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Social and fiscal impacts of statutory minimum wages in EU countries: A microsimulation analysis with EUROMOD

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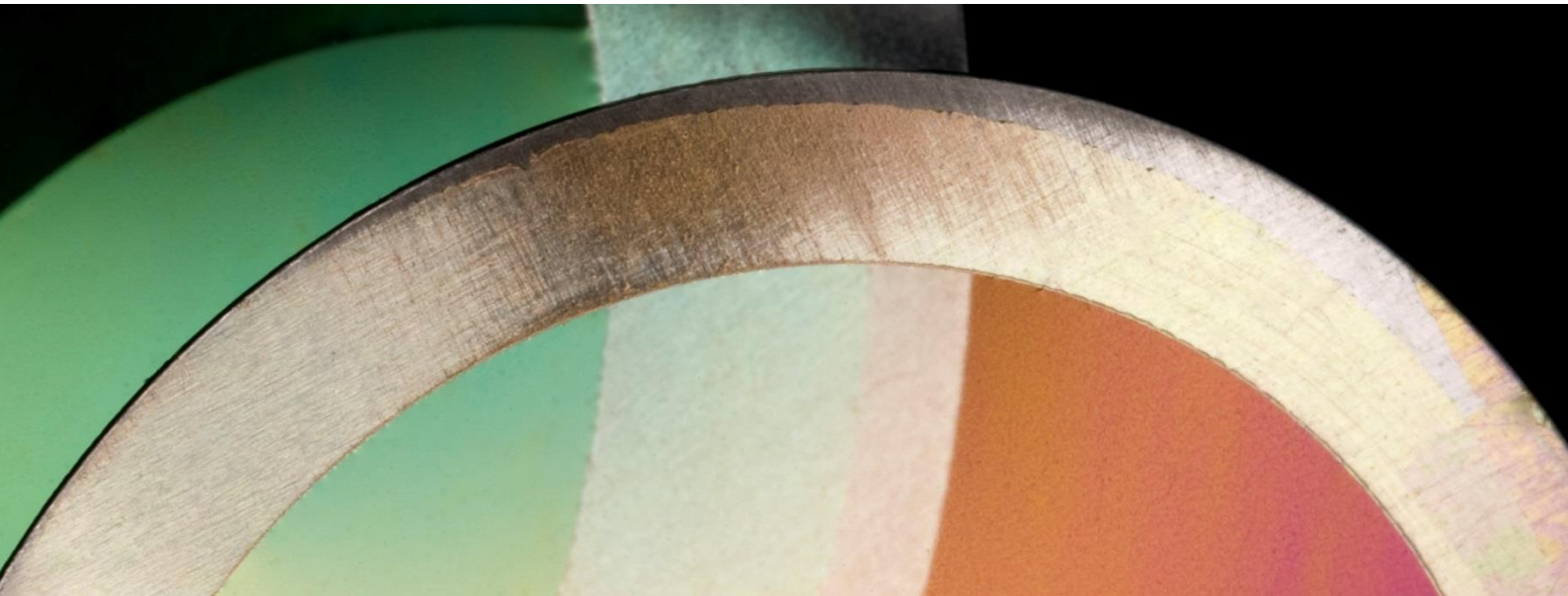

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Executive summary

In October 2020, the European Commission presented a proposal on adequate minimum wages. This EU Directive aims to ensure that workers in the Union are protected by adequate minimum wages. The analysis presented in this paper supported the impact assessment report accompanying the Commission proposal. The present study includes a detailed description of the methodology underlying the analysis and provides estimates of the social impacts of hypothetical minimum wage scenarios in 21 EU Member States with statutory national minimum wages.

Hypothetical minimum wage scenarios. This paper assesses six hypothetical scenarios. Among these, minimum wages are set to 40%, 45% and 50% of the national gross average wage and 50%, 55% and 60% of the national gross median wage. Thus, the assumed minimum wage depends on the average or median wage levels in each country. The hypothetical minimum wage levels assessed range from €266 in Bulgaria to €2,360 in Luxembourg.

Microsimulation. The paper uses EUROMOD, a tax-benefit microsimulation model for the European Union. EUROMOD simulates the tax-benefit rules of each EU Member State and applies them to representative samples of each Member State's population based on the European Union Statistics on Income and Living Conditions **(**EU-SILC) survey data. The exercise carried out in this paper assesses increases in the gross wages of low-wage earners to various hypothetical minimum wages. After gross wages are increased, taxes and transfers are recalculated with EUROMOD. Taxes and benefits depend on the rules set in each country and also on individual characteristics and household structure. As a result, changes in the disposable income of individuals and households, as well as changes in a government's fiscal balance, can be assessed in order to quantify the impact of hypothetical minimum wage scenarios. Given the static nature of the microsimulation, labour supply responses and second-round macroeconomic feedback effects are not assessed. However, employment impacts are calculated as a second-round effect by applying an appropriate elasticity to the increasing wage bill of employers.

Main results on social impacts. The results analysed include indicators of wage inequality, in-work poverty, the gender pay gap, employment effects, and also the impact on public budgets. Model simulations suggest that minimum wage increases can significantly reduce in-work poverty, wage inequality and the gender pay gap while generally improving the public budget balance. In the hypothetical scenarios with the highest reference values (50% of the national gross average wage and 60% of the national gross median wage), the average reduction in in-work poverty in all EU Member States is 12–13%, the average reduction in wage inequality is 8–10%, while the average reduction in the gender pay gap is 5%. Although wage increases are substantial for beneficiaries, increases in the aggregate wage bill are generally small, as are the possible negative effects on employment. In the hypothetical scenario where all Member States with statutory minimum wages raise them to the highest reference values, the simulated reduction in total employment in the EU is 0.4%.

Number of beneficiaries. The results indicate that if Member States increase their minimum wages to the highest reference values, wages could increase for 22 million workers (at 60% of the median wage) or 24 million workers (at 50% of the average wage). At intermediate reference values, the number of direct beneficiaries is estimated at 11 million (55% of the median wage) and 12 million (45% of the average wage). The difference is larger between both low reference values: raising statutory minimum wages to 50% of the median wage would increase wages for 5.4 million workers, while an increase to 40% of the average wage would benefit 0.7 million workers.

Budgetary effects. Minimum wage increases are estimated to have a limited impact on public budgets, and in most cases they improve the budgetary balance. The overall improvement in public budgets is below or close to 0.1% of GDP in the scenarios with smaller variations (50% of the median or 40% of the average wage), reaching 0.4% of GDP only in some cases where minimum wages have increased to 60% of the median wage (in Estonia, Germany, Greece, and the Netherlands) and 50% of the average (in the Netherlands, Poland, and Romania).

Social and fiscal impacts of statutory minimum wages in EU countries: A microsimulation analysis with EUROMOD

Klaus Grünberger[α], Edlira Narazani[α], Stefano Filauro[γ] and Áron Kiss[δ]

Abstract

This paper analyses the first-round effects of hypothetical minimum wage increases on social outcomes in 21 EU countries with a statutory national minimum wage based on a microsimulation approach using EUROMOD. The methodological challenges related to the use of available EU household survey data are described, along with the choices made to address these challenges. The paper assesses hypothetical scenarios in which countries with a statutory national minimum wage increase their minimum wage to various reference values, set in relation to the gross national median and average wage. The model simulations suggest that minimum wage increases can significantly reduce in-work poverty, wage inequality and the gender pay gap, while generally improving the public budget balance. The implied wage increases for the beneficiaries are substantial, while the implied increases in the aggregate wage bill and, as a consequence, possible negative employment impacts, are generally modest.

Key words: minimum wage, microsimulation, European Union, wage inequality, in-work poverty, gender pay gap.

JEL codes: H31, I32, J31.

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1. Introduction

The European Pillar of Social Rights includes the principle that workers have the right to fair wages in general and adequate minimum wages in particular in order to secure a decent standard of living and prevent in-work poverty. Following up on the Pillar, the European Commission (2020a) proposed an EU Directive in October 2020 to ensure that workers in the Union are protected by adequate minimum wages, allowing for a decent living wherever they work. The Commission's proposal creates a framework to improve the adequacy of minimum wages and the access of workers to minimum wage protection in the EU. At the same time, it does not oblige Member States that do not have a statutory minimum wage to introduce one, nor does it set a common minimum wage level.

In this context, this paper analyses the first-round effects of hypothetical minimum wage increases on social and fiscal outcomes across EU countries using the EU-wide microsimulation model EUROMOD. The analysis presented here supported the impact assessment report (European Commission, 2020b) accompanying the Commission proposal on adequate minimum wages. This paper describes in detail the methodology underlying the simulations, including the challenges related to the use of available EU household survey data and the choices made to address these challenges. It then presents the estimated social impacts of hypothetical minimum wage increases in 21 EU Member States with statutory national minimum wages.

The EUROMOD model is used because it allows for a comparable analysis of all EU Member States. More specifically, EUROMOD allows for an ex-ante assessment of the distributional, inequality and poverty effects of real or hypothetical reforms in a comparative way across EU countries by considering the full set of interactions within the tax-transfer system of each country.[1]

The use of individual-level data, and microsimulation tools in particular, is crucial for the ex-ante assessment of the impacts of hypothetical minimum wage increases for two reasons. First, the use of individual-level data allows the researcher to distinguish which individuals and groups would benefit considering their economic and demographic situation. Second, microsimulation offers the additional benefit of taking into account the role of taxes and benefits when assessing the impacts of a hypothetical minimum wage increase. This is important because, when the wages of minimum-wage earners increase, it is likely that their tax liabilities will also increase and the benefits they are entitled to may be reduced. Although the direction of the effect on taxes and benefits may be intuitive, it is not possible to measure its magnitude without using microsimulation models. Microsimulation is also suitable to assess in a comprehensive way the budgetary impacts of hypothetical minimum wage increases.

[1] EUROMOD can also be used to perform budgetary analyses and may be linked with micro (labour supply) or macro models (e.g., QUEST) to assess behavioural effects of reforms (see, e.g., Barrios et al., 2019).

There are only a small number of ex-ante simulation studies that have examined the impacts of hypothetical minimum wage scenarios in the EU in a comparative way.[2] Eurofound (2014, Part II, Chapters 4-7) has assessed, based on EU-SILC and EU-SES (the European Union Structure of Earnings Survey) data, how many workers, and what types, would be most affected if all EU Member States set a universally binding minimum wage floor at 60% of the national median wage. Matsaganis et al. (2015) use EUROMOD to simulate the effects on poverty of raising national minimum wages to 50% of the average hourly wage. This is complemented by an analysis, based on EU-SILC, of the individual characteristics and household circumstances of those workers earning less than this hypothetical reference value for minimum wages. The European Commission (2016) assessed, based on EU-SILC data, the impacts on poverty associated with three scenarios: (1) a 10% increase in existing statutory national minimum wages, (2) a hypothetical increase of statutory minimum wages to 40% of the average wage and (3) a hypothetical increase to 50% of the median wage in countries where statutory minimum wages are below these thresholds. Finally, Detragiache et al. (2020) simulate, based on EU-SILC, the poverty impacts of a hypothetical harmonisation of statutory minimum wages in the EU at 60% of the gross median wage.

From a methodological perspective, this paper combines two strengths of past analyses: (1) the use of microsimulation methods and (2) the inclusion of all workers, irrespective of breaks in their employment history. In particular, like Matsaganis et al. (2015), this study uses EUROMOD to control for the interactions between minimum wage policy and the tax-benefit system. However, because of challenges related to the available information on working time in the EU-SILC data, Matsaganis et al. (2015) restrict the analysis to workers who worked in the same job (part-time or full-time) over the previous year. The disadvantage of this restriction is that it risks excluding many potential beneficiaries of minimum wage policies. Therefore, following Eurofound (2014) and similarly to Detragiache et al. (2020), this paper includes workers with unstable employment histories by using the methodology proposed by Brandolini et al. (2010) to impute the working time in cases where this information is missing. The method by Brandolini et al. (2010) is applied with an additional step of outlier correction to address measurement errors in hourly wages and correct for the possible bias that results from it.[3]

Besides the methodology used, this paper contributes to the literature by assessing a broader set of scenarios and types of impacts. In particular, hypothetical scenarios include increases in statutory minimum wages to 40%, 45% and 50% of the average wage and 50%, 55% and 60% of the median wage.[4] Besides the share of workers affected and their wage increases, outcomes assessed include: the increase in the aggregate wage bill, reductions in wage inequality (based on the D5/D1 indicator[5]),

[2] In contrast, the literature studying the social impacts of actual minimum wage increases and introductions (i.e, *ex-post* statistical analyses as opposed to the *ex-ante* assessments done with microsimulation methods) is surveyed in the next section.

[3] For more details, see Section 4.2.

[4] Results from these hypothetical scenarios have been used in the European Commission's Impact Assessment Report (European Commission, 2020b), supporting the initiative on adequate minimum wages in the EU (European Commission, 2020a).

[5] The D5/D1 indicator is obtained by comparing the median (D5) with the first decile (D1) of the earnings distribution.

in-work poverty, the gender pay gap and impacts on public budgets. The simulations are static–labour supply responses and second-round macroeconomic feedbacks are not assessed. As an important exception, impacts on employment are simulated by an elasticity method based on the share of workers affected and their wage increases in the various scenarios.

The results suggest that increasing statutory minimum wages to the lowest of the reference values (50% of the median wage or 40% of the average) would affect only about one-third of the 21 Member States with a statutory minimum wage, while the highest reference values (60% of the median wage or 50% of the average) would affect almost all Member States. Although the implied wage increases are often substantial for the beneficiaries (often reaching 20%), the implied increases in the aggregate wage bill rarely exceed 2%, even in the scenarios with the highest reference values. The impact on public budgets is estimated to be generally positive because of higher revenues from personal income taxes and social security contributions, although the effect is quantitatively small.

The simulations suggest that minimum wage increases can significantly reduce in-work poverty, wage inequality and the gender pay gap. In the hypothetical scenarios with the highest reference values, the average reduction in in-work poverty over all EU Member States is 12–13%, the average reduction in wage inequality is 8–10%, while the average reduction in the gender pay gap is 5%.

