

Minimum wage violation in central and eastern Europe

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Abstract. *This article analyses minimum wage violations over the period 2003–12 in ten central and eastern European countries which all have national statutory minimum wages. Using European Union Statistics on Income and Living Conditions (EU-SILC) data and the methodology proposed by Bhorat, Kanbur and Mayet (2013), the authors measure the incidence and depth of violation. In addition, they conduct regression analyses on individual, workplace and macro-level determinants of non-compliance. While the incidence of violation remains relatively low, the workers that minimum wage policies seek to protect appear to be the most likely to be affected by non-compliance. Over time, higher minimum to average wage ratios are related to a higher incidence of violation.*

The impact of minimum wage policies continues to attract the attention of researchers and policy-makers in both the developed and the developing world. Workers in countries that are undergoing a rapid increase in GDP per capita often demand that the minimum wage be raised, while minimum wage policies may also be implemented in economies that struggle with in-work poverty or wage inequality. The Great Recession sparked a renewed interest in such policies around the world (OECD, 2015). Most of the policy debate and the economic literature on minimum wages focus on employment effects (Neumark and Wascher, 2006) and, to a lesser extent, on earnings inequality (Autor, Manning and Smith, 2010) and poverty in developing (Saget,

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2001) or developed (MaCurdy, 2015) countries. Yet, even as commentators on this issue express their hopes and concerns regarding the impact of minimum wage laws on the labour market, it is important to keep in mind that enforcement of, and compliance with, these policies are also crucial factors for their success. A proper measurement of compliance and the identification of the tactics used to violate minimum wage laws are necessary in order to explain the functioning of minimum wage policies in particular countries. Ashenfelter and Smith (1979) introduced a profit-maximizing model of non-compliance that considered the probability of getting caught and the penalty incurred if caught. Basu, Chau and Kanbur (2010) showed that governments concerned only with efficiency may choose to enforce the minimum wage imperfectly in the face of costly enforcement. Bhorat, Kanbur and Stanwix (2015a) proposed a model of partial compliance whereby employers violate the minimum wage but raise wages some of the way to the minimum wage because the probability of getting caught depends on the depth of violation. Danziger (2009) argued that if workers are income risk averse and “imprudent”, an increase in the minimum wage rate raises welfare even in the presence of non-compliance. However, few empirical studies of minimum wage violations have been conducted, especially in a multi-country setting. These issues are usually analysed in respect of developing countries (see Rani et al., 2013; Bhorat, 2014; Bhorat, Kanbur and Stanwix, 2015b; Ye, Gindling and Li, 2015; Marinakis, 2016), although Garnero, Kampelmann and Rycx (2015) also provide some evidence on non-compliance (and non-coverage) in the countries of the European Union (EU).

Through this article we seek to contribute to this emerging branch of literature by analysing minimum wage violations in ten central and eastern European (CEE) countries that joined the EU in 2004 or later, by identifying the characteristics of workers who are most exposed to non-compliance and by identifying patterns of change in non-compliance over time. These countries are especially well suited to a cross-country study on this issue as they all have national statutory minimum wage systems that cover all employees, and they are at comparable levels of development. They also share the recent experience of joining the EU, which means that they have been integrated into a union in which many member countries offer higher wages for low-skilled work. The existing literature on the role played by minimum wages in CEE countries is relatively scarce and focuses on employment effects.¹ To our knowledge, this article is the first study of minimum wage violations in CEE countries.²

The remainder of the article is organized into five sections. In the first section we outline the minimum wage regulations and developments in the CEE countries under consideration. The second section presents the methodology, as proposed by Bhorat, Kanbur and Mayet (2013), that we use to ana-

¹ See Hinnoosaar and Room (2003), Eriksson and Pytlikova (2004), Fialová and Mysíková (2009), Baranowska-Rataj and Magda (2015), Kamińska and Lewandowski (2015), and Slovenia (2017).

² In this article we use “violation” and “non-compliance” as synonyms for situations in which workers covered by minimum wage regulations are paid less than the legal minimum.

lyse both the incidence of minimum wage violations and their monetary depth, and describes our data set. In the third section, we present our estimates of the violation measures over the period 2003–2012, the individual- and the firm-level correlates of non-compliance estimated with probit models, and the results of panel regressions at the country level. The fourth section presents policy experiences and discusses the institutional features of CEE countries that may have contributed to the patterns of non-compliance that we identify. In the last section, we summarize our findings and discuss the policy implications of our results.

Minimum wages in central and eastern Europe

In 2015, of the 28 EU Member States, 22 had statutory national minimum wages. Eleven of these countries were CEE countries that joined the EU in 2004 or later: Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia. This is the group of countries that we focus on in this article.³ For reasons of data availability, we have chosen to exclude Croatia. We refer to the remaining group as the CEE-10 countries. The EU countries without a national minimum wage had minimum wages at the industry (Austria, Denmark, Finland and Italy) or occupational (Cyprus) levels, usually as a result of collective bargaining. Such procedures were not followed by any of the CEE-10 countries. The minimum wage arrangements in these countries are summarized in table 1.

A common feature of minimum wage systems in the CEE-10 countries is that they cover all workers in wage employment under a single, widely known, national minimum wage.⁴ In all of the CEE-10 countries the minimum wage was set at a monthly rate, although an hourly rate was also explicitly specified in several countries. Poland, Slovakia and the Czech Republic (until 2012) had sub-minimum wage levels for young workers or labour market entrants. The Czech Republic, Hungary and Slovakia set higher minimum wage levels

³ According to Eurostat, the other EU countries with statutory national minimum wages in 2015 were Belgium, France, Germany, Greece, Ireland, Luxembourg, Malta, the Netherlands, Portugal, Spain and the United Kingdom. The national minimum wage was introduced in Germany on 1 January 2015.

⁴ The self-employed are not covered by a minimum wage in any of the CEE-10 countries. This can be an issue in cases of bogus self-employment. Although such employment represents a broader form of non-compliance with labour regulations, it may to some extent be driven by a desire to circumvent minimum wage laws. In Poland, for instance, the minimum wage is not binding for civil law contracts (a type of temporary contract). However, the use of such contracts is prohibited if a worker is economically dependent on a company. Thus, contracting an employee using a civil law contract can be interpreted as a violation of labour regulations and as a deliberate violation of minimum wage laws if the worker earns less than the equivalent of a monthly minimum wage. In practice, it is impossible to distinguish civil law contracts from other temporary contracts in available survey data as they are clustered together as temporary contracts in the EU Labour Force Survey (EU-LFS) and EU Statistics on Income and Living Conditions (EU-SILC) databases, and are not covered by EU Structure of Earnings Survey (EU-SES).

Table 1. Minimum wage arrangements in the CEE-10 countries, 2012

Country	National minimum wage	Sub-minimum level	Groups covered by sub-minimum	Higher minimum level	Groups covered by higher minimum
Bulgaria	Yes	No	—	No	—
Czech Republic	Yes	Yes	Youth (until 2012)	Yes	Six higher minimum wage levels for higher-skilled workers
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	Work experience below one year	No	—
Romania	Yes	No	—	No	—
Slovakia	Yes	Yes	Youth	Yes	Five higher minimum wage levels for higher-skilled workers
Slovenia	Yes	No	—	No	—

Notes: Higher-skilled jobs/worker groups in the Czech Republic, Hungary and Slovakia cannot be identified using the information available in the micro-level data sets, for example, at the educational (ISCED) or occupational (ISCO) level. In each case, the assignment of a particular position to a job group with a higher minimum wage depends on 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, such as teachers and 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 time limit is 35 hours instead of 40 hours. However, in accordance with the Labour Protection Law, the employer determines whether a particular occupation entails risky or dangerous working conditions by conducting an assessment of the working environment. In practice, it is impossible to identify the workers who are covered by the higher hourly minimum wage.

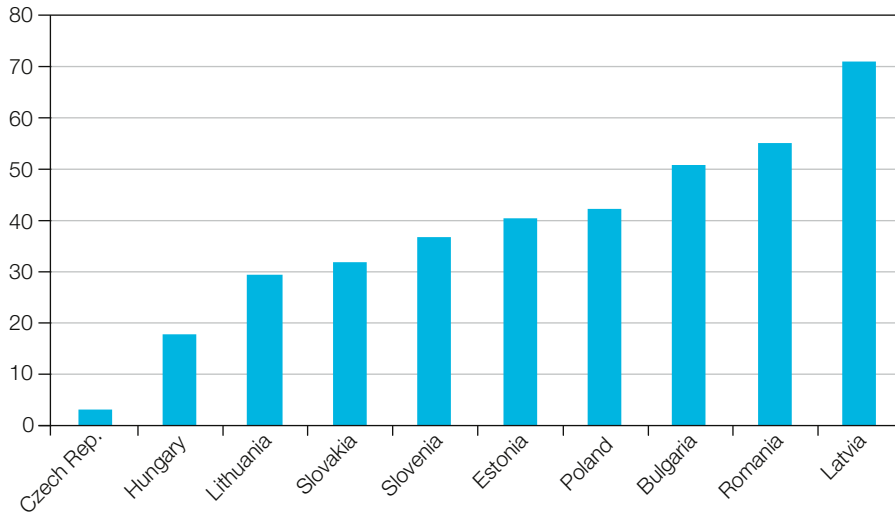
Source: Authors' elaboration based on data from OECD (2015), wageindicator.org, and country-specific sources.

for particular subgroups, such as professionals, while Latvia provided special rates for those working in risky or dangerous conditions. These additional wage floors were established at the national level, but they were not clearly defined or strictly binding (see table 1). Accordingly, our focus in this article is on compliance with basic, country-level minimum wages.

There have been no recent changes in the procedures applied to establish minimum wages in the CEE-10 countries,⁵ and the minimum wage levels have been steadily increasing in real terms and, in some countries, also relative to the average (or median) wages (see figure 1). In 2003, the CEE-10 countries had much lower ratios of nominal legal minimum to aver-

⁵ In all of the CEE-10 countries, minimum wages are set by the government following consultations with, agreements between, or recommendations by the social partners. The priorities, targets, agreements and outcomes of these processes may have changed over time, even if the basic *de jure* procedure has remained the same. We are not, however, able to analyse this issue quantitatively.

Figure 1. Total real minimum wage growth in the CEE-10 countries, 2003–12 (percentages)



Source: Authors' calculations based on Eurostat and OECD data.

age wages (Kaitz index) than the EU-15 countries.⁶ By 2012, this difference had decreased slightly, with the gap continuing to narrow over the following years. Between 2003 and 2012, the Kaitz index rose sharply in Poland, Hungary and Latvia; it remained relatively stable in Slovakia and Estonia, and decreased in the Czech Republic, Romania and Lithuania.⁷ Given that real wage growth was strong in the CEE-10 countries between 2003 and 2012, minimum wages increased in real terms by more than 30 per cent in eight of the CEE-10 countries, and by more than 50 per cent in three of these.

The simplicity of minimum wage regulations is especially desirable in countries where the levels of contract enforcement are relatively low and modern labour market institutions have a relatively short history, as is the case in the CEE-10 countries. The question that we address in this article, namely the extent to which employers in these countries comply with minimum wages, is essentially empirical.

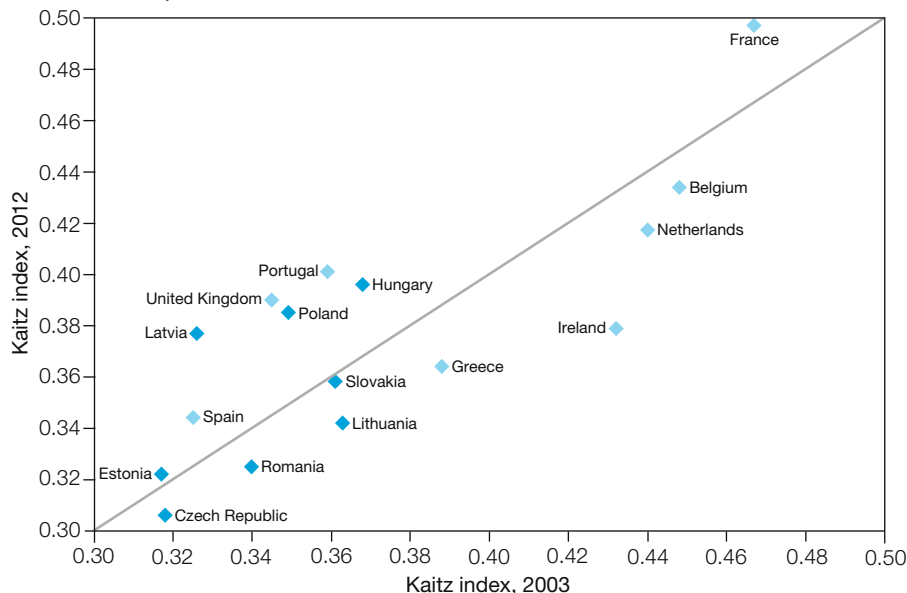
Methodology and data

We use a set of minimum wage violation measures developed by Bhorat, Kanbur and Mayet (2013) that account for both the incidence and the degree or depth of violation. Non-compliance with minimum wage laws has traditionally

⁶ Based on OECD data. Thus, figure 2 includes only the EU countries that also belong to the OECD, and have minimum wages set at the national level. Because the Eurostat data on the ratio of minimum to average wages apply to industry and services in 2003 and to industry, construction and services in 2012, they cannot be directly compared (see figure A1 in the Appendix for a comparison of the OECD and the Eurostat Kaitz indices over time).

⁷ In the cases of Romania and Lithuania, the Kaitz index increased sharply one year later. Thus in 2013 all CEE-10 countries except for the Czech Republic had Kaitz indices that were at the same level or higher than in 2003.

