Gender Dimension of Minimum Wage Non-Compliance

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1 Introduction

Minimum wage regulations have a potential to decrease the inequality and reduce earnings gaps among the low-wage employees. If such effects of minimum wage increases were to materialise, a decrease in gender wage gaps at the bottom of the distribution could be expected. Blau and Kahn (2003) identified minimum wages as one of the institutional factors that are associated with a lower gender pay gap. Ganguli and Terrell (2005) analysed the gender pay gap along the wage distribution over the period 1986 to 2003 in Ukraine, and found that setting the minimum wage at a relatively high level contributed to reduction in the gender pay gap at the bottom of the distribution.

However, those effects depend strongly on the enforcement of minimum wage laws. The recent literature that focuses on the relation between minimum wages and the gender wage gap points out the importance of the compliance. As minimum wage policies usually lead to a decrease in wage inequality, and women are disproportionately concentrated in low paid work, they should benefit more from those policies. However, the existing studies suggest that such effect may be largely limited by non-compliance, in particular when firms that employ relatively more women more often violate minimum wage laws, or if non-compliance within firms more often affects female workers.

Bargain et al. (2016) exploit the introduction of minimum wage policies in Ireland and the United Kingdom, and they find a reduction in the gender wage gap at the bottom of the distribution in Ireland. However, the authors do not find a reduced gender gap at the bottom of the distribution in the United Kingdom, and they suggest that this is due to non-compliance with the minimum wage legislation. Menon and Rodgers (2016) examine the effects of minimum wage policies on employment and wages among men and women in India. They find that minimum wages have a small impact on earnings in urban areas, but a positive impact on earnings in rural areas (and no employment effect). However, because this effect is observed predominantly for men, the residual gender wage gap increases. This can be explained by weaker compliance among firms that employ female workers. Hallward-Driemeier et al. (2015) document that minimum wage increases in Indonesia reduce the gender pay gap among production workers, but this effect is heterogeneous between persons with different levels of education. They find that women who are less educated are not benefiting, or are even loosing from these policies in their position relative to men. The above-mentioned literature suggests that increases in minimum wages might not lead to a reduction in gender pay gap at the bottom of the wage distribution, because of higher non-compliance towards female workers.

The topic of the minimum wage regulations continues to be discussed by academics and policy-makers in both developed and developing countries. Moreover, the Great Recession triggered a renewed interest

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in minimum wage policies around the world (OECD, 2015). However, most of the policy discussions and academic research on minimum wages concentrate on employment effects (Neumark and Wascher, 2007), and, to a lesser extent, on its effects on inequality (Autor et al., 2010) and poverty in a developed (MaCurdy, 2015) or a developing (Saget, 2001) country context. While there is no consensus regarding the employment effects of minimum wage increases, the literature points out its negative (albeit moderate) effect on inequality and poverty (OECD, 2015). The issue of compliance, which is a crucial dimension of minimum wage policies' effectiveness, is studied to a much lower extent, particularly in the cross-country context. Existing studies that provide a multi-country analysis of minimum wage compliance focus mainly on developing countries (see Rani et al., 2013; Bhorat, 2014; Bhorat et al., 2015a; Ye et al., 2015). Recent literature rarely addresses the gender dimension of minimum wage non-compliance, in particular in a cross-country context.

In this paper we address this gap and we aim to analyse the minimum wage non-compliance separately for male and female workers in a group of European countries which have national minimum wages. We inquire to what extent the minimum wage non-compliance affects male and female employees, and how non-compliance affects the gender pay gap in particular countries. We also propose a novel approach to studying the gender dimension of minimum wage non-compliance, as we employ decomposition methods to estimate the unexplained gender gap in non-compliance measures.

We also distinguish between Central and Eastern European (CEE) transition countries, which have experienced strong increases in minimum wage levels in XXI century, and Western and Southern European countries which in general have had higher minimum wages (in both absolute, and relative - Kaitz index - terms) but have raised them less recently. Previous research on minimum wage regulations in the CEE is relatively scarce, and it's focused on employment effects (Hinnosaar and Room, 2003; Eriksson and Pytlikova, 2004; Baranowska-Rataj and Magda, 2015). To our knowledge, the only study of minimum wage violation in CEE countries is Goraus and Lewandowski (2016). While we employ the same measures of minimum wage non-compliance, unlike Goraus and Lewandowski (2016) we focus on the gender dimension of minimum wage violation. The research on minimum wages in Western and Southern European is broad, however the evidence on the incidence and patterns of compliance is scarce. To our knowledge, only Garnero et al. (2015) provide some results on non-compliance (and non-coverage) in the EU countries.

Our methodological approach relies on applying measures introduced by Bhorat et al. (2013) to the European Union Survey of Income and Living Conditions (EU-SILC) data. We study both the incidence of minimum wage violations, as well as the extent of underpayment among those that receive sub-minimum wages in the period 2003-2012.[1] We calculate violation measures for all countries. We use logit models to identify demographic and job-related characteristics of persons that have a higher probability of receiving sub-minimum wages. In particular, we compare to what extent being a women increases the probability of receiving sub-minimum wage, and how the marginal effects estimated with probit models differ between the groups of countries. Finally, we employ decomposition methods to analyse the evolution of adjusted gender gaps in non-compliance measures over time. We also inquire whether higher gender gaps in wages correlate with higher gender differences in probabilities to receive sub-minimum wages.

We find that the measures of monthly minimum wage violation are highest in Lithuania, France, and Portugal, where around 7% of the analysed workers were receiving sub-minimum wages. These measures were also much larger for women in these three countries. In general, we find that women receive sub-minimum wages more often than men in all countries studied, even if we control for other personal characteristics. Moreover, we find that the adjusted gender gaps in minimum wage non-compliance were on average stable over time in both country groups, but there is important heterogeneity between countries. Our findings underline the importance of accounting for the gender dimension of minimum wage policy - not only women are more likely to suffer from jobs losses induced by minimum wage hikes

[1] In this paper we use "violation" and "non-compliance" as synonyms for a situation in which a worker who should be covered by minimum wage regulations is paid less than the legal minimum.

(as shown by previous literature), but they are also more likely to be underpaid.

The paper is structured as follows. In Section 2 we present the minimum wage regulations in the EU and discuss the evolution of minimum wage in analysed countries. In Section 3 we describe the methodological approach, and we discuss the data used for minimum wage violation measurement. In Section 4 we show our estimates of the violation measures for women and men in the analysed EU countries for period 2003-2012, and we employ decomposition methods to analyse the evolution of adjusted gender gaps in non-compliance measures over time. The last section concludes.

2 Minimum wages in Central and Eastern Europe

Among currently 28 EU member states, 22 had a regulatory system with national minimum wage that should cover all dependent workers. Half of them are countries from Central and Eastern Europe that had joined the EU in 2004 or later, namely Bulgaria, the Czech Republic, Croatia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia. These are transition countries on which this paper focuses. The remaining EU countries that also have minimum wages established at national level are Belgium, France, Germany, Greece, Ireland, Luxembourg, Malta, the Netherlands, Portugal, Spain, and the United Kingdom. Countries from this group will be included in the set of benchmark countries. The other six EU countries had minimum wages established at the sector (Austria, Denmark, Finland, Italy) or occupation (Cyprus) level, usually as the result of collective bargaining. These kinds of practices were not followed by any of the CEE10 countries. The minimum wage arrangements in the transition and benchmark countries are summarised in Table 1.[2]

As presented in Table 1, the selected transition countries and benchmark countries have minimum wage systems that cover all dependent workers with the same, widely known minimum wage established at the country-level.[4] In all of the analysed countries, the minimum wage is defined on a monthly basis, however in several countries, an hourly rate is also explicitly specified. Some of the transition and benchmark countries (e.g. Poland, Slovakia, the Czech Republic until 2012, and all analysed benchmark countries) defined lower minimum wages for young workers or labour market entrants, and we try to exclude such workers from our data (see Section 3). Moreover, some of the analysed countries have higher minimum wages that should apply for workers with higher skills (e.g. in the Czech Republic, Hungary, and Slovakia). In some NMS, higher minimum wages defined at national level were introduced for particular subgroups, like professionals (e.g. in the Czech Republic, Hungary, and Slovakia). However, those particular groups cannot be identified with available data. Thus, this paper concentrates on basic national minimum wage for both data availability purposes, and the intention to focus the analysis on low wage earners.[5]

[2]For the subsequent analysis of minimum wage non-compliance based on EU-SILC data, we exclude Croatia from the group of the analysed NMS, and Ireland, Luxembourg, and Malta from the group of benchmark countries. We also exclude Germany from the group of benchmark countries as national minimum wage was established there only in 2015 (see Section 3 for in-depth discussion of data). Thus, for these countries, we are also not discussing the details of minimum wage arrangements.

[4]The self-employed are not covered by minimum wage arrangements in any of the selected countries and thus they are not included in the analysis. However, there might be (temporary) employees that work on the basis of contract that is not covered with minimum wage laws or is covered by different rules. This is the case, for example, in Poland where employees may work on the basis of civil law contracts for which minimum wage laws are not binding. In Spain, there are daily minimum wage rates for some atypical contracts, and similar solution (but with hourly rates) is to be implemented in Poland. We cannot identify such workers in our data (all contracts different from permanent contracts are clustered together in the EU-SILC, and similar problem applies also to other survey data, for example the EU-LFS). However, the usage of this type of contracts is usually prohibited if a worker is dependent on a company. In our analysis we try to identify only dependent workers by limiting the sample only to employees working full-time for one employer (see Section 3 for more details on the data used). Thus, contracting a dependent worker using alternative type of contract that is not covered by minimum wage regulations and providing sub-minimum wage can be treated as an indirect non-compliance with minimum wage laws.

[5]It is an interesting question whether (and if so, then in what way) the existence of additional minimum wage levels for better educated or skilled employees affects the wages or non-compliance with minimum wage laws, but addressing it lies beyond the scope of this work, and may be an avenue for further research.

Table 1: Minimum wage arrangements in transition and benchmark countries (2012).

Country	National MW	Sub-MW level	Groups covered by sub-minimum	Higher MW level	Groups covered by higher minimum
Bulgaria	Yes	No	-	No	-
Czech Republic	Yes	Yes	Youth (until 2012)	Yes	6 higher MW levels for better skilled
Estonia	Yes	No	-	No	-
Hungary	Yes	No	-	Yes	Skilled workers
Latvia	Yes	No	-	Yes	Youth and high-risk occupations
Lithuania	Yes	No	-	No	-
Poland	Yes	Yes	Experience below one year	No	-
Romania	Yes	No	-	No	-
Slovakia	Yes	Yes	Youth	Yes	5 higher MW levels for better skilled
Slovenia	Yes	No	-	No	-
Belgium	Yes	Yes	Youth	No	-
France	Yes	Yes	Youth	No	-
Greece	Yes	Yes	Youth	Yes	More experienced workers
Netherlands	Yes	Yes	Youth	No	-
Portugal	Yes	Yes	Youth or Experience below one year	No	-
Spain	Yes	Yes	Youth or Experience below two years	No	-
United Kingdom	Yes	Yes	Youth	No	-

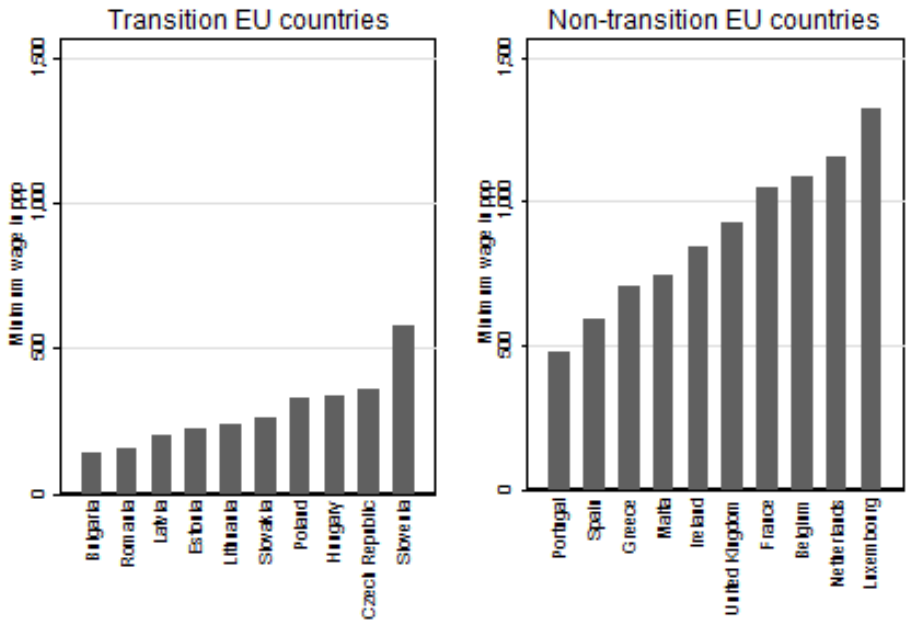
Note: Better skilled jobs / worker groups in Czech Republic, Hungary, and Slovakia cannot be identified using the information available in micro-level datasets, like educational level (ISCED) or occupation (ISCO). In each case, the assignment of a particular position to a job group with a higher minimum wage depends on the hard-to-measure characteristics of the tasks performed, such as the complexity of the cognitive processes involved or the demand for creative or abstract thinking. These rules are suggestive rather than legally binding, or they constitute a reference point for collective bargaining. Moreover, in each of these countries, there are special remuneration schemes for particular groups like teachers or scientists that we do not consider here as alternative minimum wage schemes.
In Latvia, people who work in risky or dangerous conditions are covered by the same monthly minimum wage as regular workers, but their legal weekly working hour limit is 35 hours instead of 40 hours. However, in accordance with the Labour Protection Law, the employer determines whether a particular occupation has risky or dangerous working conditions by carrying out an assessment of the working environment. In practice, it is impossible to identify the workers who are covered by the higher hourly minimum wage. In Greece, there is a monthly minimum wage for general workers, and an hourly minimum wage for technicians and craftsmen[3], and there are higher minimum wages for more experienced workers (5% increase for technicians and craftsmen and 10% for general workers for every three years of experience up to the increase of 30%). However, it would be very difficult to appropriately assign higher minimum wage to experienced workers.
Source: Goraus and Lewandowski (2016), OECD (2015), wageindicator.org and country-specific sources.

