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Minimum wages and wage compression in Belgian industries

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Abstract

Measuring the effects minimum wages have on wage inequality and employment is complex, and troubled by endogeneity issues. We use a large longitudinal dataset and sectoral minimum wage variation to analyse trends in minimum wages and wage inequality in Belgium. Building on the model of Lee (1999) and the critique by Autor, Manning and Smith (2014), we find that minimum wage increases in Belgium cause a two-sided compression of the wage distribution. Using wage indexation as a natural instrument, we find an additional source of endogeneity in sectoral bargaining. It appears that unions and employer's representatives prefer increasing lower wages over higher wages. This paper explores several hypotheses that could explain this outcome, including firm proximity to sectoral wage bargaining, and labour supply elasticity. The results suggest that a higher likelihood of firm involvement in the bargaining process indeed enhances 'endogenous' wage setting, in which minimum wage levels and wage dispersion are simultaneously determined. A similar finding appears in absence of white-collar workers, pointing to different degrees of internal redistribution in sectors depending on the outside options of workers. The minimum wage effects found when including sectoral characteristics can contribute to understanding different minimum wage effects encountered in other and future research, and advise policy makers to consider the criteria to judiciously set minimum wages at the right level through collective bargaining.

JEL classification: J31 Wage Level and Structure • Wage Differentials J52 Dispute Resolution: Strikes, Arbitration, and Mediation • Collective Bargaining

Key words: Minimum wages; Wage inequality; Collective bargaining, Wage compression

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1 Introduction

Minimum wage policies can have various configurations (e.g. statutory, sectoral, occupational), but in general they aim at reducing wage inequality while preserving employment levels. Those are the two criteria to assess a successful policy. Both ambitions have been extensively examined in the economic literature, albeit with unequivocal conclusions on the effectiveness of uprating minimum wages, which appears to depend on the targeted segment of the workforce (e.g. migrants, young workers; for a discussion, see: Neumark, 2018). A key element seems to be the degree to which setting the minimum wage is an endogenous process that simultaneously accounts for distributional effects as well as employment effects. However, this emphasis on the process has not yet been fully integrated in minimum wage research. In this paper, we attempt to investigate more complex minimum wage systems than either sectoral case-studies or studies on statutory minimum wages, based on the particular framework of wage bargaining in Belgium.

With respect to the employment effects of raising the minimum wage, Schmitt (2013) pointed at differences between the short-run, medium-run, and long-run effects. In the short run, labour demand might decrease with rising minimum wages, but the medium- and long-run effects could point in the other direction. This implies the *ceteris paribus* clause is important: as minimum wages increase, all else does not stay equal: disposable income and therefore demand, productive investments, or creative destruction may lead to economic growth and undo short-run negative effects on employment. While a meta-analysis by Neumark and Washer (2014) isolates an average negative effect, close-control studies find no short-run employment effects or positive effects (Card and Krueger, 1994; Dube et al., 2010; Allegretto et al., 2011; Dube, 2019; Sturn, 2018). In those cases, it appears that markets are not in the competitive equilibrium. There are a number of possible explanations for this observation. First, according to the efficiency wage theory (Akerlof, 1984), higher wage rates reduce monitoring and turnover costs, as workers who are paid more have more to lose even if they only face a low risk of being caught when shirking. Second, in the case of (efficient) contract curves, there is bargaining over wages so that, compared to the optimal allocation on the demand curve, the workers gain utility without an utility loss for the firm (Borjas, 2013). Third, if the firm behaves like a monopsonist in the labour market (Brown, 1999; Manning, 2006), the minimum wage will coincide with the marginal cost curve until it crosses the labour supply curve, so that uprating the minimum wage when it is below the competitive equilibrium will cause wages and employment levels to simultaneously increase. Besides these 'modelled' explanations, a host of other so-called *channels of adjustment* (Hirsch et al., 2011) are proposed, including increasing productivity and performance standards, but also working hours, prices, turnover, training, and general non-labour costs.

A second strand of the literature focuses on the distributional effects of minimum wage policies. As suggested by Piketty (2014), wage inequality has been driving income inequality more than factor inequality since the 1970s. It has been argued that the decrease in the minimum wages is responsible for most of the increase in wage inequality in the US in the 1980s (DiNardo et al., 1996; Lee, 1999). However, this is difficult to measure, as the time trend in minimum wages goes together with a trend in wage inequality, which can also be caused by other trends such as technological change. Contrary to the US, where minimum wages are decreasing relative to the median wage, one might find an inequality increasing effect in other economies where minimum wages are increasing relative to the median, when relying merely on correlations. The solution of Lee (1999) was to use cross-sectional variation between US states in the median wage levels (i.e.

the relative minimum wage or the Kaitz-index). However, in doing so, a conspicuous increase of wage inequality above the median was observed (Autor et al., 2008). Correcting for simultaneity and endogeneity issues, Autor, Manning & Smith (2014, henceforth AMS) found a much smaller effect, limited to the lower percentiles only. We will build on the latter methodology in this analysis for Belgium, focussing on inequality and distributional effects rather than employment effects, but keeping in mind the idea of channels of adjustment: as minimum wages increase, 'something has got to give'.

The limitation of most research in minimum wage research is that the studies exploit spatial or geographical variation in the minimum wage (Dube et al., 2010), as bargained wages are mostly unknown or do not exist. Comparative cross-country research indicates that 'if judiciously chosen (set different rates across sectors and age), without interfering with the available wage- setting procedures (better in decentralized systems) or with existing in-work benefit systems (it should increase participation) or payroll taxes (there may be case for subsiding the social security payments of minimum wage earners), it [minimum wages] can do more well than harm in breaking the lock of the poverty trap' (Dolado et al., 2000, p. 19). This means politically determined, statutory minimum wages could have disruptive effects – at least in the short run. Moreover, those minimum wages only affect the lowest-paying sectors, and this will be influenced by the dominant industries in the region.

1.1 Institutional wage bargaining in Belgium

Institutionally, wage setting in Belgium is a particular case. In contrast to the much-studied liberal, Anglo-Saxon welfare states, in Belgium wage rates in the private sector are settled collectively by industry in joint committees consisting of trade unions and employers' federations. A joint committee is a freely formed body that is officially recognised on demand of the social partners. There are about one hundred active joint committees and sub-committees, which cover a range of economic activities as well as a segment of the workforce. Often, there is a separate joint committee for white and blue-collar workers within an economic branch.

Due to the favourability principle, sectoral collective bargaining agreements should improve the situation of workers over normal labour law and national collective bargaining agreements, and in case there are additional firm-level agreements or individual agreements, they should improve on all higher-level agreements as well (no derogation). In sum, there is organised, autonomous multi-employer bargaining at the lowest suitable level. The principle of subsidiarity implies that the state interferes as little as possible in this process.

To some extent this model is similar to other post-war Western European industrial relations regimes (e.g. in France, Germany, the UK) which have lost much of their importance near the end of the 20th century, or to the current Nordic and Italian wage bargaining systems with high unionisation and coverage rates. Yet in contrast, Belgium also has a national minimum wage and a legal provision for automatic extension of wage agreements, backing the principle of universality. The national minimum wage, moreover, is equally determined by the social partners, represented in the bipartite National Labour Council, and it only covers the private sector.

The scope of the national minimum wage in Belgium is limited. It trails behind at about 18% of the average sectoral minimum wages, and according to a recent report by the Central Economic Council (CRB, 2018), it covers around 3% of the workforce . A similar exercise that we undertook also comes to this conclusion, noting that this share has been slightly decreasing in the last 20 years up to 2015 (Vandekerckhove, 2019). Paragraph 7.2 in appendix compares our findings with those from the CRB. Another study, by the Federal Planning Bureau (Lopez Novella, 2018), looked at the recent uprating of the now-abolished youth minimum wages to the full minimum wage previously attained at 21 years of age. It found that this policy change has increased young workers' wages and job retention, but decreased employment inflows, confirming the conventional hypotheses on minimum wage effects. There are however particularities about the Belgium wage setting system and a 'second level' of minimum wages, that can contribute to the literature, notably by addressing the bargaining dynamics at play at the sectoral level, which is the undertaking of this paper.

1.2 Outline of the research

To have the best match between the level of decision making at which minimum wages are set and the scope of the minimum wage policy, we should use variation in the sectoral minimum wages, and measure the effects at the sectoral level in the case of Belgium, whereas in other industrial relation regimes, regional variation may be better suited. To do so, Vandekerckhove, Van Gyes & Goos (2018b) have linked collective agreements to wage data for 43 joint committees, which are sectors defined by branch and job category (blue and white collar) and examined the effect of minimum wage changes on job dynamics. While the marginal effects on worker outflows and inflows varied considerably between sectors, it turned out that effects over a timespan of one year are noticeably stronger than at a quarterly basis, and that sectoral job flows dominate over labour market in- and outflows. In other words: the labour markets of different sectors are connected, arguably more so than regions or countries, and some sectors set wages that drive out workers, while other manage to have a net positive inflow rate. What we do not know, however, is what defines these job dynamics. The considerations of negotiators and the ability to shape the wage distribution through collective bargaining needs more scrutinous research.

Using the framework of Lee (1999) and correcting for endogeneity following AMS, we first replicate those analyses for Belgium, based on sectoral variation. We find that in line with our expectations, the observed correlations signal strong endogeneity, and we can correct for this. It turns out that not only is there a smaller but significant minimum wage effect on the lower percentiles of the wage distribution, and spill-over effects decreasing wage inequality up to the 30th percentile, but there is also a significant compression effect in the upper tail. Using three different explorative approaches, we verify whether this result could be attributed to some form of endogenous wage setting. With a new natural exogenous instrument, we find that the lower-tail effects increase while the upper-tail effects decrease. Worker flows are a proxy for the elasticity of labour supply, and should attenuate the compression effect by lack of internal redistribution, yet our results prove the contrary. Another proxy, the share of white-collar workers, does align with the hypothesized vanishing of upper-tail effects when high-paid workers have more outside options. Finally, greater concentration of firms should increase the compression effect, because of the proximity to the negotiating table, and this is indeed what we find. In conclusion, minimum wage effects differ by sector based on how they are implemented and who they apply to, which could explain why different studies yield different results, whether is it by sector, region, or for specific segments of the workforce.

The structure of this paper is as follows: we will first discuss the wage data, the data collection, and the sampling in section 2. In section 3, descriptive figures on wage inequality and minimum wages will be presented. In section 4, a model for assessing minimum wage effects on the wage distribution is outlined, adding extensions to account for endogeneity encountered in previous research for Belgium in section 5. Section 6 concludes this paper and discusses policy options.

2 Data

2.1 Collectively agreed wages

The data for the sectoral minimum wages for our analysis come from our Belgian Minimum Wage database, which covers 43 of the largest joint committees from 1996 onwards, accounting for 61% of all employment in the private sector. This database holds information on 1370 wage changes implemented over this period, of which 77% include wage indexations and 23% include real wage increases. Further, 15% are absolute wages increases, while 85% are relative (percentual) wage changes.