Figure 2. Minimum wage to average wage ratio (Kaitz index) in selected European countries, 2003 and 2012



Source: Authors' calculations based on Eurostat and OECD data.

been measured using a headcount method, looking at the share of all workers that are paid less than the applicable minimum wage. However, as such a measure provides no information about the extent of underpayment, cases in which workers earned slightly below the minimum wage are assigned the same weight as cases in which major violations occur. Using the headcount measure in isolation may also lead to an incomplete assessment of the impact of minimum wage increases, simply reflecting higher levels of non-compliance. The wages of workers who earn below the minimum rate may actually increase due to “spillover” effects or partial compliance (Bhorat, Kanbur and Stanwix, 2015a). In such cases, a measure accounting for the extent of underpayment would provide additional insight.

The index of violation used by Bhorat, Kanbur and Mayet (2013) builds on the standard Foster–Greer–Thorbecke (FGT) poverty measurement technique, and applies it to minimum wage analysis. This family of indices measures the depth of violation to differing degrees, and includes the standard headcount measure. The measure v_α of an individual violation is defined as:

$$v_\alpha = v_\alpha(w_{min}, w) = \left(\frac{w_{min} - w}{w_{min}} \right)^\alpha \quad (1)$$

where w is the worker's wage, w_{min} is the relevant minimum wage, $\alpha > 0$, and v_α is positive when $w < w_{min}$, and is 0 otherwise. When $\alpha = 1$, v_1 is the gap between the actual wage and the w_{min} , expressed as a percentage of w_{min} , and for greater values of $\alpha > 0$ the violation function places a greater emphasis on

cases in which the degree of underpayment was greater. In order to obtain the standard headcount measure, we also define v_0 as an indicator function that takes a value of 1 when $w < w_{min}$, and of 0 when $w \geq w_{min}$. A straightforward method for aggregating these individual violation measures is to take the expectation of v over the entire wage distribution. The overall violation V_α is then defined as:

$$V_\alpha = E \left[\left(\frac{w_{min} - w}{w_{min}} \right)^\alpha \right] \quad (2)$$

Under the headcount violation measure, v_0 , the overall measure is a share of underpaid workers defined as $V_0 = E[v_0]$. In this article, we focus on three measures: *incidence of violation*, or V_0 ; *depth of violation*, or V_1 ; and *average shortfall*, which is denoted as V_1/V_0 and measures the depth of the violation per underpaid worker. All three measures can be calculated for monthly or hourly wages.

The available data for a multi-country analysis of minimum wage violations in the CEE-10 countries (and similarly in the EU as a whole) are very limited. The harmonized version of the EU-LFS provided by Eurostat does not contain information on wages. The EU-SES has information on wages, but it is conducted only every four years and covers only firms with at least ten employees. Moreover, the information in the EU-SES is provided by employers, who might under-report violations of rules pertaining to wages or hours. Accordingly, the share of workers who earn up to the minimum wage is likely to be underestimated in the EU-SES. If we look at the case of Poland, for example, we can see that the share of workers who were earning wages at or below the minimum wage in the overall economy was estimated at 13 per cent in 2013 by the Polish Central Statistical Office (Statistics Poland, 2015), but at only 5 per cent in the EU-SES survey.

In the light of these limitations, we chose to use data from the EU-SILC, which is a household survey that covers workers in all types of companies.⁸ However, its focus is on household income. Data on the income (wages) of individual workers are available, but only on an annual basis. The respondents in the CEE-10 countries reported total income from wage employment for the previous calendar year. The point at which the survey was carried out constitutes the reference period for the information concerning employment characteristics, such as the number of hours usually worked. The reference periods for the information on wages and for other job-related information do not overlap.⁹ These are well-recognized limitations in the use of EU-SILC data for the analysis of wages (see Brandolini, Rosolia and Torrini, 2011; Iacovou, Kaminska and Levy, 2012; Jenkins and Van Kerm, 2014; Massari, Naticchioni and Ragusa, 2015). To offset these limitations, we follow a strategy described in the literature in order to use EU-SILC data for the analysis of monthly wages (see Engel and Schaffner, 2012): we consider only the workers who at the time

⁸ See table A1 in the Appendix for exact information on the years available for each country.

⁹ We name the data points according to the reference period of the wages. For example, Estonia 2003 refers to data from the EU-SILC 2004 round in Estonia.

of the survey (i) were in full-time employment and actually worked at least 40 hours per week (statutory full-time working hours in all of the countries analysed),¹⁰ (ii) had a single job, and (iii) were employed full time in all the months of the previous calendar year. While this approach leads to a decrease in the number of observations (see table A2 in the Appendix), it allows for direct interpretation. If the yearly income of a person who was working full time in all the months of a given year was lower than the yearly equivalent of the full-time minimum wage, there must have been at least one incidence of non-compliance with the monthly minimum wage rules. We also exclude respondents under the age of 25 from the sample, as the yearly data we use do not allow us to determine precisely when a worker moved from coverage by a sub-minimum wage for young workers or labour market entrants to coverage by a regular minimum wage. We apply equations (1) and (2) to monthly wage, w^m , and to monthly minimum wage, w_{min}^m , to obtain measures of monthly minimum wage violations v_a^m and V_a^m .

A violation of the monthly minimum wage rules, by definition, entails a violation of the hourly minimum wage rules.¹¹ However, non-compliance with the hourly wage rules also affects workers who earn at least the monthly minimum wage, but earn less per hour than the hourly equivalent of a relevant hourly minimum wage because of their (long) working hours. In all of the countries analysed, the full-time working schedule was 40 hours per week. We therefore calculate minimum hourly wages as $w_{min}^h = (w_{min}^m * 12) / (52 * 40)$. Following Engel and Schaffner (op. cit.) we construct hourly wages assuming that, for each individual, the reported number of hours usually worked applies to the entire previous calendar year. In the next step, we apply equations (1) and (2) to the hourly wage, w^h , and to the hourly minimum wage equivalent, w_{min}^h , to obtain measures of the level of hourly minimum wage violation v_a^h and V_a^h . As the assumptions required for hours worked are rather strict, we treat these results with caution, and as complementary to estimates of non-compliance with monthly minimum wage rules.

Our minimum wage violation estimates can be treated as lower-bound estimates given that some categories of workers were excluded from the sample. Such workers include those who were working part-time, for various em-

¹⁰ The vast majority of the full-time workers in the CEE-10 countries were working at least the statutory full-time weekly schedule (40 hours). The share of respondents in our sample with self-reported full-time employee status who were working at least 40 hours per week was 94 per cent. This share was highest in Slovenia (98.3 per cent), followed by Bulgaria (97.8 per cent), Romania (96.6 per cent), Hungary (96.2 per cent), Latvia (95.3 per cent), Estonia (94.4 per cent), Poland (93.3 per cent), the Czech Republic (92.0 per cent), Lithuania (89.7 per cent) and Slovakia (81.0 per cent). Some occupations, such as teachers or police officers, have specific full-time schedules, but we excluded such groups from our analysis. The exclusion of part-time employees also has smaller consequences in the case of the CEE-10 countries, than in the EU average. According to Eurostat, the share of part-time employment in the CEE-10 countries was on average equal to 5.9 per cent in 2003 and 6.4 per cent in 2012 (data for employees aged 25–64), while in the EU-28 it was 15.2 and 18 per cent, respectively.

¹¹ If we analysed part-time workers or workers with statutory full-time schedules of fewer than 40 hours per week, this would not be the case.

ployers, and those who had spells of unemployment or inactivity during the calendar year prior to the survey. There is an expectation that these categories of workers would be at greater risk of underpayment than full-time workers who were continuously employed by a single employer (Marx and Salverda, 2005; OECD, 2013). Furthermore, our results can be affected by errors in wage and working-hour reporting, in particular by the under-reporting of wages and the over-reporting of working hours, which would lead to an overestimation of non-compliance. On a positive note, the literature suggests that the under-reporting of earnings in surveys mainly affects the upper end of the distribution. Using a unique matched data set of survey (EU-SILC) and administrative data on incomes and wages in Estonia, Paulus (2015) shows that earnings reported in surveys tend to be higher than the earnings reported in tax records for relatively low-value earnings, and that the opposite is the case for relatively high-value earnings. Using the same approach as we applied to calculate the monthly wages of employees, Paulus also finds that the incidence of minimum wage violation is higher in the tax data (*ibid.*). Nevertheless, in order to perform cross-country and over-time comparisons, we need to assume that reporting bias does not differ between countries and over time.

We furthermore perform two robustness checks. First, we compare our Kaitz index calculations with those published by the OECD and Eurostat. We find that despite using a sub-sample of workers, the magnitudes and the trends of the estimated Kaitz indices are consistent with those reported by the OECD and Eurostat over the entire period of analysis (see figure A1 in the Appendix). This is shown to be particularly the case for the Czech Republic, Estonia, Hungary, Latvia, Lithuania and Poland. Romania is the only country for which we observed a non-negligible discrepancy between our calculations of the Kaitz indices and the OECD and Eurostat estimates. We therefore also perform an analysis of macro-level determinants of minimum wage violations for the country-level data set that excludes Romania. In a second robustness check, we estimate all of the non-compliance measures at the thresholds of 75 and 125 per cent of the minimum wage (following OECD, 2015). This allows for a 25 per cent joint reporting error in wages and hours.

We use Eurostat data on monthly minimum wages, which are defined as the monthly minimum wage levels for a person who worked the entire year and was paid a minimum monthly wage, as per the applicable legislation. The minimum wages provided by Eurostat also include the additional pay required by law in certain countries (e.g. the 13th or the 14th salary), recalculated to monthly terms. This approach is in line with the definition of income from wage employment reported in the EU-SILC. We do not account for higher minimum wage levels for occupations that require higher skills. The reasons for this are twofold: first, the primary focus of this article is to estimate the extent of minimum wage violations at the lower end of the earnings distribution; and second, in the CEE10 countries these higher levels (where they exist) are indicative but not binding. The question of how the existence of higher minimum wage levels for better educated and skilled workers affects the wages

or the extent of compliance is also relevant from the perspective of policy-making. This question lies beyond the scope of this article but may provide an avenue for further research.

Minimum wage violation in the CEE-10 countries

The scope of minimum wage violation

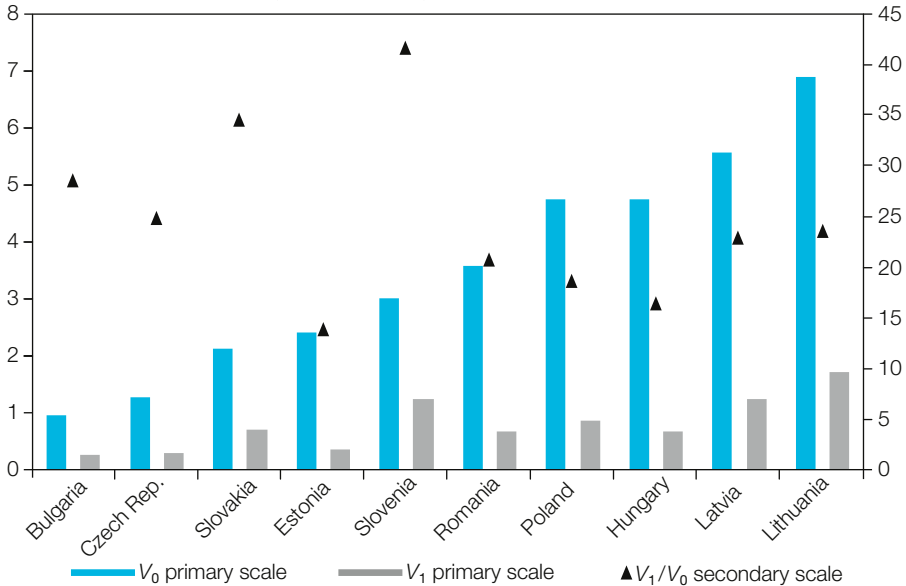
We find that the incidence of non-compliance affecting full-time workers in the CEE-10 countries was moderate, but varied considerably between countries. Over the period 2003–12, the average estimated incidence of violation of the monthly minimum wage (v_m^m) ranged from 1 per cent in Bulgaria to 1.3 per cent in the Czech Republic, around 3 per cent in Romania and Slovenia, 4.7 per cent in Poland and Hungary, 5.6 per cent in Latvia, and 6.9 per cent in Lithuania (see figure 3). By international comparison, these values are not large. Levels of non-compliance are usually much higher in developing countries. Bhorat, Kanbur and Stanwix (2015b) studied countries in sub-Saharan Africa and found that the incidence of violation ranged from 36 per cent in Zambia to 80 per cent in the United Republic of Tanzania, for an average of 58 per cent. Rani et al. (2013) analysed 11 developing and emerging countries in Africa, Asia and Latin America,¹² and estimated that the incidence of violation in the late 2000s ranged from 5 per cent in Viet Nam and 9 per cent in Mexico, to 50 per cent in Turkey and 51 per cent in Indonesia. Marinakis (2016) reported a similar range across 15 Latin American countries. Kanbur, Ronconi and Wedenoja (2013) estimated an 18 per cent average incidence of violation in Chile between 1990 and 2009. On the other hand, Ye, Gindling and Li (2015) found that the incidence of violation among full-time workers (in formal sector firms) in China stood at 3.5 per cent, or close to our results for the CEE-10 countries. Evidence in this regard for developed countries is scarce. The OECD (2015) found that, on average across the OECD countries with available data, 5.5 per cent of workers earned the minimum wage or less in 2010. However, this figure reflects both non-compliance and non-coverage. Garnero, Kampelmann and Rycx (2015) found that in the EU countries with national statutory minimum wages the share of workers earning below the minimum levels in 2008–10 ranged from 1 per cent in Bulgaria and Romania to 8 per cent in France.¹³ Data from the United States Bureau of Labor Statistics (BLS) shows that, in the United States, 2.3 per cent of workers who were over the age of 15 and were paid by the hour earned less than the hourly federal minimum wage in 2013 (BLS, 2014).¹⁴

¹² Brazil, Costa Rica, India, Indonesia, Mali, Mexico, Peru, the Philippines, South Africa, Turkey and Viet Nam.