Available micro data allow to analyse the issue of minimum wage non-compliance for period 2003-2012. Before the 2004 EU enlargement, transition countries had much lower minimum wages expressed in EUR than benchmark countries (see Figure B.1 in the appendix). Slovenia was an outlier among the transition countries, with a minimum wage higher than in Portugal and at the similar level as in Spain. In 2012, differences in minimum wages expressed in EUR were already much smaller (see Figure B.2 in the appendix).

Differences in minimum wage levels are smaller if we take into account the differences in prices. Still, in 2003 all transition countries except Slovenia had much lower minimum wages than any of the benchmark countries, and Slovenia was surpassing only Portugal (see Figure 1). By 2012, the difference in minimum wages in PPP between transition and benchmark countries becomes much smaller, Slovenia

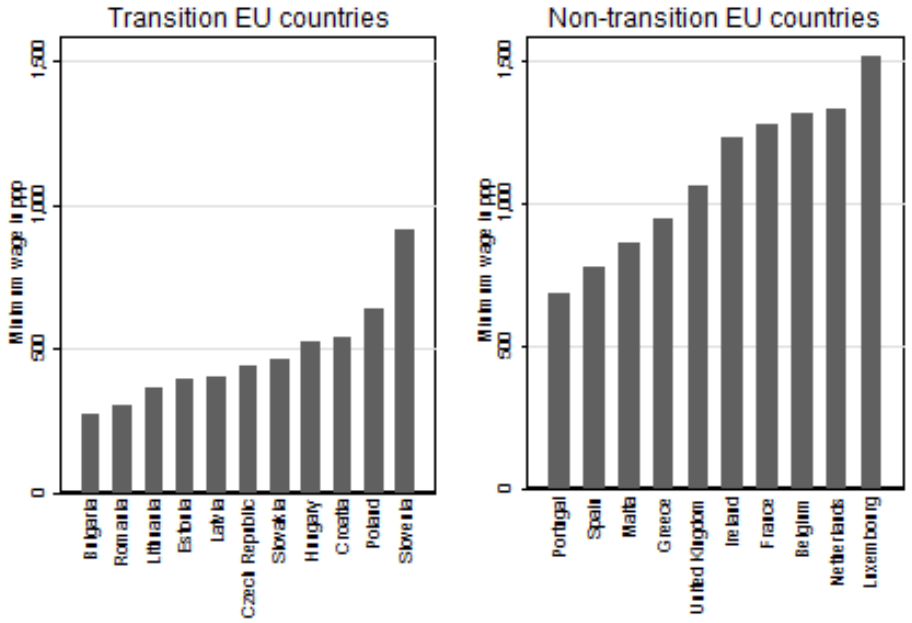
has a minimum wage higher than Portugal, Spain, and Malta, and Poland has its minimum wage at the level similar to Portugal (see Figure 2).

Figure 1: Minimum wages in PPP in 2003.



Data source: Eurostat.

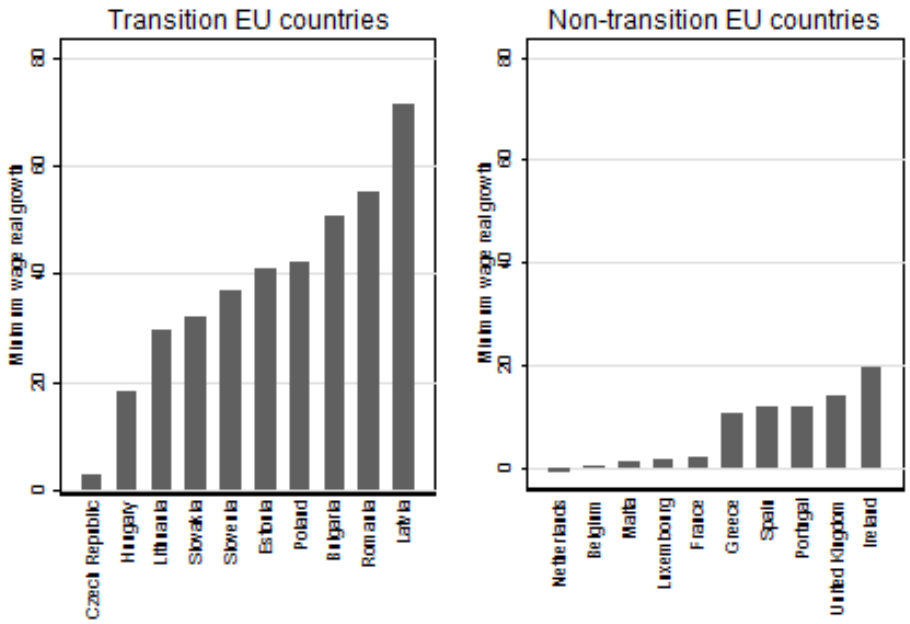
Figure 2: Minimum wages in PPP in 2012.



Data source: Eurostat.

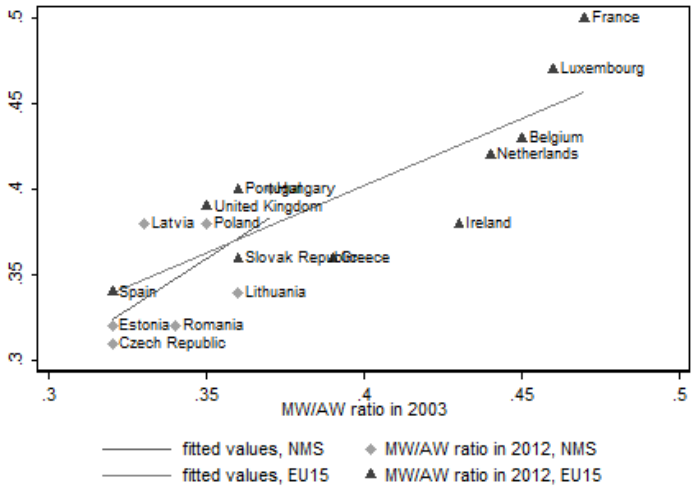
Increases in minimum wages were much higher among the analysed transition countries, as compared to benchmark countries. As depicted by Figure 3 almost all transition countries experienced over the

Figure 3: Minimum wages real growth (2003-2012).



Data source: Eurostat.

Figure 4: Minimum wage to average wage ratios in 2012 and 2003.



Data source: OECD Statistics.

period 2003-2012 higher real growth in minimum wages than Ireland, that had the highest growth in minimum wage among benchmark countries. In half of transition countries, real minimum wages in 2012 were equal to more than 140% of their level in 2003. The country with exceptionally low, close to zero, minimum wage growth among transition countries is the Czech Republic, while Bulgaria, Romania, and Latvia experienced the highest growth in minimum wage levels. Higher minimum wages in transition countries could simply reflect higher overall wage levels in 2012 as compared to 2003. However, the OECD data on ratios of minimum wages to average wages (Kaitz index) in 2003 and 2012 indicate that the Kaitz indices increased relatively more in transition countries than in benchmark countries, see Figure 4.[6] In

[6]We use data from OECD Statistics, that does not cover all analysed transition countries, for Figure 4, because the data from Eurostat on the Kaitz index apply to industry and services in 2003 and to industry, construction, and services in 2012,

2003, transition countries had much lower Kaitz indices, but this difference decreased significantly by 2012. Between 2003 and 2012, the Kaitz index rose sharply in Poland, Hungary, Lithuania, and Latvia; but remained relatively stable in Slovakia, Romania, Estonia, and the Czech Republic.

As broadly discussed in this section, minimum wages were strongly increasing in almost all analysed transition countries. The effect of those increases on the financial situation of male and female workers depends on the level of compliance with minimum wage laws. In the next section we discuss methods used to measure non-compliance, while in Section 4 we discuss how the non-compliance indices evolved for male and female workers over this period of minimum wage increases.

3 Methodology and data

In this paper, we use measures developed by Bhorat et al. (2013) to assess the extent of minimum wage violation. This approach allows to account for both the incidence of non-compliance and the depth of underpayment. The first measure, the incidence of non-compliance, was traditionally used for minimum wage violation analyses. However, looking just at the share of workers receiving sub-minimum wages among all workers covered with minimum wage laws does not allow to distinguish between the cases in which workers earned slightly below the minimum wage from those when workers earning sub-minimum wages were significantly underpaid. Moreover, when only headcount measure is used, the assessment of the effects of minimum wage hikes may not only be incomplete, but also misleading. An increase in minimum wage may lead to a higher share of workers receiving wages (slightly) lower than minimum wages, but it may also cause a "spillover" effect, and an increase of wages among those who previously were more significantly underpaid (Bhorat et al., 2015b). The question of which of the two effects dominates is empirical in nature.

The Index of Violation (Bhorat et al., 2013) builds upon the standard Foster-Greer-Thorbecke poverty measurement method, and further utilizes it for minimum wage analysis. The measure v_α of an individual violation is defined as

$$v_\alpha = v_\alpha(w_{min}, w) = \left(\frac{w_{min} - w}{w_{min}}\right)^\alpha$$

where w is worker's wage, w_{min} is stands for minimum wage, $\alpha > 0$, and v_α is positive when $w < w_{min}$, and zero otherwise. When $\alpha = 1$, v_1 is the gap between the wage received and the w_{min}, expressed as a percentage of w_{min}, and for greater values of $\alpha > 1$ the violation function places a greater weight on cases in when underpayment is greater. In order to obtain the standard headcount measure, we define v_0 as an indicator function that takes a value of one when $w < w_{min}$, and of zero when $w \geq w_{min}$. Then we aggregate these individual violation measure for selected population of workers by taking the expectation of v over the entire wage distribution in analysed population. The overall violation V_α^G is then defined as

$$V_\alpha^G = E\left[\left(\frac{w_{min} - w}{w_{min}}\right)^\alpha\right]$$

where G stands for group of covered workers for which we calculate the extent of minimum wage violation. In this paper we will calculated violation measures for all workers, V_α^T, for male workers only, V_α^M, and for female workers only V_α^F. For the headcount violation measure v_0, the overall measure is a share of underpaid workers, $V_0^G = E[v_0]$. In this paper we focus on three measures: namely, *incidence of violation*, which refers to V_0^G; *depth of violation*, which refers to V_1^G and measures depth of violation *per worker* in the selected group; and *average shortfall*, which is defined as $\frac{V_1^G}{V_0^G}$ and measures the depth of the violation *per underpaid worker*. For all of these measures we calculate extent of violation for monthly and hourly wages.

and thus they cannot be directly compared. In Section 3 we discuss in more detail the comparison of the OECD, Eurostat, and our own estimates of Kaitz indices.

The data that can be used for cross-country analysis of wages is very limited. In case of minimum wage violations, there is also an additional limitation related to the fact that some surveys collect information on wages from employers, such as the EU Structure of Earnings Survey (EU-SES), who might avoid reporting cases when workers receive sub-minimum wages, or work overtime while receiving minimum wage.[7] Thus, we use here the EU-SILC data that contain wages reported by workers for the EU countries. The procedure to construct monthly and hourly wages from the information about the total income from dependent employment last year is described in Section A in the appendix.[8] Thus, in our sample we only keep those employees that work on full-time basis. We also restrict the sample to those workers that have only one job, who reported to be employed full-time in all months of the previous calendar year, and who reported that their current number of hours usually work is actually equal or higher than the statutory full-time weekly schedule. We also exclude from the sample employees below the age of 25, as the data we use do not allow us to identify precisely whether young employees are still covered by lower minimum wage that applies to young workers or labour market entrants or is already covered by a standard minimum wage.

While imposing those restrictions decreases the number of observations, it allows for a direct interpretation: if the yearly income of a person who was working full-time in every month of the income reference year was lower than the yearly equivalent of the monthly minimum wage, than there must have been at least one incidence of violation with the minimum wage rules.

Given our data restrictions, if the person is not receiving monthly wage at least at the level of monthly minimum wage, then by definition this person is also not receiving the hourly equivalent of the monthly minimum wage. In other words, non-compliance in monthly terms also means non-compliance in hourly terms.[9] However, a violation of minimum wage in hourly terms may happen in cases when workers do receive at least monthly minimum wage but they work longer hours, and thus they do not receive hourly equivalent of the monthly minimum wage. We calculate minimum hourly wages as $w^h_{min} = \frac{w^m_{min} * 12}{52 * ft_{hours}}$, where ft_{hours} stand for the number of hours worked per week under the statutory full-time weekly schedule. Following Engel and Schaffner (2012), we make an assumption that for each employee in the selected sample the currently reported number of hours usually worked applies also to the previous calendar year. In our analysis we will calculate minimum wage non-compliance measures to both monthly ($V^{G_m}_{\alpha}$) and hourly wages ($V^{G_h}_{\alpha}$).