To build a longitudinal index of collectively agreed sectoral minimum wage floors, the same job category needs to be traced over time, unless a substantial new pay grade was introduced. One challenge is that pay grades in Belgium are often linked to age or seniority, and this system has undergone changes. As European legislation on labour market discrimination, implemented in national legislation in 2007 and effective from 2009, required seniority wages to be based on competence or tenure and not on age (OECD, 2013), there have been changes in the wage scales of all joint committees that were affected by this law. In many cases, the minimum wage was defined at 21 years, and younger workers received a percentage of this minimum wage, which was uprated after the policy change. In some sectors, this meant that the full minimum wage was paid to employees with three years seniority (most or all current workers), in others immediately from age 18. We have chosen to follow the levels set at first, in order to avoid abrupt, artificial breaks in the trend.

2.2 Effective wages

Effective wages are registered by the National Social Security Office (NSSO), which provided a 20% sample of all private-sector employment between 2000 and 2015, with quarterly entries and a panel structure. The sampling algorithm ensures that the panel structure is maintained while also being cross-sectionally representative: all workers have a single chance (of 1 in 5) to be selected for the panel, in the last quarter in which they appear in the population. In practice, this means a random sample of 20% of the population (excluding students and apprentices) is drawn in the final quarter of the final year (2015), and then every worker who has been selected is traced back year by year For all new workers in the third quarter of 2015, i.e. the workers leaving employment in the next quarter, another selection of 20% is made, and so on. The sampling procedure is simulated in a programme that can be found in annex (paragraph 7.5). The data was compared to the Structure of Earnings Survey data for Belgium to check the representativeness.

The data encompass wages and working time, as well as the firm identification number and information on the sector of employment (NACE and the joint committee), and the age and job category of the worker. The basic wage for blue-collar workers does not include the holiday allowance of around 8% of the annual wage, as it does for white-collar workers. Hence, this allowance had to be estimated based on the distribution of so-called ‘equivalent days’ (days that permit social security rights, e.g. holidays, sickness, parental leave, etc.) over the four quarters. As a result, we have a wage concept that fully corresponds to the basic wage in the collective agreements. Because the identifier for the joint committee was not a mandatory field in the social security registration until 2003, we used information on the sector, social fund, and the worker statute, as well as future information on the employer, to determine the joint commission before this date. The employment evolutions shown in the appendix (Figure 7) show that this approach was successful. The merger between the large joint committees for the general white-collar committees no. 200 and no. 218 in 2015 troubles sectoral employment trends, which is to be accounted for in the analyses.

2.3 Final data

The panel size includes 718 237 data entries (jobs) over 60 quarters. Only workers in their main job (defined by the highest labour volume per quarter) between the age of 18 and 65 are retained, giving a total of 33 107 860 entries. This implies the average worker remained in the sample for 46 quarters. The minimum sample size is 472 637 workers in the first quarter of 2000, and the maximum is 548 487 workers in the fourth quarter of 2015, reflecting an annual average growth of the workforce by 1.26%. For the analyses, only aggregated data on the percentile wage distribution per joint committee was used, and only the joint committees for which minimum wage data is available, are included. The time range is restricted to the period 2000-2015 as complete minimum wage data is missing for the period before 2000. The time range is also restricted for joint committees no. 200 and no. 218, due to their merger in 2015, which would create artificial job flows in some models.

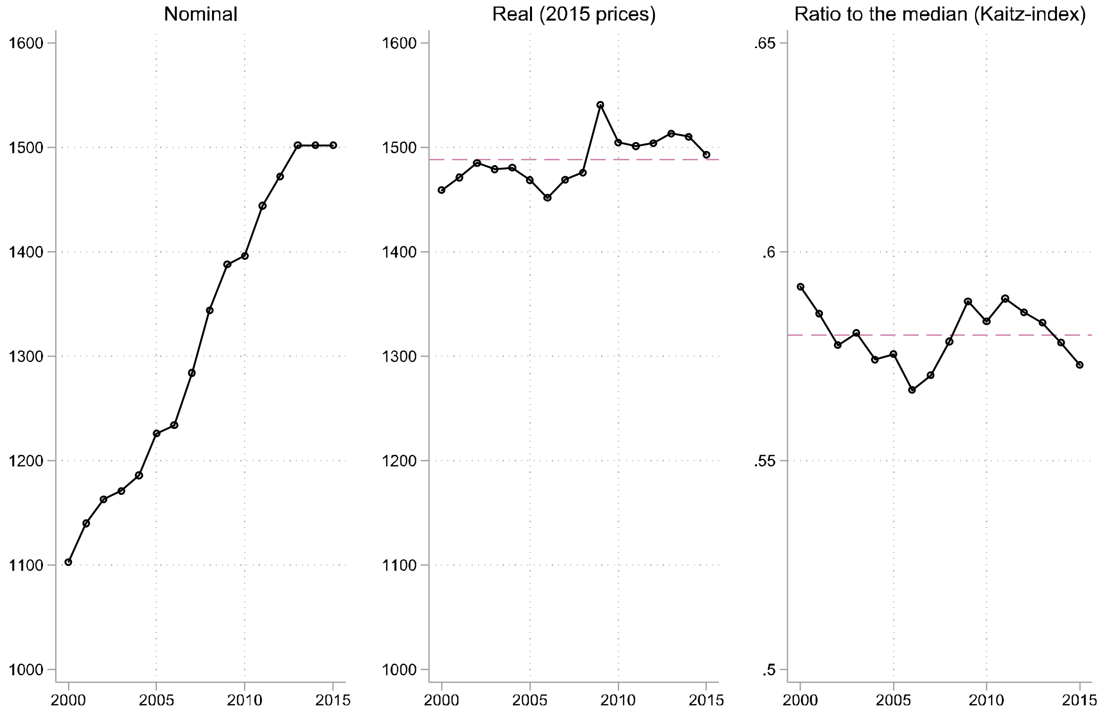
3 Descriptives

3.1 Minimum wages

Figure 1 shows the evolution of the Belgian national minimum wage from 2000 until 2015 in nominal terms (left panel), real terms (middle panel) and relative to the median wage (right panel). In real terms the minimum wage has remained fairly stable, fluctuating around 1500 EUR per month in 2015 prices. In 2007 and 2008, there was a real uprating of the minimum wage with twice 25 EUR, and in 2009, a drop in the price level (HICP) increased the value of the national minimum wage. Finally, as median wages have increased faster than inflation, the national minimum wage has decreased from nearly 60% of the median wage in 2000 to 57% in 2015.[1]

[1] This ratio is higher than reported by the OECD which estimates the ratio of minimum to median wages at 48% in 2015.

Figure 1: The evolution of the national minimum wage in Belgium

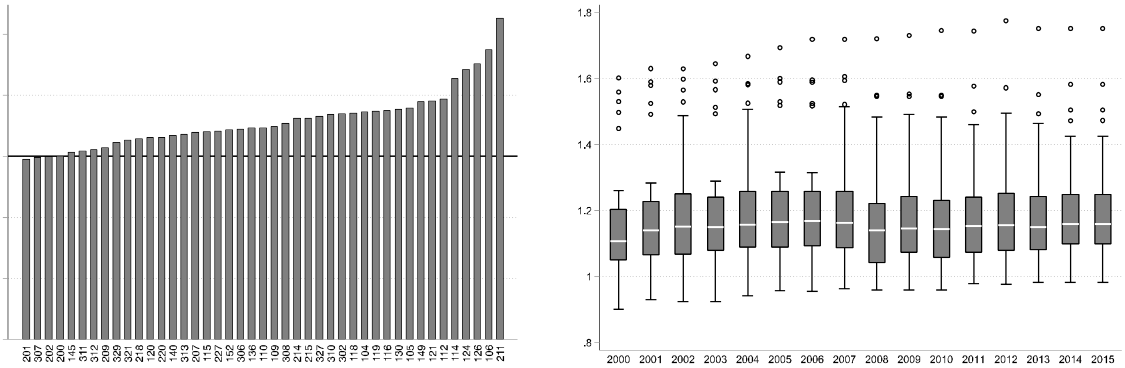


Note: Yearly average. The dashed line indicates the average value in the period 2000 to 2015.

Source: NSSO & Minimum Wage Database

Figure 2 shows the minimum wages by sector in 2015 and the evolution relative to the national minimum wage from 2000 until 2015. Over this period, sectoral minimum wages were on average 19% higher than the national minimum wage. Some joint committees have rates below the national minimum wage (e.g. no. 201: small retailers; no. 202: food stores; no. 307: insurances), which is allowed as long as total earnings including premium and end-of-year bonuses are above the national minimum wage. Other joint committees have substantially higher rates: in 2015, the sectoral minimum wage was 50% higher than the national minimum wage in three joint committees (no. 106: concrete; no. 126: woodworking; no. 211: petrol). Over time, the ratio of the sectoral to the national minimum wage has remained fairly stable in each sector (Figure 9 in appendix shows the variation we will exploit in the analyses). Both the national and sectoral minimum wages have mainly increased due to indexation following price inflation, while median wages have increased more, as we have seen.

Figure 2: Sectoral minimum wages compared to the national minimum wage: absolute figures in euro in 2015 (left-hand panel) and evolution of the ratio between 2000 and 2015

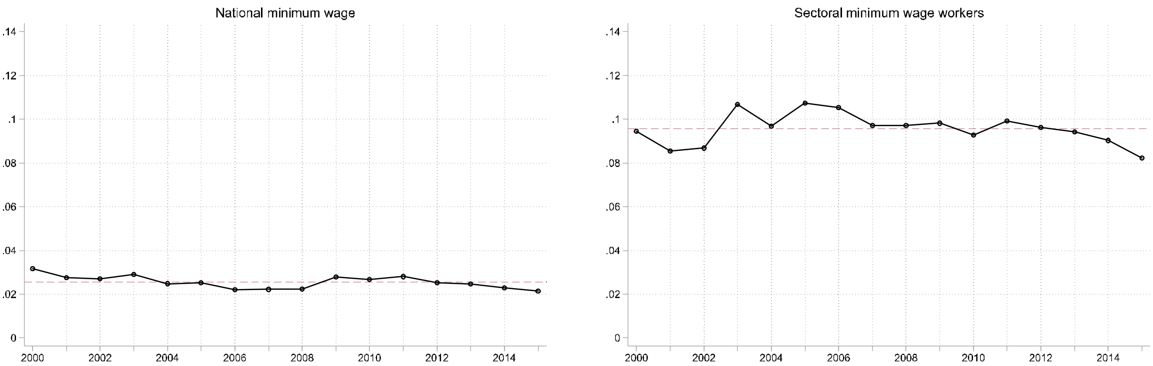


Note: Left panel: the horizontal line shows the level of the national minimum wage in 2015 (1502 EUR). Right panel: (a) The box plots show the distribution in Q4; (b) the box shows the interquartile range, the horizontal line is the median, and the whiskers are adjacent values distanced that are outside but closest to 50% more or less than the interquartile range; the dots are values outside this extended range.

