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**Article**

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# Minimum wages and employment retention: A microeconomic study for Estonia

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## ABSTRACT

This paper assesses the effect of increases in the Estonian minimum wage in 2013–2016 on the probability of workers at different wage levels retaining employment. The effect is identified by comparing the probability of workers remaining employed after increases in the minimum wage in 2013–2016 with the probability of workers at comparable wage levels remaining employed in the 2009–2011 when the minimum wage was left unchanged. Estimations on data from the Estonian Labour Force Survey show that the increases in the minimum wage in 2013–2016 had no or small and imprecisely estimated effects on employment retention for the directly affected workers and similarly for those indirectly affected. These results are robust to the choice of control variables, to refinements of the treatment group and to changes in the time sample.

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## 1. Introduction

Distributional concerns and poverty alleviation have attracted increased attention since the global financial crisis. Raising the minimum wage may be seen as one way to support low-wage workers, but a key concern is whether it will reduce the job prospects of the workers directly affected and possibly also those of workers who may be indirectly affected through wage spill-overs and shifting employment patterns. The gains from a higher minimum wage may be wiped out if it becomes harder for the workers directly or indirectly affected to retain employment. This suggests that it is important to examine the effects of increases in the minimum wage on employment retention.

Estonia is a country in post-communist Europe with substantial wage inequality. The statutory minimum wage in Estonia is set each year by the government after negotiations with representatives of employers and workers. Changes in the minimum wage take effect from 1 January the following year. The minimum wage was constant in 2008–2011 and raised moderately in 2012, but increased by around 10% each year from 2013 to 2016.<sup>1</sup> The annual increases were considerably above both the inflation rate and the average rate of wage growth, implying a substantial increase in the minimum wage in real

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terms and relative to the average wage. [Figure A1](#) in [Appendix A](#) shows the minimum wage in per cent of the average wage over the period 2000–2016.

The substantial rises in the minimum wage in Estonia in 2013–2016 provide an excellent backdrop for analysing the effects on the likelihood of directly or indirectly affected workers remaining employed. This paper estimates the probability of employment retention for full-time wage-earners across the wage distribution after the substantial rises in the minimum wage in 2013–2016. The analysis considers whether workers retain full-time employment, *not* whether they retain the job which they had when the minimum wage was increased.

The analysis uses a difference-in-differences methodology derived from key microeconomic studies of the effect of minimum wage rises on employment, principally Neumark, Schweitzer, and Wascher (2004), Stewart (2004a, 2004b) and Stewart and Swaffield (2008). Data are from the Estonian Labour Force Survey (ELFS) and we consider individuals in the ELFS who are employed full-time in the fourth quarter and are interviewed again in the fourth quarter of the following year. The individuals are divided into wage groups by their wage income in the first round of interviews. The outcome of increases in the minimum wage is identified by comparing the probability of full-time workers remaining employed after the rises in the minimum wage in 2013–2016 with the probability of workers in the same part of the wage distribution remaining employed in the period 2009–2011 when the minimum wage was constant.

Economic theory provides conflicting predictions for how a statutory minimum wage influences employment, including the employment retention of those directly affected by rises in the minimum wage (Dickens, Machin, & Manning, 1999). The standard competitive labour market model predicts that employment will decline among those directly affected by the minimum wage. The monopsony model in contrast may lead to the opposite conclusion if the minimum wage prevents companies from exploiting their market power. A minimum wage may also increase employment in a competitive model if the minimum wage enhances productivity as posited in the efficiency wage model (Rebitzer & Taylor, 1995). Finally, the statutory minimum wage may not always be enforced in practice, so wages may still be below the minimum wage in some cases, potentially limiting any effect on employment (Basu, Chau, & Kanbur, 2010). How the minimum wage influences employment and employment retention is evidently an empirical question.

The effect of minimum wages on employment is of importance for economic and social policies and so the empirical literature on the topic is extensive. Studies are particularly plentiful for the USA and the UK but there are also studies from other high-income countries, for emerging economies and for developing countries. The literature is summarised in several surveys and meta-analyses.<sup>2</sup> The main conclusion is that the employment effect is negligible or in some cases negative, depending on the labour markets considered and the level of the minimum wage relative to the general wage level. We may discuss some studies of particular relevance for our empirical analysis.

Stewart (2004a) studies the probability of low-paid workers remaining employed after the introduction of the National Minimum Wage (NMW) in the UK in 1999. He compares the retention of employment by workers with wages just below the NMW with the retention probability for those who have wages slightly above. The introduction of the NMW had no effect on the probability of the directly affected workers remaining employed. Stewart (2004b) uses the same methodology to update his previous study by including

the rises in the NMW in 2000 and 2001. The study finds no adverse effect on employment retention from the introduction of the NMW and the subsequent increases in it.<sup>3</sup>

The study for the USA by Neumark et al. (2004) estimates the effects of the minimum wage on employment retention for different points in the wage distribution using data on individuals from the Current Population Survey for the years 1979–1997. The argument for examining the effects across the wage distribution is that changes in the minimum wage may also have consequences for workers that are not directly affected. They identify the effect using variation in the minimum wage over time and over the 50 states. Workers with wages at or just above the previous minimum wage appear to experience declines in employment and hours when the minimum wage is raised, while the effects are negligible for workers higher up the wage distribution.