Minimum wage increases may have unintended negative consequences. The most discussed of the possible impacts of minimum wages in the literature is their possible negative effect on employment. In this study, the employment impacts of higher statutory minimum wages are simulated by applying an appropriate elasticity to the wage increase of affected workers. The elasticity chosen is the median estimate identified in a survey of the recent academic literature by Dube (2019b; see Section 4.4 for more details). The body of recent evidence and, based on it, the simulations in this paper, suggest that the negative employment effects of minimum wage increases are small as compared to the benefits of increased wages for low-wage earners.

The rest of this paper is organised as follows. The next section surveys the related literature on the social impacts of minimum wages. Section 3 briefly presents the current status of minimum wages across the EU, which serves as the baseline for the simulations, as well as the scenarios assessed. Section 4 discusses the data, methodological challenges and solutions chosen. Section 5 presents the results of the simulations and Section 6 concludes.

2. Related literature on the social impacts of minimum wages

The results presented in this paper fit within the recent strands of the literature which indicate that minimum wages have a positive impact on social outcomes, particularly on wage inequality, the gender pay gap, employment and (in-work) poverty. This section places the present research in the context of these respective strands of the literature.

Wage inequality. One of the main motivations behind minimum wages is to support the earnings of low earners and protect them from unfairly low wages. Minimum wages are thus expected to reduce wage inequality. This hypothesis is borne out by the literature focusing on longer-term developments

in wage inequality both in the U.S. and Europe. While there are differences between their quantitative results, both Lee (1999) and Autor et al. (2015) attribute a significant part of the increase in U.S. wage inequality since the 1980s to the erosion of the federal minimum wage. Part of the explanation for these results is that minimum wages have a positive effect on higher wage levels as well (these are called "spillover" or "ripple effects"). When minimum wages are not updated, this may result in stagnating wages for a broader spectrum of workers, not only for workers around the minimum wage. Similarly for Europe, Pereira and Galego (2019) find that minimum wage increases have been among the important factors driving differences in wage inequality in Europe since the early 2000s. The findings of the present paper are in line with these results, even though in the simulations on wage inequality the analysis does not take into account either the impacts on employment (including working hours) or possible spillover effects.

Gender pay gap. While the literature on the impacts of minimum wages on the gender pay gap is scarcer than the other strands of literature discussed here, it has been known that the majority of minimum wage earners are women, and therefore the impacts of minimum wages have a gender aspect. For instance, Belman and Wolfson (2014, p. 16) find in their survey that "[a]lthough the magnitude of the effect remains in play, there is universal agreement that the minimum wage reduces wage inequality, particularly among women". Focusing on Europe, and in particular on the introduction of the minimum wage in Ireland and the UK, Bargain et al. (2018) show a large reduction of the gender wage gap at the bottom of the distribution in Ireland but a low impact in the UK. The authors suggest that the contrasting results between the two countries may be due to the degree of non-compliance with the UK national minimum wage legislation. In the case of Poland, Majchrowska and Strawiński (2018) find minimum wage increases significantly lowered the gender wage gap among young workers, although the impact was not large for adult workers. The findings of this paper are in line with existing evidence: hypothetical minimum wage increases reduce the gender pay gap, even though this impact is quantitatively smaller than the impact on wage inequality. The reductions occur because a majority of minimum-wage earners are women in all EU Member States.[6]

Employment. While few dispute that minimum wages reduce wage inequality, some researchers argue that the minimum wage may fail to effectively protect low-wage earners because of its negative impacts on their employment. For instance, Neumark and Wascher (2008, p. 6) suggest that, "although minimum wages compress the wage distribution, because of employment and hours declines among those whose wages are most affected by minimum wage increases, a higher minimum wage tends to reduce rather than to increase the earnings of the lowest-skilled individuals." Nevertheless, conclusions from the recent literature are in contrast to this warning. While negative employment impacts are possible, they tend to be small as compared to the wage increases for beneficiaries. For instance, in a survey of the most recent research, Dube (2019b) finds that "[o]verall

[6] Based on EU-SILC data, the share of women among those earning a wage around the national minimum wage ranges between slightly above 50% and just below 80%, averaging at about 60%. See, for example, European Commission (2020b, p. 7 and p. 134).

the most up to date body of research from U.S., UK and other developed countries points to a very muted effect of minimum wages on employment, while significantly increasing the earnings of low paid workers. Importantly, this was found to be the case even for the most recent ambitious policies."[7] This paper relies on the survey of Dube (2019b) to calibrate the simulation of employment impacts.

(In-work) poverty. There is a significant academic literature on the impact of the minimum wage on poverty outcomes that also considers the socio-demographic characteristics of minimum wage earners. The poverty-alleviating impacts of minimum wages are mediated by demographic and other factors because many minimum wage earners do not live in poor households (for instance because their partner earns a higher income), while many poor people are not minimum wage earners (instead they are unemployed, inactive, self-employed, or in informal employment). For this reason, some papers have found that minimum wages have little impact on overall poverty rates (see, e.g., the survey of Belman and Wolfson, 2014). However, more recent research has found beneficial impacts of minimum wages on poverty outcomes. Based on individual-level data from the U.S. for the period 1984–2013, Dube (2019a) finds that minimum wages significantly reduce the non-elderly poverty rate.

Relevant studies in Europe largely focus on countries that recently introduced a national minimum wage, including the UK (1999), Ireland (2000) and Germany (2015). In most cases, these studies use microsimulation tools and generally find that the introduction of a minimum wage had small but beneficial effects on poverty outcomes. In particular, Sutherland (2001b), studying the UK National Minimum Wage (NMW), concludes that "the main contribution of the NMW is in underpinning the strategy of in-work benefits to supplement the family incomes of the low paid." This conclusion is supported by Atkinson et al. (2017) who find, when assessing proposals by Atkinson (2015) to reduce inequality, that increasing the UK minimum wage to a "living wage" level would reduce the poverty headcount slightly (by 0.4 percentage points), and it would also strengthen the impact of other hypothetical poverty-reducing tax-benefit reforms by about the same magnitude. Similarly, the literature on Ireland found that the minimum wage is a relatively "blunt tool" to reduce poverty, but it is still effective in protecting the wages of low-skilled workers. In particular, Maitre et al. (2017) found that 17% of minimum wage employees belong to a household that is at risk of poverty, compared to 3.3% of non-minimum wage employees. In addition, Holton and O'Neill (2017) found that the Irish minimum wage is an effective tool in protecting the income of low-skilled workers, particularly during recessions. Finally, in the case of Germany, microsimulation analyses by Müller and Steiner (2009, 2013) have concluded that the minimum wage has only a small impact on overall poverty, both because it does not target poor households and because wage gains of poor households would be dampened by increased taxes and benefits withdrawn.[8]

[7] Simulations of employment impacts in this paper are based on the median elasticity of 48 international studies surveyed by Dube (2019b). See Section 4.4 below for the methodological details.

[8] The other side of this coin is that, in countries with strong anti-poverty policies, minimum wages may have a stronger impact on improving public budgets. See results on fiscal impacts in Section 5.8.

Recent EU-wide work supports the view that minimum wages have a small reducing effect on overall poverty, but it also finds a more significant impact on in-work poverty. Analysing the labour market status of households in the EU at risk of poverty, Eurofound (2014) conclude that the impact of increased minimum wages "on relative poverty at the household level would be limited." Simulating the impacts of a hypothetical increase (or introduction) of a statutory minimum wage at 50% of the national average wage in all EU Member States, Matsaganis et al. (2015) find that the "at-risk-of-poverty rate would fall by at least 1 percentage point in 13 out of 28 Member States." Simulations by the European Commission (2016) also find small but beneficial impacts of hypothetical minimum wage increases on poverty rates in the EU. Finally, Detragiache et al. (2020) find that "[a] hypothetical European Minimum Wage (MW) set at 60 percent of each country's median wage would reduce in-work poverty but have limited effects on overall poverty."

In this context, this paper focuses on in-work poverty as a relevant poverty-related outcome of minimum wage policies since minimum wage policies have a more direct impact on the poverty rate of workers than that of the total population. While minimum wages are not the only policy measures to fight poverty, they are found to be an important element in an effective policy mix to reduce in-work poverty and to improve work incentives.[9] This is in line with conclusions from past microsimulation work cited above, as well as with recent theoretical advances on the link between minimum wages and optimal taxation.[10]

3. Minimum wages in the EU and scenarios assessed

Minimum wage protection can be provided by collective agreements or by statutory minimum wages, which are set by law. In six out of 27 EU Member States, minimum wage protection is provided by collective agreements: Austria, Cyprus, Denmark, Finland, Italy and Sweden. Of these Member States, Cyprus also has statutory minimum wages covering some low-wage occupations. The other 21 Member States have statutory national minimum wages (as opposed to statutory minimum wages that apply only to some occupations, as in Cyprus). In all Member States with statutory national minimum wages, collective agreements set wages above the statutory minimum wages in a number of sectors.

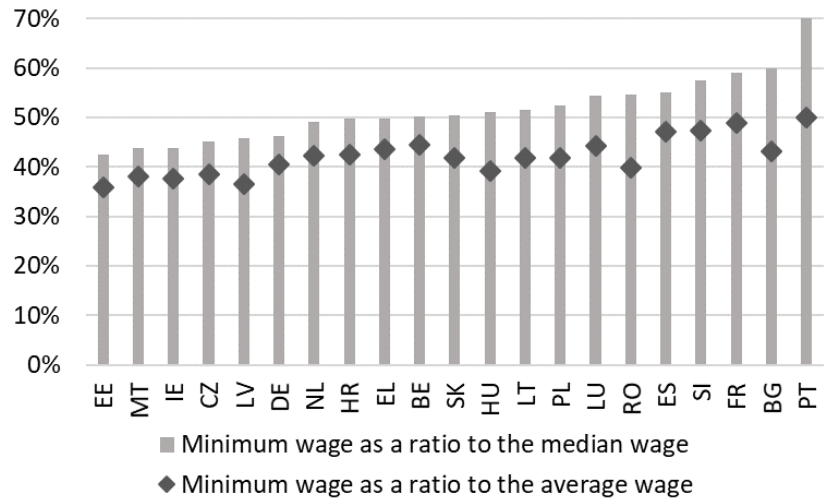
This paper analyses the impacts of hypothetical increases in statutory national minimum wages in the 21 EU Member States that have them. The simulations are assessed against a baseline scenario reflecting policies and minimum wage levels in 2019.[11] Graph 1 depicts this baseline: statutory national minimum wages expressed as a percentage of the gross national median and average wage in 2019. In 2019, minimum wages ranged from below 45% of the median wage in Estonia, Malta and

[9] See, for example, Peña-Casas et al. (2019) and Eurofound (2017).
[10] In a study of what role minimum wages can play in an optimal labour tax system, Lee and Saez (2012) find that adequate minimum wages and tax incentives for low-wage earners are complementary policies to maintaining high employment and supporting the income of low-wage workers.
[11] At the time of writing, the EUROMOD model was available until 2019. Additionally, this was the latest year with estimates of median and average wages. The latter estimates were provided by Eurostat for this project and are based on the 2014 wave of the Structure of Earnings Survey, updated by the labour cost index for the period 2014–2019.

Ireland to about 60% of the median wage in Bulgaria and France and about 70% of the median wage in Portugal. In terms of the average wage, they ranged from less than 40% (in Estonia, Malta, Ireland, Czechia, Latvia, Hungary and Romania) to about 50% in Portugal, France, Slovenia and Spain.

The paper analyses two types of hypothetical minimum wage (HMW) scenarios. The first type of country-specific HMW is anchored on the median gross wage in the respective country, while the second type is based on the average gross wage. Wage statistics for the year 2019 are taken from Eurostat (for more detail, see Annex B.1).

Graph 1: Minimum wages, expressed as a percentage of the gross median and average wage of full-time workers, 2019



Source: European Commission calculations based on Eurostat data.

For the first set of HMW scenarios, the ratios 50%, 55% and 60% of median gross wage are calculated. For the HMW scenarios based on average gross wages, ratios of 40%, 45% and 50% are applied. The ratios are set differently between both types of scenarios to make sure that they are comparable in terms of ambition (i.e., average wages are higher than median wages). Appendix A, Table A.1 contains further details about the HMW in euros corresponding to each of the scenarios.

4. Data and Methodology

4.1 The microsimulation model and the underlying data

To account for the interactions between hypothetical minimum wage increases and the tax-benefit system, this analysis uses the EU-wide microsimulation tool EUROMOD, version I2.0+. The tax-benefit systems simulated in this version of the model refer to those in place as of 30 June 2019. For each individual in the data, tax liabilities and social benefit entitlements are simulated according to the laws of the respective country. Disposable income is calculated by adding benefits to and subtracting

taxes from gross income of each individual. EUROMOD provides the same framework for all European countries and makes results comparable. Sutherland (2001a) and Sutherland and Figari (2013) provide a detailed description of the EUROMOD model.

The underlying data used in EUROMOD come from European Statistics on Income and Living Conditions (EU-SILC) surveys from 2017. EU-SILC surveys collect information on sociodemographic characteristics, income sources, employment status and gross income for representative samples of the national populations. In some countries, data are enriched by country-specific data sources.[12]

In order to align the data on earnings and other non-simulated income components to the actual situation in 2019, data on individual income sources are inflated using uprating factors. Uprating factors are collected from national tax authorities, national statistical offices or Eurostat. The sociodemographic characteristics of the population recorded in EU-SILC 2017 are kept constant.

EUROMOD can be used to assess the effects of actual or hypothetical policy changes and alternative economic and demographic scenarios. In this study, EUROMOD is used to assess the impact of hypothetical policy scenarios of increases in statutory minimum wages. These scenarios involve raising the gross wage of individuals in the data in cases where it is below the level of a hypothetical minimum wage. EUROMOD is used to calculate the taxes due, social insurance contributions and benefits for each individual and household, both in the baseline and in the hypothetical scenarios.

EUROMOD allows this study to take full account of the interactions between hypothetical minimum wage increases and the tax-benefit system. An increase in the gross wage of a minimum wage earner generally results in an increase of the net income of the worker's family, although the impact on net income is dampened by increased income taxes and reduced benefits. However, under certain circumstances, an increase in the gross wage of a low earner might lead to a decrease in their family´s disposable income. This can be caused by a discontinuity in the tax and benefit system. In some countries, low incomes are exempt of social security contributions until a certain threshold. Passing that threshold, employees need to pay a minimum level of social security contribution that can outweigh the increase in earnings. Alternatively, a household may lose the eligibility for certain means-tested benefits after their income exceeds a specific income threshold.