Source: Belgium Minimum Wage Database

The share of employees working at the national minimum wage has equally remained relatively stable since 2000 (Figure 3, left panel). Here we define minimum wage workers as employees with a wage that is at most 5% above the national minimum wage. In 2015, this corresponds to a gross monthly wage lower than 1577 EUR. The share of minimum wage work decreased from around 3% in 2000 to 2.1% in 2015. We observe similar trends when considering all workers earning within a band of 10% above the minimum wage. In this case, the share decreased from 5.2% in 2000 to 3.6% in 2015 (results not shown). Figure 10 in appendix shows the share of minimum wage workers by sector.

Figure 3: The share of national (left panel) and sectoral (right panel) minimum wage work in Belgium from 2000 to 2015



Note: (a) The dashed line indicates the average value between 2000 to 2015. (b) (Sectoral) minimum wage workers are defined as employees with a full-time equivalent wage of at most 1.05 times the (sectoral) minimum wage. (c) The rate of sectoral minimum wages is based on the subset of the population comprised by the 43 joint committees covered by the Belgian Minimum Wage database. These 43 joint committees employ 61% of the population.

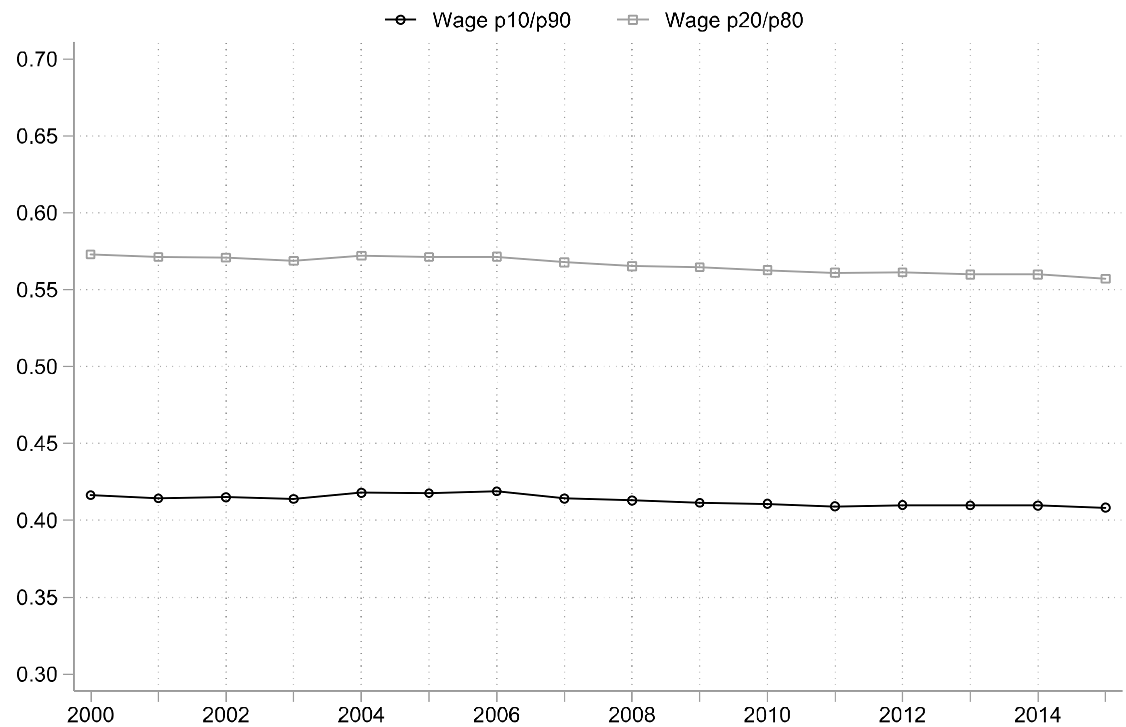
Source: NSSO & Minimum Wage Database

In contrast to the national minimum wage, sectoral minimum wages do affect a substantial share of the employees. While the national minimum wage applies to less than 3% of all Belgian employees, about 10% of the employees working in one of the 43 joint committees covered by the Belgian Minimum Wage dataset are employed at the sectoral minimum wage (Figure 3, right panel). The share of sectoral minimum wage workers has decreased from 9.5% in 2000 to 8.2% in 2015. The share of sectoral minimum wage workers varies across sectors (Figure 11 in appendix). In seven out of the 43 joint committees, at least 20% of the employees work at the sectoral minimum wage, whereas in 26 joint committees the sectoral minimum wage applies to less than 5% of the workers.

3.2 Wage inequality

Remarkably, wage inequality in Belgium has not changed from 2000 to 2015 (Figure 4). The p10/p90 ratio and the p20/p80 ratio stand at 41% and 56% respectively. In other words, the full-time equivalent wage of a worker at the 90th percentile of the wage distribution is more than twice the wage of a worker at the 10th percentile.[2] Based on this data, the Gini coefficient – which measures inequality using the entire wage distribution – is 0.21. This is comparatively low and lower than the Gini coefficient of income inequality, which stands at 0.27 in 2015 according to the OECD, while the OECD average is 0.32.[3]

Figure 4: Wage inequality in Belgium (2000-2015, annual averages)



Source: NSSO

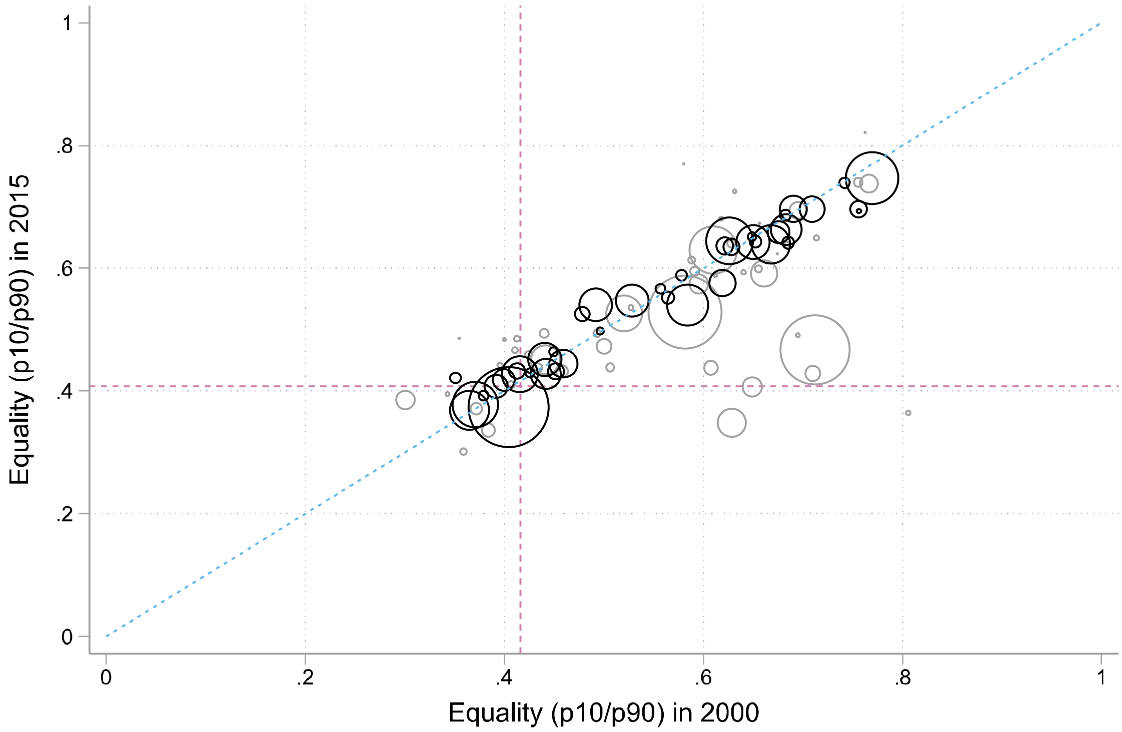
The ratio of workers' wages at the 10th percentile to the 90th percentile of the wage distribution differs across sectors and is usually larger than wage inequality in the total population, as the wage levels in various sectors are widely different, but overlap around the median (see Du Caju et al., 2009, for an analysis of inter-industry wage differentials). Some sectors are, in other words, more (un)equal than others. However, wage inequality within sectors has largely remained stable in the last two decades (Figure 5). For instance, the joint committee for the construction sector (no. 124) is one of the most equal joint committees in 2000 (p10/p90 = 77%) as well as 2015 (p10/p90 = 75%), and acts as an example for many other blue-collar sectors. On the other hand, the joint committee for white-collar workers in the chemical industry (no. 207) has a wider

[2] Inequality data based on total labour earnings (including bonuses and taking into account the annual labour volume) is much larger and steadily growing, with a p10/p90 ratio of 7% in 2000 and 4% in 2015, and a p20/p80 ratio of 26% in 2000 and 22% in 2015. This reflects increasing working time inequality rather than wage inequality.

[3] https://www.oecd.org/social/income-distribution-database.htm

wage distribution, as do many white-collar and mixed joint committees, with a p10/p90 ratio of 37% in 2000 and 36.5% in 2015.

Figure 5: Trends in wage inequality within sectors (2000-2015)



Note: (a) The cross indicates the overall inequality in 2000 and 2015. Black circles indicate sectors included in the analysis. (b) The circle size corresponds to the number of employees in 2015 within the sector. (c) The same graph with sector labels can be found in the annex, Figure 12.

Source: NSSO; Belgium Minimum Wage Database

4 The minimum wage effect on wage inequality

4.1 Model

To analyse the effect of the minimum wage on inequality or employment, bivariate statistics are not helpful. A common challenge encountered in the literature is to separate simultaneous time trends from direct effects. Furthermore, we generally have a shortage of data points to study time trends, or lack variation at a given point in time. To overcome this issue, Lee (1999) proposes to create variation using cross-sectional data by defining the relative minimum wage as the difference between the log of the (national) minimum wage, denoted w_t^m, and the log of the median wage $w_{st}(50)$ in different regions, according to (1). This is also the log of the unadjusted Kaitz index[4], which is the ratio of the minimum wage to the median (Kaitz, 1970).

$$w_{st}^l = w_t^m - w_{st}(50) \tag{1}$$

[4] The adjusted Kaitz index adds a factor to weigh by the share of workers covered by the minimum wage.

Where s is the region or state. When the median wage decreases, the relative minimum wage increases for the same national minimum wage, and we should expect an effect of the minimum wage on either inequality or employment levels, as the minimum wage takes a sizable bite out of the wage distribution. On the other hand, when the median is high, the relative minimum wage will be low and there is little impact to be expected as the minimum wage will not be binding for many workers. The relation between the relative minimum wage and wage inequality across states can therefore be a test of the effect of the minimum wage in itself.

We can apply this model to industries s rather than regions, and keep the subscript, adding also variation in the sectoral wage floors w_{st}^{m}. The aim is to find deviations from the latent wage distribution, which are correlated to variation in the minimum wage(s). If we assume that this latent wage distribution can be described by a lognormal function, then we can define any latent wage percentile w^{*} (p) = μ_{st} + $\sigma_{st}F^{-1}(p)$. As in a normal distribution $\mu_{st} = w_s(50)$, the wage inequality at percentile p, which is defined as w^{*} (p) $- w_s(50)$, will be equal to $\sigma_{st}F^{-1}(p)$ or the overall dispersion weighed by the inverse normal distribution. We will test whether minimum wage have an effect so that the $w(p) \neq w^{*}(p)$. However, there are several sources of bias that need to be controlled for to find this pure minimum wage effect.