Our estimates of the non-compliance with minimum wage can be treated as lower-bound indices due to the exclusion from the sample groups of workers who might be at a greater risk of receiving sub-minimum wages than those who work continuously on a full-time basis for the entire year: e.g. part-time workers, those who work for more than one employer on short-term contracts, or those who were for some time unemployed or inactive during the income reference year (Marx and Salverda, 2005; OECD, 2013).

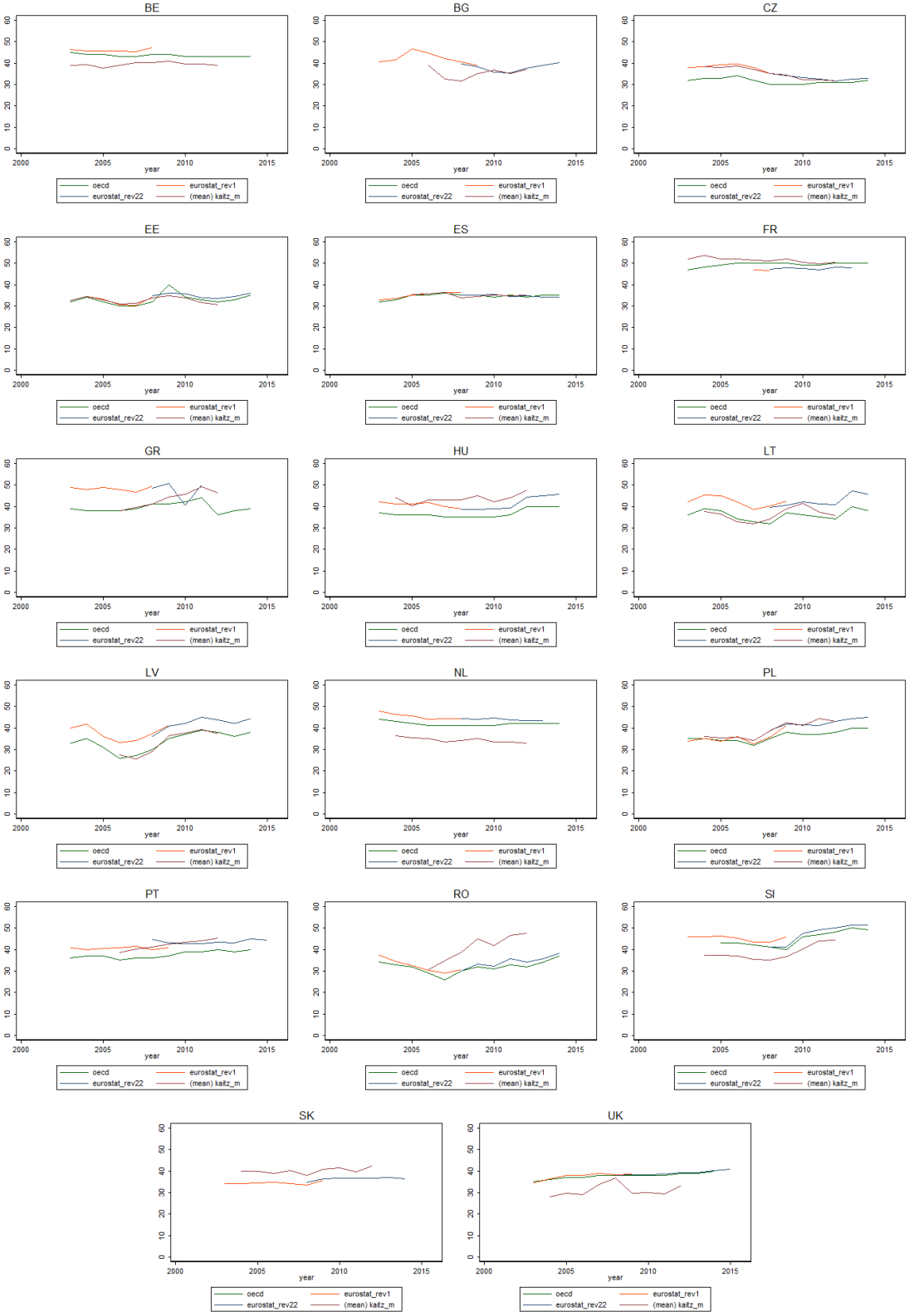
In order to validate the quality of the information on wages that we have in the restricted EU-SILC sample, we compare the ratios of minimum wages to average wages (Kaitz indices) that we have calculated using our sub-sample of the EU-SILC data with the indices published by the OECD and Eurostat. We make comparison for selection of EU countries that have statutory national minimum wage. Due to data limitations, we exclude Croatia from the group of the analysed CEE, and Ireland, Luxembourg, and Malta from the group of benchmark countries. We also exclude Germany from the group of benchmark countries as national minimum wage was established there only in 2015. We find that the trends of our estimates for analysed countries are mainly consistent with the Kaitz indices from Eurostat and the OECD (see Figure 5). This is shown to be the case for Belgium, the Czech Republic, Estonia, Spain, France, Hungary, Lithuania, Latvia, Poland, and Portugal in particular.

[7] In such case the worker will receive monthly minimum wage, but there will be non-compliance when it comes to hourly equivalent of the minimum wage.

[8] As discussed in Section A in the appendix, the reference periods for the information provided on wages and on other job-related characteristics do not overlap and we have chosen to name the data points according to the reference period of the wage variable; e.g. Poland 2012 refers to data from the EU-SILC 2013 round in Poland.

[9] If we analysed part-time employees or employees with full-time schedules of less than usual full-time schedule, this would not be the case.

Figure 5: Comparison of own measures with OECD and Eurostat indicators.



Note: The OECD publishes data on the minimum to average wages of full-time workers. Eurostat provides information on the monthly minimum wage as a proportion of the average monthly earnings for industry, construction, and services (NACE Rev. 2, from 2008 onwards); and for industry and services (NACE Rev. 1.1, 1999-2009).
Source: Own calculations on the EU-SILC data, OECD Statistics, Eurostat.

The information on monthly minimum wage levels comes from Eurostat. These are monthly minimum wage levels of a person who worked for the entire year and in every month was paid a statutory monthly minimum wage. Thus, minimum wages published by Eurostat include the top-ups to the wages, e.g. the 13th or the 14th wages, if those are required by the law in particular countries. In this way, the minimum wage levels applied are in line with the definition of yearly income from dependent employment reported in the EU-SILC.

4 Minimum wage non-compliance among women and men

4.1 The scope of minimum wage violation

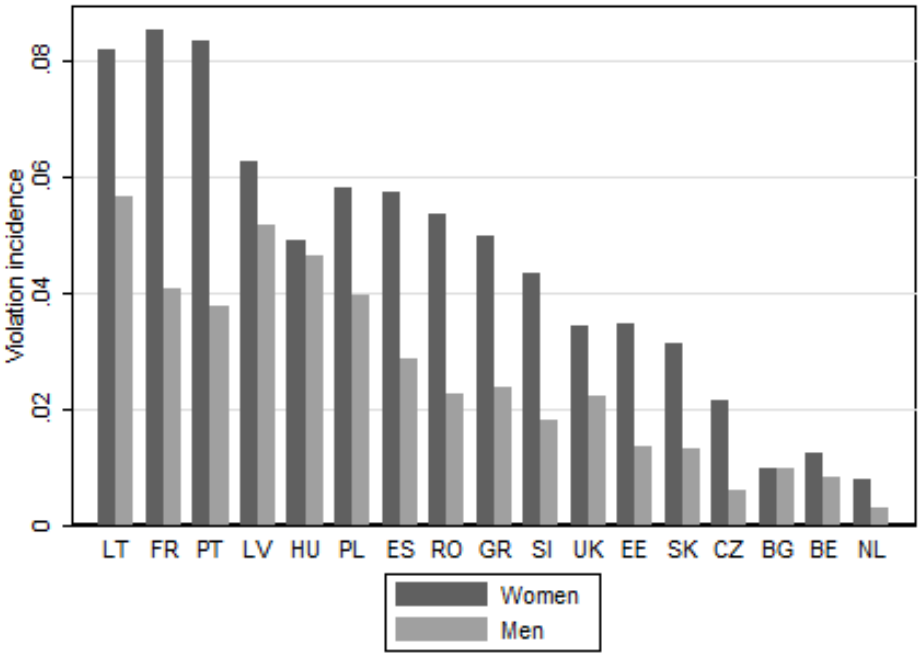
The results point out a significant heterogeneity between analysed countries both in the extent of monthly minimum wage violation, and in the extent of gender differences in minimum wage violation. Figure 6 shows the average incidence of minimum wage violation among male and female workers in 2003-2012. The ranking of countries was made according to the overall incidence of minimum wage violation ($V_0^{T_m}$), and the bars show the exact share of workers receiving sub-minimum wages among male and female workers. The overall incidence of minimum wage violation, $V_0^{T_m}$, among the analysed countries falls in range from 0 to 7%.[10] The country with the highest share of workers receiving sub-minimum wages in the EU is Lithuania. The value is much higher for women, $V_0^{F_m}$ equals around 8% while $V_0^{M_m}$ equals around 6%. France and Portugal, countries with the second and third highest $V_0^{T_m}$ are at the same time characterized by very large gender differences in the extent of minimum wage violation. Latvia and Hungary have relatively high share of workers that receive sub-minimum wages but gender differences in this measure are small, especially in Hungary. Poland is characterized by $V_0^{T_m}$ of around 5% and moderate difference between $V_0^{F_m}$ and $V_0^{M_m}$. Spain, Romania, Greece, Slovenia have $V_0^{T_m}$ of around 3%-4%, but the measure of minimum wage violation is twice bigger for women than for men. In the United Kingdom, the incidence of minimum wage violation is also around 3% but gender differences are much smaller. Estonia, Slovakia, Ireland, and the Czech Republic are characterized by low $V_0^{T_m}$, and relatively much higher $V_0^{F_m}$, than $V_0^{M_m}$. In Bulgaria, Belgium, and the Netherlands both the incidence of minimum wage violations, and the gender differences in this measure are very low.

In the analysis of gender dimension of minimum wage violation, it is important to include additional non-compliance measures on top of the standard incidence of violation measure. As evidenced in Figure 7, the average shortfall is in most countries higher for men than women. That means that although men are less often receiving sub-minimum wages, the distance between the wage they receive and the minimum wage is on average larger. It is also visible that the average shortfall is relatively bigger in both countries characterized by relatively lower minimum wage violation incidence, like Slovenia, Slovakia, the Netherlands, as well as in countries that have moderate (Spain) or the biggest minimum wage violation incidence (France). Thus, on Figure 8, we present the depth of minimum wage violation measure that captures both the incidence of non-compliance and the depth of underpayment per violated worker in

[10] Such extent of minimum wage violation is not large by international standards. In developing countries, the levels of minimum wage non-compliance are usually much higher. Bhorat et al. (2015a), who studied countries in sub-Saharan Africa, found that the minimum wage non-compliance ranged from 36% in Zambia to 80% in Tanzania, with an average of 58%. Rani et al. (2013) studied Brazil, Costa Rica, India, Indonesia, Mali, Mexico, Peru, the Philippines, South Africa, Turkey, and Vietnam and found that the incidence of minimum wage non-compliance ranged from 5% in Vietnam and 9% in Mexico, to 50% in Turkey and 51% in Indonesia (in the late 2000s). Kanbur et al. (2013) found that the incidence of minimum wage non-compliance in Chile was 18% on average between 1990 and 2009. Ye et al. (2015) focused on China and estimated that the incidence of minimum wage violations in formal-sector enterprises and among full-time workers was 3.5%, close to our results for the EU. Estimates of minimum wage violation measures for developed countries are scarce. Available literature for the EU includes OECD (2015) and Garnero et al. (2015). OECD (2015) estimated that across the OECD countries, on average, 5.5% of workers earned at or below the minimum wage in 2010. Garnero et al. (2015) found that in the EU countries with statutory minimum wages at national level, the shares of workers earning sub-minimum levels ranged from 1% in Bulgaria and Romania to 4% in Poland and 8% in France in 2008-2010. BLS (2014) showed that in the United States, among 58.8% of all wage and salary workers who are paid by hours, 2.3% of workers who were over age of 15 were paid less than the hourly federal minimum wage in 2013.

one measure. According to $V_1^{T_m}$ measure, Lithuania, France and Spain are countries with the highest depth of non-compliance per worker, and in each of these countries the depth of violation is higher for women (the difference is particularly high in France). After controlling for the extent of underpayment, Latvia is the fourth country with the highest non-compliance and men are affected more than women. In Slovakia and Portugal, there is again a very big difference between $V_1^{M_m}$ and $V_1^{F_m}$ pointing out bigger non-compliance affecting female workers. Hungary has a relatively moderate non-compliance according to $V_1^{T_m}$ measure and the gender difference is negligible. In the remaining countries that have relatively small $V_1^{T_m}$, minimum wage non-compliance affects to higher extent women than men (with the exception of Bulgaria).