EUROMOD is a static microsimulation model that simulates first-round effects of policy changes.[13] It does not take into account potential behavioural reactions of individuals, for example, changes in labour supply. Similarly, EUROMOD does not consider potential macroeconomic reactions, including the impacts of minimum wages on labour demand (and by implication employment) or consumer prices. In the hypothetical scenarios, both individuals' employment status and their working hours remain unchanged. However, employment impacts are calculated by applying an employment

[12] EUROMOD results are representative at the country level and validated against aggregate national statistics. The results of the validation, as well as a detailed description of the national models, are published every year in the country reports, which can be downloaded from https://EUROMOD-web.jrc.ec.europa.eu/using-EUROMOD/country-reports.
[13] These static first-round effects are sometimes called "overnight effects".

elasticity taken from the literature on the share of workers affected and their wage increase, as calculated based on EUROMOD (see Section 4.4 below for more details on the methodology).

4.2 Calculation of hourly earnings and hourly minimum wages

To simulate the impacts of a hypothetical minimum wage, the individuals who earn a lower wage than the hypothetical minimum wage need to be identified in the data. To do this, the actual wage observed in the data needs to be compared to the hypothetical minimum wage. The comparison can be done on the basis of the hourly or the monthly wage. In order to better account for various working patterns and different levels of working hours, this paper applies hypothetical minimum wages (HMW) to hourly wages. Hence, we have to convert both the wages observed in the microdata (expressed in yearly terms) and the HMW levels (expressed in monthly terms) to hourly levels. To convert the HMW from monthly to hourly levels, we divide HMW by the average number of weeks in a calendar month (4.345 weeks) and the observed median hours worked by full-time workers (which differ by country).[14] To obtain the gross hourly wage of an individual in the data, the reported yearly gross employment income is divided by the number of months the individual worked in 2016, the number of weeks in an average calendar month, and the number of usual weekly working hours.

The calculation of hourly wages faces three main challenges when using the EU-SILC data and EUROMOD. These difficulties are related to: 1) the time mismatch in reporting of working time and earnings in EU-SILC data, 2) the measurement error in reported working hours, months of work or annual earnings, and 3) the discrepancy in growth rates of average wages and statutory minimum wages. In the following three subsections, we describe the nature of each shortcoming and its implication for our analysis. Additionally, we outline the methodology used to mitigate the impact of each shortcoming for our analysis.

4.2.1 Imputation of missing weekly working hours

EU-SILC data have the shortcoming that earnings and working hours, which are both needed to calculate the hourly wage, refer to different time periods. More specifically, information on earnings (as well as months worked) refer to the year previous to the survey, while the reference period of weekly working hours is the time of the interview.[15] Accordingly, in the data used for this analysis (ie, in the EU-SILC 2017), information on income and months worked per year refer to 2016, while the information on usual weekly working hours refers to the survey year 2017.[16] This time mismatch can lead to missing information, particularly for individuals who worked in 2016 but not in 2017. They may report a positive income earned through a certain number of months during 2016, but they

[14] See Table A.2 in the Annex for an overview of median full-time working hours in the EU. In most countries, the median of weekly working hours of full-time employees is 40. Denmark has the lowest median of weekly working hours, 37. EU's Working Time Directive (2003/88/EC) requires EU Member States to guarantee a limit of 48 hours of weekly working hours.

[15] We use the following EU-SILC variables: PY010g for earnings; PL060 and PL100 for weekly working time.

[16] Information on current monthly earnings of employees is available only for 10 countries in EU-SILC and cannot be used in a comparable framework for all the countries.

cannot reveal any information on weekly working hours recorded at the time of the interview in 2017. In order to keep these individuals in the analysis, we need to impute the number of usual hours worked in 2016.

The missing information on working hours is imputed based on information on months in employment. EU-SILC provides information on the number of months in part-time employment (variable PL074) and the number of months in full-time employment (variable PL073). Following the method proposed by Brandolini et al. (2010), we impute working hours based on gender-specific median hours of part-time and full-time workers, respectively. An advantage of this method is that the two variables on months in employment refer to the income year, hence matching with the information on earnings. The method is explained in more detail in Appendix B.

By imputing missing working hours, we are able to derive hourly wages of individuals who changed their activity status from being employed in 2016 to unemployed or inactive in 2017. Since individuals in unstable employment are more likely to earn relatively low wages, potential beneficiaries of minimum wage policies are likely to be overrepresented among them. Hence, the imputation method allows us to include in the analysis individuals who are likely to be the beneficiaries by minimum wage policies.

4.2.2 Accounting for outliers of hourly wages

The time mismatch between the information on earnings and months worked on the one hand, and usual working hours, on the other hand, may cause a measurement error in calculating hourly wages if individuals change the number of working hours from one year to the other. Furthermore, earning data comprise all types of labour income and do not distinguish between main jobs and second jobs or between formal versus informal employment. Another limitation may come from survey non-response bias or self-reporting errors (Angel et al., 2019). All of these factors can introduce errors in the calculation of hourly wages, which is our main variable of interest.

In general, the presence of measurement error in hourly wages increases the variance of the wage distribution and therefore the incidence of low wages. This may lead to an overestimation of the effects of hypothetical minimum wage increases. To prevent such a bias in our analysis, we apply an outlier correction to hourly wages. To identify the outliers among hourly wages, we use a detection technique called interquartile range technique (Appendix B). The wages of individuals identified as outliers based on their very low level of hourly wages are not increased to the level of the new hypothetical minimum wages in the simulations.

Some individuals have hourly wages that are somewhat below the minimum wage in the baseline but high enough not to qualify as outliers. In the simulations, their wages are increased to the new hypothetical minimum wage.[17] This choice is consistent with increased compliance and a reduced use of exemptions from and variations in the statutory minimum wage. This may imply some

[17] Alternative assumptions about the increases of sub-minimum wages would be possible although somewhat arbitrary.

overestimation of the impacts of the minimum wage for the group of sub-minimum wage earners, but this possible effect is limited by the outlier correction.

4.2.3 Accounting for different evolution of minimum wage growth and average wage growth

As mentioned above, the data used in this study cover earnings in 2016. However, the considered HMW scenarios are assessed against a baseline based on fiscal regimes in 2019. To account for the changes in earnings during the period between 2016 and 2019, incomes are uprated according to income-specific indices, as is the standard practice in EUROMOD simulations.[18] In particular, in most countries, EUROMOD uses the average growth rate of employment income to uprate earnings.

Increasing wages by the average growth rate assumes that there is no heterogeneity in wage growth along the wage distribution. This is, however, often not the case. In particular, a challenge for our analysis arises when average wage growth differs from the actual increase in statutory minimum wages over the same period. In fact, as shown in Table A.3 in the Annex, in some countries there was a difference between 2016 and 2019. This is the case for instance in Spain, where average nominal wages increased by 3% between 2016 and 2019, while the monthly statutory minimum wage increased by 37% (from 765 EUR to 1050 EUR[19]). In 2016, the year when income data were recorded, the minimum wage level was therefore much lower than in 2019. If wages were uprated by 3%, a Spanish minimum wage worker, earning a monthly gross income of 765 EUR in 2016, would appear to earn just 788 EUR in 2019. The Spanish example shows how wages in the bottom part of wage distribution might be underestimated when earnings are uprated by the average wage growth. This has direct consequences for our analysis because it could overestimate the potential effect of a hypothetical minimum wage.

To tackle this issue, we increase the hourly wages below the statutory minimum wage in 2019 using the growth rate of the statutory minimum wage and not the average wage growth. In order not to distort the aggregated wage statistics, we do this uprate by adjusting the working time of the workers rather than changing the yearly gross wage. An example for the correction of working hours would be the following: suppose that a full-time Spanish worker reports earning the minimum wage in force in 2016, that is, 765 EUR. In 2019, under the assumption that this worker has not experienced any change in employment status, and he is still earning the minimum wage, his wage should be 37% higher. In such case, we increase the income by the nominal wage growth rate of 3% but reduce the hours of work by 34%, from 40 to 30 hours per week. In this way, the hourly wage would correspond to the hourly minimum wage in force in 2019.[20]

[18] Uprating indices are reported in the EUROMOD country reports.
[19] Note that Spanish workers get 14 payments per year. In order to be comparable with other countries, we divide the yearly wage by 12. The minimum wage for each calendar months is therefore 655 EUR in 2016 and 900 EUR in 2019.
[20] The adjustment of working time is done before the outlier detection to avoid identifying false outliers among potential minimum wage earners.

In contrast, some countries (such as Hungary, Latvia, Lithuania and Romania) experienced a higher growth in wages overall than in the statutory minimum wage. In fact, in these countries the increase of average wages between 2016 and 2019 was at least 10% higher than the growth in the minimum wage in these countries (see Table A.3 in Annex). Hence, an across-the-board uprating of wages by the average rate of wage growth might lead to overestimated increases at the bottom of the wage distribution and a potential underestimation of the impact of hypothetical minimum wage increases. To account for the potential underestimation, the wages of employees earning at (or close to) the statutory minimum wage (SMW) level should be uprated with a lower uprating factor than the one used in EUROMOD. However, it is difficult to determine an earnings range in which we should apply lower uprating factors. The divergence in growth rates of average wages and SMW is also relatively small, much smaller than in the case of Spain, where it was 34%. We therefore do not change uprating factors of wages in such case. As a result, our estimates of the impact of minimum wage reforms for countries like Hungary, Latvia, Lithuania and Romania might be slightly underestimated and can be considered as conservative.

4.3 Assignment of the hypothetical minimum wage and the microsimulation model

After calculating observed hourly wages and identifying outliers, we assign the new hypothetical minimum wage (HMW) to potential minimum wage workers. This assignment is done by increasing hourly wages to the level of the new HMW when the observed hourly wage is lower than that level As discussed in section 4.2.2, this is consistent with increased compliance and a reduced use of variations and exemptions. At the same time, the simulations assume no impact of minimum wage increases on wages slightly above the new hypothetical minimum wage; in other words, the simulations do not account for possible "spillover" effects.[21]

Statutory minimum wages apply to employees. Therefore, in this analysis, we do not change the incomes of individuals earning other types of income, such as self-employment or pension income. More specifically, the potential sample of HMW earners is selected under the following conditions: 1) positive employment income, 2) no self-employment income, 3) no pension income, 4) not younger than 18 years. The wages of the rest of population remain unaffected by the HMW. In a next step, we recalculate annual earnings by multiplying the new hourly wage rate by the reported yearly working time.[22] The new gross earnings are therefore higher than or equal to the gross earnings in the baseline.

Once the earnings are recalculated based on a specific HMW scenario, we run EUROMOD to calculate taxes, social insurance contributions and benefits at the new level of gross earnings. This is needed

[21] Other recent studies conducted in parallel to ours made somewhat different methodological choices. In particular, Detragiache et al. (2020, p. 12) assume that wages below the old minimum wage are increased by the rate of the minimum wage increase, which is more conservative than our assumption. In turn, they do not apply an outlier correction, and they assume spillover effects of minimum wages up to 75% of the median wage, which are less conservative assumptions than in our methodology.

[22] Following EU's Working Time Directive, the working time for which a HMW is assigned is capped at 48 hours per week.

to calculate the fiscal effects of the hypothetical scenarios and also the disposable income of households, which in turn is needed for the results on in-work poverty.

4.4 The methodology of the calculation of employment effects

Employment effects are estimated using the "elasticity method."[23] The method relies on the so-called "own-wage elasticity", which measures how employment in the group affected by the minimum wage increase responds to an increase in the average wage of that group induced by the minimum wage change.[24]

The definition of the own-wage elasticity implies that the change in total employment is the product of three factors:

(1) the own-wage elasticity (*OWE*);
(2) the estimated percentage increase in the wages of those affected by the minimum wage increase ($\%\Delta\ Wage_{aff}$); and
(3) the share of workers affected by the new minimum wage ($Share_{aff}$).

Expressed in formula, this means that:

$$\%\Delta EMP = OWE * \%\Delta\ Wage_{aff} * Share_{aff}$$

Factors (2) and (3) are outputs of the EUROMOD microsimulations of various hypothetical scenarios.

In turn, factor (1), that is, the own-wage elasticity used in this impact assessment, is based on the survey of the recent literature by Dube (2019b). Based on 48 recent international studies estimating the *OWE*, including evidence on EU Member States, Dube (2019b, p. 50) finds that the median elasticity reported in the literature is -0.16. This is close, although somewhat lower, than what was found by the Congressional Budget Office (-0.25; see CBO, 2019) based on a smaller selection of 11 studies for the U.S.

An elasticity of -0.16 means that the minimum wage raises the earnings of beneficiaries by much more than its possible negative impact on employment reduces earnings (by about a ratio of six-to-one). For the overall impact of a minimum wage increase to be negative on the overall earnings of low-wage earners, the OWE would need to be lower than -1. Accordingly, elasticities between 0 and -0.4 can be considered as "small in magnitude" (Dube, 2019b, page 27).

There is uncertainty around the elasticity used, which also affects the employment impacts obtained using the elasticity. More optimistic and pessimistic scenarios could also be constructed by rescaling the central estimate of the elasticity. For instance, a more pessimistic scenario is constructed by the

[23] A similar approach was taken by the U.S. Congressional Budget Office (CBO, 2019) in its recent assessment of hypothetical increases in the U.S. federal minimum wage.
[24] An explanation of this concept can be found in Dube, (2019b, pp. 26-27). The CBO (2019) calls this concept "direct elasticity", or the "employment elasticity for all directly affected workers".

CBO (2019) by assuming that long-term effects of minimum wage increases exceed those implied by the estimated short-term elasticities by 50%. This results in an alternative elasticity of -0.375 as compared to -0.25 in the CBO's baseline scenario. A more optimistic scenario, in turn, could be that minimum wage increases, especially at moderate levels, do not have a negative employment effect at all. Such an optimistic scenario could be based on the consideration that many of the studies used in the literature surveys focus on specific groups of workers, such as teenagers, and are not necessarily indicative of the overall impacts of minimum wages. Studies focusing on a broader set of low-wage workers, on average, imply smaller employment effects. In particular, "for the set of studies that consider broad groups of workers the median OWE estimate is quantitatively close to zero (-0.04)" (Dube, 2019b, p. 50).