The main specification of Lee is as follows:

$$w_{st}(p) - w_{st}(50) = \beta(p)[w_{st}^{m} - w_{st}(50)] + \varepsilon_{st} \tag{2}$$

Here, $w(p)$ denotes the wage at percentile p, and w_{st}^{m} is the minimum wage for sector s at time t. The regressand will have a different sign above and below the median, so that counteracting positive effects below the median and negative effects above the median point to a reduction of lower and upper-tail wage inequality. As suggested by Brown (1999), no lags or leads are assumed here when modelling short-term minimum wage effects.

To show the sources of bias, we expand the error term ε of (2) into:

$$\varepsilon_{st} = \nu_s(p) + \gamma_t^{\nu}(p) + \eta_{st}^{\nu} \tag{3}$$

This includes time variation $\gamma_t^{\nu}(p)$ which can be captured by a time indicator. $\nu_s(p)$ is the unobserved, possibly asymmetric, sectoral deviation from the overall dispersion, and η_{st}^{ν} is white noise. In this case, an OLS estimate of the minimum wage effect on inequality in the population, $\beta(p)$, will be consistent if:

$$\mathrm{Cov}(w_{st}^{m} - w_{st}(50), \nu_s(p)) = 0 \tag{4}$$

Which implies orthogonality. Sufficient conditions for this are:

$$\mathrm{Cov}(-w_{st}(50), \nu_s(p)) = 0 \tag{5}$$

$$\mathrm{Cov}(w_{st}^{m}, \nu_s(p)) = 0 \tag{6}$$

In violation of these conditions, there is an endogeneity bias. Consider first equation (5), assuming that in sectors with more latent inequality, the median wage is persistently higher. Further, similar to (3), define $w_{st}(50) = \kappa_s + \gamma_t^{\kappa} + \eta_{st}^{\kappa}$, where κ_s is the mean of the median wages in the sector over time, γ_t^{κ} is the time trend, and η_{st}^{κ} is white noise. Then we have:

$$\textbf{Bias 1.1}: \mathrm{Cov}\big(\kappa_s, \nu_s(p)\big) < 0 \text{ for } p < 50 \tag{7}$$

$$\textbf{Bias 1.2}: \mathrm{Cov}\big(\kappa_s, \nu_s(p)\big) > 0 \text{ for } p > 50 \tag{8}$$

Bias 1.1 will be an upward bias for β_{ols}, and bias 1.2 will be a downward bias. This bias is the first critique on Lee and AMS show evidence for it. Lee had argued against this, based on implausible upper-tail effects and the loss of identification in models with state and time fixed effects. The solution AMS propose is to, nevertheless, include sector fixed-effects instead of assuming strict exogeneity in the OLS estimation.

Alternatively, consider equation (6) and assume that in sectors with more latent inequality, the minimum wage is persistently lower. As before, denote $w_{st}^{m} = \omega_s + \gamma_t^{\omega} + \eta_{st}^{\omega}$ for the average minimum wage, its time trend, and random noise. We then get:

$$\textbf{Bias 2.1}: \text{Cov}\big(\omega_s, \nu_s(p)\big) < 0 \text{ for } p < 50 \tag{9}$$

$$\textbf{Bias 2.2}: \text{Cov}\big(\omega_s, \nu_s(p)\big) > 0 \text{ for } p > 50 \tag{10}$$

Again, bias 2.1 will be an upward bias for β_{ols}, and bias 2.2 will be a downward bias. In the main estimations of Lee, the endogeneity from biases 2.1 and 2.2 does not occur because there is no variation in the minimum wage, only in the regional median pay levels. However, between sectors it is more likely since the sectoral wage distribution reflects sector-specific occupational heterogeneity and the inequality aversion of unions, as the variation found in the descriptive analysis suggested.

The third apparent bias in the Lee model relates to the second critique of AMS: equation (2) has $w_{st}(50)$ on both sides, leading to division bias due to sampling error $\eta_{st}^{w(50)}$ around $w_{st}(50)$. In this case, estimates for $\beta(p)$ are biased upward both above and below the median.

$$\textbf{Bias 3}: \text{Cov}\left(w_{st}(p) - \left(w_{st}(50) + \eta_{st}^{w(50)}\right), \varepsilon + \eta_{st}^{w(50)}\right) < 0 \text{ for all } p \tag{11}$$

The solution proposed in AMS is to use w_{st}^{m} as an instrument for $w_{st}^{m} - w_{st}(50)$ in equation (2) using IV. If bias 1.1, 1.2, bias 2.1, 2.2, and bias 3 are the only biases, OLS will result in an upward bias for $p < 50$ and counteracting downward and upward biases for $p > 50$. This is indeed what AMS find when going from OLS to OLS+FE which overcomes endogeneity, and from OLS+FE to IV to tackle the division bias.

We replicate this model for Belgium with some adaptations. First, we make use of the variation over time in the wage distributions of different sectors as the main unit of analysis instead of states or regions. Although Lee opposes the use of sectors or occupations, regional minimum wages often merely reflect the industrial structure, and regional labour markets can be equally connected as sectoral labour markets. Moreover, in Belgium, minimum wages are determined at the sector level through collective bargaining wage. While this gives rise to biases 2.1 and 2.2, it actually provides insight in the wage setting process, which we will try to further explain. Second, we do not include a quadratic effect of minimum wages. Attempts to do so troubled the effects found using the linear specification, increasing standard errors without adding explanatory power. In line with earlier analyses, our base model specifications will be:

$$\textbf{Model 1 (OLS)}: w_{st}(p) - w_{st}(50) = \alpha + \beta(p) w_{st}^{k} + \varepsilon_{st} \tag{12}$$

$$\textbf{Model 2 (FE)}: w_{st}(p) - w_{\{st\}}(50) = \alpha + \beta(p) w_{st}^{k} + D_{sq} + D_t + \varepsilon_{st} \tag{13}$$

$$\textbf{Model 3 (RF)}: w_{st}(p) - w_{\{st\}}(50) = \alpha + \beta(p) w_{st}^{m} + D_{sq} + D_t + \varepsilon_{st} \tag{14}$$

$$\textbf{Model 4 (IV)}: w_{st}(p) - w_{\{st\}}(50) = \alpha + \beta(p) \widehat{w}_{st}^{k} + D_{sq} + D_t + \varepsilon_{st} \tag{15}$$

Where model 1 is Lee's equation with $w_{st}^{k} = w_{st}^{m} - w_{st}(50)$, which is the relative minimum wage, or the log of the unadjusted Kaitz index. D_{sq} and D_t in Model 2 are sectoral and seasonal fixed effects and quarterly time dummies to account for biases 1.1-2.2. Models 3 and 4 tackle bias 3 with endogeneity due to division by the same term on both sides of the equation, which causes a positive correlation in the pooled OLS estimate. Model 3 is the reduced form equation, using just the sectoral minimum wage w_{st}^{m} without the division by the median, while model 4 is the 2SLS-IV specification with the relative minimum wage $\widehat{w}_{st}^{k}$ instrumented by w_{st}^{m}.

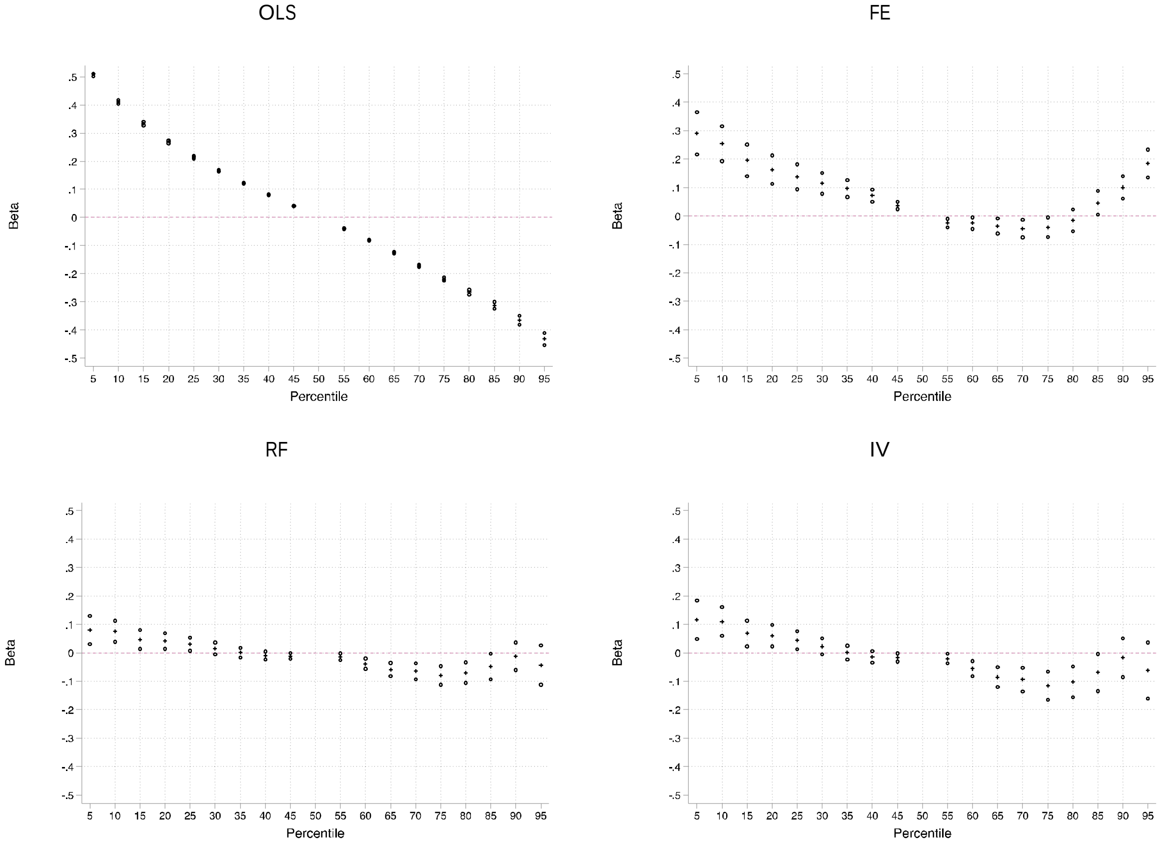
4.2 Estimations

Figure 6 illustrates the contribution of the different models to the correction of the biases discussed in the previous paragraph. On the y-axis the effect size (beta) and the 95% confidence interval band are shown, and on the x-axis the percentiles. Exact betas can be found in appendix 7.4, Table 5. Note that the betas show the *ceteris paribus* reaction (the elasticity of wage inequalities to the relative minimum wage) of a percentile in the wage distribution to an increase in minimum wages, and each of the percentiles represents one estimation. A positive effect below the median indicates decreasing lower-tail wage inequality (a dent in the latent distribution), and a negative effect above the median indicates decreasing upper-tail wage inequality.