Figure 6: Incidence of minimum wage violation.

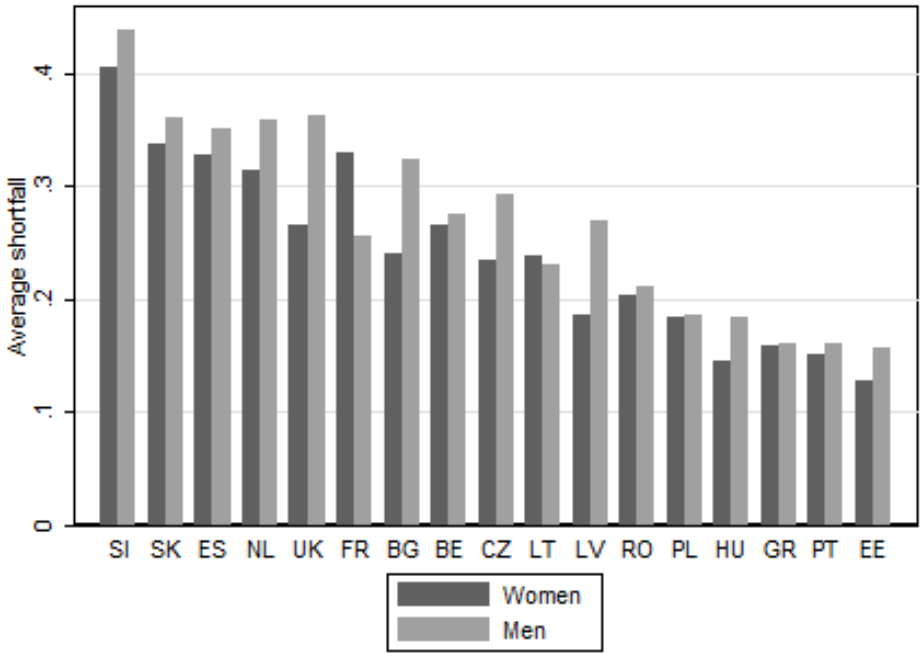


Note: We present the measures $V_0^{F_m}$ and $V_0^{M_m}$ for each country. The ranking of countries is made according to measure $V_0^{T_m}$.

We calculate the minimum wage non-compliance measures also for the hourly wages. In Figure 9 we decompose the share of male and female employees that do not receive the hourly equivalent of minimum wages to those that are violated in hourly terms only, which means that they receive monthly minimum wage but work longer hours, and to those who do not receive monthly minimum wages (the numbers are like in Figure 6).[11] After including the cases when the worker does receive a monthly minimum wage, but due to overtime does not receive its hourly equivalent, France and Portugal are on the first two positions according to $V_0^{T_h}$. In these two countries the non-compliance in hourly terms only adds up around 4 pp. to the $V_0^{T_m}$ measure. The non-violation in hourly terms only affects similar share of male and female workers in both France and Portugal. Lithuania, which has highest $V_0^{T_m}$, have the measure $V_0^{T_h}$ very similar to $V_0^{T_m}$ which means that the use of overtime to pay sub-minimum wages in hourly terms only is not very common. The situation is opposite in Poland, which comes fourth according to $V_0^{T_h}$, and the non-compliance in hourly terms only is particularly high among male workers, thus making the distance between $V_0^{M_h}$ and $V_0^{F_h}$ relatively smaller than between $V_0^{M_m}$ and $V_0^{F_m}$. The increase in non-compliance due to overtime that leads to payment of sub-minimum wages in hourly terms is also relatively high

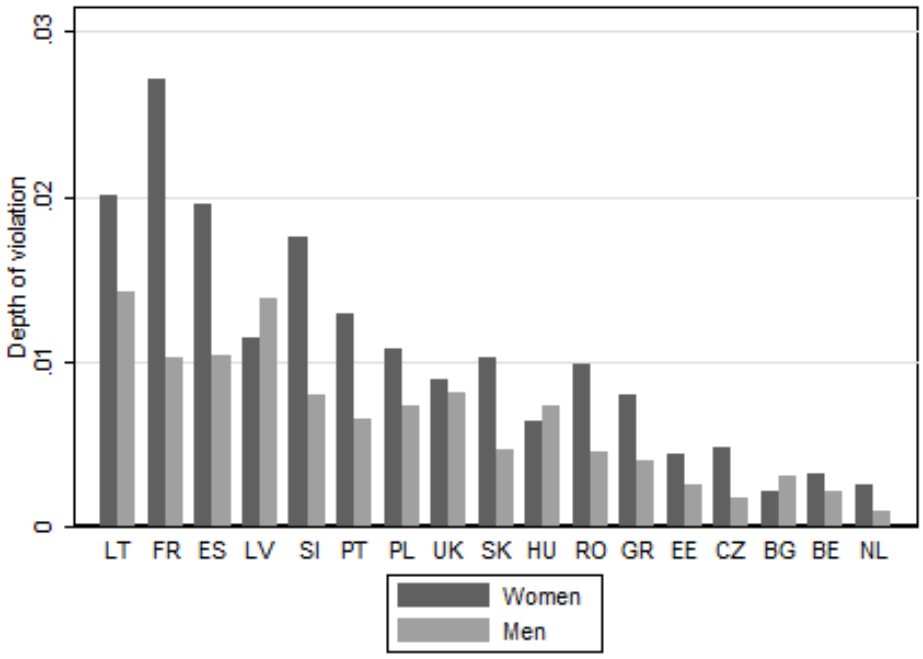
[11] Given our restriction on the hours worked, namely that we only keep workers that declare they work at least the number of hours equal to full-time schedule in the country, that means that such workers also do not receive the hourly equivalent of the monthly minimum wage.

Figure 7: Average shortfall of minimum wage violation.



Note: We present the measures $\frac{V_1}{V_0}^{F_m}$ *and* $\frac{V_1}{V_0}^{M_m}$ *for each country. The ranking of countries is made according to measure* $\frac{V_1}{V_0}^{T_m}$.

Figure 8: Depth of minimum wage violation.

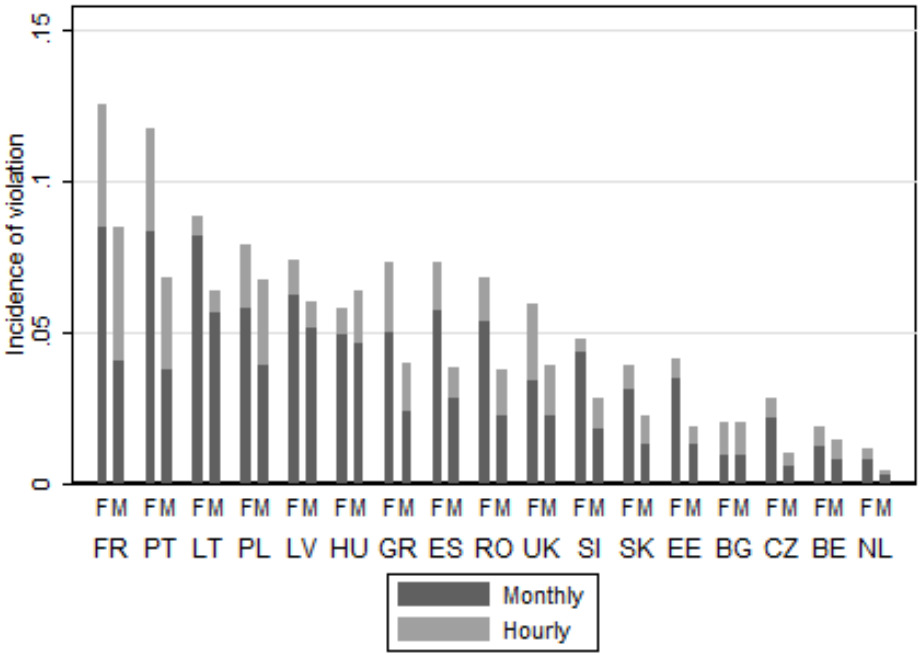


Note: We present the measures $V_1^{F_m}$ *and* $V_1^{M_m}$ *for each country. The ranking of countries is made according to measure* $V_1^{T_m}$.

in Greece, Spain, Romania, and the United Kingdom, where the increase in violation incidence equals around 1.5%-2%.

The graphical analysis of the non-compliance measures presented in Figures 6, 7, 7, and 9 does not

Figure 9: Hourly minimum wage incidence of violations: 2003-2012 averages.



Note: We present the measures $V_0^{F_h}$ and $V_0^{M_h}$ for each country. Those measures are divided into part showing the share of workers that do not receive monthly minimum wage ("monthly"), and those that do receive monthly minimum wage, but do not receive its hourly equivalent due to overtime ("hourly"). The ranking of countries is made according to measure $V_0^{T_h}$.

indicate that transitions countries on average have systematically different levels of non-compliance as compared to benchmark countries. In Table 2 we formally analyse this issue. The results of between-effects panel regression of minimum wage non-compliance measures for all workers indicate that there is no significant difference between transition and benchmark countries, when we do not control for any other characteristics of the countries.

It was discussed by e.g. Goraus and Lewandowski (2016) that levels of Kaitz index correlate with the incidence of minimum-wage violation. As discussed in Section 2, there are important differences in the minimum wage levels and their evolution over time between the NMS and benchmark countries. Thus, in subsequent analysis we inquire whether there are differences between transition and benchmark countries, once differences in Kaitz indices are controlled. Table 3 shows the results of between-effects panel regression of non-compliance measures on Kaitz index and dummy variable for transition countries. While the coefficient for transition dummy remains insignificant in every regression, Kaitz index significantly explains the differences between countries in the extent of monthly minimum wage violation incidence, hourly minimum wage violation incidence, and depth of the hourly minimum wage violation, pointing out higher levels of minimum wage violation measures in countries that have higher minimum wages in relation to average wages.

Table 4 shows the results from fixed-effects panel regressions, where we also try to inquire what is the dominant time trend in the minimum wage violation measures. We find that in case of the incidence and depth of hourly violation measures, there is a decreasing trend, but only among transition countries. Regarding the relation between Kaitz index and minimum wage violation measures, we find that, within countries increases in Kaitz index correlate with an increased minimum wage violation incidence, and with an increased depth of violation. The coefficient of Kaitz index is negative in the regressions for average shortfall, indicating that as Kaitz index increases, which as we found correlates with a higher minimum wage violation incidence, the average shortfall per worker that does not receive minimum wage

decreases.

Table 2: Differences in minimum wage violation measures between transition and benchmark countries.

	$V_0^{T_m}$	$V_0^{T_h}$	$V_1^{T_m}$	$V_1^{T_h}$	$\frac{V_1}{V_0}^{T_m}$	$\frac{V_1}{V_0}^{T_h}$
transition	0.0040	-0.0030	0.0002	-0.0014	-0.0232	-0.0160
	(0.0093)	(0.0130)	(0.0024)	(0.0030)	(0.0379)	(0.0278)
Constant	0.0314***	0.0493***	0.0079***	0.0117***	0.2681***	0.2443***
	(0.0069)	(0.0097)	(0.0018)	(0.0023)	(0.0282)	(0.0207)
Observations	155	155	155	155	155	155
R-squared	0.011	0.003	0.001	0.014	0.023	0.020
Number of c	18	18	18	18	18	18
Standard errors in parentheses						
*** p<0.01, ** p<0.05, * p<0.1						

Note: Panel regressions of minimum wage violation measures: between-effects estimator of dummy variable for transition countries.

Table 3: Differences in minimum wage violation measures between transition and benchmark countries when Kaitz index is controlled.

	$V_0^{T_m}$	$V_0^{T_h}$	$V_1^{T_m}$	$V_1^{T_h}$	$\frac{V_1}{V_0}^{T_m}$	$\frac{V_1}{V_0}^{T_h}$
Kaitz index	0.1567*	0.2938**	0.0285	0.0545*	-0.3041	-0.2312
	(0.0888)	(0.1128)	(0.0239)	(0.0286)	(0.3886)	(0.2844)
transition	0.0062	0.0013	0.0006	-0.0007	-0.0275	-0.0194
	(0.0089)	(0.0112)	(0.0024)	(0.0029)	(0.0387)	(0.0284)
Constant	-0.0292	-0.0643	-0.0031	-0.0094	0.3856**	0.3337***
	(0.0350)	(0.0444)	(0.0094)	(0.0113)	(0.1529)	(0.1119)
Observations	155	155	155	155	155	155
R-squared	0.181	0.314	0.087	0.206	0.061	0.062
Number of c	18	18	18	18	18	18
Standard errors in parentheses						
*** p<0.01, ** p<0.05, * p<0.1						

Note: Panel regressions of minimum wage violation measures: between-effects estimator of dummy variable for transition countries and the Kaitz index.

The second step of the regression analysis of the estimated measures of minimum wage violation is based on the dataset with two minimum wage non-compliance measures per country-year: one for women, and one for men. The results of the regressions of minimum wage violation incidence with country and year fixed-effects and controlling for Kaitz index for all workers presented in Table 5 indicate that the incidence of violation is significantly higher for women, both in case of monthly minimum wage and in its hourly equivalent. In case of monthly minimum wages, the gender difference in non-compliance measures is the same for transition and benchmark countries. However, in case of the non-compliance measure for hourly wages, the gender differences are smaller among transition countries, as hourly minimum wage violation through overtime affects male workers to a higher extent in this group of countries. In Table 6 we repeat the same exercise but we construct a separate Kaitz index for male and for female workers. As extensively evidenced in the literature, women in the analysed transition and benchmark countries receive lower wages as compared to men. These differences remain largely unexplained by observable characteristics. If employers wanted to keep such gender difference at the lower end of the distribution,

Table 4: Time trends in minimum wage violation measures.