Meta-analyses on emerging economies from Europe, Asia, Latin America and Africa suggest that the employment effects there are stronger than those that are typically found for advanced economies, perhaps because the minimum wage in many emerging economies is often comparatively high relative to the average wage (Broecke, Forti, & Vandeweyer, 2017; Nataraj, Perez-Arce, Kumar, & Srinivasan, 2014). Moreover, some studies find that higher minimum wages lead to a shift from formal to informal employment.

Estonia shares many economic and institutional features with other European post-communist countries but there are very few studies from this region. A survey conducted within the framework of the ECB Wage Dynamics Network asked firms in a number of CEE countries how they had reacted to increases in the minimum wage in the period 2010–2013 (Bodnár et al., 2018). The most important adjustment channels were increases in productivity, cuts in non-labour costs and price increases, while the least important channel was firing of staff. The relative unimportance of firing of staff was particularly prevalent in Estonia where less than 10% of the interviewed firms stated that this was a relevant adjustment channel.

Country-specific studies include Vodopivec (2015) who uses administrative data from Slovenia and a difference-in-differences methodology to study employment retention after an increase in the minimum wage in 2010. It is found that the increase had a negative effect on employment retention for the workers directly affected by the rise.

Poland is a comparatively large country with large regional differences. This is exploited by Majchrowska, Broniatowska, and Żółkiewski (2016) to identify the overall employment effects of changes in the minimum wage in the period 1999–2012. They find no effect for the labour market as a whole but do find negative effects for young workers in disadvantaged regions. Baranowska-Rataj and Magda (2015) focus on young workers in Poland and apply a difference-in-differences estimation on a matched sample. They discover a substantial negative effect on the employment of the young workers.

The only formal econometric analysis of the employment effects of the minimum wage for Estonia is the study by Hinnosaar and Rõõm (2003) for Estonia. They use micro data from the ELFS for 1995–2000 and a difference-in-differences methodology derived from the working paper version of Neumark et al. (2004). They find substantial negative effects on employment retention for those directly affected but little effect for other groups.<sup>4</sup> It is interesting to revisit this result given that worker reallocation was very intensive in the 1990s but subsided to the levels of western European countries in the 2000s (Meriküll, 2016).

This paper considers the effects on employment retention in Estonia after the substantial minimum wage rises in 2013–2016. Studies of the Estonian labour market suggest that Estonia represents an interesting case study. It is an EU country from Central and Eastern Europe with largely unorganised labour markets and weakly enforced employment protection (Eamets, Masso, & Altosaar, 2005). Collective wage bargaining plays a very limited role, the participation rate is high, and the unemployment rate exhibits substantial variation over time. Malk (2014) finds, however, that a strengthening of employment protection laws at the end of the 2000s had a negative influence on employment.

The rest of the paper is organised as follows. Section 2 presents the methodology and data used in the empirical study, Section 3 provides the main estimation results, Section 4 shows the results of robustness analyses, including a refinement of the treatment group, and finally Section 5 summarises the results.

## 2. Methodology and data

This section discusses the methodology that the empirical analysis uses to identify the effect of increases in the minimum wage in Estonia in 2013–2016 on employment retention.

Rises in the minimum wage may not only impact the employment retention of those directly affected. One channel through which the impact can be felt more widely is spill-over effects, where rises in the minimum wage lead to upwards wage drift further up the wage distribution.<sup>5</sup> Ferraro, Meriküll, and Staehr (forthcoming) find for Estonia that although the minimum wage after tax is typically around the 5th percentile of the wage distribution, there are substantial spill-over effects up to the 20th percentile and some effects up to the 40th percentile.

Another channel goes through substitution and complementarity effects. Substitution effects occur if employers shift away from the workers directly affected and instead employ workers elsewhere in the wage distribution, while complementarity effects occur when directly affected workers being laid off leads to workers at higher wage levels being made redundant. These effects are most likely to touch workers with wages fairly close to the wage of the workers directly affected by the new minimum wage.

The net effect of spill-over, substitution and complementarity effects on employment retention for the workers that are indirectly affected cannot be ascertained *ex ante* (Stewart, 2004a). The possibility of these effects suggests that we should consider the impact on employment retention not only for those directly affected by rises in the minimum wage but also for workers that may be affected indirectly. These may be workers who had wages higher than the new minimum wage but may also, be workers with wages lower than the initial minimum wage. In other words, we should consider how employment retention is impacted across the wage distribution up to the point where it is unlikely there are any effects.

The sample of the ELFS is relatively small and the number of observations is, therefore, limited, especially of those directly affected by increases in the minimum wage. This would suggest that we should use several years of observations in the estimations. Fortunately, the pattern of changes in the minimum wage in Estonia makes this possible. The minimum wage was held constant in the years 2008–2011, while a minor increase in 2012 was followed by rises of approximately 10% each year in 2013–2016. We seek to identify the

effect of the rises in the minimum wage using a standard difference-in-differences methodology comparing employment retention across the wage distribution in 2013–2016, with retention at comparable wage levels when the minimum wage was constant in 2009–2011. The rise of around 10% every year in the minimum wage in the treatment period facilitates the comparison of the wage distributions across the reference period and the treatment period.<sup>6</sup>

The difference-in-differences methodology we use draws on Neumark et al. (2004), Stewart (2004a, 2004b) and Stewart and Swaffield (2008). All working individuals are divided into groups by their wage before the minimum wage was raised and then we test whether the probability of employment retention for individuals in the different wage groups was different in the years 2013–2016 when the minimum wage was increased from what it was in the years 2009–2011 when there were no changes. The null hypothesis is that raising the minimum wage does not lower the probability of individuals in the treatment period remaining employed. Note that the comparison of employment retention can be carried out for workers in groups directly affected and for workers in groups indirectly affected through the spill-over and substitution effects.