The first model gives the results of the OLS-regression on specification (2), replicating the equation from Lee (1999). The strong linear connection between wage percentiles and estimated betas is due to the correlation of high minimum wages in sectors with a narrow wage distribution, as well as higher median wages in sectors with a wider wage distribution (biases 1.1, 1.2, 2.1, and 2.2). In the FE model, we add quarterly dummies to account for a common time trends and inflation, as well as sectoral fixed effects and sectoral seasonal dummies. Although adding fixed effects alleviates the dominant non-orthogonality biases, we are left with inexplicable wage expansion in the upper tail as minimum wages increase, which was the reason for Lee (1999) to refute this specification.

The reduced form and the IV-estimates account for the second source of endogeneity: division bias (bias 3). In the reduced form equation, we use the logged sectoral minimum wage instead of the relative (normalised) minimum wage. This undoes the positive bias in both tails, leaving some significant lower-tail wage compression as well as upper-tail wage compression up to p85. In the IV-model, which mimics the model from AMS, the relative minimum wage is instrumented by the logged sectoral minimum wage, replicating the same pattern from the reduced form equation, but with larger point estimates and larger confidence intervals. The overall picture confirms earlier findings in Vandekerckhove, Goos, and Van Gyes (2018a) and in Vandekerckhove, Van Gyes, and Goos (2018b), with a smaller positive effect below the median, and a negative effect above the median, indicating a 'compression' effect on the wage distribution when minimum wages increase.

Figure 6: The effect of the relative minimum wage on wage dispersion (2000-2015, quarterly data)



Note: (a) The plus sign is the measured effect, the hollow circles indicate the 95% confidence interval. (b) Joint committees no. 200 and no. 218 (“other white-collar services”) are exempt from 2014Q3 onwards due to their merging, data for joint committee for the private education sector (no. 152) is available from 2001Q4 onwards, data for the media sector (no. 227) from 2009Q3 onwards. Robustness tests, excluding joint committees 200 and 218, or restricting the time range to 2000-2014, did not alter these results substantially. (c) Equal weights for all sectors. A robustness test using the sectoral size as weights reduced the effects in models 3 and 4 to compression in p5-p10 and p60-P65, but otherwise follows the same patterns as shown here.

5 Explaining endogeneity

5.1 Hypotheses

In the previous section we established that minimum wages in Belgium have a compression effect on both tails of the wage distribution, which suggests that minimum wages are indeed set endogenously (Vandekerckhove et al., 2018b, 2018a). Now let us imagine that a fully specified model using only fully exogenous variation would have zeroed out all or most of the initially observed correlations between minimum wages and wage dispersion, as in AMS. In this case our interest should be drawn by the sources of endogeneity, other than technical biases. To do so, we propose three additional approaches, based on the institutional mechanisms (wage indexation), the elasticity of labour supply (worker flows and ability), and the relation between the sectoral firm structure and wage bargaining. The main line of thinking is that compression effects are expected if sectors are more likely to simultaneously determine minimum wage levels and wage inequality – the between-variation that leads to bias 2.1 and 2.2.

In the first approach, we consider the sectoral minimum wage alone as a poor instrument, because it might be correlated with median wage levels and wage dispersion. However, we can isolate variation in the sectoral minimum wage that is beyond the reach of sectoral negotiations: wage indexation, or the automatic adjustment of wages in Belgium to the cost of living, to maintain real wages. This mechanism has been the main driver of nominal wage growth in Belgium (Vandekerckhove, 2018). Importantly, the indexation mechanisms (pace and applicability) vary by sector: for instance twice a year on fixed dates and affecting effective wages, or whenever the 2% threshold in inflation is surpassed and only affecting negotiated wages, in which case workers may not receive a pay raise if already paid above the (indexed) negotiated wage level – this is the case in the iron industry, where at the sectoral level only one job category is defined, so that in practice wage indexation is not applied to many workers, or depends on the company collective agreement or policy. We will therefore interact the price level per quarter (the log of the consumer price index) with sectoral dummies representing the different ways in which the price level is translated into wage setting. Any change in the relative minimum wage that is explained by the sectoral indexation mechanism, is considered outside of the control of sectors in the short run (more exogenous), as these mechanisms have been fixed in the past. We will also test for both instruments together. The hypothesis is that more exogenous minimum wages still impact lower-tail wage inequality, but as they do not stem from a simultaneous internal redistribution within sectors, upper-tail effects should be smaller or non-existent. The difference with self-organised 'internal redistribution' is that the latter takes place when it is possible to top off high-wage wage growth during an economic upswing, while wage increases due to wage indexation takes place regardless of the financial margins. In a similar fashion, single-sided wage compression is also what you would expect from a politically imposed minimum wage uprating.

The second approach is based on (potential) worker turnover. Negotiated wages can only affect the wage distribution without employment effects as long as the labour supply curve for the sector is relatively inelastic. Conversely, increased worker mobility or worker ability will increase the elasticity of labour supply, and this might impede minimum wage effects, as workers 'vote with their feet' when not pleased by bargaining outcomes. It is the same idea which, in Baumol's cost disease, pushes sectors without productivity increases to increase wages if productivity-increasing sectors do, provided they can absorb the costs (i.e. product or service demand is price inelastic). In this case, sectors might conversely postpone wage increases of higher-paid workers to absorb the costs of increasing minimum wages, preventing wage inequality that would otherwise grow. To test this, we include an interaction term in model 4, altering the effect of the relative minimum wage in three different ways based on (a) the lagged annual sectoral worker outflow rate for all workers (share of workers from the sector in quarter Q-4 that have left the sector in quarter Q), (b) the outflow rate for workers paid above the median only, to account specifically for possible upper-tail wage compression, and (c) based on the average share of white-collar workers, that are assumed to have higher ability and therefore more outside options for employment in other sectors. We hypothesise that upper-tail wage compression is stronger when sectoral outflows are lower, or when less white-collar workers are employed in the sector. In other words, the compression effect should be highest in blue-collar industries with the least worker mobility.

The third approach relates to the influence of firm proximity to wage bargaining. In case a limited number of companies holds a large share of the sectoral workforce, they will also try to influence wage bargaining, which a greater number of scattered companies cannot do. For instance, in the sector of department stores (joint committee no. 312), there are just four major firms, while in construction (no. 124) or accommodation (no. 302), there are thousands. We define this number in absolute terms and in relative terms. In absolute terms it is the average number of firms per sector in the period under scope. In relative terms it is a dispersion (inversed concentration) index: the average number of firms in the sector over the full time period, divided by the number of workers in the sector. This figure is between 0% (low dispersion or high concentration, large firms relative to the sector size) and 100% (high dispersion or low concentration, as many firms as employees). It is hypothesised that in case more firms are operating in the sector, or when the firm concentration is smaller, more companies will be faced with wage settlements beyond their control and hence lower tail wage-inequality may will be affected by minimum wage changes, but upper-tail wage inequality less so.

5.2 Estimations

5.2.1 Additional instruments

Table 1 shows the results of the two additional IV models next to the models shown in the graphs. The IV-1 model is the IV model from the graphs from the previous section, using the registered sectoral minimum wage floor as an instrument for the relative minimum wage. We find that the lower-tail effects are positive and significant up to p25, and the upper-tail effects signal substantial compression around p65 and p75. IV-2 uses an alternative exogenous source of variation: the logged consumer price index interacted with the sector dummies, to test for the sensitivity to (exogenous) inflation as a source of minimum wage increases. This approach blows up the lower-tail effects and retains much smaller negative upper-tail effects around p65, as was hypothesised, because in this segment of the wage distribution, compression would be caused by a simultaneous consideration of minimum wages and wage inequality, but we have ruled out biases 2.1 and 2.2. Inexplicably, however, the highest percentiles (p85 and p95) increase significantly relative to the median when minimum wages increase. The combination of the sectoral wage floors and the logged consumer price index in the IV-3 model also brings forth a combination of the IV-1 and IV-2 results: stronger lower-tail effect, as well as compression effects in the upper tail and a suspicious inequality increasing effect around p85 and p95. As there is no sensible explanation for the 'swing' in the upper-tail effects, and because the compression effect clearly remains present in the IV-1 model, this will be used to build interaction models upon and check the hypotheses on the endogenous processes.

Table 1: Regression output for different controls for endogeneity

	IV-1		IV-2		IV-3	
p	b^{mw}		b^{mw}		b^{mw}	
5	0,117	***	0,362	***	0,326	***
	(0,035)		(0,025)		(0,024)	
15	0,068	**	0,211	***	0,179	***
	(0,023)		(0,019)		(0,018)	
25	0,044	**	0,136	***	0,114	***
	(0,016)		(0,013)		(0,013)	
35	0,000		0,077	***	0,068	***
	(0,012)		(0,009)		(0,009)	
45	-0,016	*	0,023	***	0,022	***
	(0,007)		(0,005)		(0,005)	
55	-0,020	*	-0,002		-0,015	*
	(0,008)		(0,005)		(0,006)	
65	-0,085	***	-0,017		-0,029	**
	(0,018)		(0,010)		(0,010)	
75	-0,116	***	-0,038	*	-0,047	***
	(0,025)		(0,015)		(0,014)	
85	-0,069	*	0,085	***	0,048	*
	(0,033)		(0,021)		(0,020)	
95	-0,063		0,292	***	0,229	***
	(0,050)		(0,034)		(0,030)	

Note: (a) Each percentile p represents a different estimation. The specifications of the models are given in section 4.1. (b) *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; + $p < 0.10$.

5.2.2 Labour elasticity

In the models that follow, proxies for labour elasticity are added as an interaction term besides the direct effect of relative minimum wage that is in the IV-1 model, which acts as the baseline in Table 2. The first interaction model includes the annual sectoral outflow rate by joint committee, i.e. the share of workers in Q-4 that has left the sector by quarter Q, as a proxy for more elastic labour supply. Looking at the overall sectoral worker flows, it appears that lower-tail minimum wage effects on inequality are only present in the sectors with high worker outflow rates, while upper-tail effects are not hindered, but reinforced by higher worker flows. This is not fully in line with the expectations as lower-tail effects were thought to be stronger in case of low worker flows. However, the absence of direct lower-tail minimum wage effects may actually mean that all of the workers paid up to the median receive a pay raise when minimum wages increase. Indeed, in this model we find an overall reduction in wage inequality due to stalling upper-tail wage increases. Next, the second interaction model only accounts for the worker flows of workers paid above median pay levels within the sector. The effects are very similar and therefore indicate that upper-tail worker mobility is shaping the sectoral response to minimum wage changes: if there is less high-paid mobility, all workers below the median enjoy a pay rise, while only the lowest wages are uprated in case of increase high-paid worker outflows. Still, at p75 the two-sided wage compression intensifies in case of higher worker flows, which raises doubts about the direction of the causality and the ‘stylized fact’ that minimum wages have quick instead of no trailing effects on worker flows (Brown, 1999, p. 2119). It may be that sectors with increasing minimum wages either discourage future higher-paid workers or act as stepping stones to other, better-paid sectors.