	$V_0^{T_m}$	$V_0^{T_h}$	$V_1^{T_m}$	$V_1^{T_h}$	$\frac{V_1}{V_0}^{T_m}$	$\frac{V_1}{V_0}^{T_h}$
year	0.0001	-0.0003	0.0002	0.0001	0.0006	-0.0009
	(0.0006)	(0.0006)	(0.0002)	(0.0002)	(0.0035)	(0.0024)
x transition	-0.0011	-0.0020**	-0.0003	-0.0005*	0.0015	0.0028
	(0.0008)	(0.0009)	(0.0003)	(0.0003)	(0.0049)	(0.0034)
Kaitz index	0.2972***	0.4060***	0.0546***	0.0749***	-0.5251**	-0.3618**
	(0.0406)	(0.0436)	(0.0127)	(0.0133)	(0.2411)	(0.1680)
Constant	0.9201	2.7362***	-0.0995	0.2681	-2.3484	-0.8251
	(0.8438)	(0.9074)	(0.2641)	(0.2765)	(5.0142)	(3.4941)
Observations	155	155	155	155	155	155
R-squared	0.291	0.393	0.139	0.197	0.034	0.035
Number of c	18	18	18	18	18	18

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: Panel regressions of minimum wage violation measures: fixed-effects estimators.

the minimum wage will be more binding for them when employing women. This difference in how binding minimum wage is for employers that systematically offer lower wages to women is captured by the Kaitz index that is constructed by country-year-gender. Indeed, when we regress the incidence of minimum wage violation on gender specific Kaitz index, the female dummy is no longer significant for monthly minimum wage violation, while for hourly minimum wage violation incidence, the indices are lower among women in transition countries than what would be predicted by gender-specific Kaitz index only.

From the regressions on the depth of violation index, that also capture the extent of underpayment, we also get the result that non-compliance is higher among female workers, and that the gender difference in the depth of violation measure is smaller in transition countries (see Table 7). In the regressions that control for gender specific Kaitz index the gender dummy is positive for monthly wages, but the coefficient of the female dummy interaction with dummy variable for transition countries indicates that the depth of violation is higher among females only in benchmark countries (see Table 8). In case of the depth of violation in hourly wages there is no significant difference among women and men in benchmark countries, while in transition countries the depth of violation is lower once the gender-specific Kaitz index is controlled.

To sum up, the analysis of the estimated measures of minimum wage violation among all, only male and only female workers in transition and benchmark countries, indicates that there are no systematic differences in overall non-compliance between transition and benchmark countries, and gender differences in those measures are slightly smaller among transition countries in case of non-compliance with hourly equivalent of monthly minimum wages. The Kaitz indices calculated as the ratio between minimum wage and average wage for each country and year significantly explain the differences in minimum wage non-compliance within countries, and, to some extent, between countries. The indices of minimum wage non-compliance are higher among female workers, and that relates to the fact that overall women's wages are lower and the same pattern is replicated at the bottom of the distribution. This indicates that the ability of minimum wages to improve the position of women at the bottom of the distribution is reduced by the higher non-compliance among this group of workers.

4.2 Characteristics of workers affected by non-compliance

In this section we seek to identify the individual and the job-related characteristics that make it more probable for a worker to receive a sub-minimum wage. We pay particular attention to the effect of gender

Table 5: Regressions of minimum wage violation incidence among women and men with: Kaitz indices for all workers.

	Monthly	Monthly	Hourly	Hourly
Kaitz index	0.2887***	0.2887***	0.3855***	0.3855***
	(0.0351)	(0.0351)	(0.0386)	(0.0382)
female	0.0195***	0.0224***	0.0195***	0.0247***
	(0.0017)	(0.0025)	(0.0019)	(0.0027)
x transition		-0.0053		-0.0094**
		(0.0034)		(0.0037)
Constant	-0.0825***	-0.0740***	-0.0988***	-0.0864***
	(0.0159)	(0.0122)	(0.0175)	(0.0133)
Observations	310	310	310	310
R-squared	0.720	0.723	0.790	0.795
Standard errors in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				

Note: Country and year fixed effects included.

Table 6: Regressions of minimum wage violation incidence among women and men: separate Kaitz indices for male and female workers.

	Monthly	Monthly	Hourly	Hourly
Kaitz index	0.2512***	0.2543***	0.3303***	0.3353***
	(0.0293)	(0.0292)	(0.0322)	(0.0318)
female	-0.0007	0.0029	-0.0070**	-0.0011
	(0.0029)	(0.0034)	(0.0032)	(0.0037)
x transition		-0.0069**		-0.0114***
		(0.0034)		(0.0037)
Constant	-0.0597***	-0.0566***	-0.0664***	-0.0619***
	(0.0130)	(0.0098)	(0.0143)	(0.0107)
Observations	310	310	310	310
R-squared	0.725	0.729	0.793	0.800
Standard errors in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				

Note: Country and year fixed effects included.

on this probability, once all other characteristics are controlled for. We estimate a probit regression of the dummy variable that takes value of one when a worker is not receiving minimum wage in hourly wage terms, v_0^h. We first estimate two regressions on pooled datasets separately for transition and benchmark countries with country and time controls. We also estimate separate models for each country to see in which countries the coefficient standing next to the gender dummy is significant and how its values differ among the analysed countries.

The set of significant categorical independent variables is similar to those found in the Mincerian wage regressions, which are broadly used in the literature to study determinants of wages.

The marginal effects obtained from the pooled regressions for transition and benchmark countries (see Table 9) show that once other characteristics like age, education, type of contract, size of the company, occupation and sector are controlled for, being a women increases the probability of receiving a sub-minimum wage by 1.8 pp. in benchmark countries and by 2 pp. in transition countries.

Regarding other characteristics, the point coefficients are similar in transition and benchmark coun-

Table 7: Regressions of minimum wage depth of violation among women and men: Kaitz indices for all workers.

	Monthly	Monthly	Hourly	Hourly
Kaitz index	0.0515***	0.0515***	0.0685***	0.0685***
	(0.0115)	(0.0114)	(0.0122)	(0.0120)
female	0.0044***	0.0058***	0.0044***	0.0065***
	(0.0006)	(0.0008)	(0.0006)	(0.0009)
x transition		-0.0026**		-0.0038***
		(0.0011)		(0.0012)
Constant	-0.0155***	-0.0101**	-0.0182***	-0.0114***
	(0.0052)	(0.0040)	(0.0055)	(0.0042)
Observations	310	310	310	310
R-squared	0.606	0.613	0.678	0.690
Standard errors in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				

Note: Country and year fixed effects included.

Table 8: Regressions of minimum wage depth of violation among women and men: separate Kaitz indices for male and female workers.

	Monthly	Monthly	Hourly	Hourly
Kaitz index	0.0424***	0.0436***	0.0572***	0.0591***
	(0.0097)	(0.0096)	(0.0103)	(0.0101)
female	0.0010	0.0024**	-0.0002	0.0019
	(0.0010)	(0.0011)	(0.0010)	(0.0012)
x transition		-0.0028**		-0.0041***
		(0.0011)		(0.0012)
Constant	-0.0106**	-0.0065**	-0.0119***	-0.0069**
	(0.0043)	(0.0032)	(0.0046)	(0.0034)
Observations	310	310	310	310
R-squared	0.604	0.613	0.678	0.691
Standard errors in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				

Note: Country and year fixed effects included.

tries. The youngest workers (aged 25-30) faced the highest, and workers aged 41-50 faced the lowest probability of receiving a sub-minimum wage (respectively 1.2 pp. higher and 0.5-0.6 pp. lower than for workers aged 31-40). For workers aged above 55, the probability is not significantly different (transition countries) or slightly lower (benchmark countries) than for those aged 31-40. The results also point out the importance of education and skills. Workers with medium education had a 0.6 pp. in transition countries and 1.3 pp. in benchmark countries lower probability of receiving a sub-minimum wage than workers with low education, and the effect for workers with tertiary education was 2.1 pp. for both transition and benchmark countries.[12]

Regarding the occupation types, workers in high-skilled occupations (ISCO 1-3) were much less likely (by 4.4 among transition and 4.6 pp. in benchmark countries) than workers in elementary occupations to be receiving sub-minimum wages (the strongest marginal effect in the model). Negative and noticeable marginal effects are also found for machine operators (ISCO 4-5, 2.0 pp.); clerks (ISCO 6, 0.5 and 0.7

[12]We define low education as levels 1-2, medium education as levels 3-4, and high education as levels 5-6 of the ISCED classification.

Table 9: Probit regressions of minimum wage non-compliance dummy variable.

	EU-15	NMS
female	0.0177***	0.0204***
	(0.0006)	(0.0006)
age below 31	0.0116***	0.0112***
	(0.0009)	(0.0009)
age 41-55	-0.0057***	-0.0049***
	(0.0005)	(0.0006)
age above 55	-0.0023***	-0.0006
	(0.0009)	(0.0009)
married	-0.0009*	-0.0021***
	(0.0005)	(0.0005)
medium education	-0.0132***	-0.0064***
	(0.0007)	(0.0006)
high education	-0.0213***	-0.0212***
	(0.0007)	(0.0007)
micro firm	0.0438***	0.0442***
	(0.0010)	(0.0010)
small firm	0.0137***	0.0149***
	(0.0007)	(0.0007)
temporary worker	0.0502***	0.0447***
	(0.0015)	(0.0014)
ISCO 1-3	-0.0457***	-0.0443***
	(0.0008)	(0.0008)
ISCO 4-5	-0.0196***	-0.0195***
	(0.0006)	(0.0006)
ISCO 6	-0.0072***	-0.0049***
	(0.0015)	(0.0017)
ISCO 7	-0.0163***	-0.0169***
	(0.0006)	(0.0006)
ISCO 8	-0.0165***	-0.0151***
	(0.0006)	(0.0006)
Agriculture	0.0291***	0.0306***
	(0.0022)	(0.0023)
Construction	0.0027***	0.0027***
	(0.0010)	(0.0010)
Market services	0.0078***	0.0059***
	(0.0007)	(0.0007)
Non-market services	-0.0012	-0.0002
	(0.0008)	(0.0008)
Observations	471,795	471,795
Standard errors in parentheses		
*** p<0.01, ** p<0.05, * p<0.1		

Note: For reference we omit dummies "age 31 to 40", "medium or large firm" for people working in medium or large companies, "ISCO 9" for people working in elementary occupations, and "Industry" for people working in industry.

pp.), sales, and service workers (ISCO 7, 1.7 and 1.6 pp.); and craft workers (ISCO 8, 1.5 and 1.7 pp.). In terms of sectors, the probability of receiving a sub-minimum wage was never significantly lower than in the reference sector of industry. Agriculture had the highest marginal effect of all sectors: the probability of being affected by non-compliance was by 3.1 pp. in transition countries and by 2.9 pp. in benchmark countries higher in agriculture than in industry. The effects for construction and market services were also positive, but small. We also find a negative and strong relationship between firm size where the

worker is employed and the probability of receiving a sub-minimum wage: compared to workers in firms with 50 or more employees, workers in micro firms (with fewer than 10 employees) were 4.4 pp. more likely and workers in small firms (10-49 employees) were 1.5 pp. and 1.4 pp. more likely to be affected by non-compliance. Moreover, we identify a strong and positive marginal effect for temporary workers, who were by 4.5 pp. (transition countries) and 5 pp. (benchmark countries) more likely to receive sub-minimum wage than workers with open-ended contracts. These findings may indicate that employers in both transition and benchmark countries use atypical working arrangements to pay wages below the statutory minimum levels.[13]

Looking at the results for specific countries, presented in Table C.2 for transition countries and in Table C.3 in the appendix for benchmark countries reveals, that after controlling for other demographic and job related characteristics, being a women significantly increases probability of receiving a sub-minimum wage in most analysed countries, except for Bulgaria. Within the group of transition countries, the marginal effects are highest in Lithuania (3.4 pp.), followed by Slovenia (2.8 pp.), Poland and Slovakia (1.9 pp.), Romania and Latvia (1.8 pp.), Estonia (1.5 pp.), the Czech Republic (by 1.1 pp.) and Hungary (1.1 pp.). Among benchmark countries, being a woman increases the probability of being affected by non-compliance the most in Portugal (by 4.4 pp.), followed by the United Kingdom (2.7 pp.), Greece (2.2 pp.), France (2.1 pp.), Spain (1.8 pp.). The marginal effects are lowest in the Netherlands and Belgium (0.3 pp.).