The paper uses micro data from the ELFS for 2008–2016, documented in Statistics Estonia (2013).<sup>7</sup> The survey has a panel dimension with four interview rounds over two years. Individuals are interviewed two quarters in a row in the first year and in the same two quarters in the second year. Our sample consists of individuals who were full-time employed and reported positive wage income in the fourth quarter one year and were interviewed again in the fourth quarter of the following year.

The baseline estimations are run for a cross-sectional model with the observations for all individuals pooled across the years 2013–2016, when the minimum wage was raised, and the reference years 2009–2011, when it was constant. The time index  $t$  denotes the second year the individual is interviewed and  $t - 1$  denotes the first interview year. The index  $i$  depicts the individuals included in the sample, which are those in full-time employment with non-missing wage data in year  $t - 1$ .

Data on gross or pre-tax monthly wage income in year  $t - 1$  are available in the ELFS for all the individuals in the sample. We define eight different wage groups, labelled Group1 to Group8, into which individuals are placed depending on their wage income in the fourth quarter of year  $t - 1$ .

For the treatment period 2013–2016, when the minimum wage was increased every year, individuals are placed in Group2 if their wage in the fourth quarter of year  $t - 1$  is above the minimum wage in that year but below the minimum wage in year  $t$ . This implies that individuals in Group2 are those directly affected or treated by the increase in the minimum wage from year  $t - 1$  to year  $t$ . The monthly gross minimum wage for the full-time employed was 290 euros in 2012, 320 euros in 2013, 355 euros in 2014, 390 euros in 2015 and 430 euros in 2016 (EMTA, 2017).

Group1 consists of individuals whose wage income is already lower than the minimum wage in year  $t - 1$ . Given that the criteria for choosing the individuals in the sample are that they work full-time and report positive wage income in year  $t - 1$ , there should in principle not be anybody in Group1. There are, however, a number of individuals who report wages below the minimum wage. This may be caused by erroneous reporting, with people stating lower wage income than they actually received, but the reporting may also reflect imperfect enforcement of the minimum wage regulation (Basu et al.,

2010). In any case, Group1 contains individuals who report wage income just below the minimum wage.

Group3 contains individuals who had wage income in year  $t - 1$  and who received wage income in year  $t$  above the new minimum wage but below 1.4 times the new minimum wage. The wage of the individuals in Group3 implies that they are not directly affected or treated by the increased minimum wage, but their wage is close to the wage of those in Group2. This may make Group3 particularly susceptible to spill-over, substitution and complementarity effects.

Group4 consists of individuals with wage income in year  $t - 1$  and with income in period  $t$  that is more than 1.4 times the new minimum wage but less than 1.8 times the new minimum wage. Group5 to Group8 contain individuals with even higher wage incomes. Table 1 shows the intervals of the eight different wage groups. The thresholds are chosen so that the number of individuals is relatively similar in each of the groups from 3 to 8.

For the reference sample of the years 2009–2011, the groups are constructed so that the relative wage distribution is as similar as possible to the distribution for the treatment sample 2013–2016. The minimum wage increased by 10.4% per year on average in 2013–2016 and there was little difference between the years. We seek to make Group2 for the reference period when the minimum wage was constant comparable to Group2 for the treatment period, and so we let Group2 for the reference period consist of individuals who had wage income in the fourth quarter of year  $t - 1$  above the minimum wage in year  $t - 1$  but below the minimum wage times 1.104. Group2 for the reference period can be seen to contain those who would have been directly affected *if* the minimum wage had been increased by 10.4%.

As before Group1 consists of individuals with wage income below the minimum wage in year  $t - 1$ . Group3 contains individuals with wage income in year  $t$  above 1.104 times the constant minimum wage but lower than 1.4 times the minimum wage. Group4 and above are defined as for the treatment period. Table B1 in Appendix B shows the average wage and the number of observations for each group for each of the years 2009–2011 and 2013–2016.

We use a difference-in-differences approach with a dummy variable for the treatment period to estimate the effect of rises in the minimum wage on the probability of individuals in different wage groups retaining employment. The dummy variable  $Treat_t$  takes the value 1 for the treatment years  $t = 2013$ –2016 and 0 for the reference years  $t = 2009$ –2011. The employment indicator  $L_{it}$  takes the value 1 if individual  $i$  is full-time employed in year  $t$