Finally, it is possible that the actual elasticity would be different across various countries depending on the structure of the economy (e.g., the characteristics of firms employing most minimum-wage earners). Nevertheless, the existing literature does not provide an evidence base to postulate systematic differences across countries regarding the elasticity, and there is no academic literature to link the variation in estimated elasticities to observable differences between countries. For this reason, the same elasticity has been applied to all countries.

Alternative approaches to assess the impacts of minimum wages on employment are also conceivable. It is possible, for instance, to use fully-fledged macroeconomic models to do so. However, some macroeconomic models have a simplified "neoclassical" labour market module. This implies that wage increases "imposed from the outside" result in large job losses by construction, which is in contradiction to the existing empirical evidence. Therefore, such models are not particularly suitable to study the macroeconomic effects of minimum wage increases.

5. Results

This section presents the results by type of impact. The first four subsections present: the impacts on statutory minimum wages themselves (Section 5.1), the share of workers affected by the minimum wage increase, that is, the share of workers earning the minimum wage under the scenarios (Section 5.2), the implied wage increase for those affected (Section 5.3), and the implied increase in aggregate wages (Section 5.4).

The next three subsections present the impacts of various hypothetical scenarios on indicators related to the most relevant social outcomes: on wage inequality (Section 5.5), in-work poverty (Section 5.6), and the gender pay gap (Section 5.7).

Impacts on public budgets are presented in Section 5.8, while impacts on employment are found in Section 5.9. The presentation of the results in Sections 5.1 to 5.9 focuses on the impacts on the 21 Member States with a statutory national minimum wage. To complement these results, Section 5.10 summarises selected implications of these results at the EU level.

5.1 Statutory minimum wages

For all countries with statutory minimum wages, the minimum wage levels are increased to certain reference values, expressed as a percentage of the gross median or average wage. These values are 50%, 55% and 60% of the median wage and 40%, 45% and 50% of the average wage.

Hypothetical minimum wages at 60% of the median wage and 50% of the average wage are the two highest ones of the six reference values assessed. As can be seen in Graph 1 in Section 3, they are close to the highest statutory minimum wages currently observed in the EU. The minimum wages in Bulgaria, France, Portugal and Slovenia are at or close to 60% of the median, while the countries approximating 50% of the average wage are France, Portugal, Slovenia and Spain.

In contrast, the lowest reference values would imply a gap to be closed for about one-quarter to one-third of Member States. A reference value of 50% of the median wage would imply increases for 9 Member States from their 2019 levels (Czechia, Croatia, Estonia, Germany, Greece, Ireland, Latvia, Malta, the Netherlands; the implied increase would be small in Croatia, Greece and the Netherlands). Meanwhile, a reference value of 40% of the average wage would imply increases for 6 Member States: Czechia, Estonia, Hungary, Ireland, Latvia and Malta.

Intermediate reference values would imply gaps to close for one-half to two-thirds of the Member States. In particular, an intermediate reference value of 55% of the median wage would imply increases for 15 Member States. These are (in addition to the ones below 50% in 2019): Belgium, Slovakia, Hungary, Lithuania, Luxembourg and Poland. Meanwhile, an intermediate reference value of 45% of the average wage would imply increases for 17 Member States. These are (in addition to the ones below 40% in 2019): Belgium, Bulgaria, Croatia, Germany, Greece, Lithuania, Luxembourg, the Netherlands, Poland, Romania and Slovakia (see Graph 1 in Section 3 above).

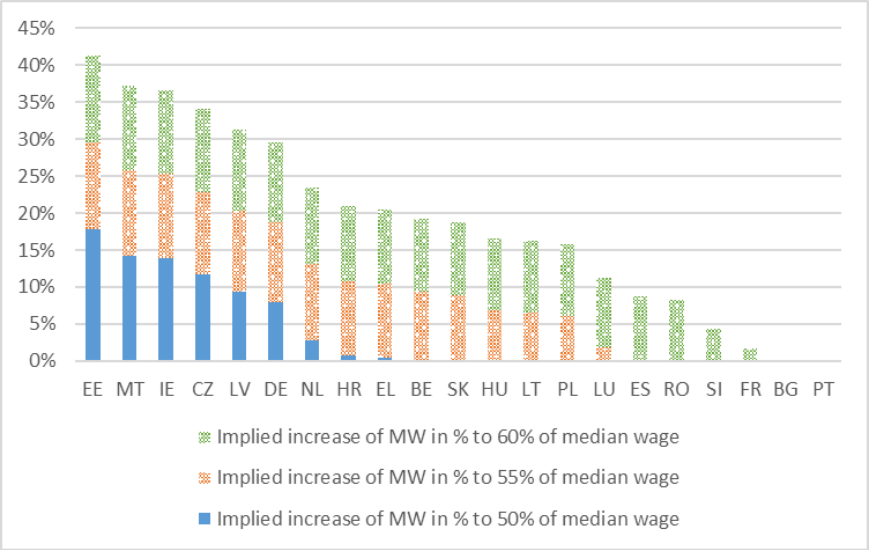
The percentage increase in statutory minimum wages, implied by the various indicative reference values, are shown in Graph 2. (Table A.1 in the Annex presents the implied increases in nominal terms.) The largest increases in minimum wages (i.e., reaching 30% in the case of the highest reference values) are implied in Member States such as Czechia, Estonia, Ireland, Latvia and Malta, while the smallest increases (below 10% for the highest reference values) are implied for France, Portugal, Slovenia, and Spain.

While higher or lower reference values can be defined both in terms of the average and the median wage, the two indicators have somewhat different implications across Member States. In particular, reference values based on the average wage imply somewhat higher minimum wages for Member States such as Bulgaria, Hungary, Portugal and Romania, while the reverse is true for Member States such as Belgium, Germany, Greece, Malta, and the Netherlands. The reason is that, while the average wage is higher than the median wage in all countries, the difference between both is not uniform across Member States: the gap between the median and the average wage is larger in countries where wage inequality is higher, especially at the top of the wage distribution. This is because top wages

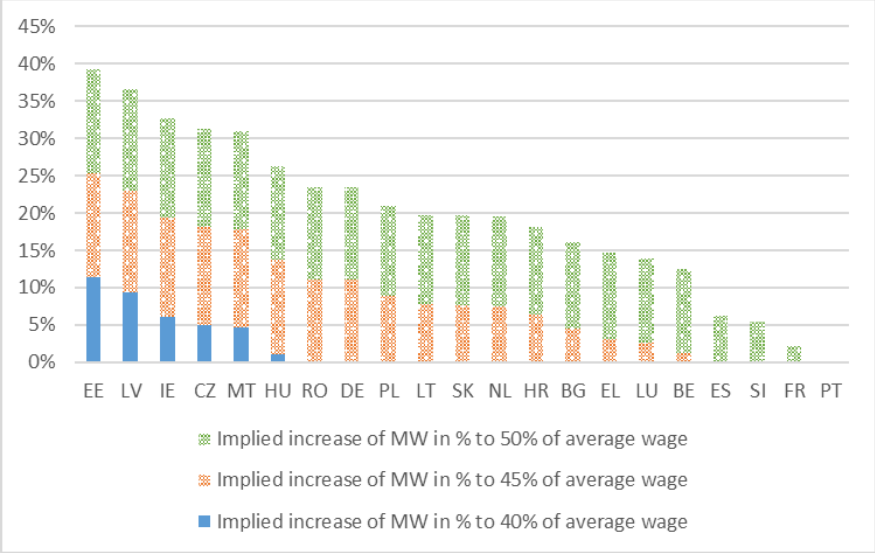
affect the average wage but not the median. Graph 3 shows that the relative difference between the average and the median wage ranges from slightly above 10% in Scandinavian countries to about 40% in Bulgaria and Portugal.

Graph 2: Implied minimum wage increases for various indicative reference values (%)

(a) Scenarios of minimum wages as a proportion of the median wage

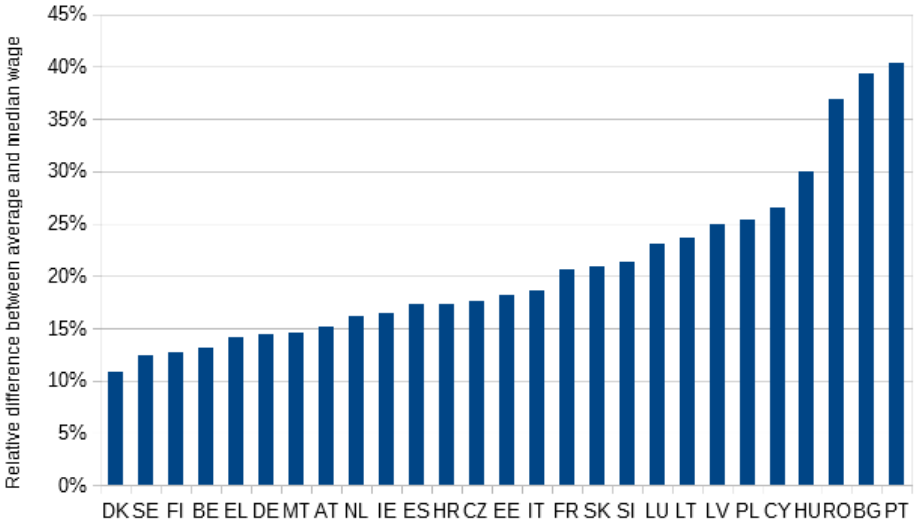


(b) Scenarios of minimum wages as a proportion of the average wage



Source: Own calculations based on Eurofound data on monthly minimum wage levels in 2019 (Eurofound, 2019) and Eurostat data on monthly earnings in 2019.

Graph 3: The relative difference between the average and the median wage, 2019



Source: Eurostat.

5.2 The share of workers affected

The share of workers affected by hypothetical minimum wage increases depends on two factors: the level of the hypothetical minimum wage and the concentration of workers at low wages.

Countries can be divided into three groups based on the share of workers affected by the highest reference values. In seven Member States, the share of workers earning the minimum wage would exceed 20% if the minimum wage were set at 60% of the median wage; these countries include Estonia, Greece, Ireland, Luxembourg, Poland, Spain, and Romania. If set at 50% of the average wage, the share of workers would reach 20% also in Bulgaria and Hungary (see Graph A.1).

In contrast, the share of minimum-wage earners would remain below 10% in Belgium, France, Lithuania, the Netherlands and Slovenia even if the minimum wage were set at 60% of the median or 50% of the average wage. In the rest of the countries, the share of minimum wage earners is estimated to be between 10% and 20% at the highest reference values for statutory minimum wages (see Graph A.1 in the Annex).

5.3 The wages of those affected

The increase in the wages of beneficiaries (i.e., those workers originally earning at or below the hypothetical minimum wage) would reach 20% in a number of countries under all scenarios. The average wage increase for the workers affected depends mainly on the initial level of the statutory minimum wage and the shape of the wage distribution close to the minimum wage, that is, the number of workers around the statutory minimum wage that are affected when the minimum wage increases. For the scenario in which minimum wages are set at 60% of the gross median wage, the average wage increase would reach 30% in Estonia and 25% in Germany, Greece and Ireland. In the scenario

where minimum wages are set at 50% of the average wage, the wage increase for affected workers would reach 25% only in Estonia (see Graph A.2 in the Annex).

5.4 Aggregate wages

The simulated increase of the wage bill depends on two factors: the share of workers affected and the average increase in earnings triggered by the new minimum wage.

In the scenario where minimum wages are set at 60% of the median wage, the largest increase in the wage bill would be recorded in Greece, exceeding 4%. Other EU countries with an increase in the wage bill above 2% would be Ireland, Estonia and Poland. In the scenario where minimum wages are set at 50% of the average wage, the largest increase in the wage bill would be recorded in Romania (above 4%) followed by Bulgaria, Estonia, Greece, Ireland and Poland (above 2%; see Graph A.3 in the Annex). These countries exhibit both a high share of minimum wage earners at such levels of the minimum wage (especially Greece and Poland) and a large increase in the wages of affected workers (especially Estonia and Ireland).

5.5 Wage inequality

A reduction of at least 10% in wage inequality would be observed in 12 Member States if their minimum wages were raised to 60% of the median wage. A reduction of at least 15% in wage inequality would be observed in 7 Member States (Czechia, Germany, Estonia, Spain, Luxembourg, Poland, Slovakia; see Graph **A.4: Reduction in wage inequality in simulated hypothetical minimum wage scenarios, D5/D1 indicator (%)** A.4 in the Annex). These decreases occur from a high initial level of wage inequality in Spain but lower initial levels in other countries, such as Czechia, Poland and Slovakia. For this reason, the highest reduction in absolute terms of the D5/D1 wage ratio would be achieved in Spain (a reduction of over 0.6).

In the scenario where minimum wages are set at 50% of the average wage, the largest decreases in wage inequality are observed in Estonia and Romania (above 20%). Countries with a decrease exceeding 15% is largely overlapping with the group of countries with a similar decrease in the scenario of 60% of the median wage, but it also includes Bulgaria and Greece, while excluding Germany.

5.6 In-work poverty

Eight EU countries would record a reduction by more than 20% in in-work poverty should they increase their statutory minimum wage to a reference value of 60% of the median gross wage or 50% of the average (see Graph A.5 in the Annex).[25] The most significant reductions in absolute terms are observed in Estonia, Greece and Romania, where this would imply a decline in in-work poverty of more than 2 pps. However, decreases also reach 20% in Germany, Hungary and Luxembourg, albeit from a lower

[25] The indicator measures the share of persons aged 18 or over who are employed and have an equivalised disposable income below the at-risk-of-poverty threshold, which is set at 60% of the national median equivalised disposable income (after social transfers). For the purpose of this indicator, an individual is considered as being employed if he/she was employed for more than half of the reference year.

baseline. Reductions would be lower, the most significant ones typically between 10% and 20%, if minimum wages were increased to the intermediate reference values (45% of the average wage or 55% of the median), while they would remain close or below 10% for the lower values (40% of the average wage or 50% of the median).