For the countries in which we find significant and non-negligible gender differences in probability of being affected by minimum wage non-compliance, we provide a detailed analysis of the evolution of gender gap in non-compliance measures in the next section using decomposition methods.[14]

4.3 Decomposition of gender differences in minimum wage non-compliance measure

In order to analyse how the gender differences in the probability of receiving a sub-minimum wage were evolving over time in the selected countries, we apply methodology that is broadly used in the literature focused on gender wage differentials, namely Ñopo (2008) non-parametric decomposition, and we control for all characteristics showed in the Tables 9, C.2 and C.3. The presentation of the Ñopo (2008) method that was designed as a tool to decompose the gender wage gap is provided in Section D in the appendix. The raw gender gap in such setting is equal to the difference between the probability of men to receive a sub-minimum wage and probability of women to receive a sub-minimum wage, expressed as the share of the probability of women to receive a sub-minimum wage in the given country and year. Following the analysis presented in Section 4.1 we expect the raw gap to be negative, and after the analysis in Section 4.2 we also expect the adjusted gaps to be negative.

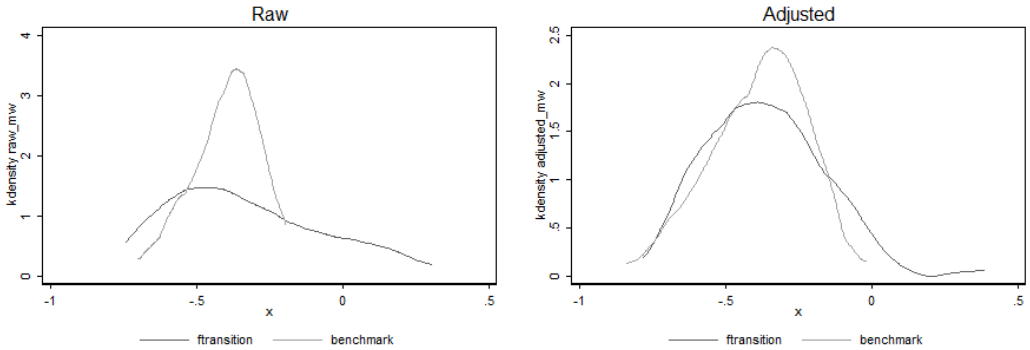
Indeed, as reflected in Figure 10, the raw gender gaps in both transition and benchmark countries are negative, with the exception of some observations among transition countries. The distribution among benchmark countries is more compressed and concentrated around the raw gap of -30%. Among transition countries there is more heterogeneity in the raw gaps in minimum wage non-compliance measure, and the

[13] For instance, in Poland the minimum wage rules do not apply for civil law contracts, and reforms to change this situation are being discussed. However, in the EU-SILC data, such non-standard contracts are categorised together with fixed-term and other types of temporary employment contracts, which makes it impossible to distinguish between contract types in the micro data.

[14] Decomposition methods are mainly used for the analyses of wage gaps. However, they are also employed for the analyses of gaps in employment (e.g O'Higgins and Brüggemann, 2013), or unemployment rates (e.g Kingdon and Knight, 2004; Masagué, 2008). It must be kept in mind, that when decomposition methods are applied for the analyses of gender gaps in e.g. unemployment rates, the outcome variable might be in some countries close to zero, and in some countries it may reach several dozen percent. However, decomposition methods focus only on the gender difference, thus the difference between unemployment rate of 0.5% among men and 1% among women, is assessed the same as in the case of e.g. 5% unemployment rate among men and 10% among women, namely as -50% gap. In the next section, we do not focus on the levels of minimum wage non-compliance, but rather we aim to analyse the evolution of gender gaps in minimum wage non-compliance measures, controlling for differences in characteristics, thus the decomposition methods might be of use. However, we arbitrarily decide to exclude countries where the incidence of minimum wage non-compliance is below 2%, namely the Netherlands, Belgium, Bulgaria, and the Czech Republic.

distribution is most concentrated around the value of -30% in benchmark and -40% in transition countries. These results indicate that in most cases the raw gaps are not explained by observable characteristics.

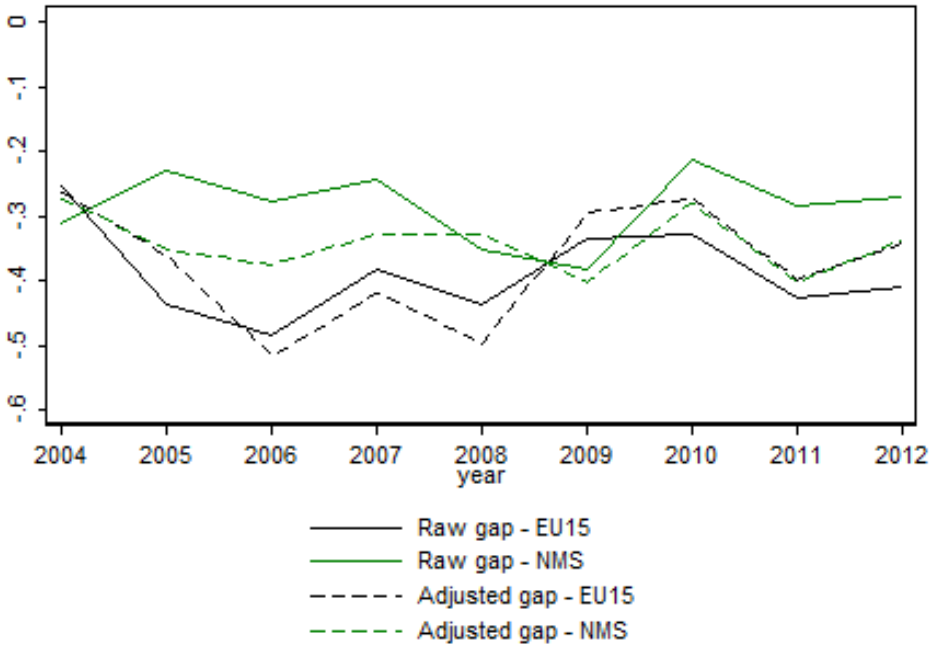
Figure 10: Distribution of the gender gap in probability of receiving sub-minimum wage among transition and benchmark countries.



Note: The raw gap equals the difference between $V_0^{M_h}$ and $V_0^{F_h}$ divided by $V_0^{F_h}$. The adjusted gap is calculated using the non-parametric decomposition of Ñopo (2008).

Figure 11 presents the evolution of raw and adjusted gender gaps in non-compliance measures for transition and benchmark countries on average, and points out gender gaps that are similar and stable over time between the two groups of countries. Although we not only control for demographic and human capital characteristics but also for job-related characteristics, the observable characteristics do not explain the observed gender difference in minimum wage non-compliance measures. This is true for both transition and benchmark countries.

Figure 11: Gender gap in probability of receiving sub-minimum wage over time among transition and benchmark countries.

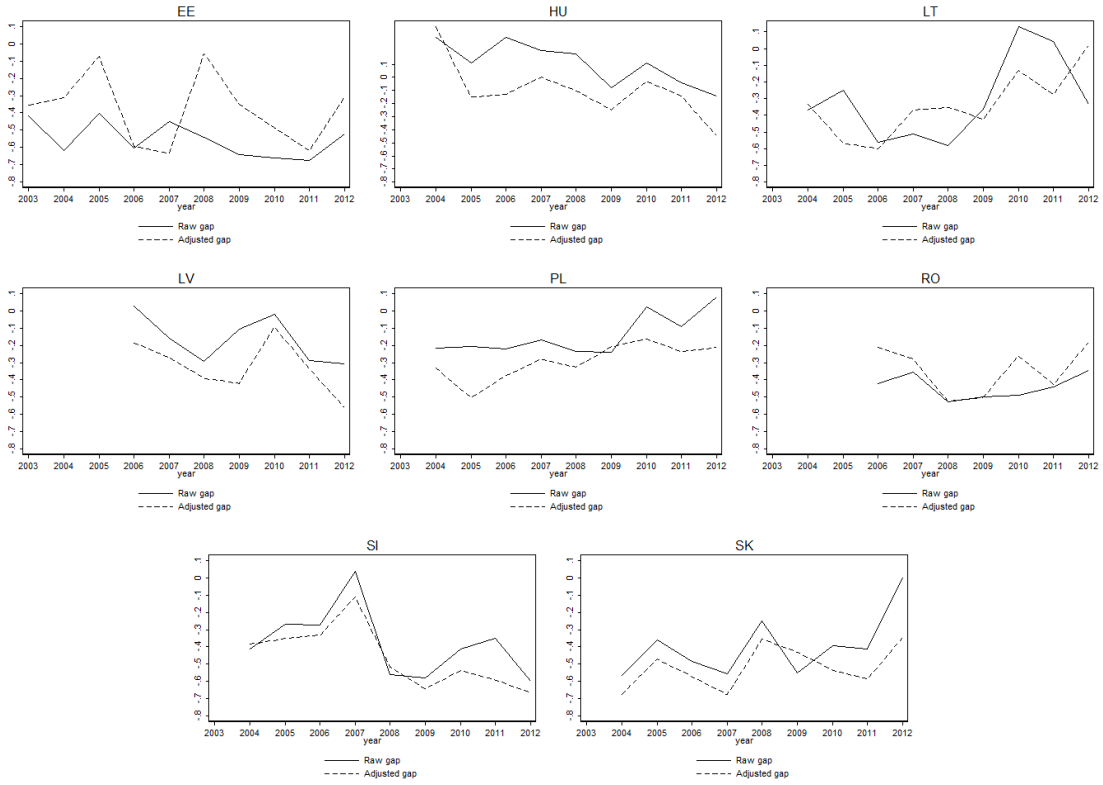


Note: See Note for Figure 10.

The analysis of gender gaps in minimum wage violation incidence in particular countries reveals, that in most countries observable characteristics do not explain gender differences in the incidence of minimum

wage violation, and such result is preserved over time. Moreover, in Hungary, Latvia, Poland, and Slovakia, the adjusted gaps are consistently larger (in absolute terms) than the raw gaps, which suggests that if women had the same characteristics as men, the incidence of minimum wage violation among female workers would actually be even larger. Regarding time trends, there is important heterogeneity among transition countries. In Latvia and Hungary, the adjusted gender gaps in non-compliance measures were close to zero or even positive at the beginning of the analysed period. This suggest that non-compliance among similar women and men was similar between genders or even smaller among women. However, over time the gaps turned negative, and reached levels of around -50% in 2012 pointing out twice higher non-compliance towards women. At the same time, Hungary and Latvia are countries with relatively high non-compliance measures. Our results point out the importance of including the gender dimension of minimum wage non-compliance in the discussions on minimum wage policies in those countries. In Lithuania, Poland, and Slovakia, the adjusted gender gaps in minimum wage non-compliance measure was highest (in absolute terms) and negative at the beginning of the analysed period, and over time the gender difference became closer to zero. In Romania, the gender gaps were stable over time, and in Estonia, and Slovenia there is no clear time trend and the gender gaps were quite volatile thorough the period.

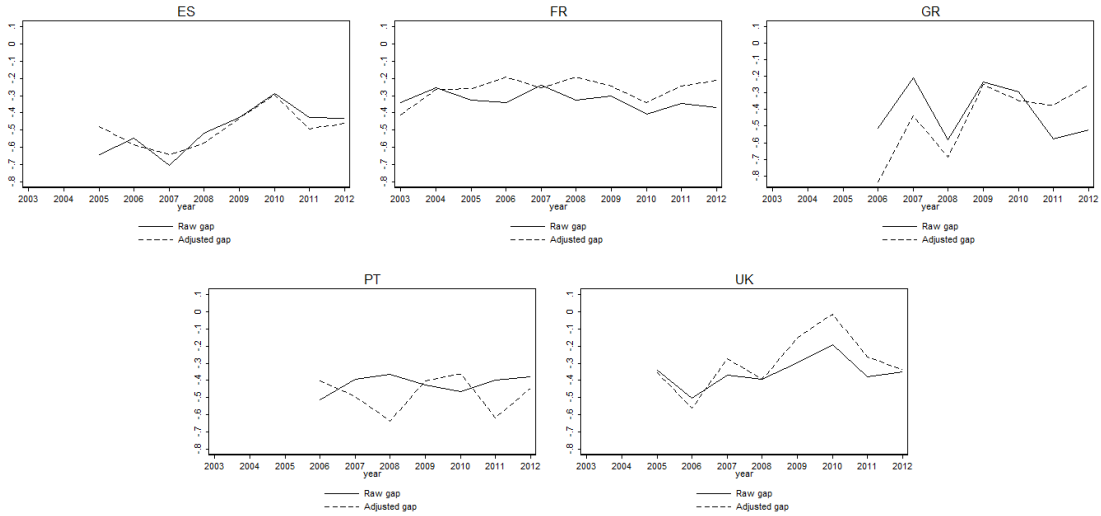
Figure 12: Gender gap in probability of receiving sub-minimum wage over time: transition countries.



Note: See Note for Figure 10.

In benchmark countries, raw and adjusted gender gaps in minimum wage violation incidence rates are similar, pointing out the inability of observable characteristics to explain those gender differences. The adjusted gaps are also negative thorough the analysed period, as the share of women receiving sub-minimum wages is higher, than this share among similar men. In France and Portugal the gender gaps are stable over time, while in Spain, Greece, and the United Kingdom they were highest (in absolute terms) at the beginning of the analysed period, and became closer to zero over time.