**Table 1.** Definition of wage groups.

	Reference period, 2009–2011	Treatment period, 2013–2016
Group1	$w_{it-1} < mw_{it-1}$	$w_{it-1} < mw_{it-1}$
Group2	$mw_{it-1} \leq w_{it-1} < 1.104 \times mw_{it-1}$	$mw_{it-1} \leq w_{it-1} < mw_{it}$
Group3	$1.104 \times mw_{it} \leq w_{it-1} < 1.37 \times mw_{it}$	$mw_{it} \leq w_{it-1} < 1.37 \times mw_{it}$
Group4	$1.37 \times mw_{it} \leq w_{it-1} < 1.79 \times mw_{it}$	$1.37 \times mw_{it} \leq w_{it-1} < 1.79 \times mw_{it}$
Group5	$1.79 \times mw_{it} \leq w_{it-1} < 2.15 \times mw_{it}$	$1.79 \times mw_{it} \leq w_{it-1} < 2.15 \times mw_{it}$
Group6	$2.15 \times mw_{it} \leq w_{it-1} < 2.52 \times mw_{it}$	$2.15 \times mw_{it} \leq w_{it-1} < 2.52 \times mw_{it}$
Group7	$2.52 \times mw_{it} \leq w_{it-1} < 3.58 \times mw_{it}$	$2.52 \times mw_{it} \leq w_{it-1} < 3.58 \times mw_{it}$
Group8	$3.58 \times mw_{it} \leq w_{it-1}$	$3.58 \times mw_{it} \leq w_{it-1}$

Note: The term  $w_{it-1}$  is the wage of individual  $i$  in year  $t-1$ ,  $mw_{it-1}$  is the minimum wage in year  $t-1$  and  $mw_{it}$  is the minimum wage in year  $t$  after the rise of the minimum wage.



and 0 if the individual is not full-time employed. The term  $\Pr(L_{it} = 1 | \text{Group } n_{it-1})$  is then the probability of individual  $i$  retaining full-time employment in year  $t$  given that the individual was employed and belonged to wage group  $\text{Group } n_{it-1}$  in year  $t - 1$ . The employment probability is estimated using the follow specification:

$$\begin{aligned} \Pr(L_{it} = 1 | \text{Group } n_{it-1}) \\ = \alpha + \sum_{n \neq 7} \beta_n \text{Group } n_{it-1} + \sum_{n \neq 7} \gamma_n \text{Group } n_{it-1} \times \text{Treat}_t + \tau_t + \delta X_{it-1} + \varepsilon_{it} \end{aligned} \quad (1)$$

The  $\beta$ -coefficients of the group dummies  $\text{Group } n_{it-1}$  capture the overall differences in employment retention across the wage groups, while the  $\gamma$ -coefficients of the interaction terms  $\text{Group } n_{it-1} \times \text{Treat}_t$  capture the additional effects of the treatment period. The term  $\alpha$  is a constant and to avoid perfect multicollinearity,  $\text{Group}7$  is omitted so that the  $\beta_n$  and  $\gamma_n$  coefficients must be interpreted as the additional effect relative to that of  $\text{Group}7$ .  $\text{Group}7$  is chosen as the omitted group because changes in the minimum wage are unlikely to influence employment retention so high in the wage distribution.  $\text{Group}8$  could have been chosen but it contains individuals with very high wages and they may experience idiosyncratic changes in employment retention without relevance to changes in the minimum wage.

The control variables include the year dummies  $\tau_t$  which are meant to absorb business cycle effects that impact the employment probabilities of the eight wage groups in equal proportion. The rest of the control variables are collected in the vector  $X_{it-1}$  and are specific to the individual for year  $t - 1$ . The controls are for the region of residence, gender, ethnicity, age, education level, sector of activity and occupation. The vector of coefficients of the control variables  $X_{it-1}$  is labelled  $\delta$ . Finally,  $\varepsilon_{it}$  is the error term.

The employment indicator  $L_{it}$  takes the values 0 and 1 so the model in Eq. (1) is estimated using Probit and we report the marginal effects evaluated at the means of all explanatory variables. The results are very similar if the model is estimated as a linear probability model using ordinary least squares (not shown).

### 3. Estimation results

This section presents the results of the analyses using the difference-in-differences methodology developed in Section 2. The estimation results are presented separately for the full treatment sample and for subsamples.

#### 3.1. Full sample

Table 2 shows the results when Eq. (1) is estimated with Probit using different sets of control variables. The marginal effects presented are relative to the omitted variable, the  $\text{Group}7$  dummy, and the interaction of the  $\text{Group}7$  dummy and the treatment dummy for the years 2013–2016. Column (2.1) provides the baseline results where the control variables are year dummies together with the region of residence, gender, ethnicity, age, education level, sector of activity and occupation of the worker during the first interview round.

**Table 2.** Group dummies and treatment effects 2013–2016.

	(2.1) Baseline	(2.2) Only year dummies
Group1	−0.056** (0.026)	−0.051** (0.025)
Group2	−0.088*** (0.024)	−0.085*** (0.024)
Group3	−0.041** (0.020)	−0.039** (0.019)
Group4	−0.026 (0.019)	−0.026 (0.019)
Group5	0.013 (0.021)	0.011 (0.021)
Group6	−0.001 (0.020)	−0.004 (0.021)
Group7 (omitted)	0.000	0.000
Group8	−0.009 (0.020)	−0.015 (0.021)
Group1 × Treat	−0.057* (0.032)	−0.061* (0.032)
Group2 × Treat	−0.006 (0.032)	0.002 (0.033)
Group3 × Treat	−0.032 (0.024)	−0.029 (0.025)
Group4 × Treat	−0.012 (0.025)	−0.006 (0.025)
Group5 × Treat	−0.040 (0.027)	−0.032 (0.028)
Group6 × Treat	−0.012 (0.025)	−0.005 (0.028)
Group7 × Treat (omitted)	0.000	0.000
Group8 × Treat	0.048 (0.030)	0.055* (0.030)
Pseudo $R^2$	0.064	0.051
Obs.	5063	5091

Notes: Probit estimations with employment dummy as dependent variable. Cells show the marginal effects evaluated at the means of all explanatory variables. Robust standard errors are shown in brackets below. Superscripts \*\*\*, \*\* and \* denote statistical significance at the 1%, 5% and 10% levels respectively. The control variables in Column (2.1) are year dummies, region of residence, gender, ethnicity, age, education level, sector of activity and occupation are used as control variables; in Column (2.2) only year dummies.

