8653***	0.0718			-0.9528***	0.0667
dprof2	-0.9351***	0.0743			-0.9862***	0.0706
dprof3	-0.6751***	0.0605			-0.6723***	0.0566
dprof4	-0.4822***	0.0807			-0.4364***	0.0757
dprof5	-0.5056***	0.0598			-0.5378***	0.0565
dprof6	-0.598***	0.0856			-0.9237***	0.0790
dprof7	-0.5279***	0.0561			-0.5333***	0.0541
dprof8	-0.5287***	0.0583			-0.5008***	0.0549
dsector1	0.1215	0.0841			0.1275	0.0805
dsector2	-0.3408	0.2478			-0.2656	0.2153
dsector3	-1.1104***	0.2787			-1.0863***	0.2773
dsector4	-0.3805***	0.0778			-0.3352***	0.0743
dsector5	-0.5251***	0.1317			-0.5076***	0.1280
dsector6	-0.4945***	0.1024			-0.4371***	0.0970
dsector7	-0.1711**	0.0776			-0.0973	0.0718
dsector8	0.0277	0.0986			0.0804	0.0930
dsector9	-0.5001***	0.0939			-0.4747***	0.0889
dsector10	-0.0848	0.1527			-0.0872	0.1488
dsector11	-0.0280	0.0919			0.0292	0.0866
dsector12	-0.4249***	0.1101			-0.4084***	0.1076
dsector13	0.0071	0.0802			0.0670	0.0779
dsector14	-0.1821***	0.0928			-0.1666*	0.0896
dregion1	-0.0723	0.0820	-0.0036	0.0232	-0.039	0.0779
dregion2	0.3416***	0.1175	-0.1258***	0.0425	0.3137***	0.1108
dregion3	0.1792***	0.0611	-0.028	0.0195	0.1783***	0.0588

dregion4	0.3951***	0.0798	-0.2217***	0.0285	0.3961***	0.0746
dregion5	0.0389	0.0808	-0.0884***	0.0277	0.0701	0.0761
dregion6	0.1765*	0.0936	-0.0791**	0.0321	0.1391	0.0863
dregion7	0.0389	0.0705	-0.0758***	0.0231	0.0729	0.0672
dregion8	0.2616***	0.0898	-0.3115***	0.0317	0.2995***	0.0824
dregion9	0.0468	0.0781	-0.099***	0.0261	0.0380	0.0714
dregion10	0.0573	0.0904	-0.1354***	0.0280	0.0761	0.0841
dregion11	-0.0042	0.0926	-0.1388***	0.0286	0.0511	0.0855
dregion12	0.2823***	0.0617	-0.1653***	0.0212	0.2741***	0.0575
dregion13	0.0516	0.0935	-0.1889***	0.0296	0.0656	0.0857
dregion14	0.2855***	0.0741	-0.2639***	0.0263	0.2308***	0.0689
dregion15	0.244***	0.0785	-0.3135***	0.0282	0.2768***	0.0729
_cons	-15.9346***	4.0426	-4.9948***	0.0524	-14.9926***	3.8385

Notes: *** significant at 1% level, ** significant at 5% level, and * significant at 10% level. The explanation of model variables is presented in appendix 5.