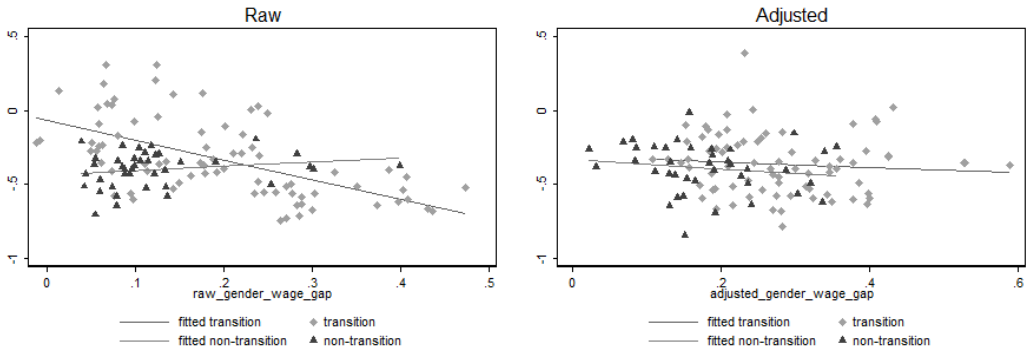
Figure 13: Gender gap in probability of receiving sub-minimum wage over time: benchmark countries.



Note: See Note for Figure 10.

As presented in Tables 6 and 8, the differences in average wages of women and men, and resulting from this differences in Kaitz indices among women and men may explain the difference in non-compliance rates among women and men. We aim to look at the correlation of gender gaps in minimum wage violation incidence rates with the gender gaps in wages. Thus, we estimate the adjusted gender wage gap at the mean using again the Ñopo (2008) methodology, and the same data and set of controlled variables as in the case of the decomposition of minimum wage violation measure. For the group of transition countries, we find that in countries where differences in wages between women and men are bigger, women more often, relatively to men, receive sub-minimum wages. This may suggest that in the countries where women have a weaker position in the labour market, which is expressed by bigger raw gender wage gaps, the violation of minimum wage laws also more often happens in the disadvantage of women. We do not see such correlation for benchmark countries. We also do not find any clear pattern between adjusted gaps in wages and adjusted gaps in non-compliance measure.

Figure 14: Gender gaps in probability of receiving sub-minimum wage and gender gaps in wages.



Note: See Note for Figure 10. Adjusted gender wage gaps calculated with the Ñopo (2008) method, controlling for the full set of available characetristics, as presented in Table 9.

5 Conclusions

In this paper we employed the EU-SILC data and methodology proposed by Bhorat et al. (2013) to analyse the minimum wage non-compliance among male and female workers in transition and benchmark countries.

Regarding the extent of minimum wage non-compliance, we find that the measures of monthly minimum wage violation are highest in Lithuania, France, Portugal, where around 7% of the analysed workers were receiving sub-minimum wages. These measures were much larger for women in all these countries. We also find that in France, Portugal, Poland, Greece, Romania, and the United Kingdom, a non-negligible share of workers receives a monthly minimum wage, but due to longer working hours does not receive its hourly equivalent. We also find that the obtained measures of non-compliance increase together with increased Kaitz index. Given the fact that women have lower average wages, the Kaitz index for this group is larger, and this is associated with larger non-compliance. We do not find significant differences in minimum wage non-compliance measures between transition and benchmark countries.

The existing literature suggests that minimum wage policies might not be effective in reducing the gender wage gaps at the bottom of the wage distribution due to higher non-compliance towards female workers. In this chapter we find that non-compliance measures are higher for women in almost all analysed countries, and observable characteristics do not explain those differences. We also find that gender differences in non-compliance are relatively stable over time in transition and benchmark countries on average, but there is important heterogeneity between countries in each country group regarding the evolution of gender gaps in non-compliance measures. Moreover, among transition countries, the raw gender gaps in non-compliance correlate with the raw gender wage gap. This points out the importance of the analysis of non-compliance with minimum wage policies, along with the analyses concentrated on employment or poverty and inequality reducing effects of those policies. As shown in this chapter, due to non-compliance with minimum wage laws, women that are disadvantaged when it comes to wages above the minimum wage threshold are also disadvantaged below the minimum wage threshold.

Appendix A Data

Data availability for the cross-country analysis of gender dimension of wage differentials is an important constrained. In order to estimate gender gaps in the most reliable way possible, it is desirable to have information on demographic characteristics and job-related characteristics. This relatively broad set of characteristics must be harmonised over time and between countries.

The biggest challenge is related to the fact that the data sources that contain comparable information for multiple countries rarely contain information on wages that is suitable for the analysis that is performed in this paper. The harmonised version of the EU Labour Force Survey (EU-LFS) that is provided by Eurostat does not have information on wages. The EU Structure of Earnings Survey (EU-SES) contains data on wages, but it is conducted only every four years and covers a non-random sample of employees.[15] Moreover, wages might be over-reported in surveys conducted among the employers, not employees.

Given these limitations, we use data from the European Union Survey of Income and Living Conditions (EU-SILC). This household survey covers workers in all types of companies. Data on individual earned income are available on a yearly basis. While respondents in most countries report total income from employment from previous calendar year,[16] the reference period for the information concerning demographic or job-related characteristics, such as the hours usually worked, is the moment when the survey was carried out. Thus, the reference periods for the information on wages and for other related information may not overlap.[17] These are well-recognised problems related to the use of EU-SILC data for the analysis of wages, see Brandolini et al. (2011), Iacovou et al. (2012), Jenkins and Kerm (2014), Massari et al. (2015).

To deal with those limitations, we follow a strategy described in the literature that recognises the need to use the EU-SILC data for the analysis of monthly and hourly wages, see Engel and Schaffner (2012): we consider only the workers who at the time of the survey (i) had only one job, and (ii) were employed full-time in all months of the previous calendar year.[18]

While such approach leads to a decrease in the number of observations, it allows us to obtain a measure of monthly and hourly wages that can be compared among workers. Table A.1 shows which years are available for each country in the EU-SILC data. Due to data limitations we exclude Russia and Croatia from the group of the analysed CEE countries. Thus, the group of transition countries analysed in this section consists of European Union New Member States (NMS) that include Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Slovakia, Slovenia, Poland, and Romania. In the group of benchmark countries we include Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, the Netherlands, Portugal, Sweden, Spain, and the United Kingdom.

EU-SILC data contain information on demographic, human capital, and job-related characteristics, which we control when estimating the adjusted gender gaps. The data were prepared for the decompositions in the following way: information on age is recoded into intervals. For education level we distinguish three levels: the first level stands for pre-primary, primary or lower secondary; the second level stands for upper secondary and post-secondary non tertiary; and the third level stands for first and second stage of tertiary education. For marital status we distinguish between two statuses, one for married individuals, and second for single, separated, divorced or widowed. For occupation variable

[15] EU-SES covers only employees in firms that employ at least 10 workers, and existing literature suggests that non-compliance with labour law regulations is more pronounced in small firms. Thus, excluding micro firms from the analysis could significantly affect the results.

[16] The two exceptions are Ireland, where the income data refer to the 12 months prior to the interview, and the United Kingdom, where the income reference period refers to the period around the date of interview with income totals subsequently converted to annual equivalents, see Jenkins and Kerm (2014).

[17] We name the data points according to the reference period of the income information; e.g. PL 2012 refers to data from the EU-SILC 2013 round in Poland, while UK 2012 refers to the EU-SILC 2012 round in the United Kingdom. We also exclude Ireland from the analysis, as the income reference periods may not overlap for women and men that we compare.

[18] The hourly wages are calculated as $w_{hourly} = \frac{w_{yearly}}{52 * hours_{weekly}}$. While moving from yearly to hourly wages definitely induces some error, we were not able to identify better data for the cross-country analyses of wages, and in the context of adjusted gender gaps estimation it is particularly important to control for hours worked whenever possible.

Table A.1: EU-SILC data availability by country.

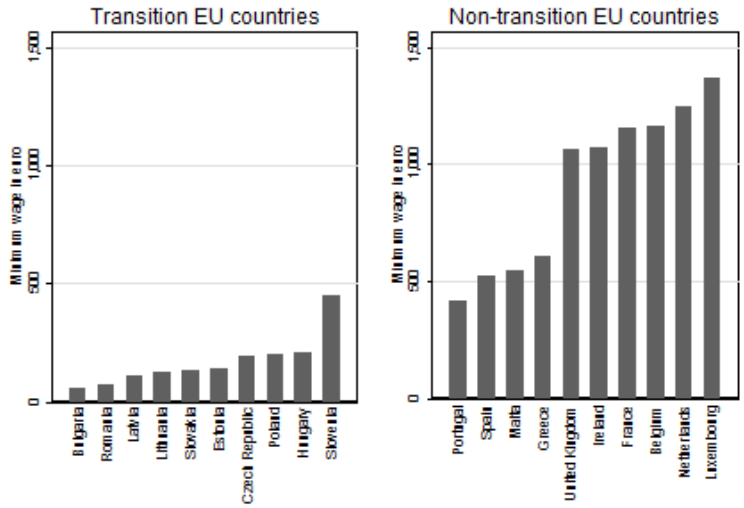
Available years	Countries
2003 - 2012	Austria, Belgium, Estonia, Finland, France, Greece, Iceland, Italy, Luxembourg, Norway, Portugal, Sweden, Spain
2004 - 2012	Cyprus, Czech Republic, Denmark, Germany, Hungary, Lithuania, Netherlands, Poland, Slovakia, Slovenia
2005 - 2013	United Kingdom
2006 - 2012	Bulgaria, Latvia, Romania
2007 - 2012	Malta, Switzerland
2009 - 2012	Croatia
2012	Russia

Note: The available years relate to the years for which income is reported. While most variables in the EU-SILC reflect the current situation of the surveyed individuals, the information on income relates mainly to the previous calendar year. Thus, the EU-SILC data from 2004-2013 in most cases provide information on incomes from 2003-2012.

we distinguish 6 categories, one for managers, professionals, and technicians and associate professionals (ISCO 1-3 categories), second for clerical support workers and service and sales workers (ISCO 4-5 categories), third for skilled agricultural, forestry and fishery workers (ISCO 6), fourth for craft and related trades workers (ISCO 7), fifth for plant and machine operators and assemblers (ISCO 8), and sixth for elementary occupations (ISCO 9). For sector we distinguish between agriculture (NACE Rev. 2 category A), industry (NACE Rev. 2 categories B - E), construction (NACE Rev. 2 category F), market services (NACE Rev. 2 categories G - N), and non-market services (NACE Rev. 2 categories O, P, Q). For firm size we distinguish three categories, one for micro firm (up to 10 workers), second for small firms (11 - 49), and third for medium and large forms (50 or more). We also distinguish between workers with permanent and temporary contracts.

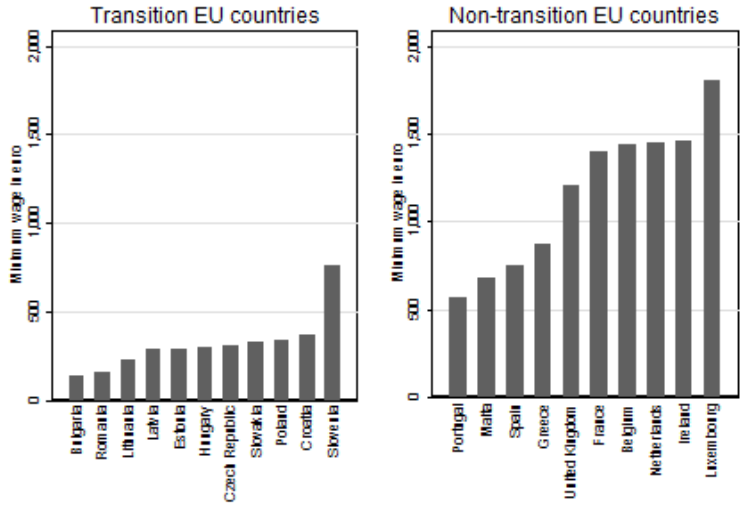
Appendix B Minimum wages in CEE

Figure B.1: Minimum wages in EUR in 2003.



Data source: Eurostat.

Figure B.2: Minimum wages in EUR in 2012.



Data source: Eurostat.