Taking first the results for the group dummies it is notable that the estimated probabilities of employment retention increase quite consistently with the wage income of the groups, especially from Group2 upwards. Individuals with high wages have a substantially higher probability of retaining employment than do those with lower wages, even in the presence of year dummies and control variables for a large number of individual characteristics. Taken literally this would suggest that a higher wage by itself is a factor in employed workers retaining employment. One possible explanation may be that a higher wage makes workers strive harder to avoid dismissal but other factors might also be in play. Similar patterns of employment retention increasing over the wage distribution even with numerous control variables are found for the UK by Neumark et al. (2004), for China by Sun, Wang, and Zhang (2015) and for Estonia by Hinnosaar and Rõõm (2003).

The marginal effects of the group dummies interacted with the treatment dummy show the treatment effect, the effect of the higher minimum wage in 2013–2016 on

employment retention relative to what it is for Group7. The estimated marginal for Group2, which contains those directly affected by the minimum wage increases, is negative but statistically and economically insignificant. The probability of those paid the minimum wage and up to 10.4% more retaining their employment remains virtually unchanged from the reference period with no changes in the minimum wage to the treatment period with increases in the minimum wage.

The estimated treatment effects for Group3 to Group6 are similarly statistically insignificant although they are negative in all cases. This suggests that spill-over and substitution effects do not have a discernible effect on employment retention for the groups comprising individuals with wages above the wage level in Group2. Remarkably, there may be an effect on Group1, which contains the workers who report wage income below the minimum wage *before* the minimum wage is increased. The effect is however only statistically significant at the 10% level and anyway applies to a small group of workers who may not be employed in the formal labour market.

Column (2.2) in Table 2 shows the results when only year dummies are included as control variables while all the individual control variables are left out. The results are very similar to those obtained with the broader set of control variables but the pseudo coefficient of determination declines somewhat. The upshot is that the results in the baseline estimation are robust to a smaller set of control variables.

### **3.2. Changing treatment years**

The effects of raising the minimum wage may differ over time as economic conditions change. This may be particularly important for Estonia where the minimum wage relative to the average wage increased markedly over the years 2013–2016 as shown in Figure A1 in Appendix A. Given the low number of treated or directly affected workers, it is not feasible to estimate the treatment effects for individual years, so instead we split the treatment sample of four years into two subsamples of two years each, 2013–2014 and 2015–2016. Table 3 shows the estimation results with the baseline results repeated for ease of comparison.

It follows from Columns (3.2) and (3.3) that the estimated treatment effects for the directly treated in Group2 and for the indirectly treated in Group3–Group6 are quite similar across the two subsamples. The main notable difference between the two subsamples is in the treatment effects for Group1, for which the effects are negative and economically and statistically significant in 2013–2014 but statistically insignificant in 2015–2016. The importance of this result is difficult to assess given the marginal status of the workers in Group1, but it may suggest that the early rises in the minimum wage led to disruptions in the lowest paid segments of the labour market. These results are in any case estimated on a group with relatively few individuals.

We repeat the baseline estimation in Column (2.2) for men and women separately to ascertain whether minimum wage increases have different effects on the eight groups, but the result is again that no differences can be found (not shown). The same applies when the sample is split along age groups (not shown). The absence of any differences between gender and age groups should however be considered in light of the very low number of observations in some of wage groups, especially Group1 and Group2.

**Table 3.** Group dummies and treatment effects for treatment periods.

	(3.1) Baseline	(3.2) 2013–2014	(3.3) 2015–2016
Group1	−0.056** (0.026)	−0.056** (0.027)	−0.052* (0.027)
Group2	−0.088*** (0.024)	−0.091*** (0.026)	−0.086** (0.026)
Group3	−0.041** (0.020)	−0.041** (0.021)	−0.039* (0.021)
Group4	−0.026 (0.019)	−0.026 (0.020)	−0.025 (0.020)
Group5	0.013 (0.021)	0.016 (0.022)	0.016 (0.023)
Group6	−0.001 (0.020)	0.000 (0.021)	0.001 (0.021)
Group7 (omitted)	0.000	0.000	0.000
Group8	−0.009 (0.020)	−0.009 (0.021)	−0.009 (0.021)
Group1 × Treat	−0.057* (0.032)	−0.091** (0.039)	−0.031 (0.039)
Group2 × Treat	−0.006 (0.032)	−0.029 (0.038)	0.028 (0.045)
Group3 × Treat	−0.032 (0.024)	−0.045 (0.030)	−0.020 (0.030)
Group4 × Treat	−0.012 (0.025)	−0.007 (0.031)	−0.018 (0.031)
Group5 × Treat	−0.040 (0.027)	−0.012 (0.037)	−0.060* (0.033)
Group6 × Treat	−0.012 (0.025)	−0.027 (0.034)	0.003 (0.036)
Group7 × Treat (omitted)	0.000	0.000	0.000
Group8 × Treat	0.048 (0.030)	0.028 (0.036)	0.089** (0.045)
Pseudo $R^2$	0.064	0.073	0.069
Obs.	5063	3566	3492

Notes: Probit estimations with the employment dummy as the dependent variable. Cells show the marginal effects evaluated at the means of all explanatory variables. Robust standard errors are shown in brackets below. Superscripts \*\*\*, \*\* and \* denote statistical significance at the 1%, 5% and 10% levels respectively. The control variables are year dummies, region of residence, gender, ethnicity, age, education level, sector of activity and occupation.