¹³ Garnero, Kampelmann and Rycx (2015) cover five of the ten CEE countries that we analyse, and several EU-15 countries. Although they make a distinction between non-compliance and non-coverage, in the CEE economies the coverage is de jure universal. Accordingly, their results for CEE countries can be interpreted as representing the incidence of non-compliance.

¹⁴ In 2013, 75.9 million workers in the United States over the age of 15 were paid at hourly rates, representing 58.8 per cent of all workers in wage employment.

Figure 3. Monthly minimum wage violation measures in the CEE-10 countries, 2003–12 averages (percentages)



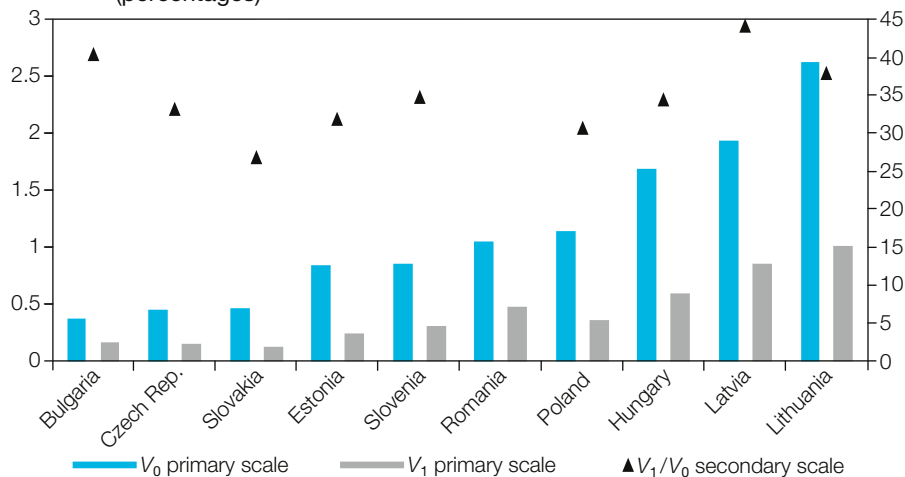
Notes: V_0 - incidence of violation; V_1 - depth of violation; V_1/V_0 - average shortfall per underpaid worker.

Source: Authors' calculations based on EU-SILC data.

In our findings, the average depth of violation per worker (V_1^m) in 2003–12 ranged from 0.3 per cent (of the country–year specific minimum wage) in Bulgaria, the Czech Republic and Estonia to 1.3 per cent in Latvia and Slovenia and 1.7 per cent in Lithuania. Such low values are not surprising considering the moderate incidence of violation. We thus find that the average shortfall per underpaid worker is a more informative measure. Figure 3 shows that, with the exception of Estonia, countries with a below-average incidence of violation exhibited above-average shortfalls that ranged from 24.7 per cent of the country–year specific minimum wage in the Czech Republic to 41.7 per cent in Slovenia for an average of 32.3 per cent across these countries in 2003–12. On the other hand, the countries with an above-average incidence of violation (and Estonia) recorded below-average shortfalls that ranged from 13.7 per cent of the country–year specific minimum wage in Estonia to 23.5 per cent in Lithuania for an average of 19.3 per cent across these countries in 2003–12.

Figures 4 and 5 present the monthly minimum wage violation measures, V_a^m , calculated for the thresholds of 75 and 125 per cent of the minimum wage, respectively. The incidence of violation (V_0^m) is obviously much lower for the 75 per cent threshold (between 0.4 per cent in Bulgaria and 2.6 per cent in Lithuania) and much higher for the 125 per cent threshold (between 4.6 per cent in the Czech Republic and 19.0 per cent in Hungary), but the country ranking is generally preserved. This same pattern is found with regard to

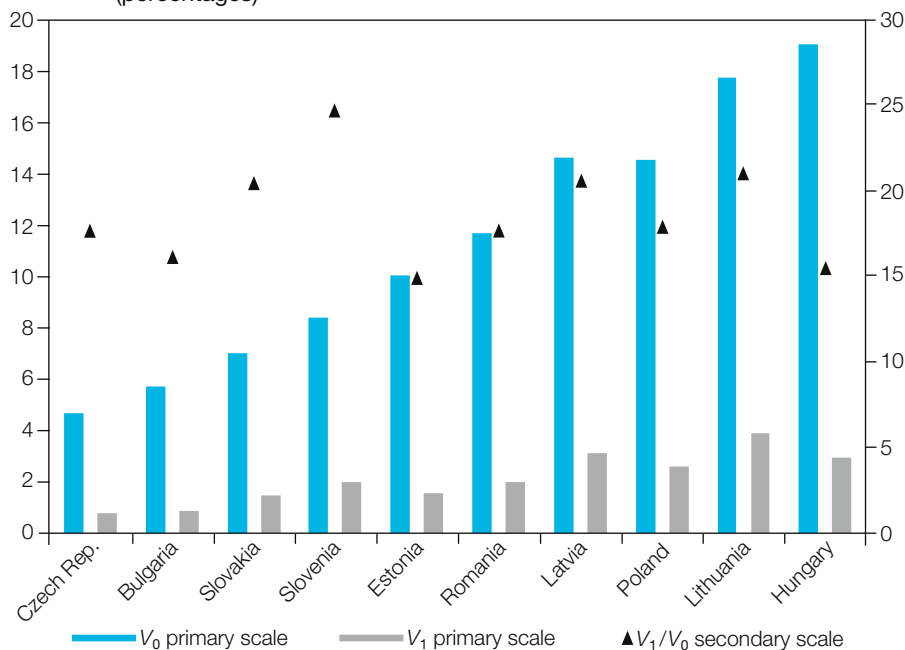
Figure 4. Monthly minimum wage violation measures in the CEE-10 countries at the threshold of 75 per cent of the minimum wage, 2003–12 averages (percentages)



Notes: V_0 - incidence of violation; V_1 - depth of violation; V_1/V_0 - average shortfall per underpaid worker.

Source: Authors' calculations based on EU-SILC data.

Figure 5. Monthly minimum wage violation measures in the CEE-10 countries at the threshold of 125 per cent of the minimum wage, 2003–12 averages (percentages)



Notes: V_0 - incidence of violation; V_1 - depth of violation; V_1/V_0 - average shortfall per underpaid worker.

Source: Authors' calculations based on EU-SILC data.

average shortfall and depth of violation. Table A3 in the Appendix shows that the cross-country correlations between all the basic measures calculated for the threshold of 100 per cent of the minimum wage and the alternative thresholds are high: above 75 per cent for the incidence of violation and above 80 per cent for the depth measures. The findings from our basic estimates are thus quite robust to changes in the threshold. Accordingly, in the remainder of the article we will present our results for the threshold of 100 per cent of the minimum wage, while selected results for the other two thresholds can be found in the Appendix.

We identify three patterns of change in the incidence of non-compliance over time (figure 6). In Bulgaria, Lithuania, Romania and Slovakia, the incidence of violation increased temporarily during the crisis of 2008–10. In 2011–12, it returned to pre-crisis levels in Bulgaria, Lithuania and Slovakia, but it decreased only slightly in Romania. The average shortfall rose in Bulgaria and Lithuania, while the average depth of violation per worker followed an inverted-U pattern. In Romania and Slovakia the average shortfall decreased over the period under analysis, and the average depth of violation per worker decreased in Slovakia and remained constant in Romania.

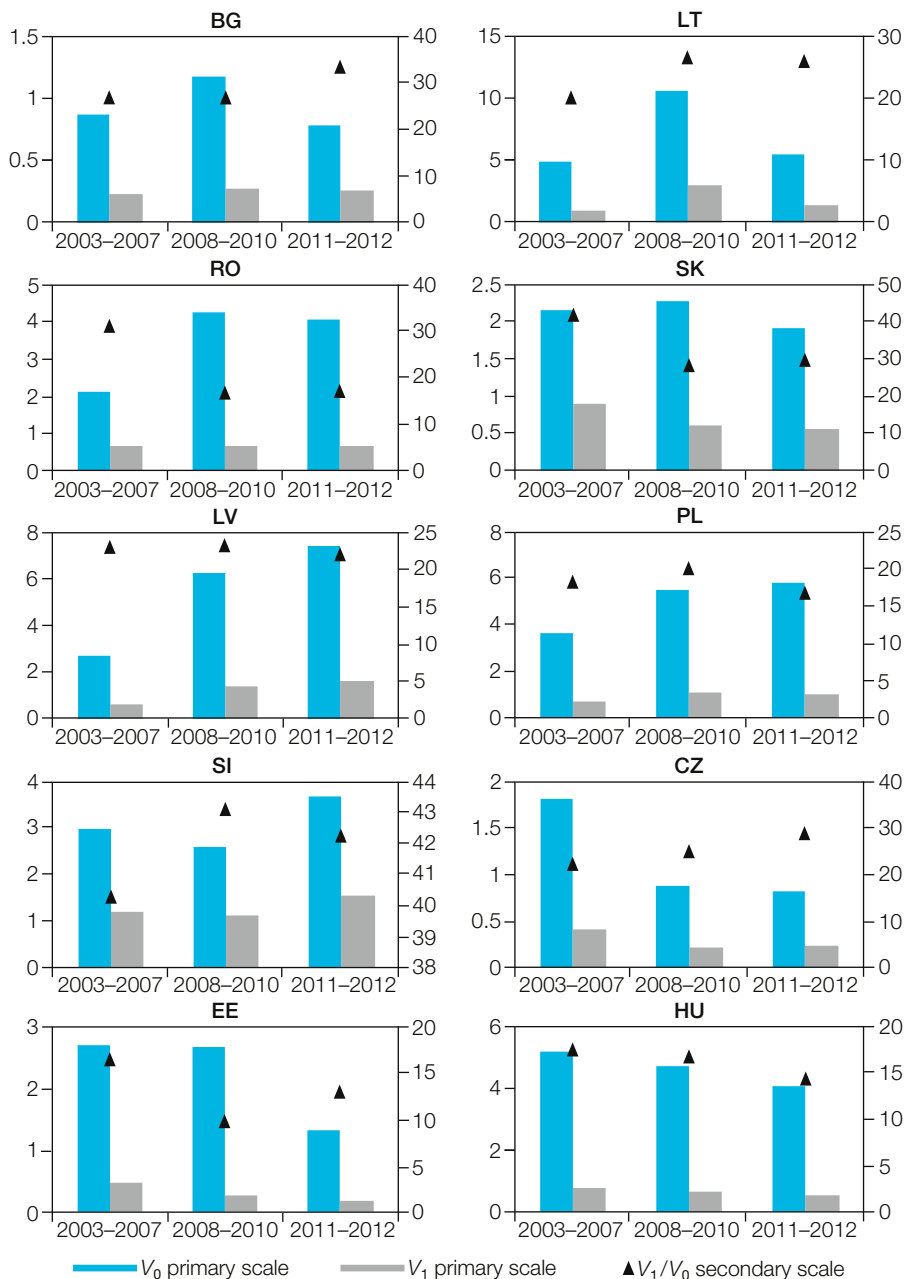
In Latvia, Poland and Slovenia, the incidence of violation rose over the period under analysis. In Latvia and Poland the increase was gradual, and the sharpest rise occurred in 2008–10.¹⁵ In Slovenia, the incidence of violation declined in 2008–10, but rose sharply in 2011–12. In all three countries, the average shortfall increased slightly in 2008–10 and declined thereafter. Overall, the average depth of violation in 2011–12 was higher than in 2003–07.

In the Czech Republic, Estonia and Hungary, and especially in these last two countries, the incidence of violation decreased over the period. The trends in the average shortfall were diverse: in the Czech Republic it increased, in Estonia it was U-shaped, and in Hungary it decreased. Nevertheless, in all three countries the average depth of violation per worker declined.

Accounting for hourly minimum wage violations, we find that the overall incidence rose by about one third, as shown in figure 7, which decomposes the average incidence of hourly minimum wage violations, V_0^h , into the incidence of monthly minimum wage violations, V_0^m (see figure 3), and the incidence of hourly minimum wage violations only, $V_0^h - V_0^m$. On average in 2003–12, this last type of violation was most pronounced in Poland (affecting 2.5 per cent of full-time workers), Romania (1.5 per cent) and Hungary (1.3 per cent); and was least pronounced in the Czech Republic (0.5 per cent), Estonia (0.6 per cent) and Lithuania (0.7 per cent). The incidence of hourly minimum wage

¹⁵ In both countries the largest minimum wage hikes occurred in 2008–10. In Latvia, 50 per cent of the total real minimum wage growth between 2003 and 2012 occurred in 2008–10 (46 per cent in nominal terms). The respective figures for Poland were 56 per cent in real terms and 48 per cent in nominal terms. Kamińska and Lewandowski (2015) show that in Poland 1.35 million more workers (out of a total of 13.55 million) were directly affected by the increase in the minimum wage between 2007 and 2008 than by the increase in the minimum wage between 2006 and 2007.