Appendix C Characteristics of workers affected by non-compliance

Table C.2: Probit regressions of minimum wage non-compliance dummy variable: models for each of transition countries

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	BG	CZ	EE	HU	LT	LV	PL	RO	SI	SK
female	0.0015	0.0114***	0.0146***	0.0105***	0.0336***	0.0184***	0.0189***	0.0178***	0.0282***	0.0185***
	(0.0014)	(0.0012)	(0.0017)	(0.0018)	(0.0033)	(0.0033)	(0.0022)	(0.0024)	(0.0024)	(0.0021)
age_below_31	0.0034	0.0023	-0.0014	0.0108***	0.0223***	0.0018	0.0119***	0.0236***	0.0391***	0.0050
	(0.0028)	(0.0016)	(0.0027)	(0.0030)	(0.0065)	(0.0050)	(0.0029)	(0.0045)	(0.0047)	(0.0031)
age_41_55	0.0014	0.0025**	0.0031*	-0.0011	-0.0169***	-0.0012	-0.0123***	-0.0057***	-0.0158***	0.0000
	(0.0016)	(0.0010)	(0.0017)	(0.0018)	(0.0034)	(0.0034)	(0.0020)	(0.0022)	(0.0024)	(0.0020)
age_above_55	0.0065**	0.0078***	0.0154***	-0.0000	-0.0156***	-0.0059	-0.0062*	-0.0112***	-0.0062	0.0083*
	(0.0028)	(0.0021)	(0.0032)	(0.0034)	(0.0040)	(0.0041)	(0.0037)	(0.0034)	(0.0052)	(0.0043)
married	-0.0008	-0.0002	0.0028**	-0.0021	-0.0002	-0.0082***	-0.0028	-0.0058**	0.0072***	0.0027
	(0.0015)	(0.0009)	(0.0014)	(0.0017)	(0.0034)	(0.0029)	(0.0022)	(0.0025)	(0.0021)	(0.0019)
medium_edu	-0.0061***	-0.0062***	-0.0017	-0.0204***	-0.0063	-0.0191***	-0.0225***	-0.0275***	-0.0130***	-0.0098**
	(0.0020)	(0.0018)	(0.0021)	(0.0026)	(0.0057)	(0.0043)	(0.0036)	(0.0037)	(0.0032)	(0.0043)
high_edu	-0.0057***	-0.0089***	-0.0069***	-0.0321***	-0.0316***	-0.0415***	-0.0426***	-0.0325***	-0.0196***	-0.0100***
	(0.0022)	(0.0012)	(0.0022)	(0.0025)	(0.0057)	(0.0042)	(0.0029)	(0.0027)	(0.0033)	(0.0037)
micro	0.0129***	0.0160***	0.0360***	0.0507***	0.1248***	0.0816***	0.0624***	0.0342***	0.0364***	0.0131***
	(0.0031)	(0.0020)	(0.0037)	(0.0033)	(0.0088)	(0.0066)	(0.0033)	(0.0049)	(0.0045)	(0.0028)
small	0.0014	0.0045***	0.0072***	0.0218***	0.0449***	0.0337***	0.0407***	0.0055**	0.0082***	0.0025
	(0.0016)	(0.0011)	(0.0018)	(0.0025)	(0.0039)	(0.0042)	(0.0029)	(0.0024)	(0.0029)	(0.0025)
temporary	0.0266***	0.0089***	0.0375**	0.0509***	0.0306***	0.0839***	0.0471***	0.0156*	0.0064*	0.0151***
	(0.0077)	(0.0020)	(0.0162)	(0.0056)	(0.0110)	(0.0174)	(0.0031)	(0.0090)	(0.0039)	(0.0040)
isco1_3	-0.0145***	-0.0178***	-0.0413***	-0.0529***	-0.0740***	-0.0626***	-0.0667***	-0.0457***	-0.0200***	-0.0384***
	(0.0020)	(0.0015)	(0.0023)	(0.0028)	(0.0046)	(0.0043)	(0.0029)	(0.0036)	(0.0039)	(0.0030)
isco4_5	-0.0054***	-0.0082***	-0.0151***	-0.0224***	-0.0376***	-0.0289***	-0.0214***	-0.0092***	-0.0135***	-0.0143***
	(0.0016)	(0.0009)	(0.0012)	(0.0020)	(0.0031)	(0.0030)	(0.0025)	(0.0029)	(0.0030)	(0.0022)
isco6	0.0020	-0.0035*	-0.0144***	-0.0007	-0.0079	-0.0101	-0.0148*	-0.0083	0.0019	-0.0201***
	(0.0049)	(0.0019)	(0.0011)	(0.0055)	(0.0114)	(0.0080)	(0.0077)	(0.0063)	(0.0151)	(0.0024)
isco7	-0.0080***	-0.0073***	-0.0176***	-0.0181***	-0.0292***	-0.0283***	-0.0236***	-0.0194***	0.0003	-0.0114***
	(0.0014)	(0.0010)	(0.0013)	(0.0022)	(0.0037)	(0.0032)	(0.0025)	(0.0026)	(0.0043)	(0.0025)
isco8	-0.0084***	-0.0074***	-0.0189***	-0.0171***	-0.0333***	-0.0295***	-0.0316***	-0.0141***	0.0051	-0.0107***
	(0.0013)	(0.0009)	(0.0013)	(0.0021)	(0.0034)	(0.0030)	(0.0022)	(0.0025)	(0.0044)	(0.0024)
agr	0.0104*	0.0037	0.0274***	0.0197***	0.0379***	0.0359***	0.0290***	0.0482***	0.0151	0.0181***
	(0.0055)	(0.0027)	(0.0056)	(0.0059)	(0.0109)	(0.0095)	(0.0083)	(0.0114)	(0.0165)	(0.0067)
con	-0.0092***	-0.0016	-0.0050*	0.0193***	-0.0026	-0.0195***	0.0105***	-0.0043	0.0094*	0.0048
	(0.0013)	(0.0015)	(0.0026)	(0.0043)	(0.0055)	(0.0045)	(0.0036)	(0.0035)	(0.0055)	(0.0039)
mser	-0.0006	0.0026**	0.0019	0.0060**	0.0047	0.0011	0.0106***	-0.0059**	0.0021	0.0049*
	(0.0019)	(0.0012)	(0.0021)	(0.0024)	(0.0042)	(0.0041)	(0.0027)	(0.0028)	(0.0029)	(0.0026)
nmser	-0.0046**	-0.0041***	0.0045*	-0.0136***	-0.0086**	-0.0145***	-0.0228***	0.0067*	0.0040	-0.0009
	(0.0019)	(0.0011)	(0.0025)	(0.0024)	(0.0043)	(0.0042)	(0.0026)	(0.0040)	(0.0034)	(0.0027)
Observations	19,788	44,770	29,992	43,464	23,618	19,331	54,395	21,275	25,317	30,941

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: For reference we omit dummies age_31_40 for people aged 31 to 40, medium_large for people working in medium or large companies, isco9 for people working in elementary occupations, and ind for people working in industry.

Table C.3: Probit regressions of minimum wage non-compliance dummy variable: models for each of benchmark countries

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	BE	ES	FR	GR	NL	PT	UK
female	0.0031*	0.0176***	0.0207***	0.0216***	0.0025**	0.0441***	0.0269***
	(0.0016)	(0.0020)	(0.0025)	(0.0034)	(0.0010)	(0.0053)	(0.0056)
age_below_31	0.0070***	0.0018	0.0275***	0.0110**	0.0021*	0.0076	0.0048
	(0.0025)	(0.0022)	(0.0039)	(0.0043)	(0.0012)	(0.0072)	(0.0068)
age_41_55	-0.0021	-0.0055***	-0.0228***	-0.0072**	0.0004	0.0007	-0.0073
	(0.0015)	(0.0017)	(0.0023)	(0.0029)	(0.0006)	(0.0049)	(0.0046)
age_above_55	0.0059	-0.0036	-0.0144***	-0.0109**	0.0008	0.0018	0.0017
	(0.0038)	(0.0026)	(0.0035)	(0.0044)	(0.0013)	(0.0082)	(0.0062)
married	-0.0020	-0.0082***	-0.0049**	-0.0106***	-0.0010*	-0.0036	-0.0075*
	(0.0014)	(0.0017)	(0.0021)	(0.0032)	(0.0006)	(0.0050)	(0.0042)
medium_edu	-0.0036**	-0.0061***	-0.0256***	-0.0050	-0.0002	-0.0325***	-0.0222***
	(0.0016)	(0.0016)	(0.0024)	(0.0031)	(0.0006)	(0.0048)	(0.0056)
high_edu	-0.0072***	-0.0132***	-0.0481***	-0.0136***	-0.0019**	-0.0563***	-0.0321***
	(0.0021)	(0.0019)	(0.0029)	(0.0039)	(0.0008)	(0.0048)	(0.0066)
micro	0.0225***	0.0312***	0.0932***	0.0318***	0.0069***	0.0926***	0.1012***
	(0.0037)	(0.0028)	(0.0045)	(0.0049)	(0.0022)	(0.0073)	(0.0095)
small	0.0016	0.0125***	0.0206***	0.0064	-0.0004	0.0228***	0.0264***
	(0.0018)	(0.0023)	(0.0027)	(0.0044)	(0.0006)	(0.0066)	(0.0071)
temporary	0.0302***	0.0666***	0.1489***	0.0497***	0.0071***	0.0762***	0.0473**
	(0.0070)	(0.0045)	(0.0084)	(0.0072)	(0.0025)	(0.0104)	(0.0233)
isco1_3	-0.0116***	-0.0181***	-0.0913***	-0.0295***	-0.0022	-0.0335***	-0.0419***
	(0.0026)	(0.0022)	(0.0040)	(0.0038)	(0.0014)	(0.0070)	(0.0089)
isco4_5	-0.0086***	-0.0099***	-0.0323***	-0.0174***	-0.0014**	-0.0226***	-0.0060
	(0.0017)	(0.0020)	(0.0026)	(0.0037)	(0.0006)	(0.0064)	(0.0070)
isco6	-0.0069**	-0.0068*	-0.0103	0.0140	0.0015	0.0456*	-0.0014
	(0.0032)	(0.0040)	(0.0077)	(0.0176)	(0.0028)	(0.0240)	(0.0196)
isco7	-0.0052***	-0.0078***	-0.0363***	-0.0111***	-0.0014**	-0.0208***	-0.0231***
	(0.0018)	(0.0022)	(0.0026)	(0.0036)	(0.0005)	(0.0069)	(0.0050)
isco8	-0.0027	-0.0074***	-0.0129***	-0.0163***	-0.0012**	-0.0131*	-0.0170***
	(0.0022)	(0.0023)	(0.0035)	(0.0031)	(0.0005)	(0.0075)	(0.0060)
agr	0.0007	0.0477***	0.0511***	0.0749**	0.0043	0.0451**	-0.0209**
	(0.0078)	(0.0094)	(0.0141)	(0.0319)	(0.0045)	(0.0209)	(0.0088)
con	0.0030	-0.0053**	0.0167***	0.0106	0.0006	0.0076	-0.0061
	(0.0033)	(0.0024)	(0.0049)	(0.0075)	(0.0012)	(0.0080)	(0.0071)
mser	0.0038*	0.0088***	0.0320***	0.0132***	-0.0001	-0.0068	0.0076
	(0.0022)	(0.0022)	(0.0035)	(0.0043)	(0.0006)	(0.0061)	(0.0057)
nmser	0.0069***	-0.0018	0.0279***	-0.0093**	-0.0008	-0.0229***	-0.0043
	(0.0025)	(0.0027)	(0.0036)	(0.0042)	(0.0006)	(0.0066)	(0.0066)
Observations	20,613	36,861	50,087	11,691	18,018	12,875	8,759

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: For reference we omit dummies age_31_40 for people aged 31 to 40, medium_large for people working in medium or large companies, isco9 for people working in elementary occupations, and ind for people working in industry.

Appendix D Decomposition method

Gender gaps are usually computed as a difference in mean of the variable of interest for men and women, and expressed as the percentage share of this difference in the mean value of women. Gender gaps calculated in such a straightforward manner are referred to as raw gaps, and they do not allow distinguishing whether measured gender differences are a reflection of differences in characteristics between women and men, or are related to other factors.

A number of decomposition methods were developed in order to allow for the estimation of the component of the observed gender gaps, that cannot be explained by differences in unequal underlying characteristics (see Fortin et al., 2011, for a methodological overview). Typically, each of these methods produces a share of the gender gap that can be attributed to differences in endowments (i.e. explained gap) and a part that cannot be captured by these factors (i.e. unexplained or adjusted gap).

In this paper we apply the non-parametric decomposition of Ñopo (2008), who employs one-to-

many perfect matching, to estimate adjusted gender gaps and assure that only "similar" individuals are compared (e.g. men and women of exactly the same age category, education, residence and family situation, occupation etc.).

As opposed to multiple parametric techniques, non-parametric alternative of Ñopo (2008) is a very universal method, that can be applied to different types of outcome variables. This is the major reason why Ñopo (2008) decomposition technique is used for the analysis in this paper. Moreover, this non-parametric technique is the only approach that tackles the issue of differences in the supports of the distributions of observable characteristics..

This decomposition allows to measure directly what part of the observed raw gap could be attributed to men being different from women.[19] The shortcoming of this technique is a trade-off between the number of characteristics to control for and the ratio between matched and unmatched observations for both men and women, which affects the external validity of findings. However, a comparative exercise conducted by Goraus et al. (2015) shows that under Ñopo (2008) decomposition the estimates with only some conditioning variables were fairly similar to those for a larger set of control factors.

Ñopo (2008) decomposes the raw gender gap in the outcome variable into four components:

- $D0$, which is the part due to differences in unobservable characteristics, or discrimination;
- DX, which is the part due to differences in observable characteristics within the common support;
- DM, which is component related to differences between unmatched and matched men[20]; and
- DF, which is due to differences between matched and unmatched women.[21]

In this paper we analyse the information whether person is receiving sub-minimum wage or not, thus our outcome variable is binary. These factors, as well as the universality of the method, stand behind the selection of the Ñopo (2008) approach for the analyses in this paper.

[19] Ñopo (2008) was not the only to use matching to measure discrimination. For example, Pratap and Quintin (2002) employed propensity score matching to measure wage differences between formal and informal sectors in Argentina.

[20] Technically, calculated as the difference between the expected men's outcomes out of the common support minus the expected men's outcomes in the common support, weighted by the probability measure (under the distribution of men's characteristics) of the set of characteristics that women's sample does not comprise.

[21] Computed as the difference between the expected women's outcomes in the common support minus the expected women's outcomes out of the common support, weighted by the probability measure (under the distribution of characteristics of women) of the set of characteristics that men's sample does not comprise.

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