## 4. Robustness checks

This section examines whether the results obtained in Section 3 are robust to changes in the way the treatment effects are identified.

### 4.1. Changing reference years

The reference years when the minimum wage was left unchanged are the years when the global financial crisis affected the Estonian economy and the Estonian labour market very severely. The year 2009 saw a deep decline in output, lower employment and rapidly rising unemployment, while this picture was reversed in 2011. This pronounced cyclical pattern raises the question of whether the years 2009–2011 are an appropriate choice of reference period. If the macroeconomic developments impacted the probabilities of employment retention equally for the different wage groups, then the year dummies will pick the effect up and the cyclical pattern in 2009–2011 should be inconsequential. If, however,

the developments impacted on employment retention differently for different wage groups, then the treatment effects may be estimated incorrectly.

To examine whether these concerns are warranted, we repeat the baseline estimation of Equation (1) but remove the years of the reference period sequentially one at a time. Table 4 presents the results. Column (4.2) shows the results when the crisis year 2009 is removed from the sample, Column (4.3) when 2010 is removed and Column (4.4) when the rebound year 2011 is removed.

The results are very similar to the results of the baseline estimation and this applies also for the treatment effects of Group2, the group directly affected by the rises in the minimum wage in 2013–2016. The only partial exception is the estimated employment probability and treatment effect for Group1 if 2011 is left out of the reference period. It should be noted however Group1 contains very few individuals and removing a year from the reference period may thus be of particular importance for the results for this group. The overall conclusion is nevertheless that the employment retention probabilities do not seem to be impacted in any discernible way by the particularly volatile macroeconomic environment in the reference period.

**Table 4.** Group dummies and treatment effects 2013–2016.

	(4.1) Baseline	(4.2) Without 2009	(4.3) Without 2010	(4.4) Without 2011
Group1	−0.056** (0.026)	−0.078** (0.031)	−0.062** (0.031)	−0.038 (0.030)
Group2	−0.088*** (0.024)	−0.095*** (0.031)	−0.092*** (0.029)	−0.081*** (0.028)
Group3	−0.041** (0.020)	−0.052** (0.026)	−0.043* (0.023)	−0.035 (0.022)
Group4	−0.026 (0.019)	−0.037 (0.026)	−0.033 (0.021)	−0.012 (0.022)
Group5	0.013 (0.021)	−0.004 (0.030)	0.012 (0.024)	0.021 (0.024)
Group6	−0.001 (0.020)	0.040 (0.026)	0.012 (0.024)	0.015 (0.023)
Group7 (omitted)	0.000	0.000	0.000	0.000
Group8	−0.009 (0.020)	−0.021 (0.029)	−0.013 (0.022)	0.001 (0.023)
Group1 × Treat	−0.057* (0.032)	−0.026 (0.036)	−0.049 (0.035)	−0.076** (0.036)
Group2 × Treat	−0.006 (0.032)	0.010 (0.036)	−0.002 (0.035)	−0.015 (0.035)
Group3 × Treat	−0.032 (0.024)	−0.015 (0.029)	−0.030 (0.026)	−0.040 (0.027)
Group4 × Treat	−0.012 (0.025)	0.003 (0.029)	−0.006 (0.026)	−0.026 (0.027)
Group5 × Treat	−0.040 (0.027)	−0.020 (0.034)	−0.039 (0.029)	−0.048 (0.030)
Group6 × Treat	−0.012 (0.025)	0.028 (0.031)	−0.026 (0.030)	−0.029 (0.030)
Group7 × Treat (omitted)	0.000	0.000	0.000	0.000
Group8 × Treat	0.048 (0.030)	0.057 (0.035)	0.050 (0.030)	0.038 (0.032)
Pseudo $R^2$	0.064	0.056	0.071	0.067
Obs.	5063	4272	4475	4447

Notes: Probit estimations with the employment dummy as the dependent variable. Cells show the marginal effects evaluated at the means of all explanatory variables. Robust standard errors are shown in brackets below. Superscripts \*\*\*, \*\*, and \* denote statistical significance at the 1%, 5% and 10% levels respectively. The control variables are in year dummies, region of residence, gender, ethnicity, age, education level, sector of activity and occupation.

## 4.2. Refinement of treatment group

The nominal wage growth in the ELFS sample used in this paper was on average 7.0% in 2013, 5.9% in 2014, 6.0% in 2015 and 7.6% in 2016. If the wage increases were evenly distributed across the wage distribution, some low-wage workers may have received substantial wage increases without these being related to or caused by the minimum wage rises. Workers in Group2 may thus have received wage increases due to the overall wage drift in the labour market and not because of the higher minimum wage. This subsection seeks to assess whether this could be behind the muted effect on employment retention for Group2. The idea is to refine the treatment group so that it is more likely to contain workers that have effectively been treated by higher minimum wages.