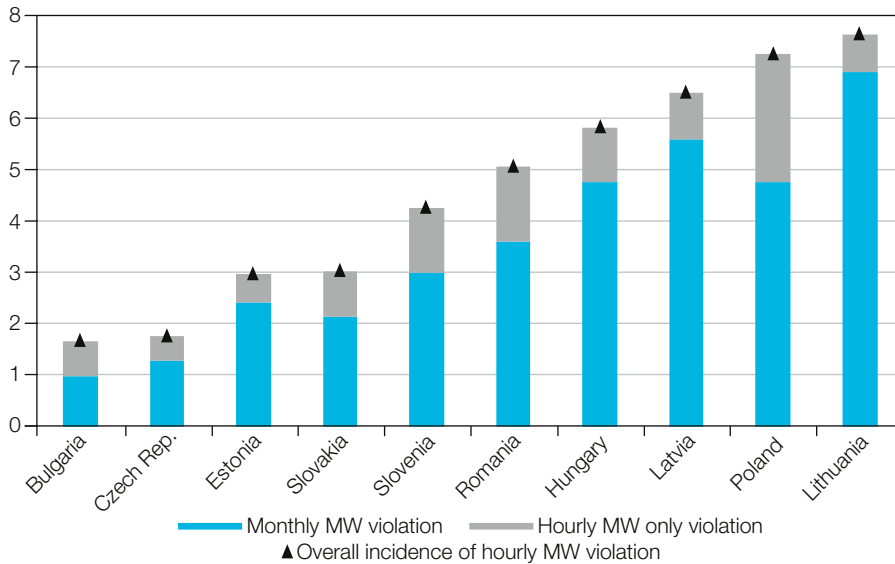
Figure 6. Monthly minimum wage violation measures in the CEE-10 countries over time, 2003–12 (percentages)



Notes: V_0 - incidence of violation; V_1 - depth of violation; V_1/V_0 - average shortfall per underpaid worker. Eurostat country codes.

Source: Authors' calculations based on EU-SILC data.

Figure 7. Incidence of hourly minimum wage violation in the CEE-10 countries, 2003–12 averages (percentages)



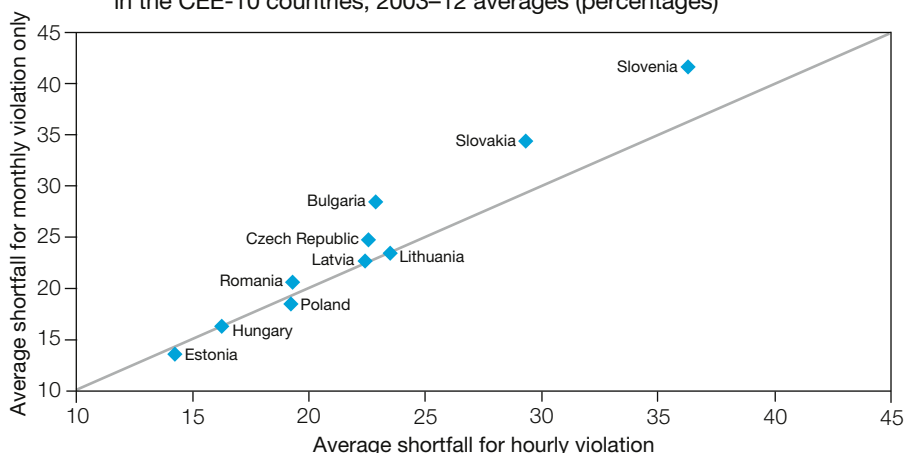
Source: Authors' calculations based on EU-SILC data.

violations among workers earning at least the monthly minimum wage ($V_0^h - V_0^m$) was moderately correlated with the incidence of monthly minimum wage violations, V_0^m , for a cross-country correlation coefficient of 32.6 per cent; but if Lithuania (which had the highest incidence of monthly minimum wage violations) is omitted, the correlation becomes solid (60.7 per cent). Thus, the only substantial difference we find when ranking the CEE-10 countries in terms of incidence of monthly minimum wage violation and incidence of hourly minimum wage violation is that Poland emerges as the country with the second-highest incidence of hourly violation.

Figure 8 indicates that the countries in which the shortfall in terms of monthly wage, V_1^m/V_0^m , was above average (Bulgaria, the Czech Republic, Slovakia and Slovenia) had a lower average shortfall in terms of hourly wage, V_1^h/V_0^h . This implies that the shortfall among workers who were earning at least the monthly minimum wage, but who were working so many hours that their hourly wages were below the hourly equivalent of the applicable minimum wage, was smaller than the shortfall among workers who were not earning the monthly minimum wage. The opposite was the case in the countries with a below-average shortfall in monthly terms (except for Lithuania). As a result, the cross-country dispersion of the average shortfall was lower for hourly wage violations than for monthly violations. The number of hours worked per week was higher in the CEE-10 countries than in the EU-15 countries,¹⁶

¹⁶ According to EU-LFS 2012 data, all of the CEE-10 countries are among the 12 countries with the highest usual weekly hours worked (the other two countries are Portugal and Greece, ranked eighth and ninth, respectively).

Figure 8. Average shortfall of monthly vs hourly underpaid workers in the CEE-10 countries, 2003–12 averages (percentages)



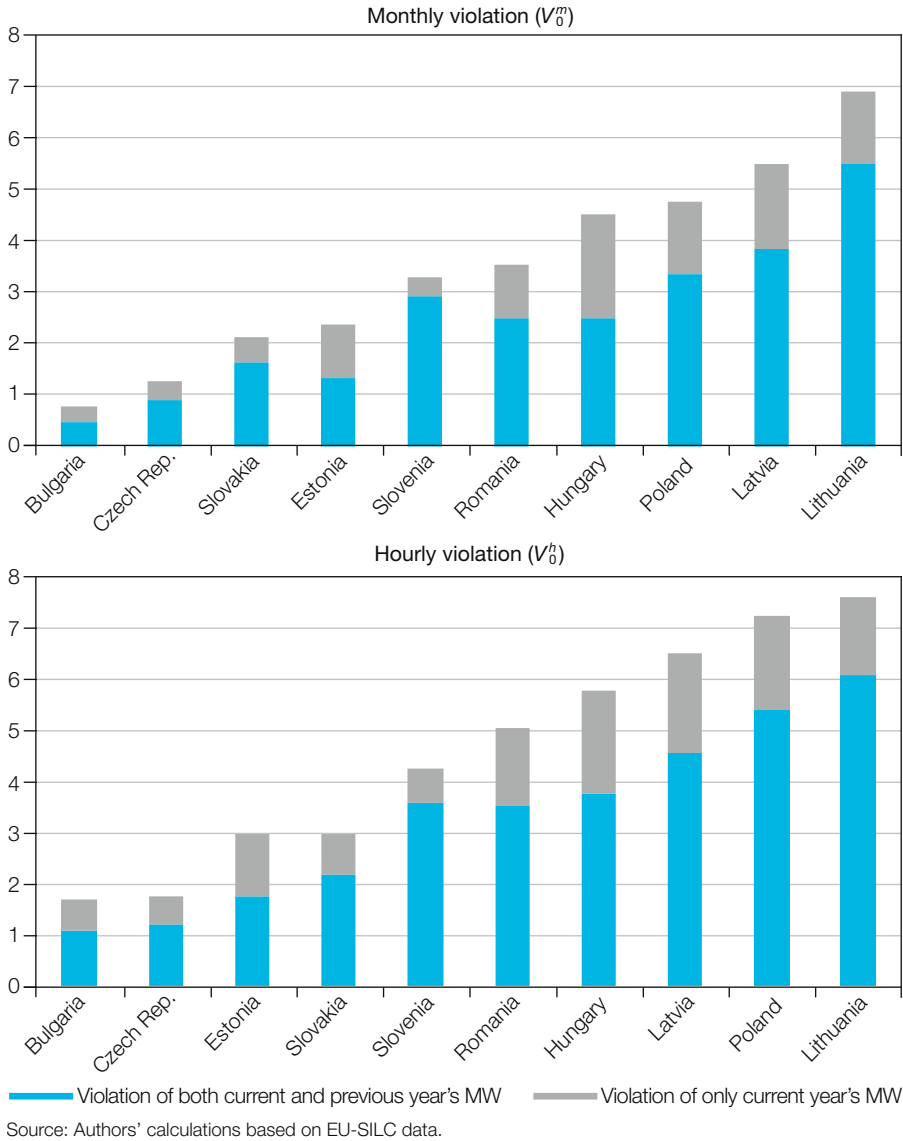
Notes: Horizontal axis - average shortfall per all workers underpaid in monthly terms or in hourly terms only; Vertical axis - average shortfall per workers underpaid in monthly terms only. Eurostat country codes.

Source: Authors' calculations based on EU-SILC data.

and our evidence suggests that in the CEE-10 extra hours might be used to ensure compliance with monthly minimum wage laws while paying sub-minimum hourly wages.

We also find that minimum wage violations in the CEE-10 countries did not result only from failure to comply with a minimum wage increase introduced in a given year. Figure 9 shows that in all the CEE-10 countries a majority of underpaid workers were earning less than both the current minimum wage and the minimum wage for the previous year. The patterns were very similar for monthly and hourly violations. On average in 2003–12, the share of such workers among all workers who were underpaid in monthly terms ranged from 55 per cent (64 per cent in hourly terms) in Hungary to 57 per cent (60 per cent) in Estonia, 80 per cent (80 per cent) in Latvia, and 89 per cent (85 per cent) in Slovenia; while the cross-country average was 70 per cent (68 per cent). There were no systematic differences in the shares of these workers between countries with high and low levels of violation. The data do not allow us to verify whether the workers whose rights were violated under the current and the previous minimum wage rules were also underpaid in the previous year, or were, for example, jobless before moving into low-paid employment. While the shares of workers who were earning less than both the current and the previous year's minimum wage among all workers affected by non-compliance were generally high, we find that the concentration of wages close to the increased minimum wage was slightly greater than at other points of the wage distribution across all the countries. The sensitivity analysis calculations at the thresholds of 75 and 125 per cent of the minimum

Figure 9. Decomposition of the average incidence of violation into violations of both the current and the previous year's minimum wage, and of the current minimum wage only, CEE-10 countries, 2003–12 (percentages)



wage (figures A2 and A3 in the Appendix) show that the shares of workers who earned less than both the current and the previous year's (proportionally adjusted) minimum wage were higher than in the benchmark case: on average, the shares were 85 per cent (78 per cent) and 73 per cent (76 per cent), respectively.

Individual and workplace characteristics of workers affected by non-compliance

In this subsection we seek to identify the individual and workplace characteristics related to minimum wage violations. To this end, we estimate a probit regression for the probability of non-compliance in hourly wage terms, v_0^h , on a pooled data set with country and time controls. We also estimate separate models for each country. The results are presented in table A4 in the Appendix and in most cases the relative importance of the various regressors is preserved.

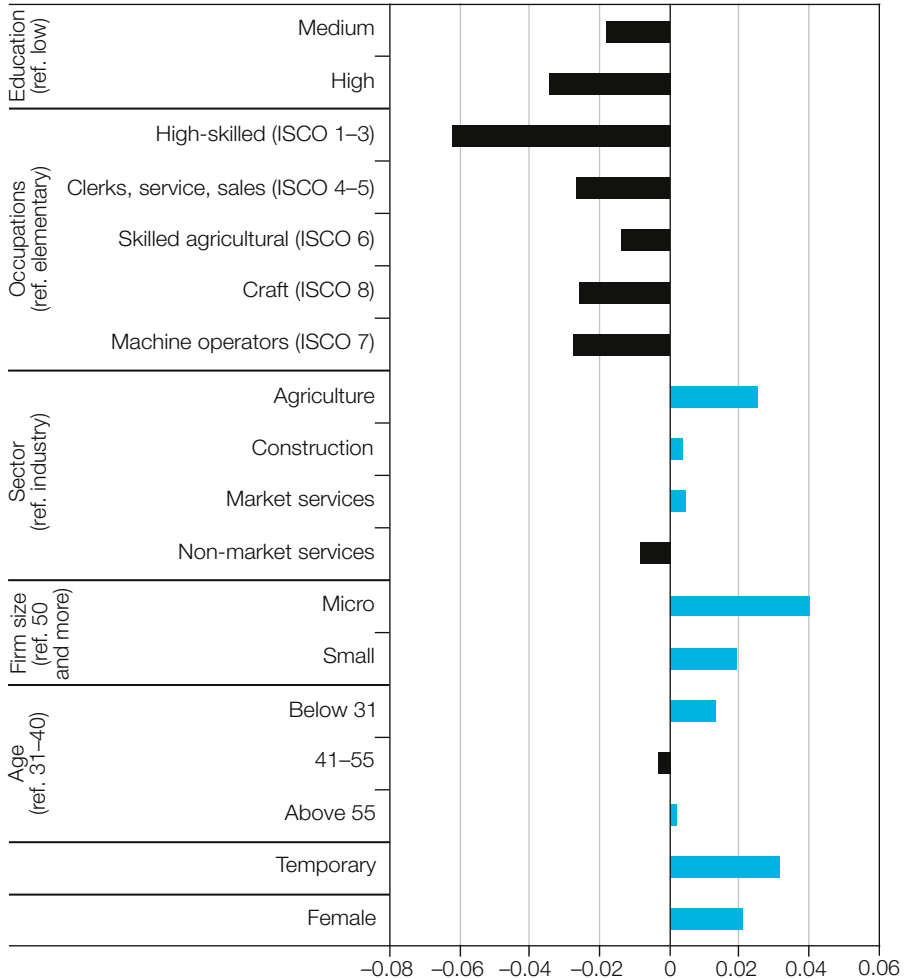
The set of significant categorical independent variables is similar to those found in the Mincerian wage regressions that are used in the literature to study the determinants of wages. The marginal effects obtained from the pooled regression (see figure 10) show that the youngest workers (aged 25–30) faced the highest probability of being affected by non-compliance, and workers aged 41–50 faced the lowest (respectively 1.3 percentage points higher and 0.4 percentage points lower than for workers aged 31–40). However, the relationship between the probability of being affected by non-compliance and age is not monotonic, in other words, workers aged 55 and above were 0.2 percentage points more likely to have experienced non-compliance than workers aged 31–40. Importantly, women were significantly more likely to have been affected by non-compliance than men: the marginal effect for women was of 2.1 percentage points, which we consider to be relatively strong.¹⁷ Our results also point to the importance of education and skills. Across the CEE-10 countries, workers with medium education levels had a 1.8 percentage point lower probability of being affected by non-compliance than workers with low levels of education, while the effect for workers with tertiary education was twice as high (3.5 percentage points).¹⁸ Workers in high-skilled occupations (managers, professionals and technicians) – in groups 1–3 of the International Standard Classification of Occupations (ISCO) – were much less likely (by 6.3 percentage points) to be affected by non-compliance (the strongest marginal effect in the model) than workers in elementary occupations. Negative and noticeable marginal effects are also found for machine operators (2.7 percentage points); clerks, sales and service workers (2.7 percentage points); and craft workers (2.6 percentage points).