In some countries, such as Slovenia and the Netherlands, minimum wage increases do not always reduce in-work poverty in the simulations. This is due to increased taxes (in the Netherlands) and reduced means-tested benefits (in Slovenia) for some beneficiary households. It is possible that the parameters of the tax-benefit systems would be adjusted by governments in the wake of minimum wage adjustments to avoid such effects or to keep incentive effects unchanged. Such adjustments are also not modelled if they are done in a discretionary, rather than an automatic way.[26]

5.7 The gender pay gap

The gap between the average wages of men and women declines in all EU countries as the minimum wage increases. In the scenario where minimum wages are set at 60% of the median wage, the gender pay gap declines by more than 20% in Greece and by more than 10% in Spain, Romania and Slovakia (see Graph A.6). In the scenario in which minimum wages are set at 50% of the average wage, the gender pay gap declines by 25% in Romania and by more than 10% in Greece, Luxembourg, Poland, and Slovakia.

In these hypothetical scenarios, the reduction in the gender pay gap is significant, exceeding 5% in a number of countries, including in some where the gap in average wages between men and women is high (e.g., Czechia, Latvia, Germany).

5.8 Fiscal effects

Minimum wages affect public budgets in a number of ways. As a direct cost, higher minimum wages may increase the public sector wage bill in the case where a share of public-sector employees earn the minimum wage; the public sector wage bill can also increase due to possible links of public sector pay scales to the minimum wage. Higher minimum wages may also raise the cost of some public procurements.[27] This effect is, however, likely more than counterbalanced by the indirect effects on public revenues.

An increase in the minimum wage raises revenues from labour taxes and contributions and may also reduce benefits expenditure. This effect is indirect but larger than any negative effect on the public sector wage bill because few public employees earn wages close to the minimum wage. For instance,

[26] Such adjustments may affect the fiscal impact of minimum wage increases. Accordingly, in the current simulations, minimum wage increases improve the budget balance in the Netherlands and Slovenia. Adjusting tax and benefit rules to keep social benefits of minimum wage increases positive would likely reduce these positive fiscal impacts.

[27] For an explanation of these effects in the case of the U.S., see: Congressional Budget Office (2019): "The effects on employment and family income of increasing the federal minimum wage".

Zandvliet et al. (2019) estimate that, in the Netherlands, increased revenues from labour taxes and benefits exceed direct costs related to the public wage bill by a factor between 4 and 5. Similarly, in the U.S. case, Zipperer et al. (2021) estimate that an increase of the federal minimum wage would significantly reduce expenditure on public assistance programs and increase social security-related revenue.[28] On the other hand, benefits expenditure may increase in countries where some social benefits are automatically linked to the minimum wage.[29]

It is these impacts, on personal income taxes, social security contributions and benefits entitlements that are simulated in the present analysis using EUROMOD. Possible second-round effects, including impacts through taxes on corporations and consumption, are not modelled.

According to the simulations, minimum wage increases have a small but positive effect on public budgets, driven by increases in tax revenues and reductions of benefit expenditure (see Graph A.7 in the Annex). The magnitude of these effects is small; the overall improvement of public budgets is smaller than or equal to 0.1% of GDP in the scenarios implying smaller changes (50% of the median or 40% of the average wage), reaching 0.4% of GDP only in a few cases where minimum wages are increased to 60% of the median wage (in Estonia, Germany, Greece, and the Netherlands) and 50% of the average (in the Netherlands, Poland, and Romania). In turn, the simulations imply a small negative impact on the public budget balance for Hungary and Spain. Negative fiscal effects are driven by lower tax revenues in Hungary and by lower revenues from social security contributions in Spain. Results may be sensitive to modelling assumptions, including those related to how other policies, which are not automatically linked to the minimum wage (e.g., tax brackets, rules of tax credits), would change under the various scenarios.

5.9 Employment

As explained in more detail in Section 4.4 above, possible negative employment effects of higher statutory minimum wages are derived from the implied wage increase of affected workers by applying an "own-wage elasticity". The calculations are based on an own-wage elasticity of -0.16, corresponding to the central estimate of 48 international studies, including on EU Member States, as surveyed by Dube (2019b, p. 50). This elasticity means that when the wages of minimum wage earners increase by 10%, their employment is estimated to decrease by 1.6%, implying that the minimum wage raises the earnings of beneficiaries by much more than its possible negative impact on earnings through a reduction in employment.

The results show that possible negative employment effects remain below 0.2% in most cases if Member States increased their minimum wages to the lower reference values. The employment effect exceeds this level in Estonia and Ireland in the case of 40% of the average wage and also in Germany

[28] These impacts are confirmed by the Congressional Budget Office's simulations (CBO 2021) of the same proposal, although the CBO's assessment also includes significant increases in estimated healthcare-related expenditure.
[29] The links between minimum wages and benefits may in some cases not be automatic. In such cases, impact assessments may differ based on the assumptions they make on these links.

and Greece in the case of 50% of the median (see Graph A.8 in the Annex). If minimum wages were increased to intermediate reference values, negative employment effects would remain below 0.5% of total employment in most cases, and below 1% in all cases.

Finally, negative employment effects would remain below 0.8% in most cases for high reference values, but would reach 1% in Estonia, Greece and Ireland (at 60% of the median wage) as well as in Greece and Romania (at 50% of the average wage).

5.10 Implied impacts at the EU level

This section presents some hypothetical EU-level impacts derived from the country-level simulations. These derived EU-level impacts are summarised in Table 1.

Number of beneficiaries. The share of workers benefitting from a minimum wage increase in Member States can be used to obtain estimates of the number of beneficiaries in the EU of various hypothetical scenarios.[30] The results indicate that if Member States increased their minimum wages to the highest reference values, wages could increase for 22 million workers (at 60% of the median wage) or 24 million workers (at 50% of the average wage). At intermediate reference values, the number of direct beneficiaries is estimated to be 11 million (55% of median wage) and 12 million (45% of the average wage). The difference is larger between both low reference values: if statutory minimum wages were increased to 50% of the median wage, this would increase wages for 5.4 million workers, while increases to 40% of the average wage would benefit 0.7 million workers.

Increase in the EU wage bill. Simulations of the increase in the aggregate wage bill of individual Member States can be used to derive implied increases in the EU wage bill.[31] Minimum wage increases to the level of the highest reference values (60% of the median wage or 50% of the average) would imply increases in overall wages of about 1% at the EU level. Increases to intermediate reference values (i.e., 55% of the median wage or 45% of the average) would imply an overall wage increase of about 0.4%. The lower reference values imply smaller increases: an increase in the EU wage bill of about 0.2% (at 50% of the median wage) or an increase of 0.01% (at 40% of the average wage).

Wage inequality, in-work poverty, gender pay gap. Country-specific simulations on social indicators can be summarised at the EU level by taking a simple arithmetic mean of the results over all EU Member States. Increasing statutory minimum wages to the lowest reference values would reduce wage inequality in EU Member States by 1–2%, on average. Increases to intermediate reference values would imply an average decrease in wage inequality of about 5–6%, while increases to high reference values would imply an average decrease in wage inequality of about 8–10% (Table 1).

[30] To obtain these estimates, the share of workers affected, as simulated in EUROMOD, have been multiplied by the number of employees in the affected Member States in 2019.
[31] This is done by multiplying the estimated increases in the wage bill shown in Graph A.3 by the wage bill in EU Member States in 2019.

The implied EU-wide impacts on in-work poverty are somewhat larger than the impacts on wage inequality, while the impacts on the gender pay gap are somewhat smaller. In particular, increases in statutory minimum wages to the highest reference values would imply in EU Member States a decrease in in-work poverty of about 12–13%, on average, and a 5% average decrease in the gender pay gap (Table 1).

Employment effects. Finally, an EU-wide employment effect can also be calculated based on the country-specific simulations. Increasing all statutory minimum wages to the lower reference values (40% of the average wage or 50% of the median wage) would imply a reduction of 0.1% of EU employment or less. Increasing statutory minimum wages to intermediate reference values implies a reduction in total employment of 0.2%, while increasing statutory minimum wages to the highest reference values implies a reduction in total employment of 0.4%.

As explained in Section 4.4, these estimations are based on an elasticity which implies that the wage gains of beneficiaries of minimum wage increases are much larger (by a ratio of about 6-to-1) than the wage losses implied by the negative employment effects.

Table 1: A summary of results at the EU level

	Median Wage			Average wage		
	50% of median wage	55% of median wage	60% of median wage	40% of average wage	45% of average wage	50% of average wage
Countries affected (of the 21 with a statutory nat'l minimum wage)	9 MS: CZ, DE, EE, EL, HR, IE, LV, MT, NL	15 MS: all but BG, ES, FR, PT, RO, SI	19 MS: all but PT and BG	6 MS: CZ, EE, HU, IE, LV, MT	17 MS: all but ES, FR, PT, SI	20 MS: all but PT
Number of workers affected	5 mio.	11 mio.	22 mio.	0.7 mio.	12 mio.	24 mio.
Increase in the EU wage bill	0.2%	0.4%	1.0%	0.01%	0.4%	1.0%
Impact on wage inequality	-2%	-5%	-8%	-1%	-6%	-10%
Impact on in-work poverty	-2%	-6%	-12%	-1%	-7%	-13%
Gender pay gap	-0,7%	-2%	-5%	-0,2%	-2%	-5%
Impact on total employment	-0.1%	-0.2%	-0.4%	-0.01%	-0.2%	-0.5%

Notes: EUROMOD simulations. The baseline scenario reflects minimum wages in 2019.

6. Conclusions

This paper analyses the first-round effects of hypothetical minimum wage increases on social outcomes in 21 EU countries with a statutory national minimum wage. Using the microsimulation model EUROMOD, it assesses the impact of hypothetical minimum wage increases on wages and wage inequality, in-work poverty, the gender pay gap, as well as on the public budgets of Member States. Results of this analysis were used in the impact assessment of the European Commission's proposal for an EU Directive on adequate minimum wages in the EU.

From a methodological perspective, the paper combines two important strengths of past analyses: First, following Matsaganis et al. (2015), it uses EUROMOD to control for the interactions between minimum wage policy and the tax-benefit system. Second, following Eurofound (2014) and similarly to Detragiache (2020), it includes individuals with an unstable employment history. The inclusion of these workers is important for the analysis given that they are an especially vulnerable group of workers with potentially low wages. The methodological challenges include potential measurement error in reported earnings and working time in EU-SILC. The possible bias resulting from this challenge is addressed by an outlier correction methodology.

The simulations suggest that minimum wage increases can reduce in-work poverty, wage inequality and the gender pay gap significantly. In the hypothetical scenarios with the highest reference values, the average reduction in in-work poverty over all EU Member States is 12–13%, the average reduction in wage inequality is 8–10%, and the average reduction in the gender pay gap is 5%. While the implied wage increases are substantial for the beneficiaries, the implied increases in the aggregate wage bill are generally modest. Finally, minimum wage increases are estimated to have a small impact on public budgets, improving the budget balance in most cases.

The simulations are static: labour supply responses and second-round macroeconomic feedbacks are not assessed. As an important exception, impacts on employment are simulated by an elasticity method based on the share of workers affected and their wage increases in the various scenarios. The applied "own-wage elasticity" of -0.16 means that the minimum wage raises the earnings of beneficiaries by much more than its possible negative impact on employment reduces earnings (by about a ratio of 6-to-1). In the hypothetical scenario in which all Member States with statutory minimum wages raise them to the highest reference values, the simulated reduction in total employment would be 0.4% in the EU.

There is uncertainty around the simulated results. In particular, some of the methodological choices taken may result in an overstatement or understatement of the simulated impacts. For example, the assumption of full compliance with the hypothetical minimum wage may imply an overestimation of the impacts, although this possible effect is limited by the outlier correction method. On the other hand, the assumption of no spillover effects (i.e., no impacts on the wages of workers earning slightly more than the minimum wage) may result in an underestimation of the impacts. However, in case the results overstate the positive social impacts of the hypothetical scenarios, they also overstate the negative impacts on employment by the same degree (and vice versa).

A possible avenue for further research would be to model more comprehensively second-round effects of minimum wage increases in the economy. One possible extension would include modelling labour supply responses. Minimum wages generally improve work incentives, although the final employment impact would also depend on how easy it is to find a job. Another more comprehensive extension would be to link the microsimulation model with a macroeconomic model to take account of such general-equilibrium feedback effects. However, in such approaches there is a risk that the implications of the macroeconomic model are not consistent with the latest empirical research on the impacts of minimum wages. Some macroeconomic models, due to their simplified neoclassical labour market module, overemphasise possible negative impacts of minimum wage increases on employment and economic activity as compared to the body of recent empirical evidence.

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Appendix A: Additional tables and graphs

A1. Additional tables

Table A1. Statutory minimum wages in the various scenarios

Countries	Statutory MW	Hypothetical MW as a ratio of					
		median wage			average wage		
		50%	55%	60%	40%	45%	50%
Belgium	1,594	1,584	1,742	1,900	1,434	1,613	1,792
Bulgaria	286	239	262	286	266	299	332
Czechia	519	580	638	695	545	613	681
Germany	1,557	1,680	1,848	2,016	1,537	1,729	1,921
Estonia	540	636	699	763	601	676	751
Greece	758	761	837	914	695	782	869
Spain	1,050	952	1,047	1,142	893	1,005	1,116
France	1,521	1,288	1,417	1,546	1,243	1,399	1,554
Croatia	506	510	561	611	478	538	598
Hungary	464	451	496	541	469	528	586
Ireland	1,656	1,886	2,074	2,263	1,757	1,977	2,196
Lithuania	555	538	591	645	532	598	665
Luxembourg	2,071	1,919	2,110	2,302	1,888	2,124	2,360
Latvia	430	470	517	564	470	529	588
Malta	762	871	958	1,045	798	898	997
Netherlands	1,616	1,662	1,828	1,994	1,545	1,738	1,931
Poland	523	505	555	606	506	570	633
Portugal	700	499	549	599	561	631	701
Romania	446	402	443	483	440	495	551
Slovenia	887	771	848	925	748	842	935
Slovakia	520	515	566	618	498	560	622

Source: Statutory minimum wages from Eurofound (2019). Hypothetical minimum wages are derived from Eurostat data on median and average wages.
Note: Hypothetical minimum wages, which are smaller than actual statutory minimum wages, are marked in grey. Wages of countries outside the euro area are expressed in EUR. All wage levels are reported in gross terms.