We split Group2 into two groups, Group2A and Group2B. Group2A consists of the individuals in Group2 with the lowest wages of the group while Group2B is composed of those with highest wages. Group2B is then those who would have ended up with a wage exceeding the new minimum wage *if* they had received the average wage increase of that year. Group2A then consists of those who would *not* have reached the new minimum wage even if they had received the average wage increase of that year. Group2A is thus more likely to have been directly affected or ‘treated’ by the higher minimum wage than Group2B is.

For each of the years of the treatment sample, the cut-offs between Group2A and Group2B are computed using the average wage growth of the year. For 2013, Group2B contains individuals who would reach or surpass the minimum wage for 2014 if they received 7.0% higher wage income, while Group2A consists of the remaining individuals from Group2. The wage growth used to compute the cut-off is 5.9% in 2014, 6.0% in 2015 and 7.6% in 2016. For the reference period, the cut-offs are 1.1% in 2009 and 5.9% in 2010.

The drawback of this refinement is that the number of observations is very small in Group2A and especially in Group2B. Over the four years of the treatment sample there are 73 observations in Group2A and 58 in Group2B. Of even greater concern is that over the three years in the reference sample there are 95 observations in Group2A but only 5 in Group2B. The lack of observations for Group2B in the reference period means that the results for this group are inconsequential and should not be given any attention.

Table 5 shows the results when the baseline estimation is modified so that Group2 and its interaction with the treatment dummy are replaced by Group2A and Group2B and their interactions with the treatment dummy. The set of control variables differs across the columns but corresponds to those in Table 2. The main issue is whether the results for the low-paid workers in Group2A, the workers most likely to have been directly affected by the minimum wage increases in 2013–2016, are different from those for Group5 reported in Table 2.

The estimated treatment effects for Group2A reported in Table 5 are in all cases negative and in numerical terms larger than the effects for Group2 reported in Table 2. This suggests that refining Group2 so that it consists of the workers most likely to have been affected by the rises in the minimum wage did change the estimation results somewhat. However, the treatment effects for Group2A are still very small and statistically insignificant, suggesting that the results reported for Group2 in Table 2 are not substantially influenced by any imprecision in the definition of the group of workers directly affected by rises in the minimum wage.

**Table 5.** Group dummies and treatment effects 2013–2016.

	(5.1) Main controls	(5.2) Only year dummies
Group1	−0.056** (0.026)	−0.051** (0.025)
Group2A	−0.081** (0.025)	−0.079** (0.025)
Group2B	−0.198** (0.074)	−0.185** (0.076)
Group3	−0.041** (0.020)	−0.039** (0.019)
Group4	−0.026 (0.019)	−0.026 (0.019)
Group5	0.013 (0.021)	0.011 (0.021)
Group6	−0.001 (0.020)	−0.004 (0.021)
Group7 (omitted)	0.000	0.000
Group8	−0.009 (0.020)	−0.014 (0.021)
Group1 × Treat	−0.057* (0.032)	−0.060* (0.032)
Group2A × Treat	−0.020 (0.036)	−0.009 (0.036)
Group2B × Treat	0.114 (0.079)	0.108 (0.082)
Group3 × Treat	−0.032 (0.024)	−0.029 (0.025)
Group4 × Treat	−0.012 (0.025)	−0.006 (0.025)
Group5 × Treat	−0.040 (0.028)	−0.032 (0.028)
Group6 × Treat	−0.013 (0.028)	−0.005 (0.028)
Group7 × Treat (omitted)	0.000	0.000
Group8 × Treat	0.047 (0.030)	0.055* (0.030)
Pseudo $R^2$	0.065	0.052
Obs.	5063	5091

Notes: Probit estimations with the employment dummy as the dependent variable. Cells show the marginal effects evaluated at the means of all explanatory variables. Robust standard errors are shown in brackets below. Superscripts \*\*\*, \*\*, and \* denote statistical significance at the 1%, 5% and 10% levels respectively. The control variables in Column (5.1) are year dummies, region of residence, gender, ethnicity, age, education level, sector of activity and occupation; in Column (5.2) only year dummies.

## 5. Final comments

This paper assesses whether the rises in the Estonian minimum wage in 2013–2016 changed the probability of workers across the wage distribution retaining full-time employment, either in the job they had when the minimum wage was increased or in another job. The effect is identified using a difference-in-differences methodology in which the probability of a worker retaining employment during the treatment period 2013–2016 is compared with the probability in the reference period 2009–2011 when the minimum wage was constant.

The estimations show that the probability of retaining employment for different wage groups during the period of rises in the minimum wage was not different from the probability of retaining employment for comparable wage groups during the years 2009–2011

when there were no increases in the minimum wage. This suggests that the increases in 2013–2016 had no, or only indiscernible, effects on employment retention in the period. The result is very robust and holds irrespective of the set of control variables used in the estimations, and also holds if the early stage and the later stage of the rises in the minimum wage are considered separately, if the reference period is altered, or if the group of the directly treated is refined.

The results are not in line with the negative effect for those directly affected found in Hinnosaar and Rõõm (2003), who use Estonian data for the period 1995–2000. Hinnosaar and Rõõm (2003), however, identify the effect from year-on-year changes in the minimum wage, while we use a traditional difference-in-differences methodology. Moreover, there were very large rises in the minimum wage and intensive worker reallocation during the period 1995–2000, while our sample comprises a period of moderate increases and less intensive reallocation of workers (Meriküll, 2016).