The only sector in which the probability of being affected by non-compliance was lower than in industry was non-market services (–0.9 percentage points). Agriculture had the highest marginal effect of all sectors: the probability of violation was 2.5 percentage points higher than in industry. The effects for construction and market services were also positive, but small. We find a negative relationship between firm size and the probability of violation: compared to workers in firms with 50 or more employees, workers in micro firms (with fewer than 10 employees) and workers in small firms (10–49 employees) were respectively 4.0 and 1.9 percentage points more likely to be affected by non-compliance.

¹⁷ This effect is observed for both permanent and temporary workers and is even stronger, 3.1 percentage points, for the latter.

¹⁸ We define low education as levels 1–2, medium education as levels 3–4, and high education as levels 5–6 of the International Standard Classification of Education (ISCED).

Figure 10. Marginal effects from probit regression on non-compliance dummy, 2003–12 CEE-10 aggregates



Notes: All coefficients are significant at the 1 per cent level. Country dummies and time trends are included.
 Source: Authors' estimations based on EU-SILC data.

We identify a strong and positive marginal effect for temporary workers, who were 3.1 percentage points more likely to be affected by non-compliance than workers with open-ended contracts. These findings may indicate that employers in the CEE-10 countries used non-standard working arrangements to pay wages below the statutory minimum levels. Indeed, table A5 in the Appendix shows that the incidence of violation was much higher among temporary workers in all the CEE-10 countries. However, because the share of workers who were in temporary employment was relatively low in most countries, the overall incidence of violation among all workers was basically

the same as the incidence among permanent workers. The only exception is Poland (the country with the highest share of workers who were in temporary employment in the EU in 2012), where the overall incidence of violation was 1 percentage point higher than the incidence of violation among permanent workers only, given that the incidence of violation among temporary workers was 10 percentage points higher than among permanent workers. In general, the countries with the highest incidence of violation in monthly terms (V_0^m) – namely Latvia, Poland and Hungary – also had a relatively high incidence of violation in hourly wage terms only ($V_0^h - V_0^m$), and large differences in the incidence of violation between temporary and permanent workers.

The above findings are confirmed by sensitivity analysis estimations using non-compliance dummies calculated at the thresholds of 75 or 125 per cent of the minimum wage. While there are some differences in the magnitude of the marginal effects between these alternative estimations and the benchmark estimations, the relative sizes of the marginal effects (related to the highest marginal effect, estimated for high-skilled occupations) are virtually identical in each estimation (see figure A4 in the Appendix).¹⁹ The relative importance of particular characteristics is thus robust to the selection of the non-compliance threshold.

Macro-level determinants of minimum wage violation

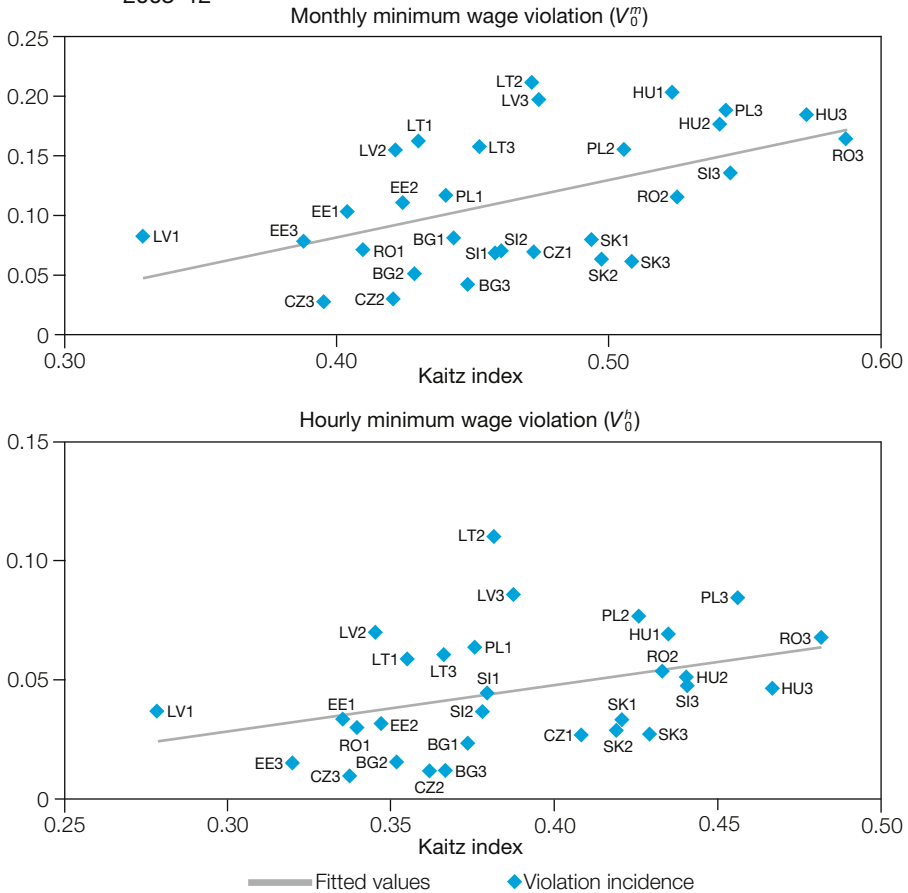
The patterns of the incidence and depth measures of violation may be related to various patterns in the development of the Kaitz index and other macroeconomic or institutional variables in particular countries. The Kaitz index did not change in Slovakia over the 2003–12 period (see figure 2 above), and in these countries the incidence of violation increased only temporarily during the crisis (see figure 6 above).²⁰ Poland and Latvia experienced strong increases in both the Kaitz index and in the incidence of violation. The Czech Republic was the only CEE-10 country with a decreasing (if only slightly) Kaitz index and a declining incidence of non-compliance. Figure 11 confirms that the Kaitz index was positively correlated with the incidence of violation in the CEE-10 countries, in line with the literature showing that a higher Kaitz index is accompanied by a higher incidence of violation.²¹

¹⁹ Detailed estimation results at the thresholds of 75 and 125 per cent of the minimum wage are available from the authors upon request.

²⁰ Romania is the only country for which there was a discrepancy between our estimate of the Kaitz index and the Eurostat and the OECD estimates. We report the results of macro-level analyses, excluding Romania, in tables A6–A8 in the Appendix.

²¹ Andalón and Pagés (2008) show that sectors and occupations with a higher Kaitz index in Kenya also have higher levels of non-compliance. Bhorat, Kanbur and Mayet (2012) find a positive relationship between the Kaitz index and the likelihood of violations for sector-occupation-location categories in South Africa. Bhorat, Kanbur and Stanwix (2015b) show that higher Kaitz indices are associated with higher levels of non-compliance in a sample of sub-Saharan African countries. Rani et al. (2013) find a positive correlation between the incidence of violations and the Kaitz index across 11 developing economies. Garnero, Kampelmann and Rycx (2015) identify a link between higher Kaitz index values and the incidence of underpaid workers at the sectoral level in a sample of EU countries.

Figure 11. Incidence of minimum wage violation vs Kaitz index in the CEE-10 countries, 2003–12

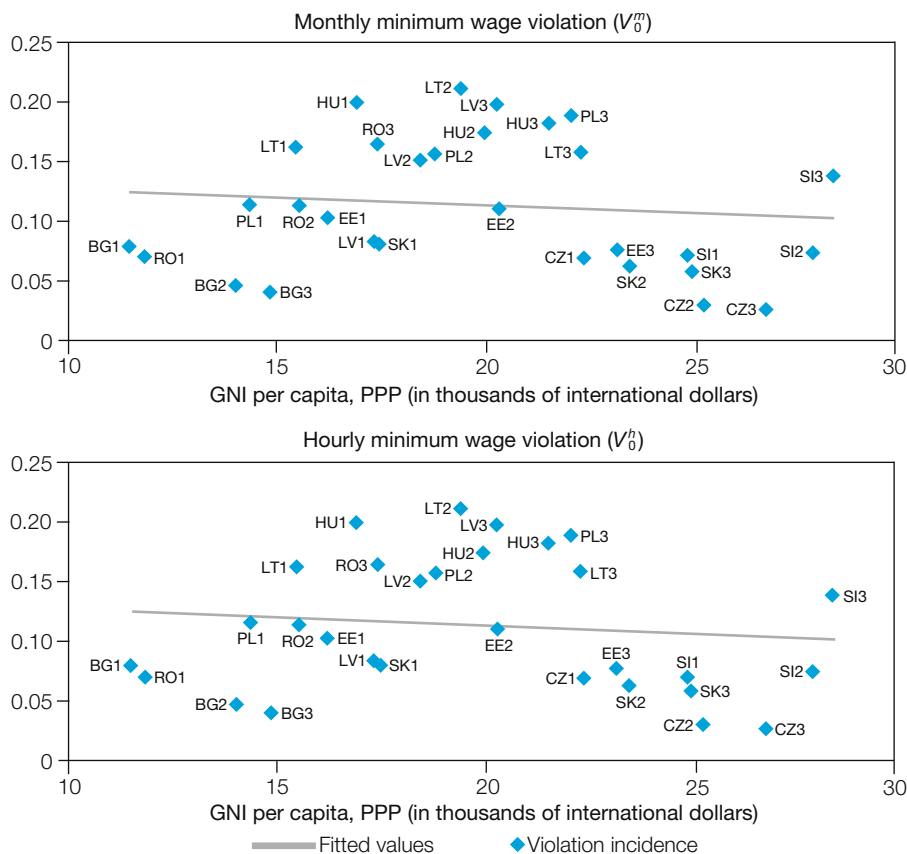


Notes: The data points marked "1" represent the period 2003–07, the data points marked "2" represent the period 2008–10, and the data points marked "3" represent the period 2011–12. Eurostat country codes.
 Source: Authors' calculations based on EU-SILC data.

As indicated above, previous studies have also shown that more developed countries usually record higher levels of compliance. However, figure 12 shows that the incidence of violation was not correlated with output (gross national income) per capita in the CEE-10 countries over the period 2003–12.

We analyse the relationship between the incidence of violation, the Kaitz index and gross national income (GNI) using a country-level panel regression. We also control for the unemployment rate, given that changes in unemployment may affect the bargaining power of workers regardless of changes in the macroeconomic conditions that affect labour demand. We focus on monthly minimum wage violations, V_0^m , but also estimate models for violations of the hourly minimum wage, V_0^h , as a robustness check. The estimation results, using fixed effects, suggest that within countries an increase in the Kaitz index

Figure 12. Incidence of minimum wage violation vs GNI per capita (in PPP) in the CEE-10 countries



Notes: The data points marked "1" represent the period 2003–07, the data points marked "2" represent the period 2008–10, and the data points marked "3" represent the period 2011–12. The GNI per capita is reported in thousands of current international dollars. Eurostat country codes.

Source: Authors' calculations based on EU-SILC and *World Development Indicators* data.

translated into a higher incidence of violation (see table 2). A 1 percentage point increase in the Kaitz index was, on average, associated with a 0.27 percentage point increase in the incidence of monthly minimum wage violations. However, no significant relationship was found in the between-country variation. Moreover, within countries the unemployment rate was significantly and positively related to the incidence of monthly minimum wage violation (a 10 per cent increase in the unemployment rate was associated with a 0.01 percentage point increase in the incidence of violation), but there was no significant between-country relationship. Table 2 shows that for hourly minimum wage violations the findings for the Kaitz index are the same, and the effect is, in absolute terms, even stronger. GNI per capita becomes significant in this specification (an increase in the GNI per capita of one thousand current

Table 2. Relationship between the incidence of minimum wage violation (V_0), the Kaitz index, GNI and the unemployment rate in the CEE-10 countries: Panel regression

Variables	(1)	(2)	(3)	(4)
	Monthly violation (V_0^m) Between-effects	Monthly violation (V_0^m) Fixed-effects	Hourly violation (V_0^h) Between-effects	Hourly violation (V_0^h) Fixed-effects
Unemployment rate	0.0031 (0.0032)	0.0010* (0.0006)	0.0034 (0.0036)	0.0007 (0.0006)
GNI per capita (PPP)	-0.0001 (0.0019)	-0.0010 (0.0006)	-0.0005 (0.0021)	-0.0020*** (0.0006)
Kaitz index	0.1052 (0.2123)	0.2745*** (0.0545)	0.1948 (0.2325)	0.3518*** (0.0530)
Constant	-0.0289 (0.1001)	-0.0564*** (0.0192)	-0.0456 (0.1096)	-0.0520*** (0.0186)
Observations	85	85	85	85
R-squared	0.151	0.378	0.209	0.487
No. of countries	10	10	10	10

***, ** and * indicate significance at the 1, 5 and 10 per cent levels, respectively.

Note: Standard errors are indicated in parentheses.