Table A.2: Median number of hours worked by full-time employees

Country	Median working hours
BE	38
FR	38
IE	39
All other 18 EU Member States with statutory minimum wages	40

Note: People working more than 30 hours per week are defined as full-time employees.
Source: EUROMOD input data based on EU-SILC 2017.

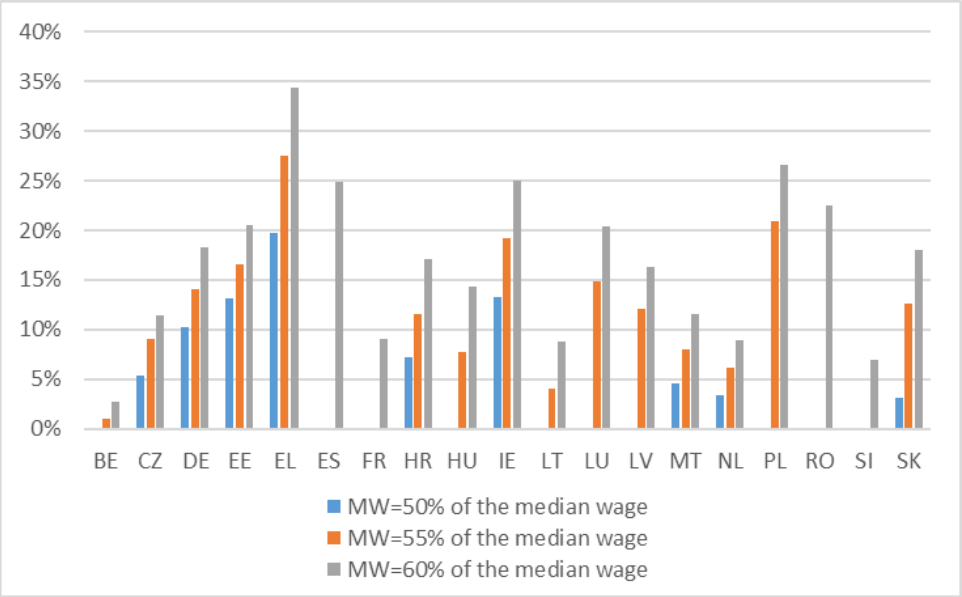
Table A.3: Difference in growth between statutory minimum wages and average wages from 2016 to 2019

Country	(A) Nominal growth of statutory minimum wage 2016–19	(B) Average nominal wage growth 2016–19	Difference between (A) and (B)
Belgium	4%	7%	-3%
Bulgaria	33%	28%	5%
Czechia	44%	24%	20%
Germany	8%	9%	-1%
Estonia	26%	22%	4%
Greece	11%	4%	7%
Spain	37%	3%	34%
France	4%	10%	-6%
Croatia	22%	14%	8%
Hungary	32%	43%	-12%
Ireland	7%	10%	-3%
Lithuania	46%	66%	-20%
Luxembourg	9%	8%	1%
Latvia	16%	26%	-10%
Malta	5%	12%	-7%
Netherlands	6%	5%	2%
Poland	27%	19%	8%
Portugal	13%	8%	6%
Romania	59%	79%	-20%
Slovenia	12%	9%	3%
Slovakia	28%	18%	10%

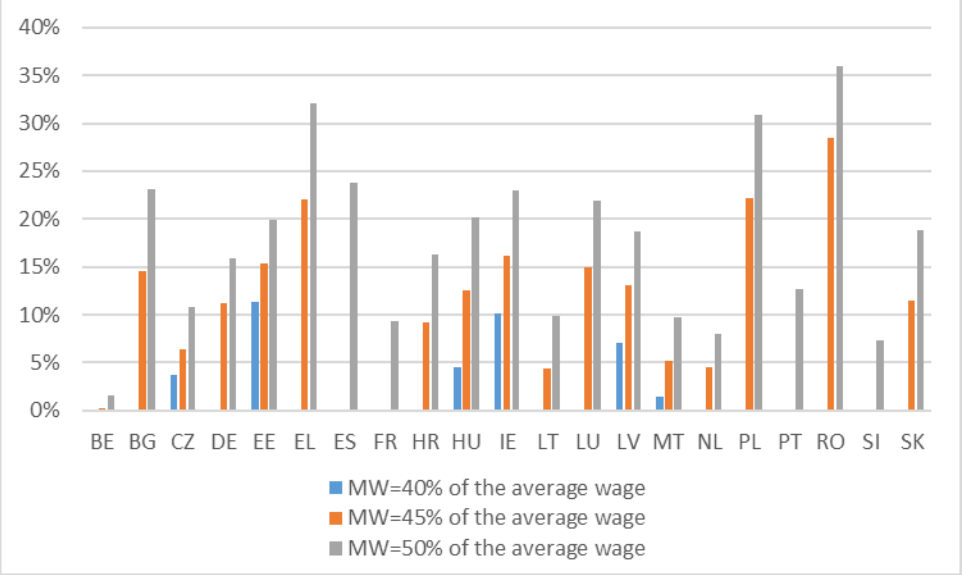
A2. Additional graphs

Graph A.1: Share of workers affected by increases of the minimum wage (%)

(a) Scenarios of minimum wages as a proportion of the median wage



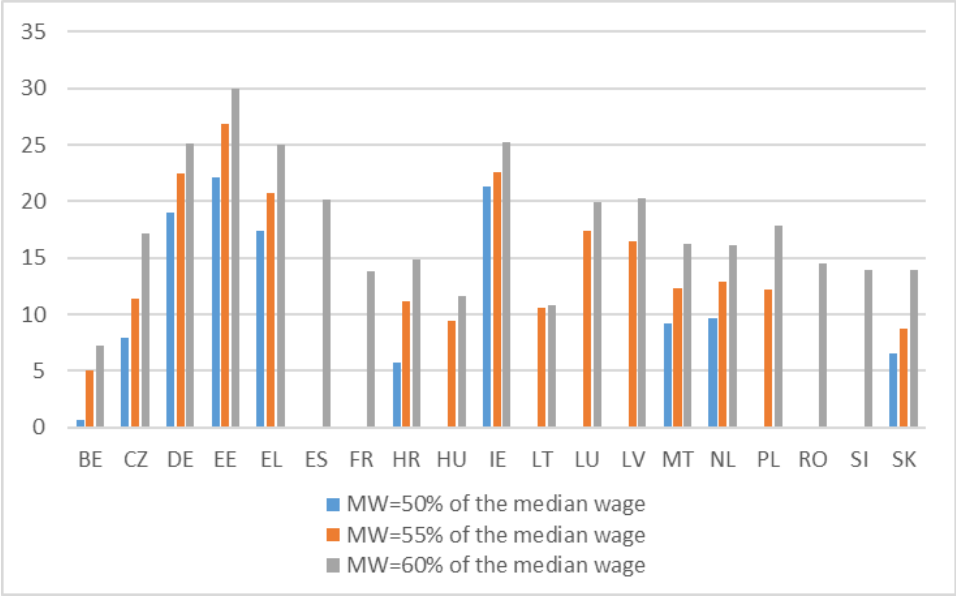
(b) Scenarios of minimum wages as a proportion of the average wage



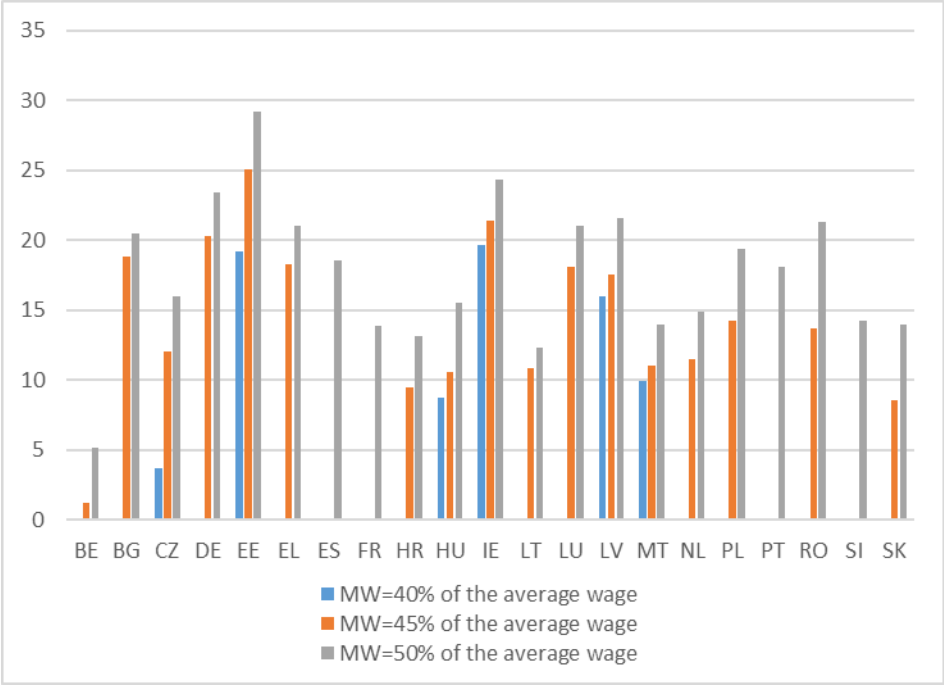
Notes: EUROMOD simulations. The baseline scenario reflects minimum wages in 2019. Countries are sorted alphabetically. Countries with actual minimum wages above the hypothetical scenarios are excluded.

Graph A.2: Average increase in the wages of those affected by increases in the minimum wage (%)

(c) Scenarios of minimum wages as a proportion of the median wage



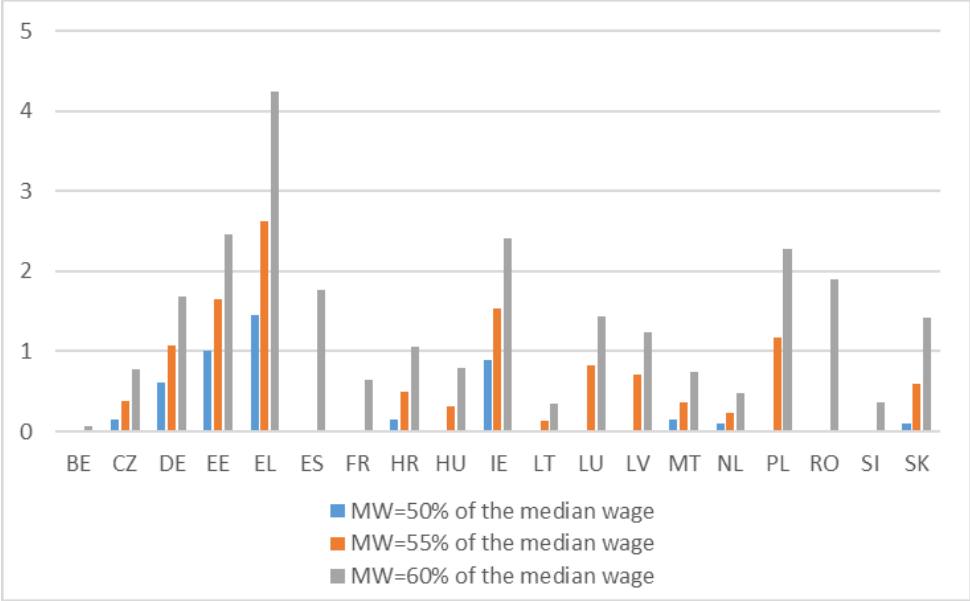
(d) Scenarios of minimum wages as a proportion of the average wage



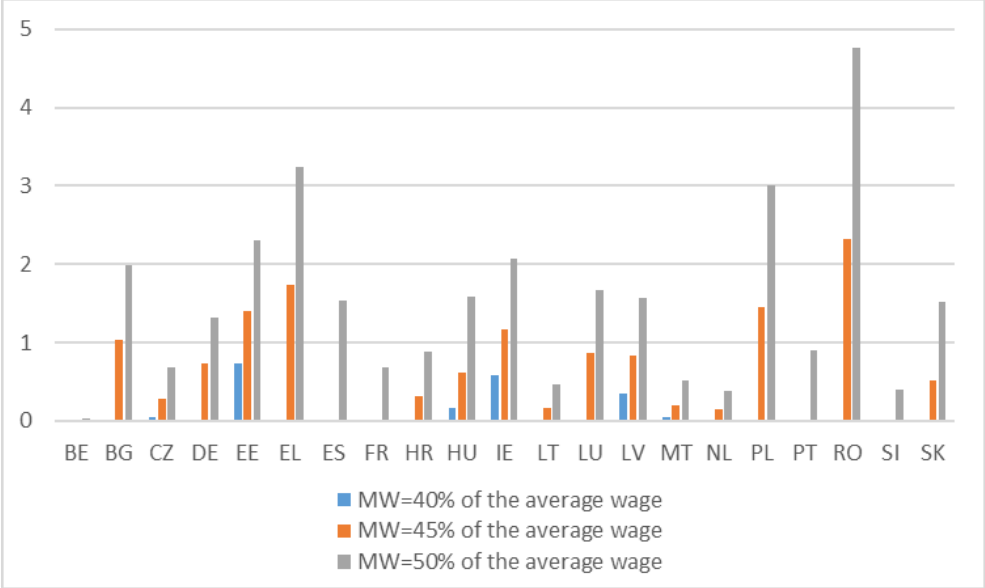
Notes: EUROMOD simulations. The baseline scenario reflects minimum wages in 2019. Countries are sorted alphabetically. Countries with actual minimum wages above the hypothetical scenarios are excluded.