Finally, including an interaction term with the share of white-collar workers, which are assumed to have more ability and therefore more outside options, we find that the lower-tail minimum wage effects also disappear in the direct estimate (in absence of white-collar workers), while the upper-tail compression effects in this case become stronger. In other words, lower-tail wage compression due to minimum wage increases occurs in white-collar sectors only, while upper-tail wage compression occurs in all sectors. An explanation for this could be that the wage scheme matches the effective wage distribution of blue-collar workers more closely, so that minimum wage increases mechanically move up the first quartile of the wage distribution, while simultaneously causing some percentiles in the lower-tail to move back to negotiated pay levels after a temporary pay raise, for instance because past and permanent individual pay increases are caught up by increasing minimum wages. This has been seen in the UK as well with the uprating of the national minimum wage, acting as a force of gravity to wages of workers paid just above the minimum wage. In absence of white-collar workers, the compression in the upper tail is found up to p95. On the other hand, as the share of white-collar workers increases, the hypothesized effects are confirmed: stronger minimum wage effects in the lower tail, and an annihilation of wage compression in the upper tail above p75.

Table 2: Regression output for the models including proxies for labour supply elasticity

	IV-1		Flows (all workers)				Flows (high pay)				White collar share			
p	b^{mw}		b^{mw}		b^{int}		b^{mw}		b^{int}		b^{mw}		b^{int}	
5	0,117	***	0,042		0,241	***	0,052		0,284	***	-0,040		0,468	***
	(0,035)		(0,036)		(0,036)		(0,036)		(0,065)		(0,060)		(0,105)	
15	0,068	**	0,024		0,231	***	0,035		0,201	***	0,002		0,197	**
	(0,023)		(0,025)		(0,028)		(0,025)		(0,050)		(0,041)		(0,075)	
25	0,044	**	0,010		0,171	***	0,017		0,171	***	-0,002		0,139	*
	(0,016)		(0,018)		(0,016)		(0,018)		(0,034)		(0,029)		(0,056)	
35	0,000		-0,022		0,093	***	-0,019		0,128	***	-0,064	**	0,192	***
	(0,012)		(0,014)		(0,011)		(0,014)		(0,020)		(0,021)		(0,037)	
45	-0,016	*	-0,026	**	0,040	***	-0,025	**	0,064	***	-0,053	***	0,110	***
	(0,007)		(0,009)		(0,006)		(0,009)		(0,010)		(0,012)		(0,017)	
55	-0,020	*	-0,024	*	-0,016	**	-0,025	*	-0,004		-0,013		-0,023	
	(0,008)		(0,010)		(0,006)		(0,010)		(0,010)		(0,012)		(0,019)	
65	-0,085	***	-0,091	***	-0,035	**	-0,093	***	-0,009		-0,104	***	0,055	
	(0,018)		(0,021)		(0,012)		(0,021)		(0,019)		(0,027)		(0,039)	
75	-0,116	***	-0,109	***	-0,107	***	-0,114	***	-0,093	**	-0,144	***	0,084	+
	(0,025)		(0,029)		(0,018)		(0,028)		(0,032)		(0,038)		(0,051)	
85	-0,069	*	-0,070	+	-0,080	***	-0,074	*	-0,051		-0,133	**	0,190	**
	(0,033)		(0,038)		(0,024)		(0,038)		(0,043)		(0,048)		(0,059)	
95	-0,063		-0,102	+	0,018		-0,103	+	0,135	+	-0,211	**	0,443	***
	(0,050)		(0,062)		(0,034)		(0,061)		(0,069)		(0,073)		(0,076)	

Note: (a) b(mw) is the direct estimate, b(int) is the effect of the interaction term. (b) *** p < 0.001; ** p < 0.01; * p < 0.05; + p < 0.10.

5.2.3 Firm structure

Looking at the sectoral firm structure, we interact the relative minimum wage of the IV-1 model with either the number of companies within the sector (in hundreds), or the firm dispersion (number of companies per worker or the inverse of the average firm size). Compared to the baseline model, the number of companies does reduce the upper-tail wage compression, as hypothesized, but only with borderline significance. Note that the number of firms ranges from single digits to thousands, so the small interaction effect adds up.

Firm dispersion, however, appears to be much more important and in line with the hypothesis, even if the estimates are far from the baseline and the inequality increasing effect in the lower-tail is unexpected. Nevertheless, to the extent that more firms are active in the sector, covering a workforce of the same size, therefore increasing firm dispersion, minimum wages appear to decrease lower-tail wage inequality, and reduce upper-tail wage compression, as hypothesized.

Table 3: Regression output for the models including proxies for firm involvement in negotiations

	IV-1		Number of firms (100s)				Firm dispersion			
p	b^{mw}		b^{mw}		b^{int}		b^{mw}		b^{int}	
5	0,117	***	0,191	***	0,005		-0,109		0,963	***
	(0,035)		(0,043)		(0,003)		(0,078)		(0,156)	
15	0,068	**	0,051	+	0,011	***	-0,279	***	1,114	***
	(0,023)		(0,031)		(0,002)		(0,058)		(0,113)	
25	0,044	**	0,032		0,006	***	-0,180	***	0,704	***
	(0,016)		(0,022)		(0,001)		(0,042)		(0,082)	
35	0,000		-0,016		0,004	***	-0,179	***	0,533	***
	(0,012)		(0,017)		(0,001)		(0,035)		(0,069)	
45	-0,016	*	-0,032	**	0,003	***	-0,128	***	0,320	***
	(0,007)		(0,010)		(0,000)		(0,021)		(0,043)	
55	-0,020	*	-0,019	+	0,000		-0,002		-0,054	
	(0,008)		(0,011)		(0,000)		(0,022)		(0,046)	
65	-0,085	***	-0,099	***	0,003	**	-0,218	***	0,391	***
	(0,018)		(0,023)		(0,001)		(0,049)		(0,089)	
75	-0,116	***	-0,112	***	0,002	+	-0,224	***	0,367	**
	(0,025)		(0,030)		(0,001)		(0,063)		(0,113)	
85	-0,069	*	0,005		0,001		-0,079		0,267	*
	(0,033)		(0,035)		(0,002)		(0,068)		(0,120)	
95	-0,063		-0,052		0,013	***	-0,304	*	0,891	***
	(0,050)		(0,058)		(0,003)		(0,118)		(0,199)	

Note: (a) b(mw) is the direct estimate, b(int) is the effect of the interaction term. (b) *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; + $p < 0.10$.

6 Conclusions

There is a growing consensus that the effect of minimum wages on employment and wage inequality depends on whether or not the outcomes of the policies are internalised in the decision-making process. In other words, a minimum wage that is set externally, for instance by political parties aiming for poverty reduction, may be set above the market clearing wage, and harm employment. On the other hand, the social partners may bargain for wages in line with the (targeted) productivity of workers, but if they fail to do so, it can make room for increased wage inequality.

In Belgium, wages are primarily set in collective bargaining agreements. As the descriptive analyses have shown, the weight of decision making on minimum wages lies at the sectoral level, as – on average – sectoral wage floors are 19% above the national minimum wage, and less than 3% of workers earn within 5% of the national minimum wage, compared to 10% of workers for the sectoral minimum wage. Moreover, the national minimum wage has hardly increased in real terms over the course of 15 years, and even declined relative to the median (Kaitz index), while sectoral minimum wages, to a varying degree, have increased relative to the national minimum wage. Nevertheless, while wide inter-sectoral wage differences remain, wage inequality within sectors and on the whole has remained stable for full-time equivalent jobs.

Using a large administrative dataset, which covers one-fifth of the working population in the private sector, and hand-coded time series on minimum wage floors for 43 joint committees, we investigated the effect of changes in the relative minimum wage on the sectoral wage distribution, following the model of Lee (1999). Adding controls for endogeneity based on Author, Manning, and Smith (2014), we managed to correct the strong correlations originally observed, and conclude that minimum wages spill-over into the lower deciles, but also between the 60th and the 80th percentile, where we find a decrease of the ratio to the median as the minimum wage increases. The interpretation of this finding is that the stalling of higher-wage increases that fall within the scope of collective bargaining, could compensate for the wage increases. It therefore appears that even the instrument variable – the sectoral minimum wage itself – has a logical correlation with wage inequality at higher wage percentiles.

Because bargaining effects can only be found when the bargaining parties are involved and capacitated, we explored three additional approaches to understand the potential endogeneity: differences in job flows and ability as a proxy for labour supply elasticity, accounting for the number and dispersion of firms to capture the span of control, and the sector-specific sensitivity of firms to external inflation (wage indexation mechanisms) as a better naturally exogenous instrument for minimum wage changes. The results confirm that minimum wage changes that are exogenously driven affect the lower tail more than the upper tail, whereas minimum wage changes that are judiciously set, for instance with less firm dispersion, may imply a transfer within sectors from high-paid workers to low-wages workers. However, one should be careful with this interpretation, as we have also found that in the context of high-paid worker outflows, which are not indicative of well-planned wage policies, minimum wage effects actually intensify across the board.

Exposing the endogeneity in the wage setting process addresses the choice for law-makers in Belgium and abroad to adjust the national minimum wage or to revive collective bargaining. It also explains why the literature is inconclusive about minimum wage effects on, for instance, employment: the coverage of the agreements, the structure of the negotiating parties, and the level at which decision are made seem to matter. Increasing the national or statutory minimum wage would yield effects similar to exogenous drivers of minimum wage increases.

Since we have demonstrated that there is a growing divide between sectoral minimum wages and the national minimum wages, this would suggest there is room for a moderate increase of the national minimum wage. However, this only affects the sectors with the lowest minimum wages, which are often sectors with higher median wages and more wage dispersion. If policy makers want to target low-paying sectors, changing the national minimum wage might be ineffective as the existing legal framework, which rests on the principle of subsidiarity, allows sectors (joint committees) to freely determine wages, possibly in relation to the national minimum wage.

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7 Annex

7.1 List of joint committees covered in the analysis

No.	Shorthand name	N	No.	Shorthand name	N
104	Iron	1285	200	General white collar	2735
105	Non-ferro	845	201	Independent retail	17220
106	Concrete	1165	202	Food retail	10225
109	Clothing	1400	207	Chemistry	14460
110	Textile care	1130	209	Metal	12925
112	Garages	5035	211	Petrol	1145
114	Stone	200	214	Textile	865
115	Glass	890	215	Clothing	1005
116	Chemistry	8120	218	General white collar	81565
118	Food	11135	220	Food	5310
119	Food trade	6535	227	Media	830
120	Textile	2550	302	Accommodation	21115
121	Cleaning	7090	306	Insurances	4880
124	Construction	27715	307	Insurance brokers	2470
126	Woodworking	2905	308	Savings banks	710
130	Print	1515	310	Banks	10775
136	Paper processing	1370	311	Large retailers	10400
140	Transport	14635	312	Department stores	2045
145	Horticulture	2910	313	Pharmacies	2605
149	Metal related	9505	321	Wholesale of drugs	515
152	Private education	1980	327	Sheltered workshops	6925
			329	Social and cultural work	8990

7.2 Similarities and differences between our findings and CRB's findings

In 2018, the Central Economic Council (CRB) published statistics regarding minimum wage employment in Belgium in 2015 using NSSO data (CRB, 2018). This appendix shows that our descriptive statistics, are similar to the findings of the CRB.