Source: Authors' estimations based on EU-SILC, Eurostat and World Bank data.

international dollars was associated with a 0.2 percentage point decrease in the incidence of hourly minimum wage violations).

This suggests that different developments in the Kaitz index (and macroeconomic variables) within countries can explain trends in the incidence of violation within the CEE-10 countries, but that differences in the Kaitz index (and macroeconomic variables) between countries cannot explain the trends in the average incidence of violation levels between the CEE-10 countries.²²

We also estimate analogous, country-level panel regressions with the depth of non-compliance or the average shortfall as an explanatory variable. We find that (as in the case of the incidence of violation) the higher the Kaitz index, the greater the depth of violation (V_1). According to our estimates (table 3), a 1 percentage point increase in the Kaitz index was associated with a 0.05 percentage point increase in the depth of monthly violations and with a 0.07 percentage point increase in the depth of hourly violations. A higher GNI per capita was associated with a significantly smaller depth of violation (only in the specification for hourly violations), and a higher unemployment rate with a significantly greater depth of violation, but both these effect were small. The between-country effects were insignificant for both the Kaitz index and GNI per capita. This suggests that both these variables were related to

²² The insignificant estimates of the between-country parameters could be related to the small sample size, but we also ran separate regressions using the Kaitz index and GNI per capita as explanatory variables only, and the results were essentially the same. These are available from the authors upon request.

Table 3. Relationship between the average depth of minimum wage violation (V_1), the Kaitz index, GNI and the unemployment rate in the CEE-10 countries: Panel regression

Variables	(1)	(2)	(3)	(4)
	Monthly violation (V_1^m) Between-effects	Monthly violation (V_1^m) Fixed-effects	Hourly violation (V_1^h) Between-effects	Hourly violation (V_1^h) Fixed-effects
Unemployment rate	0.0007 (0.0008)	0.0004** (0.0002)	0.0009 (0.0009)	0.0004** (0.0002)
GNI per capita (PPP)	0.0004 (0.0005)	-0.0002 (0.0002)	0.0003 (0.0005)	-0.0004** (0.0002)
Kaitz index	0.0116 (0.0542)	0.0526*** (0.0172)	0.0304 (0.0574)	0.0668*** (0.0171)
Constant	-0.0105 (0.0256)	-0.0115* (0.0061)	-0.0148 (0.0271)	-0.0098 (0.0060)
Observations	85	85	85	85
R-squared	0.172	0.264	0.173	0.324
No. of countries	10	10	10	10

***, ** and * indicate significance at the 1, 5 and 10 per cent levels, respectively.

Note: Standard errors are indicated in parentheses.

Source: Authors' estimations based on EU-SILC, Eurostat and World Bank data.

the within-country developments, also in the case of the depth of violation. The results for hourly minimum wage violations are consistent with those for monthly violations, and show higher values in absolute terms.

Table 4 shows that there was no robust relationship between the average shortfall (V_1/V_0) and the Kaitz index, and no significant relationship between unemployment rate and GNI either between or within countries. The Kaitz index coefficient is significant only in the fixed-effects regression on the hourly violation measure, and it is significant only at the 10 per cent level. We thus conclude that the positive within-country relationship between the average depth of violation and the Kaitz index resulted from a positive relationship between the Kaitz index and the incidence of violation. A higher Kaitz index is related to a higher incidence of violation (V_0) and, as there was no robust pattern in terms of the gap per underpaid worker (V_1/V_0), the average depth of violation (V_1) also turned out to be greater.

Tables A6–A8 in the Appendix present the results of robustness tests: estimates of panel regressions applied to violation measures calculated at the thresholds of 75 and 125 per cent of the minimum wage, and to benchmark violation measures in the sample excluding Romania. The significance of the Kaitz index and the sign of the estimated parameter were preserved in all of the alternative specifications, except for the Kaitz index coefficient pertaining to hourly average shortfall, which proves insignificant in the alternative specifications and confirms our interpretation of the benchmark regression. The significance of the coefficients for GNI per capita and unemployment rate changes in some specifications, but their sign is preserved.

Table 4. Relationship between the average shortfall (V_1/V_0) the Kaitz index, GNI and the unemployment rate in the CEE-10 countries: Panel regression

Variables	(1)	(2)	(3)	(4)
	Monthly violation (V_1^m/V_0^m) Between-effects	Monthly violation (V_1^m/V_0^m) Fixed-effects	Hourly violation (V_1^h/V_0^h) Between-effects	Hourly violation (V_1^h/V_0^h) Fixed-effects
Unemployment rate	0.0013 (0.0132)	0.0029 (0.0028)	0.0025 (0.0092)	0.0029 (0.0020)
GNI per capita (PPP)	0.0122 (0.0078)	-0.0012 (0.0028)	0.0102 (0.0054)	-0.0004 (0.0019)
Kaitz index	0.1640 (0.8658)	-0.3710 (0.2558)	0.1493 (0.5998)	-0.3161* (0.1757)
Constant	-0.0636 (0.4082)	0.3786*** (0.0899)	-0.0474 (0.2828)	0.3272*** (0.0617)
Observations	85	85	85	85
R-squared	0.297	0.041	0.378	0.059
No. of countries	10	10	10	10

***, ** and * indicate significance at the 1, 5 and 10 per cent levels, respectively.
 Note: Standard errors are indicated in parentheses.
 Source: Authors' estimations based on EU-SILC, Eurostat and World Bank data.

Discussion

Rani et al. (2013) argued that high minimum wage levels and complex legal provisions (resulting from, for instance, multiple wage floors for different types of workers) are key explanatory factors for non-compliance. As regards European countries, Garnero, Kampelmann and Rycx (2015) found that the link between higher Kaitz index values and the incidence of minimum wage violation is significantly weaker in systems with a national wage floor. As all of the CEE-10 countries have national wage systems with statutory minimum wages, the differences between them in relation to the incidence of violation cannot be related to a multiplicity of wage floors or to sectoral differences in terms of coverage. The short period covered by our analysis and the data gaps pertaining to measures of labour market institutions and the functioning of labour inspection systems prevent us from analysing the relationship between non-compliance and institutions quantitatively.²³ In this section, however, we identify potential factors which may have contributed to the patterns of non-compliance that we have identified.

The low effectiveness of labour inspection has been a matter of concern in several of the CEE-10 countries. Table 5 shows that some of the countries which, according to our results, recorded a high incidence of non-compliance, recorded a relatively low number of labour inspectors per 10,000 workers (Hungary and Latvia) or a relatively low number of inspections per inspector

²³ For instance, ILO statistics on labour inspection are available for only 39 out of the total 85 country-year data points covered by our sample.

Table 5. Descriptive statistics on labour inspection in the CEE-10 countries, 2009–14 averages

	Bulgaria	Czech Republic	Estonia	Hungary	Latvia	Lithuania	Poland	Romania	Slovakia	Slovenia
Inspectors per 10,000 workers	1.1	1.0	0.7	0.8	1.3	1.6	1.3	2.1	1.4	0.8
Annual visits per inspector	172	71	103	81	94	64	49	132	210	212

Source: Authors' calculations based on ILOSTAT data.

(Lithuania and Poland). Previous literature on the Baltic States has indicated that non-compliance with labour regulations was pervasive and was attributed to insufficient monitoring and to the lengthiness of labour court cases (Paas and Eamets, 2006). As regards Poland, it has been argued that the organization of the labour inspection system discourages inspectors from tackling serious cases that would need to be referred to the labour courts, given that inspectors are not rewarded for resolving such cases. They have targets to meet in terms of the number of fines that they issue and, therefore, choose to focus on small infringements, such as missing documents and workers with outdated health and safety training. Moreover, underpayment may not have been perceived as the priority challenge for inspectorates in CEE countries due to a focus on widespread non-compliance with employment protection legislation, as in the case of the Baltic States and Hungary (*ibid.*), or on firms that are not paying wages on time – or even at all – as in the case of Poland, according to the Polish Chief Labour Inspectorate's annual reports.²⁴ Unfortunately, there are no comparable and consistent data on the amounts of fines issued for non-compliance in particular countries over the period of our study.

Moreover, to the best of our knowledge, the CEE countries have not allowed anonymous reporting of minimum wage violation, which has proved to be an effective way of improving compliance in other countries (Gindling, Mossaad and Trejos, 2015). Nor have these countries been using name-and-shame campaigns. Such a policy was introduced only recently in Lithuania, which exhibits a particularly high incidence of non-compliance in our results. In 2015, it accordingly published a list of 40,000 companies that underpaid workers (Eurofound, 2017). However, this move was implemented outside the period of our analysis so it is not reflected in our results.

On the other hand, the large shortfall seems to bear a stronger relationship with the over-representation of some types of workers (who tend to be paid less) than with institutional factors (it is uncorrelated with the Kaitz index). For instance, in Slovenia, which recorded the largest average shortfall,

²⁴ Available at: <https://www.pip.gov.pl/en/about-us/summary-of-nli-s-annual-report> [accessed 2 May 2019].

non-compliance affected young workers, female workers, employees in small firms and workers in services to a higher degree than in other countries (see table A4 in the Appendix).

Conclusions

In this article we study non-compliance with minimum wages in the CEE-10 countries – ten central and eastern European countries that have joined the EU since 2004 and have statutory national minimum wages. Although enforcement and compliance are key elements for any minimum wage policy to achieve its goals, they are rarely analysed. This can be partly explained by a lack of data availability. None of the EU-wide surveys provide monthly wage data directly reported by workers, which would allow an analysis of minimum wage violations across all workers. In order to quantify minimum wage violations in the CEE-10 countries, we use EU-SILC data and restrict our sample to full-time workers who had a single job and were in full-time employment in every month of the calendar year prior to the survey. Consequently, our results should be taken as lower-bound estimates of the incidence of minimum wage violations. Better data are needed in order to understand the channels of minimum wage policy violations and design evidence-based policies to improve compliance.

Using the methodology proposed by Borat, Kanbur and Mayet (2013), we analyse the incidence of violation and its monetary depth. We find that on average over the period 2003–12, the estimated incidence of monthly minimum wage violations ranged from 1 per cent in Bulgaria to 6.9 per cent in Lithuania. These values are much lower than those found in developing countries, but are similar to those estimated for the United States, other EU countries and China. Violations in terms of hourly wage only, in other words, violations affecting workers earning at least the monthly minimum wage but less than its hourly equivalent due to extra unpaid hours, were especially noticeable in Poland, Romania and Hungary. In all CEE-10 countries, non-compliance reflected not only the violation of the current minimum wage but also a more systematic underpayment. Accordingly, most of the workers affected by non-compliance were also earning less than the minimum wage applicable a year earlier, creating a noticeable depth of violation. The average monetary shortfall ranged from 13.7 per cent of the country–year specific minimum wage in Estonia, to 41.7 per cent in Slovenia. In all the CEE-10 countries, workers affected by violations earned not only less than the current minimum wage, but also less than the minimum wage prior to the most recent increase. Using probit regression we find that women, individuals with a low-level of education, and workers in services or agriculture, in micro firms and with temporary contracts were more likely to be affected by non-compliance across all CEE-10 countries.

We also run a series of country-level panel regressions to understand relationships between patterns of violation, minimum to average wage ratios (Kaitz index), output (GNI) per capita and unemployment rate. We find that

higher Kaitz index estimations were associated with higher non-compliance. This effect was present within countries over time, but not between them. On the other hand, higher GNI was related to a lower incidence of violation, also within countries. The average shortfall per worker subject to minimum wage violations was not related to Kaitz index estimates, GNI or unemployment rate in the CEE-10. Thus, the fact that the average depth of violation per worker was positively related to the Kaitz index and negatively related to GNI per capita, resulted from a higher incidence of violation related to higher Kaitz or lower GNI. These findings are found to be robust to alternative wage thresholds and panel regression specifications.

Our findings show that the workers who are supposed to be protected by minimum wage policies are, in fact, the most likely to be affected by non-compliance, and that higher minimum wages (relative to average wage) are related to a higher incidence of non-compliance in the CEE-10 countries. Policy-makers considering minimum wage hikes should take this trend into account. Large hikes may increase non-compliance and the workers likely to be affected are those with the weakest bargaining power. It is thus crucial to find the right balance between minimum wage increases, employers' willingness and ability to pay low-earners more, and enforcement costs. A minimum wage increase that would lead to a rise in non-compliance and require a substantial enforcement effort is not meaningful. Nevertheless, enforcement can be enhanced by simplifying the reporting of minimum wage violations. For instance, anonymous and simple telephone hotlines have proved effective in some countries (Gindling, Mossaad and Trejos, 2015). Penalties and due wage top-ups can be levied without referral to the labour courts, especially in the case of repeated infringements. The effects of name-and-shame policies, such as the policy introduced in Lithuania in 2015 (Eurofound, 2017), should be evaluated and the lessons learned should be communicated to other CEE countries. Furthermore, some firms and workers may actually not be aware of currently binding minimum wages, calling for wider communication on policies – in particular hikes, but also fines – drawing on collaboration with the social partners.

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Appendix

Table A1. EU-SILC data availability by country (CEE-10 countries)

Available years	Countries
2003 –12	Estonia
2004 –12	Czech Republic, Hungary, Lithuania, Poland, Slovakia, Slovenia
2006 –12	Bulgaria, Latvia, Romania

Notes: 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 to the previous calendar year. Thus, the EU-SILC data from 2004–13 provide information on incomes for 2003–12.