Graph A.3: Change in the total wage bill as a result of changes in the minimum wages (%)

(a) Scenarios of minimum wages as a proportion of the median wage



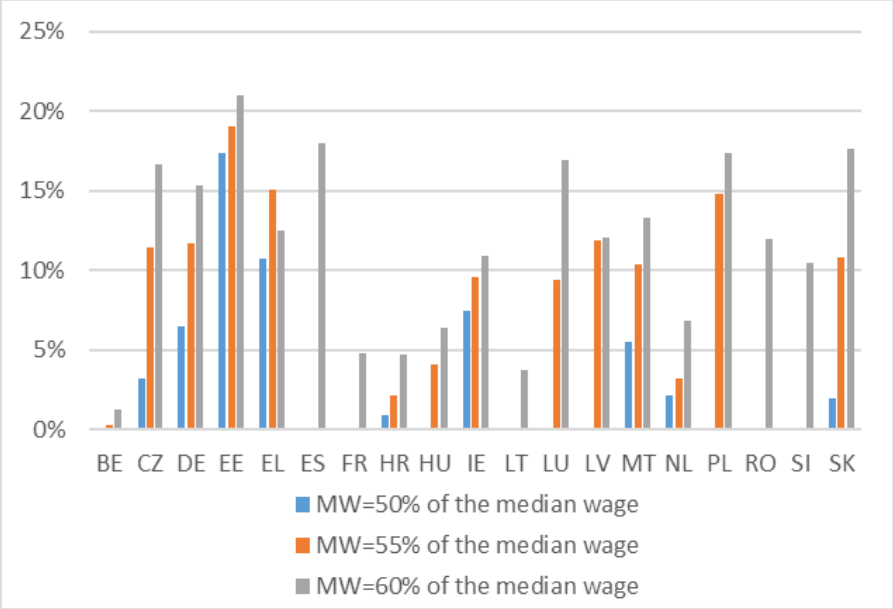
(b) Scenarios of minimum wages as a proportion of the average wage



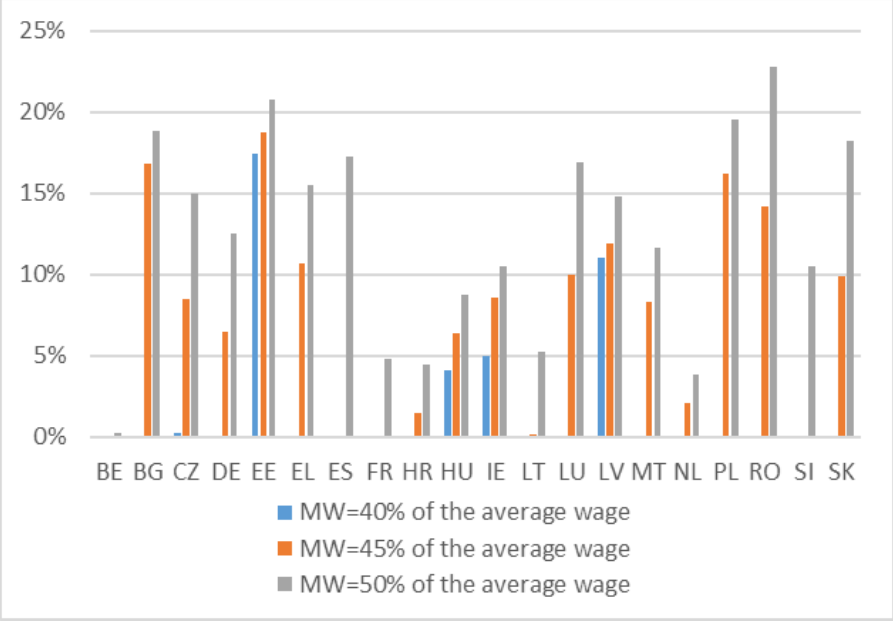
Notes: EUROMOD simulations. The baseline scenario reflects minimum wages in 2019. Countries are sorted alphabetically. Countries with actual minimum wages above the hypothetical scenarios are excluded.

Graph A.4: Reduction in wage inequality in simulated hypothetical minimum wage scenarios, D5/D1 indicator (%)

(a) Scenarios of minimum wages as a proportion of the median wage



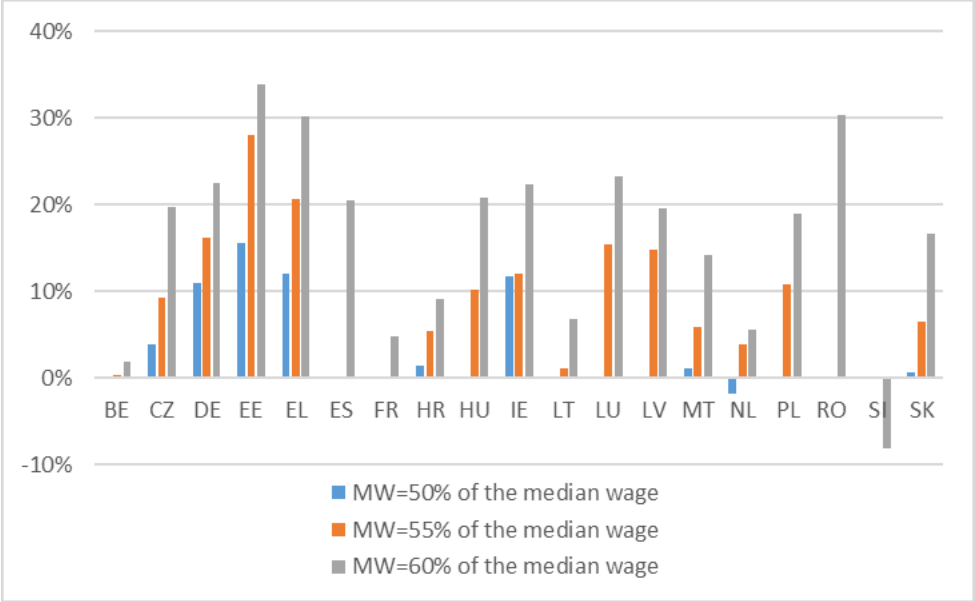
(b) Scenarios of minimum wages as a proportion of the average wage



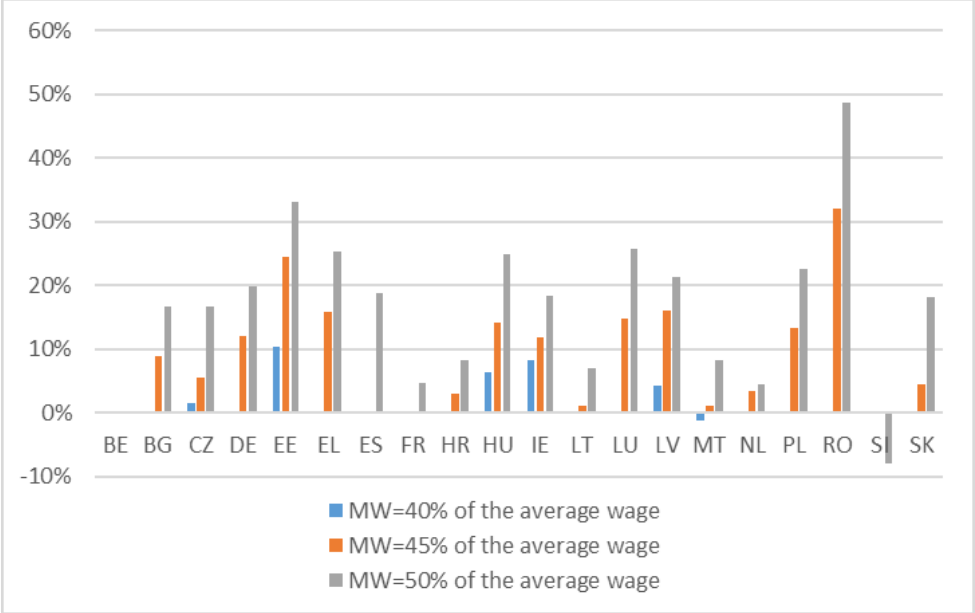
Notes: EUROMOD simulations. The baseline scenario reflects minimum wages in 2019. Countries are sorted alphabetically. Countries with actual minimum wages above the hypothetical scenarios are excluded. The D5/D1 indicator is obtained by comparing the median (D5) divided by the first decile (D1) of the earnings distribution.

Graph A.5: Reduction in in-work poverty in simulated hypothetical minimum wage scenarios (%)

(c) Scenarios of minimum wages as a proportion of the median wage



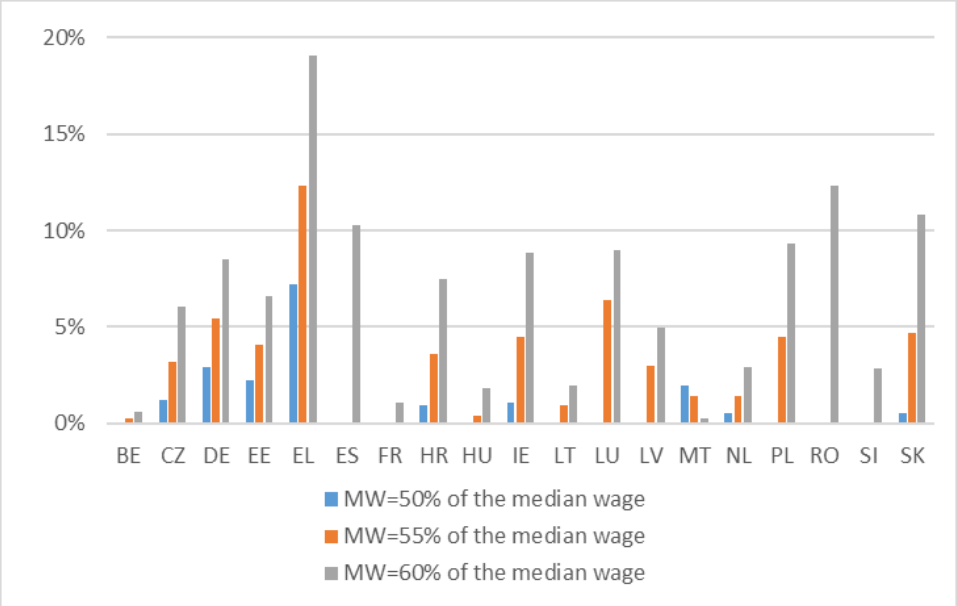
(d) Scenarios of minimum wages as a proportion of the average wage



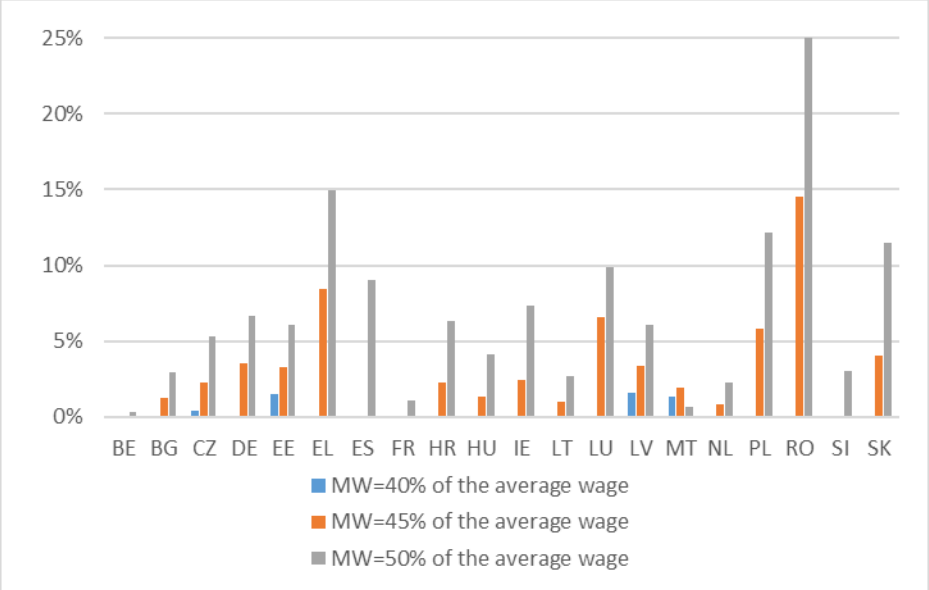
Notes: EUROMOD simulations. The baseline scenario reflects minimum wages in 2019. Countries are sorted alphabetically. Countries with actual minimum wages above the hypothetical scenarios are excluded.

Graph A.6: Reduction in the gender pay gap in simulated hypothetical minimum wage scenarios (%)

(e) Scenarios of minimum wages as a proportion of the median wage



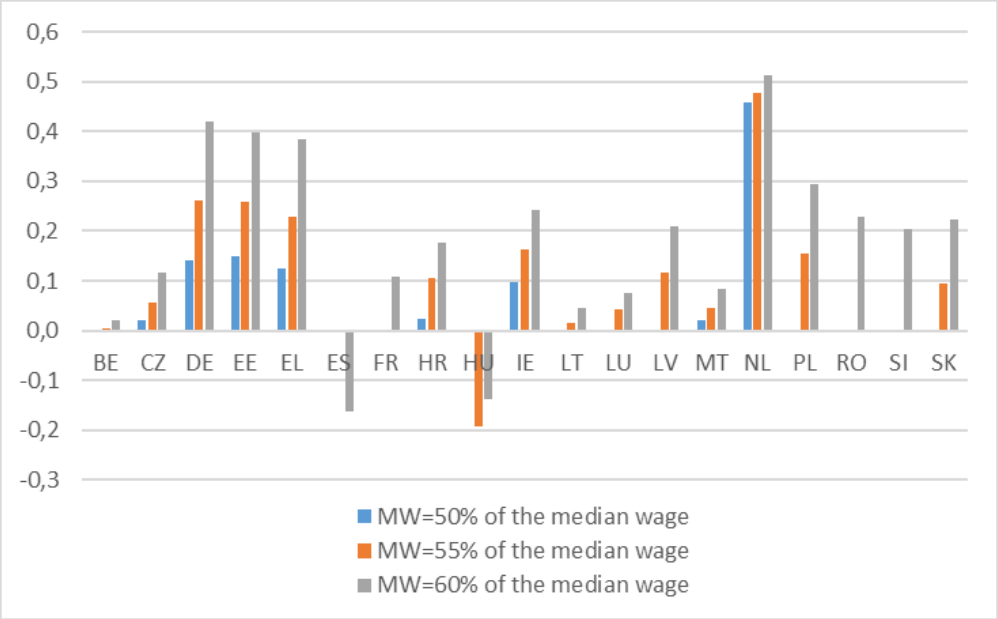
(f) Scenarios of minimum wages as a proportion of the average wage