The results are, however, in accordance with the finding in Bodnár et al. (2018) where only a few firms in Estonia report that they find firing of staff a relevant adjustment channel after hikes in the minimum wage. The results are also in line with a number of studies from other countries, which find little or no effect of minimum wages on employment or employment retention, at least as long as the minimum wage remains at moderate levels (see the reviews by Belman & Wolfson, 2014, ch. 4; Doucouliagos & Stanley, 2009; de Linde Leonard, Stanley, & Doucouliagos, 2014). Schmitt (2015) posits that the effect on employment is likely to be small because employers have many adjustment channels available to them when faced with a higher minimum wage.

The absence of any effects from minimum wage hikes on employment retention as found by this study does not necessarily mean that a higher minimum wage has no overall employment effects. The minimum wage could for instance make it harder for the unemployed to enter the labour market, or the labour market could be subject to substitution and complementarity effects that are not captured in this study. These considerations suggest that it would be useful to consider the broader effects of rises in the minimum wage using other empirical models. Such exercises are left for future research.

## Notes

1. The monthly gross minimum wage for the full-time employed was 278.02 euros in 2008–2011, 290 euros in 2012, 320 euros in 2013, 355 euros in 2014, 390 euros in 2015 and 430 euros in 2016 (EMTA 2017).
2. For reviews of the empirical literature on developed economies, see Card and Krueger (1995a, 1995b), Doucouliagos and Stanley (2009), Belman and Wolfson (2014, ch. 4) and OECD (2015).
3. Stewart and Swaffield (2002) distinguish between the extensive and intensive margins as impact on employment or impact on hours per worker. The authors find no reduction in employment but do find a reduction in hours worked.
4. These results are in line with the findings in Neumark et al. (2004). The impact on the directly affected is so large that it affects overall employment, as an increase of 10% in the minimum wage reduced overall employment retention by around 0.5%.
5. Empirical studies of such spill-overs go back to the 1970s (Gramlich, 1976). Subsequent studies have found sizeable spill-over effects for some countries, including the USA and several emerging markets, but limited spill-overs for other countries such as the UK (Ferraro et al. Forthcoming).
6. We do not use the data for 2012 in the analysis in order to ensure that the treatment group is as homogenous as possible over the years.



7. The summary statistics and estimations are produced using the sample data of the ELFS and as such pertain to the data of the ELFS databases. We have also produced summary statistics and estimations using sampling weights (the results are available from the corresponding author upon request). The results are, however, qualitatively similar to those of the unweighted data with only insignificant differences at the upper and lower wage levels and so we choose to present the results using the results from the unweighted data set; see also Solon, Haider, and Wooldridge (2015).

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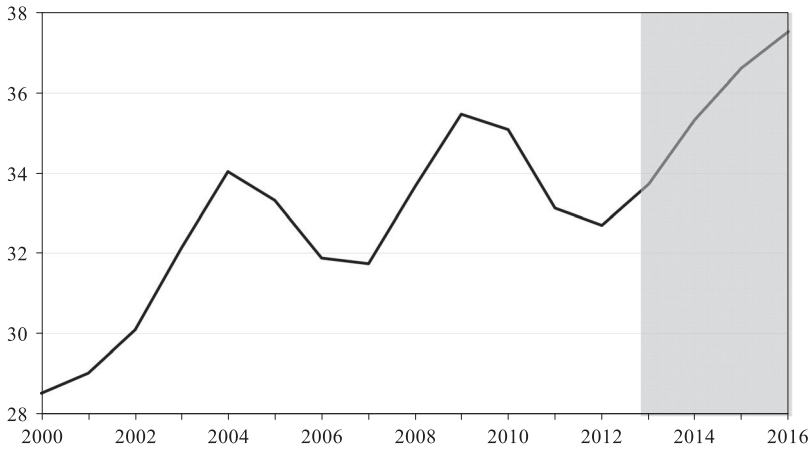
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## Appendices

### Appendix A



**Figure A1.** Gross minimum wage in per cent of the gross average wage, 2000–2016. *Source:* EMTA (2017), Statistics Estonia (2017, codes: *WS5211*, *WS5311*), authors’ calculations.

### Appendix B

**Table B1.** Mean gross wage and the number of observations in the eight wage groups.

		2009	2010	2011	2013	2014	2015	2016
Group1	Mean wage	242	219	203	187	171	307	342
	Obs.	31	41	33	39	23	37	39
Group2	Mean wage	288	287	286	304	333	363	402
	Obs.	32	38	29	27	50	32	22
Group3	Mean wage	366	359	358	366	428	467	520
	Obs.	105	114	88	102	125	138	131
Group4	Mean wage	489	486	483	493	569	611	690
	Obs.	153	102	137	106	146	120	95
Group5	Mean wage	610	613	606	617	699	742	834
	Obs.	124	72	82	96	103	128	98
Group6	Mean wage	744	735	735	743	828	915	979
	Obs.	121	89	93	100	91	122	71
Group7	Mean wage	924	939	931	955	1075	1174	1246
	Obs.	111	72	84	155	170	160	137
Group8	Mean wage	1563	1589	1539	1710	1954	1927	2225
	Obs.	120	63	73	134	110	103	74
All	Mean wage	653	653	643	672	757	813	905
	Obs.	797	591	619	759	818	840	667

Note: The mean wage is the mean of the nominal pre-tax wage in euros of the group.