The CRB presents the number of employees by wage level. The wage levels are defined relative to the national minimum wage. Table 4 replicates one of the key tables in CRB's report using the same wage levels. The differences between our findings and CRB's findings are limited. For instance, according to CRB, 1.92% of the employees earned less than the national minimum wage in 2015, while we estimate this share at 1.84%. Similarly, the share of minimum wage workers – defined here as employees with a wage lower than €1,637– is 3.72% in our data compared to 3.31% according to CRB's statistics.

There are several reasons why we cannot exactly replicate CRB's findings. First, the definition of a 'full-time equivalent wage' is not exactly the same. CRB uses NSSO's concept of 'monthly equivalent wage' which includes some bonuses, but does not always include holiday allowances. Our definition of 'full-time equivalent wage' does not include bonuses, but accounts for holiday allowances for white- as well as blue-collar workers. Second, when aggregating the data, choices have to be made about the treatment of workers having several jobs within the same quarter, about workers who work a limited number of days within a quarter and about how to aggregate the data from a quarterly to a yearly level. Despite these differences, it is reassuring that our findings are consistent with CRB's findings.

Table 4: Low-wage employment in 2015: comparison with the CRB study

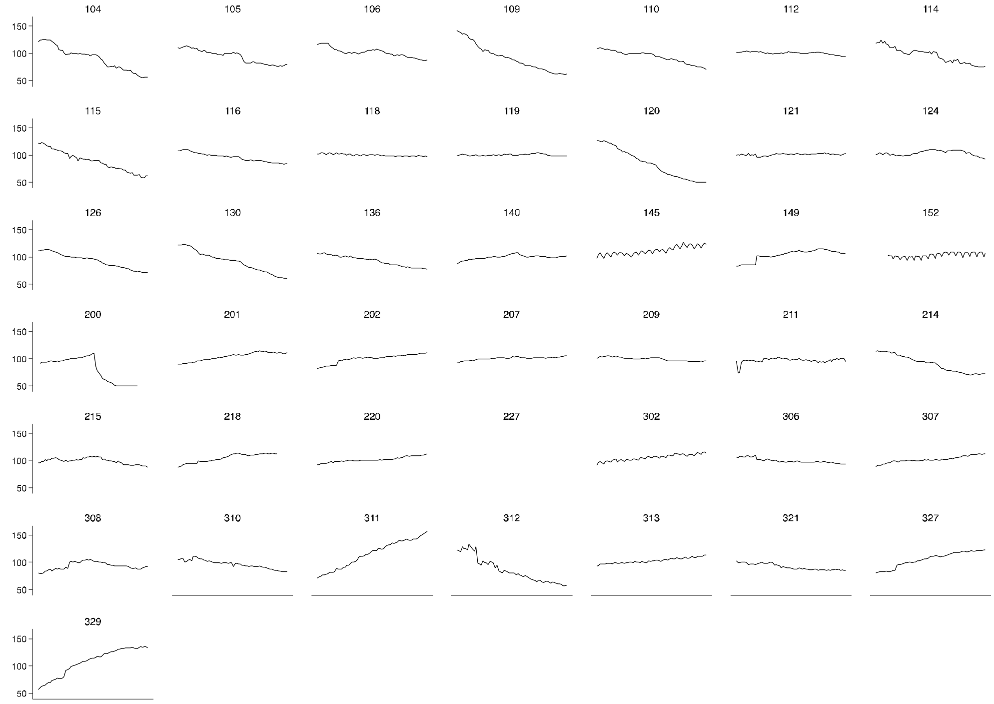
Wage level	Maximum wage (€/month)	Cum. distr. (sample)	Cum. distr. (CRB)	Difference
< minimum wage	1,559	1.84%	1.92%	-0.08%
< minimum wage +2%	1,591	2.47%	2.69%	-0.22%
< minimum wage + 5%	1,637	3.37%	3.72%	-0.35%
< minimum wage + 10%	1,715	5.28%	6.02%	-0.74%
< minimum wage + 15%	1,793	7.99%	8.33%	-0.34%
< minimum wage + 20%	1,871	11.46%	11.48%	-0.02%
< minimum wage + 25%	1,949	15.21%	15.95%	-0.74%
< minimum wage + 30%	2,027	19.27%	20.31%	-1.04%
< minimum wage + 35%	2,105	23.18%	24.87%	-1.69%
< minimum wage + 40%	2,183	27.13%	29.75%	-2.62%
< minimum wage + 45%	2,261	31.21%	33.67%	-2.46%
< minimum wage + 50%	2,339	35.28%	37.58%	-2.30%
=> minimum wage + 50%	11,569	100.0%	100%	0.00%

Note: (a) In order to make our findings as consistent as possible with the findings of the CRB, we used the 'maximum wage levels' as reported in Table 2.1. of the CRB report. (b) A minor difference in the concepts used is that the CRB used the minimum wage for workers with one year of tenure, while we simply used the minimum wage without tenure.

Source: NSSO, CRB

7.3 Descriptive figures

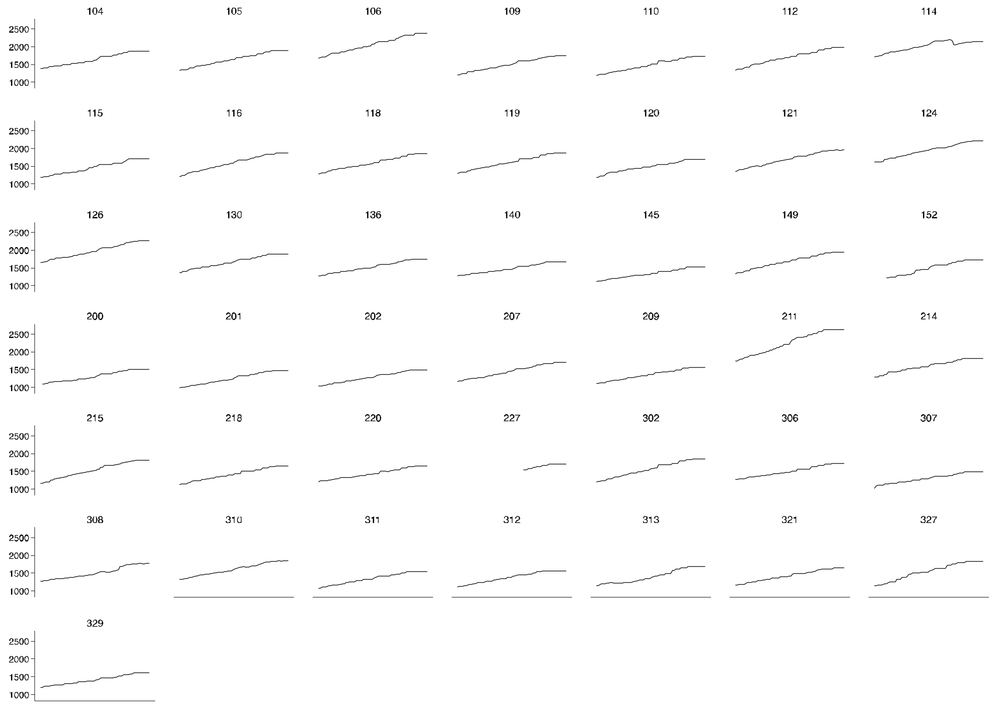
Figure 7: Employment evolution by joint committee (2000-2015)



Note: for the period before 2003, the joint committee was retrieved using a probabilistic model

Source: National Social Security Office, own calculations

Figure 8: Evolution of sectoral minimum wage rates by joint committee (2000-2015)

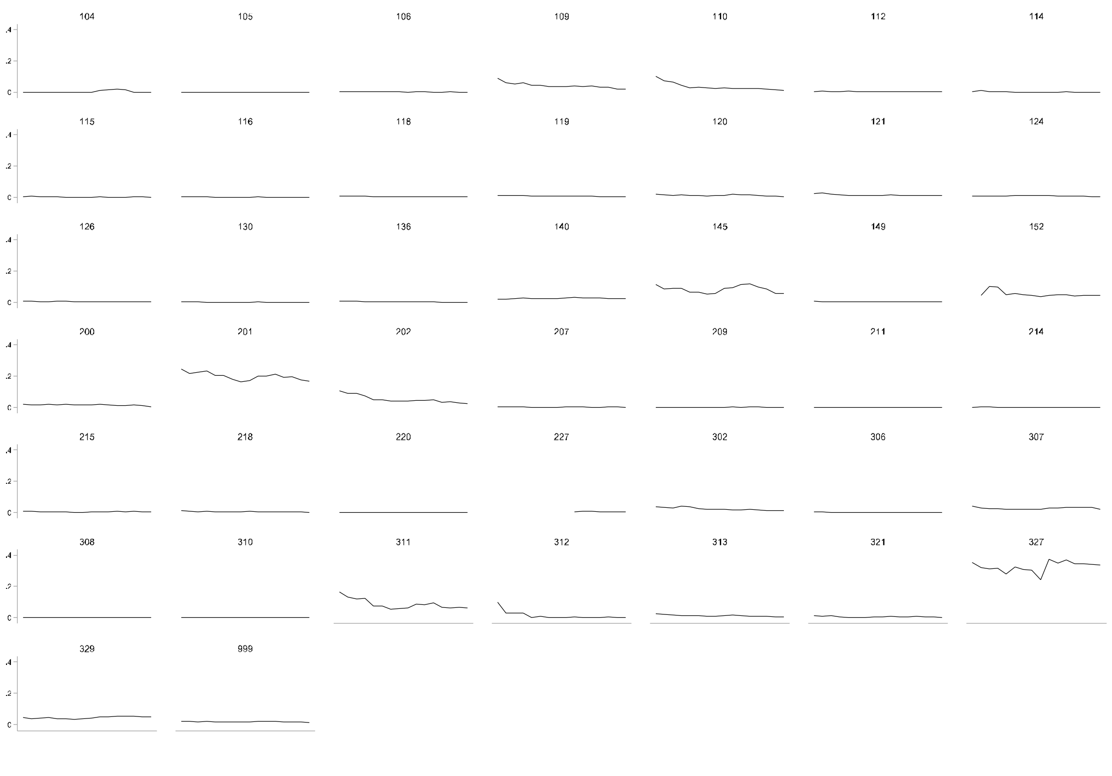


Source: Belgian Minimum Wage Database.

Figure 9: Evolution of sectoral minimum wages relative to the national minimum wage by joint committee (2000-2015)

Source: Belgian Minimum Wage Database.