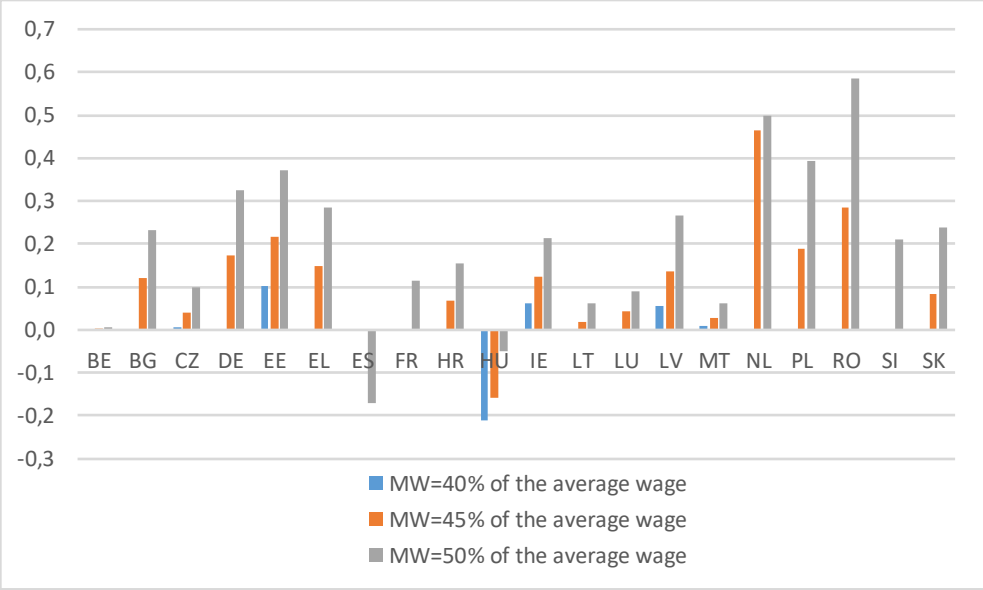
Notes: EUROMOD simulations. The baseline scenario reflects minimum wages in 2019. Countries are sorted alphabetically. Countries with actual minimum wages above the hypothetical scenarios are excluded. The gender pay gap is the difference between average gross hourly wages of male and female employees as a % of male wages, unadjusted for individual characteristics.

Graph A.7: Impact on public budgets (change in fiscal balance as % of GDP)

(a) Changes in fiscal balance when minimum wages are set as a proportion of the median wage



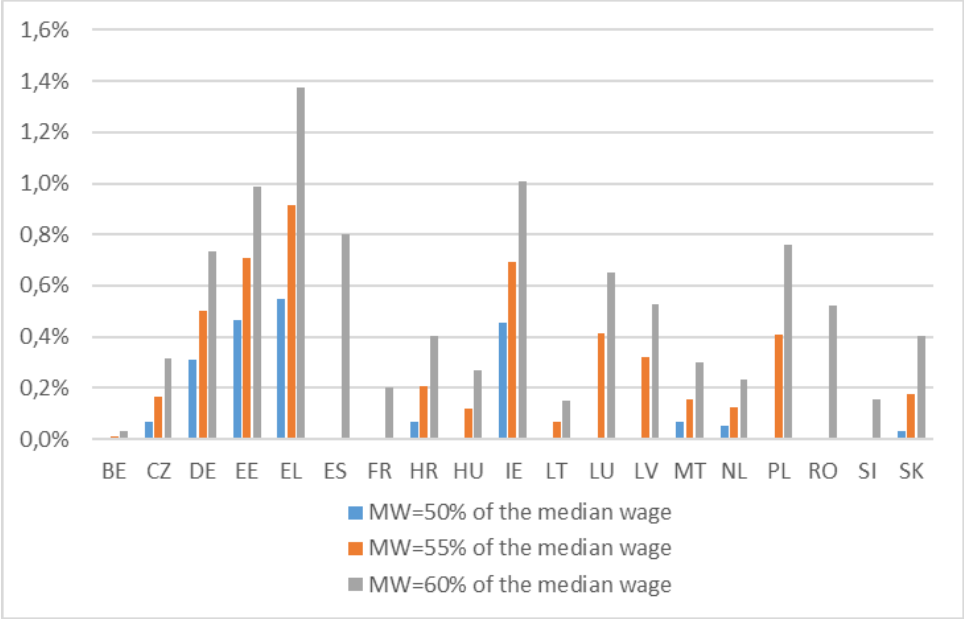
(b) Changes in fiscal balance when minimum wages are set as a proportion of the average wage



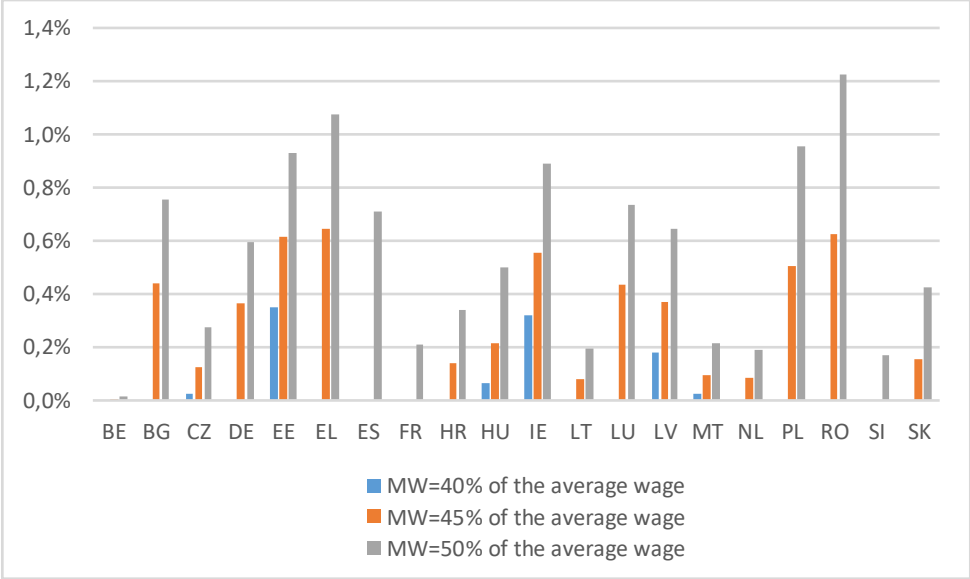
Notes: EUROMOD simulations. Positive numbers reflect improvements in the public fiscal balance. Countries are sorted alphabetically. Countries with minimum wages above 60% of the median wage are excluded.

Graph A.8: Estimation of possible negative employment effects in simulated hypothetical minimum wage scenarios (%)

(a) Scenarios of minimum wages as a proportion of the median wage



(b) Scenarios of minimum wages as a proportion of the average wage



Notes: EUROMOD simulations. The baseline scenario reflects minimum wages in 2019. Countries are sorted alphabetically. Countries with actual minimum wages above the hypothetical scenarios are excluded.

Appendix B: Additional details on methodology

B.1 Median and average wages

Median and average wages used in this analysis have been provided by Eurostat. Eurostat calculates both the average and the median wage based on earnings surveys. In particular, the latest available wave of the Structure of Earnings Survey (SES, referring to 2014 earnings) has been used to extrapolate median and average wages in 2019. The derived medians and means have been extrapolated using the wage component of the labour cost index (LCI) data, published in the dataset '*lc_lci_r2_a*' of Eurobase. The final ratios have been calculated as the monthly gross minimum wage in force on 1 July 2019 divided by the median / mean monthly earnings estimated for the reference year 2019.

The basis of the calculations are monthly gross earnings in national currency. These include non-regular revenues such as bonuses and overtime. The corresponding figures are published in the dataset '*earn_ses_monthly*' of Eurobase.

The indicators shown in this impact assessment are based on the earnings of full-time workers, similarly to the definition used by the OECD.

B.2 Imputation of missing working hours

The method of imputation of working hours is based on Brandolini et al. (2010). It uses information from the EU-SILC on gender-specific median hours and workers' history of full-time and part-time employment to assign a value of working hours to employees without reported values. In particular, the formula of adjusted working hours of an individual *i* is the following

$$WH_i = \frac{Median_{g_i}(HPT) * MPT_i}{M_i} + \frac{Median_{g_i}(HFT) * MFT_i}{M_i}$$

where WH_i refers to weekly working hours; $Median_{g_i}(HPT)$ and $Median_{g_i}(HPT)$ refer to the median weekly working hours of workers who declare themselves as part-time and full-time workers, respectively. The index g_i refers to the gender of individual *i*, indicating that the medians are calculated for men and women separately. The medians of part-time and full-time working hours are therefore country-gender specific. MPT_i and MFT_i refer to individual i's number of months in part-time and full-time employment (in the income year 2016). M_i refers to the total number of months in employment of both part-time and full-time work. To give an example: assume that in a certain country the median full-time working hours of men is 40 and the median part-time working hours of men is 20. If a male individual reported to have worked part-time for 6 months and full-time for 6 months, he would be assigned 30 weekly working hours.[32]

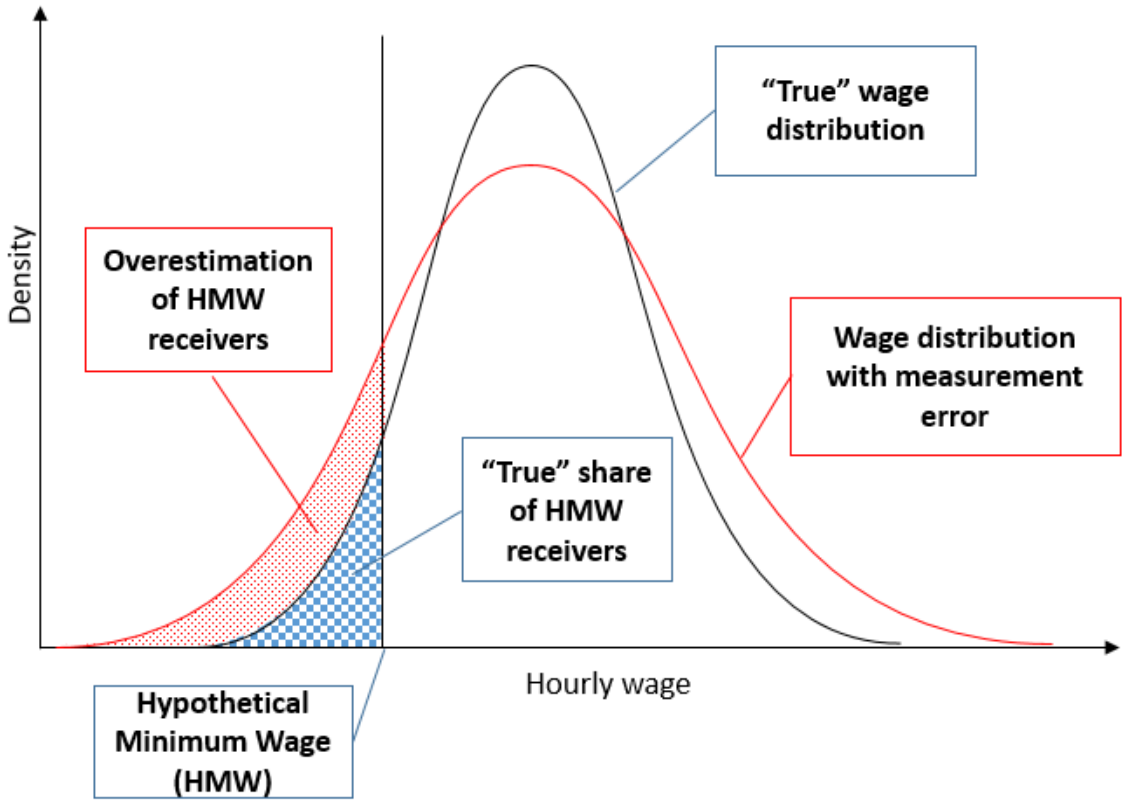
[32] $WH_i = \frac{20*6}{12} + \frac{40*6}{12} = 30$

The advantage of this approach is that it uses the information on months worked full-time and part-time in the income year, rather than relying on information in the survey year. The approach has, however, a shortcoming as the imputation of hours can produce a bias in countries where atypical employment (e.g., mini jobs in Germany) is very common and therefore leaving no space for working hour agreements outside the standard working hour schedule.

B.3 Outlier detection and correction

Figure B.1 illustrates the potential impact of measurement error of wages on our impact assessment. It shows two wage distributions: the 'true' distribution of hourly wages and the distribution with measurement errors. The measurement error increases the variance of the distribution and leads to wider tails.[33] The vertical line indicates the level of the hourly HMW. The area on the left of the vertical line defines the share of HMW receivers. As shown in Figure B.1, this share is higher in the case of the distribution with a measurement error, where the red area indicates the amount of overestimation of MW receivers due to measurement error. For this reason, we have applied an outlier detection procedure.

Figure B.1: Distribution of gross hourly wages



[33] In theory, a measurement could have the opposite effect. Namely the variance of the distribution would be reduced if the measurement error would be negatively correlated with hourly wages, which is however unlikely the case.

An outlier is identified based on the interquartile range (IQR) of log(hourly wage). The method is based on the logarithm of hourly wages, and it assumes that hourly wages follow a log-normal distribution. The IQR is the distance between the 25% percentile and the 75% percentile of the wage distribution. We identify outliers as observations smaller than the median minus 1.5 times the IQR:

$$Outlier_i = \log(HW_i) < \log\big(Median(HW)\big) - 1.5 * IQR$$

Where $Outlier_i$ indicates whether the hourly wage of individual i is an outlier, HW_i refers to hourly wage, and $Median(HW)$ refers to the median hourly wage in the sample.

Multiplying the IQR by 1.5 implies that method identifies as outliers all observations that are outside the main area of the normal distribution. The IQR of a standard normal distribution would be 1.34 because the 1st quartiles is at -0.67 and the 3rd quartile is at 0.67. Given that its median is zero, the outlier detection threshold of a standard normal distribution would be therefore at -2.01, which corresponds to a p-value of 0.35%. Hence, in the case that hourly wages follow a log-normal distribution and have no outliers, this outlier correction would flag just 0.35% of the sample erroneously as outliers.

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The European Commission's science and knowledge service

Joint Research Centre

JRC Mission

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