Source: Author's compilation based on EU-SILC data.

Table A2. Number of observations per CEE-10 country (total, after applying consecutive restrictions)

Country	Total	Employees	Information on wages	Working full-time	Single workplace	Worked 12 months last year	Above the age of 25
Bulgaria	87 413	67 671	39 513	37 852	37 150	28 628	26 010
Czech Republic	154 793	128 079	71 879	64 409	62 844	54 466	48 843
Estonia	112 529	88 816	56 950	50 858	48 960	38 674	34 466
Hungary	179 963	142 950	80 752	75 070	73 397	56 906	50 970
Latvia	101 279	85 281	42 045	38 598	37 145	27 464	24 192
Lithuania	97 091	79 468	44 276	38 469	36 080	29 298	26 835
Poland	296 766	192 064	105 918	93 028	85 913	69 161	60 490
Romania	113 704	68 672	36 130	35 635	33 938	32 651	29 460
Slovakia	120 434	93 565	59 425	47 366	46 777	39 845	34 495
Slovenia	223 265	145 669	104 656	100 026	97 566	83 237	75 927

Source: Authors' calculations based on EU-SILC data.

Table A3. Correlations between the minimum wage violation measures calculated for the thresholds of 75 and 125 per cent of the minimum wage and the benchmark measures calculated for the threshold of 100 per cent of the minimum wage, CEE-10 countries (percentages)

	Monthly minimum wage violation			Hourly minimum wage violation		
	V_0^m	V_1^m	V_1^m/V_0^m	V_0^h	V_1^h	V_1^h/V_0^h
75% threshold	76	95	90	79	92	90
125% threshold	92	84	78	93	88	81

Notes: V_0 - incidence of violation; V_1 - depth of violation; V_1/V_0 - average shortfall per underpaid worker.

Source: Authors' calculations based on EU-SILC data.

Table A4. Marginal effects from probit regression on non-compliance dummy for the CEE-10 countries

	BG	CZ	EE	HU	LT	LV	PL	RO	SI	SK
Results from the regression on the pooled sample (country dummy coefficients)										
	-0.052	-0.048	-0.030	-0.013	-0.002	-0.004	ref	-0.008	-0.016	-0.035
Results from separate regressions by country										
Results from the regression on the pooled sample										
Education (ref. low)	-0.018	-0.009	n.s.	-0.024	n.s.	-0.021	-0.027	-0.034	-0.016	-0.012
Medium	-0.035	-0.010	-0.020	-0.011	-0.052	-0.040	-0.066	-0.065	-0.027	-0.015
High	-0.063	-0.023	-0.030	-0.067	-0.077	-0.078	-0.087	-0.095	-0.026	-0.044
Occupations (ref. elementary)										
High-skilled (ISCO 1-3) clerks, service and sales (ISCO 4-5)	-0.027	-0.009	-0.018	-0.029	-0.035	-0.050	-0.028	-0.024	-0.019	-0.019
Skilled agricultural (ISCO 6)	-0.014	n.s.	n.s.	-0.040	n.s.	n.s.	-0.025	-0.022	n.s.	-0.043
Craft (ISCO 7)	-0.026	-0.013	-0.015	-0.039	-0.030	-0.033	-0.03	-0.043	n.s.	-0.014
Machine operators (ISCO 8)	-0.028	-0.015	-0.017	-0.040	-0.025	-0.043	-0.044	-0.030	n.s.	-0.014
Sector (ref. elementary)										
Agriculture	0.025	0.010	n.s.	0.026	0.021	0.032	0.028	0.030	0.038	0.019
Construction	0.003	-0.020	n.s.	-0.008	0.021	n.s.	-0.030	0.011	n.s.	0.013
Market services	0.004	n.s.	0.004	n.s.	0.008	n.s.	0.014	-0.009	n.s.	0.006
Non-market services	-0.009	-0.006	-0.006	0.006	-0.020	-0.009	-0.017	-0.030	0.009	n.s.
Firm size (ref. 50 and more)										
Micro	0.040	0.011	0.018	0.035	0.051	0.083	0.069	0.058	0.038	0.014
Small	0.019	n.s.	0.007	0.010	0.025	0.040	0.032	0.040	0.010	0.008
Age (ref. 31-40)										
Below 31	0.013	n.s.	n.s.	n.s.	0.015	0.018	n.s.	0.013	0.025	0.008
41-55	-0.004	n.s.	0.003	0.005	n.s.	-0.015	n.s.	-0.016	-0.008	n.s.
Above 55	0.002	0.008	0.009	0.018	n.s.	-0.015	-0.011	-0.013	-0.014	0.011
Temporary	0.031	0.021	0.010	0.031	0.047	0.030	0.065	0.046	0.022	0.013
Female	0.021	n.s.	0.016	0.021	0.012	0.035	0.022	0.021	0.027	0.032

Notes: n.s. = non-significant. All shown coefficients significant at the 10 per cent level. Eurostat country codes.

Source: Authors' estimations based on EU-SILC data.

Table A5. Monthly minimum wage violation measures among permanent and temporary workers in the CEE-10 countries, 2003–12 averages (percentages)

Country	Workers	Incidence of violation (V_0^m)	Depth of violation (V_1^m)
Bulgaria	Total	2	23
	Permanent	2	23
	Temporary	6	22
Czech Republic	Total	2	23
	Permanent	2	23
	Temporary	4	20
Estonia	Total	3	14
	Permanent	3	14
	Temporary	10	28
Hungary	Total	6	16
	Permanent	5	16
	Temporary	15	17
Latvia	Total	7	22
	Permanent	6	22
	Temporary	17	39
Lithuania	Total	8	24
	Permanent	7	23
	Temporary	13	32
Poland	Total	7	19
	Permanent	6	19
	Temporary	15	19
Romania	Total	5	19
	Permanent	5	19
	Temporary	12	24
Slovakia	Total	3	29
	Permanent	3	30
	Temporary	5	25
Slovenia	Total	4	36
	Permanent	4	37
	Temporary	7	34

Source: Authors' calculations based on EU-SILC data.

Table A6. Relationship between the incidence of minimum wage violation (V_0), the Kaitz index, GNI and the unemployment rate in the CEE-10 countries: Ppanel regression (alternative specifications)

Variables	(1) Monthly violation (V_0^m) Between-effects	(2) Monthly violation (V_0^m) Fixed-effects	(3) Hourly violation (V_0^h) Between-effects	(4) Hourly violation (V_0^h) Fixed-effects
75% of minimum wage threshold				
Unemployment rate	0.0010 (0.0013)	0.0007** (0.0003)	0.0013 (0.0013)	0.0006* (0.0003)
GNI per capita (PPP)	0.0008 (0.0008)	-0.0002 (0.0003)	0.0007 (0.0008)	-0.0006* (0.0003)
Kaitz index	0.0109 (0.1119)	0.0764* (0.0393)	0.0505 (0.1174)	0.1010*** (0.0392)
Constant	-0.0145 (0.0396)	-0.0116 (0.0103)	-0.0233 (0.0415)	-0.0074 (0.0103)
Observations	85	85	85	85
R-squared	0.181	0.165	0.186	0.213
No. of countries	10	10	10	10
125% of minimum wage threshold				
Unemployment rate	0.0065 (0.0080)	0.0002 (0.0007)	0.0068 (0.0077)	-0.0001 (0.0007)
GNI per capita (PPP)	-0.0024 (0.0047)	-0.0031*** (0.0007)	-0.0027 (0.0045)	-0.0047*** (0.0007)
Kaitz index	0.4149 (0.4165)	0.6993*** (0.0519)	0.4994 (0.4012)	0.7524*** (0.0507)
Constant	-0.0890 (0.2455)	-0.1537*** (0.0228)	-0.1086 (0.2365)	-0.1277*** (0.0223)
Observations	85	85	85	85
R-squared	0.238	0.760	0.302	0.793
No. of countries	10	10	10	10
Romania excluded				
Unemployment rate	0.0005 (0.0007)	0.0003* (0.0001)	0.0006 (0.0007)	0.0003* (0.0001)
GNI per capita (PPP)	0.0005 (0.0004)	-0.0001 (0.0001)	0.0004 (0.0004)	-0.0001 (0.0001)
Kaitz index	0.0027 (0.0520)	0.0497*** (0.0186)	0.0087 (0.0527)	0.0515*** (0.0187)
Constant	-0.0098 (0.0176)	-0.0104** (0.0049)	-0.0111 (0.0178)	-0.0088* (0.0049)
Observations	78	78	78	78
R-squared	0.227	0.236	0.228	0.247
No. of countries	9	9	9	9

***, ** and * indicate significance at the 1, 5 and 10 per cent levels, respectively.

Note: Standard errors are indicated in parentheses.

Source: Authors' estimations based on EU-SILC, Eurostat and World Bank data.

Table A7. Relationship between the average depth of minimum wage violation (V_1), Kaitz index, GNI, and the unemployment rate in the CEE-10 countries: Panel regression (alternative specifications)

Variables	(1) Monthly violation (V_1^m) Between-effects	(2) Monthly violation (V_1^m) Fixed-effects	(3) Hourly violation (V_1^h) Between-effects	(4) Hourly violation (V_1^h) Fixed-effects
75% of minimum wage threshold				
Unemployment rate	0.0004 (0.0005)	0.0003** (0.0001)	0.0005 (0.0005)	0.0003** (0.0001)
GNI per capita (PPP)	0.0004 (0.0003)	-0.0001 (0.0001)	0.0004 (0.0003)	-0.0001 (0.0001)
Kaitz index	0.0077 (0.0452)	0.0289* (0.0157)	0.0134 (0.0457)	0.0316** (0.0157)
Constant	-0.0089 (0.0160)	-0.0051 (0.0041)	-0.0103 (0.0161)	-0.0038 (0.0041)
Observations	85	85	85	85
R-squared	0.247	0.184	0.250	0.201
No. of countries	10	10	10	10
125% of minimum wage threshold				
Unemployment rate	0.0016 (0.0017)	0.0004* (0.0003)	0.0018 (0.0018)	0.0004 (0.0003)
GNI per capita (PPP)	0.0000 (0.0010)	-0.0006** (0.0003)	-0.0001 (0.0010)	-0.0011*** (0.0003)
Kaitz index	0.0532 (0.0882)	0.1297*** (0.0188)	0.0809 (0.0918)	0.1500*** (0.0190)
Constant	-0.0184 (0.0520)	-0.0306*** (0.0083)	-0.0253 (0.0541)	-0.0264*** (0.0083)
Observations	85	85	85	85
R-squared	0.159	0.511	0.212	0.568
No. of countries	10	10	10	10
Romania excluded				
Unemployment rate	0.0005 (0.0007)	0.0003* (0.0001)	0.0006 (0.0007)	0.0003* (0.0001)
GNI per capita (PPP)	0.0005 (0.0004)	-0.0001 (0.0001)	0.0004 (0.0004)	-0.0001 (0.0001)
Kaitz index	0.0027 (0.0520)	0.0497*** (0.0186)	0.0087 (0.0527)	0.0515*** (0.0187)
Constant	-0.0098 (0.0176)	-0.0104** (0.0049)	-0.0111 (0.0178)	-0.0088* (0.0049)
Observations	78	78	78	78
R-squared	0.227	0.236	0.228	0.247
No. of countries	9	9	9	9

***, ** and * indicate significance at the 1, 5 and 10 per cent levels, respectively.

Note: Standard errors are indicated in parentheses.

Source: Authors' estimations based on EU-SILC, Eurostat and World Bank data.

Table A8. Relationship between the average shortfall (V_1/V_0), the Kaitz index, GNI and the unemployment rate in the CEE-10 countries: Panel regression (alternative specifications)

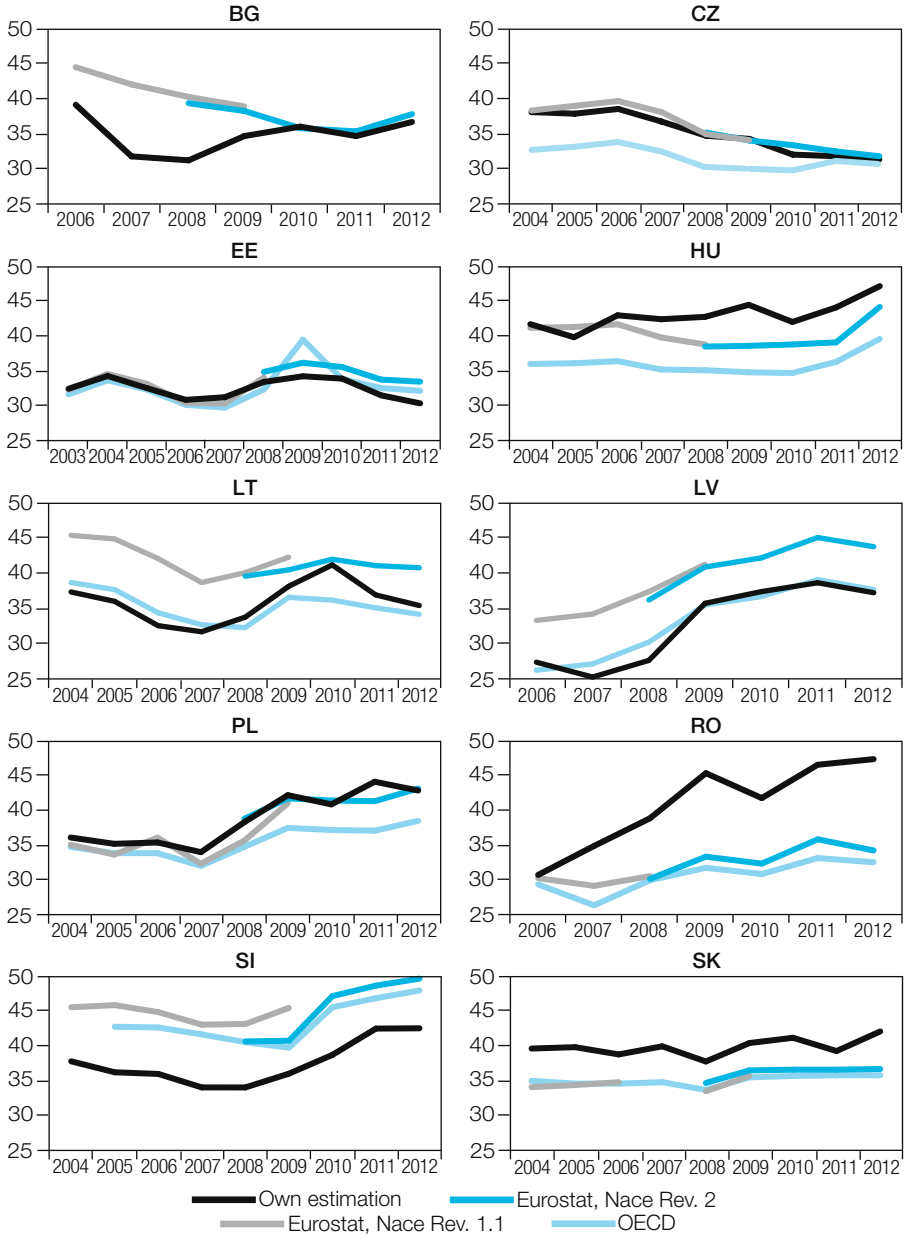
Variables	(1) Monthly violation (V_1^m/V_0^m) Between-effects	(2) Monthly violation (V_1^m/V_0^m) Fixed-effects	(3) Hourly violation (V_1^h/V_0^h) Between-effects	(4) Hourly violation (V_1^h/V_0^h) Fixed-effects
75% of minimum wage threshold				
Unemployment rate	0.0064 (0.0100)	0.0036 (0.0035)	0.0054 (0.0097)	0.0051 (0.0034)
GNI per capita (PPP)	0.0057 (0.0059)	0.0003 (0.0035)	0.0079 (0.0057)	0.0023 (0.0034)
Kaitz index	0.6699 (0.8750)	-0.1445 (0.4185)	0.0977 (0.8438)	-0.3796 (0.4041)
Constant	0.0121 (0.3094)	0.3660*** (0.1103)	0.1011 (0.2984)	0.3440*** (0.1065)
Observations	85	85	85	85
R-squared	0.203	0.015	0.251	0.034
No. of countries	10	10	10	10
125% of minimum wage threshold				
Unemployment rate	0.0025 (0.0048)	0.0014 (0.0013)	0.0030 (0.0047)	0.0013 (0.0011)
GNI per capita (PPP)	0.0062* (0.0028)	-0.0016 (0.0013)	0.0044 (0.0028)	-0.0019* (0.0011)
Kaitz index	0.0403 (0.2532)	-0.0347 (0.0964)	0.0717 (0.2469)	0.0066 (0.0760)
Constant	0.0275 (0.1492)	0.2208*** (0.0423)	0.0503 (0.1455)	0.2175*** (0.0334)
Observations	85	85	85	85
R-squared	0.439	0.040	0.303	0.076
No. of countries	10	10	10	10
Romania excluded				
Unemployment rate	0.0042 (0.0130)	0.0026 (0.0029)	0.0042 (0.0126)	0.0037 (0.0028)
GNI per capita (PPP)	0.0044 (0.0077)	0.0001 (0.0028)	0.0072 (0.0074)	0.0024 (0.0028)
Kaitz index	0.7740 (1.0073)	0.3090 (0.4039)	0.1575 (0.9774)	0.2087 (0.3931)
Constant	0.0300 (0.3407)	0.2539** (0.1066)	0.1113 (0.3306)	0.1944* (0.1037)
Observations	78	78	78	78
R-squared	0.176	0.039	0.172	0.060
No. of countries	9	9	9	9

***, ** and * indicate significance at the 1, 5 and 10 per cent levels, respectively.

Note: Standard errors are indicated in parentheses.

Source: Authors' estimations based on EU-SILC, Eurostat and World Bank data.

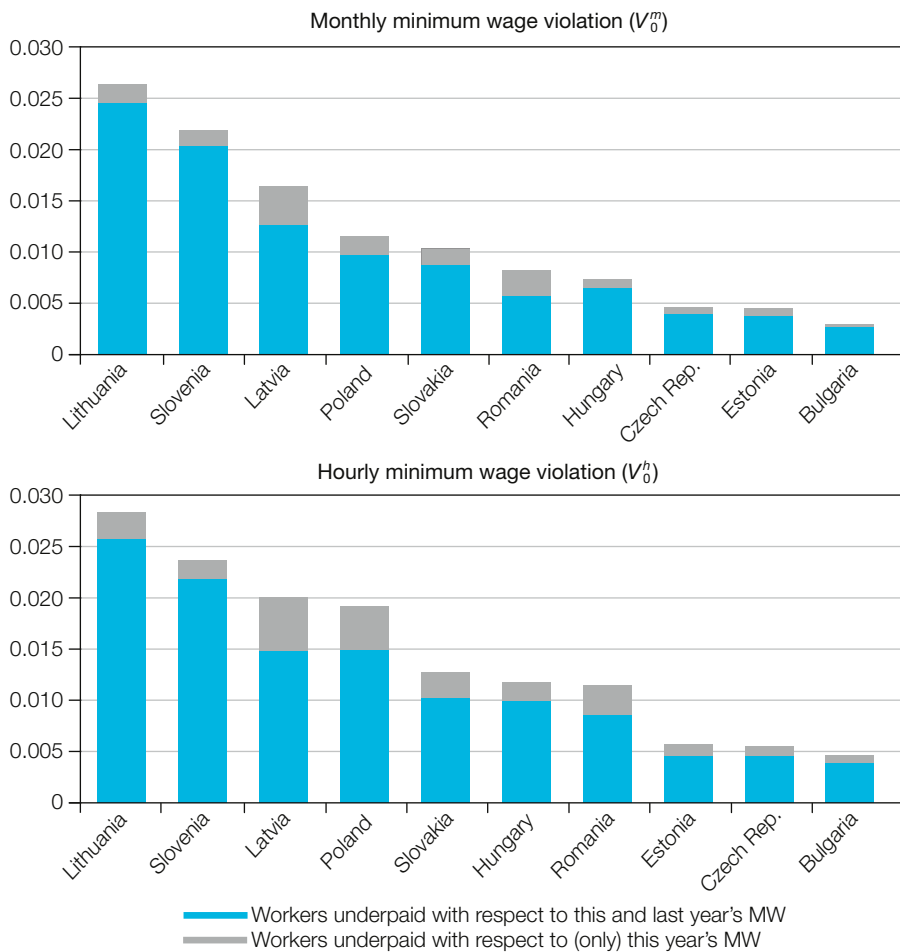
Figure A1. Comparison of the authors' estimates of the Kaitz indices with the OECD and Eurostat estimates for CEE-10 countries



Notes: The OECD publishes data on the ratio of 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, 1999–09); and covers full-time employees working in enterprises of all sizes. Eurostat country codes.

Source: Authors' calculations based on EU-SILC, OECD Statistics and Eurostat data.

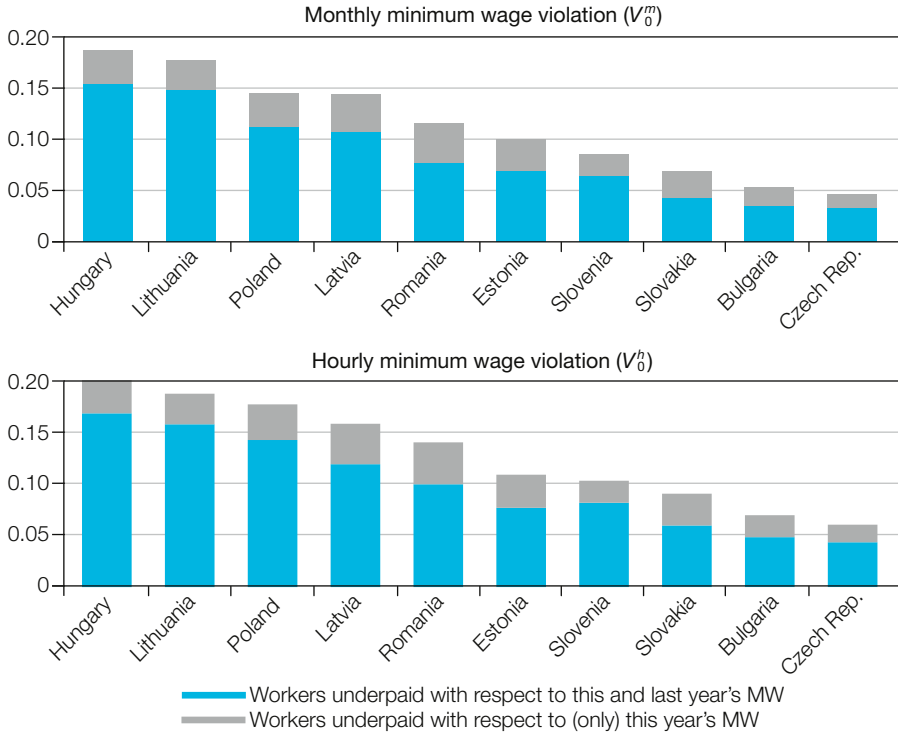
Figure A2. Decomposition of the average incidence of violation (2003–12) into violations of both the current and the previous year's minimum wage, and the current minimum wage only, at the threshold of 75 per cent of the minimum wage, in the CEE-10 countries



Note: Eurostat country codes.

Source: Authors' calculations based on EU-SILC data.

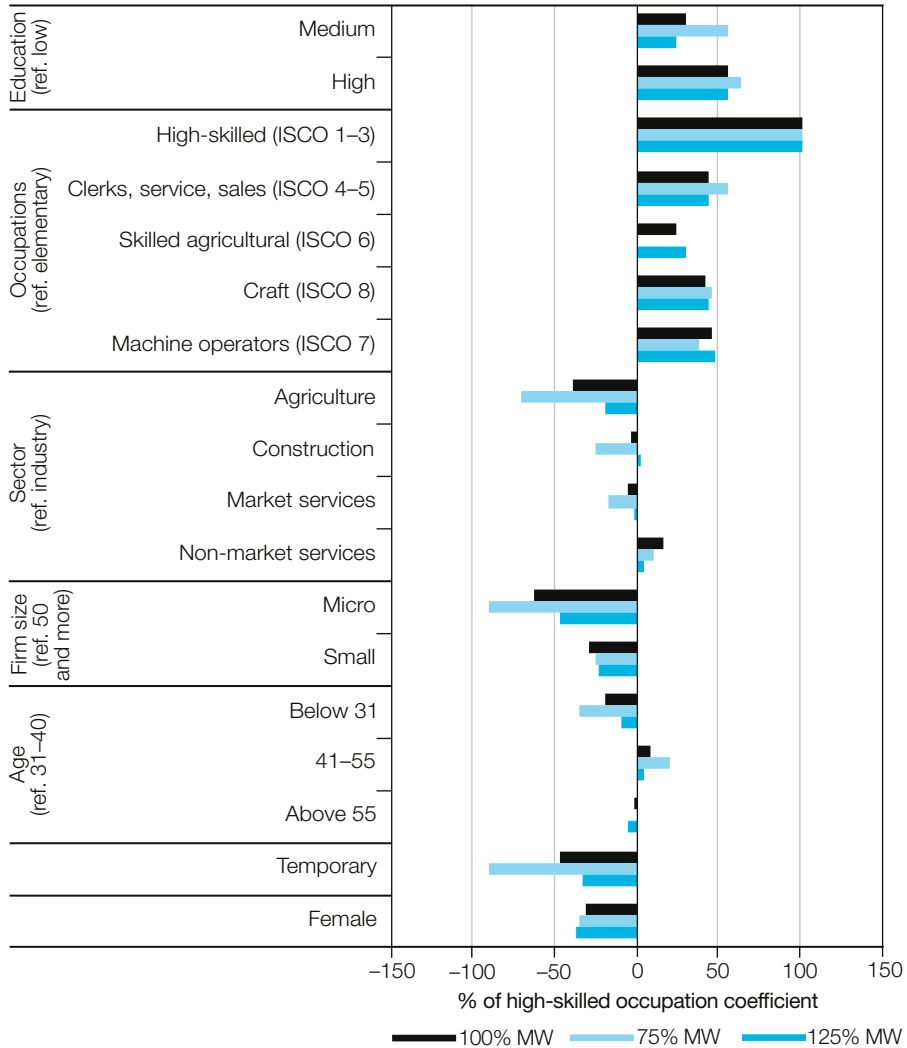
Figure A3. Decomposition of the average incidence of violation (2003–12) into violations of both the current and the previous year’s minimum wage, and of the current minimum wage only, at the threshold of 125 per cent of the minimum wage, in the CEE-10 countries



Note: Eurostat country codes.

Source: Authors' calculations based on EU-SILC data.

Figure A4. Comparison of marginal effects from probit regression on the non-compliance dummy calculated with the threshold of 100 per cent of the minimum wage (benchmark estimation) and the thresholds of 75 and 125 per cent of the minimum wage (sensitivity analysis estimation), 2003–12 CEE-10 aggregates



Note: For each estimation, all of the marginal effects are expressed in relation to the highest marginal effect in a particular estimation, which was found for high-skilled occupations in every estimation.

Source: Authors' calculations based on EU-SILC data.