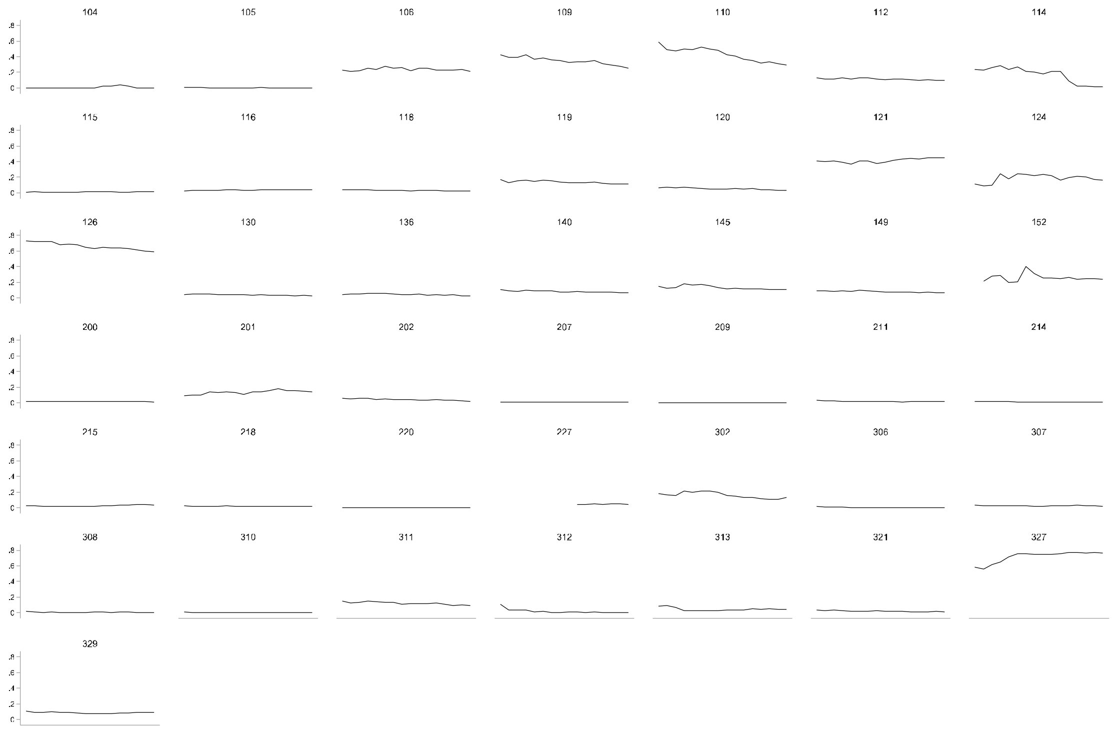
Figure 10: Share of national minimum wage work by sector (2000-2015)



Note: The label 999 consists of all joint committees not included in the minimum wage database.

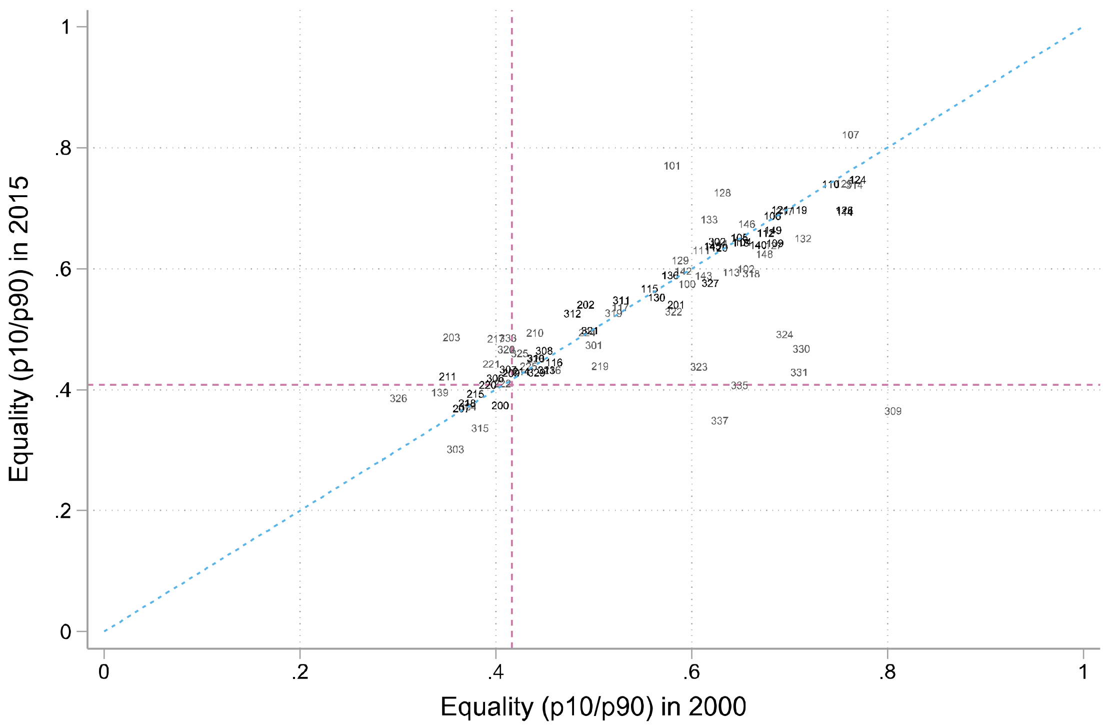
Source: NSSO; Belgian Minimum Wage Database.

Figure 11: Share of sectoral minimum wage work by sector (2000-2015)



Source: NSSO; Belgian Minimum Wage Database.

Figure 12: Trends in wage inequality within sectors (2000-2015)



Note: (a) The cross indicates the overall inequality in 2000 and 2015. Black labels indicate sectors included in the analysis.

Source: NSSO; Belgium Minimum Wage Database

7.4 Estimation results for section 4.2

Table 5: Regression output for the least squares models and the baseline IV model

	OLS		FE		RF		IV-1	
p	b^{mw}		b^{mw}		b^{mw}		b^{mw}	
5	0,511	***	0,291	***	0,080	**	0,117	***
	(0,005)		(0,038)		(0,025)		(0,035)	
15	0,334	***	0,195	***	0,047	**	0,068	**
	(0,003)		(0,029)		(0,017)		(0,023)	
25	0,214	***	0,138	***	0,030	*	0,044	**
	(0,002)		(0,022)		(0,012)		(0,016)	
35	0,122	***	0,096	***	0,000		0,000	
	(0,001)		(0,015)		(0,009)		(0,012)	
45	0,041	***	0,037	***	-0,011	*	-0,016	*
	(0,001)		(0,006)		(0,005)		(0,007)	
55	-0,040	***	-0,025	***	-0,014	*	-0,020	*
	(0,001)		(0,008)		(0,006)		(0,008)	
65	-0,125	***	-0,035	*	-0,059	***	-0,085	***
	(0,002)		(0,014)		(0,012)		(0,018)	
75	-0,219	***	-0,040	*	-0,080	***	-0,116	***
	(0,003)		(0,018)		(0,017)		(0,025)	
85	-0,312	***	0,046	*	-0,048	*	-0,069	*
	(0,006)		(0,021)		(0,023)		(0,033)	
95	-0,432	***	0,184	***	-0,043		-0,063	
	(0,011)		(0,025)		(0,035)		(0,050)	

Note: (a) Each percentile p represents a different estimation. The specifications of the models are given in section 4.1. (b) *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; + $p < 0.10$.

7.5 Sampling strategy

The programme **`smals`** simulates the algorithm of the wage setting and origins of flows samples. It has been presented to the programmers at SMALS in order to establish the sample from the administrative databank for the IPSWICH project (https://hiva.kuleuven.be/sites/ipswich).

In this simulation, we take a population of, at first, 100 000 potential cases, divided up into two groups: units known before (group 1, 50 000 at first), and units not known before (group 2, inflow or outflow).

From the population, a sample of 10% is drawn (e.g. 5 000 at time 1). Note that if units have different entries (e.g. a worker having different jobs), we select units. In this example, only units are tracked. The inflow rate and outflow rate are randomly determined between 0 and 3 percent (in steps of 0.5 percent). The selection is repeated ten times (i.e. ten time periods).

At the end of the syntax, the output shows that if units have one single selection chance of 10%, there will at any point be a random selection of 10% from the total population, even if it changes over time.

```
. version 14.0

. set seed 20190724

.
. * Define program
. * ==============
.
. cap program drop smals

. program define smals, rclass
          syntax [, obs(integer 1) prob(real 1)]
.         clear
.         di as result "Observations: " `obs'
          di as result "Sampling probability: " `prob'
.         set obs `obs'
.         gene byte c = 0 // has ever had a selection chance
          gene byte v = 0 // has ever been selected
. // Runs
.         forvalues j = 1/10 {
                  local ifrate = round(runiform()*3,.5)/100
                  local ofrate = round(runiform()*3,.5)/100
                  di as text "Inflow rate: " `ifrate'
                  di as text "Outflow rate: " `ofrate'
.                 gene ifr`j' = `ifrate'
                  gene ofr`j' = `ofrate'
.                 if `j' == 1 {
                          local ifrate = .5
                          local ofrate = 0
                          gene byte j`j' = runiform() <= `ifrate'
                          }
                  if `j' >= 2 {
                          gene byte j`j' = runiform()<(1-`ofrate') if j`=`j'-1' == 1
                          replace j`j' = runiform()<`ifrate' if j`=`j'-1' == 0
                          }
.                 gene byte s`j' = v == 1 & j`j' == 1
                  replace s`j' = runiform() <= `prob' if c == 0 & j`j' == 1
                  replace c = 1 if j`j' == 1
                  replace v = 1 if s`j' == 1
                  }
                  .
          export delimited smals_test_sample`j'.txt, replace
.         collapse (sum) s* j* c v (mean) ifr* ofr*
.         forvalues j = 1/10 {
                  gene r`j' = s`j'/j`j'
                  }
                  .
          reshape long s j r ifr ofr, i(c v) j(y)
. // Variable labels
.         label var s "Sample size"
          label var j "Population size"
          label var r "Sample rate"
          label var ifr "Inflow rate"
          label var ofr "Outflow rate"
          label var v "Selection pool"
          label var c "Selection chance"
. // Rclass
.         qui sum r
          return scalar r_mean = r(mean)
          return scalar r_sd = r(sd)
.         qui sum j
          return scalar j_mean = r(mean)
          return scalar j_min = r(min)
          return scalar j_max = r(max)
```

```
 51.
.         qui sum s
 52.         return scalar s_mean = r(mean)
 53.         return scalar s_min = r(min)
 54.         return scalar s_max = r(max)
 55.
.         qui sum ifr
 56.         return scalar ifr_mean = r(mean)
 57.         return scalar ifr_min = r(min)
 58.         return scalar ifr_max = r(max)
 59.
.         qui sum ofr
 60.         return scalar ofr_mean = r(mean)
 61.         return scalar ofr_min = r(min)
 62.         return scalar ofr_max = r(max)
 63.
.         qui sum v
 64.         return scalar v_tot = r(mean)
 65.
.         qui sum c
 66.         return scalar c_tot = r(mean)
 67.
. end

.
.
. * Execute program
. * ===============
. qui foreach i in "r_mean" "r_sd" "j_mean" "j_min" "j_max" "s_mean" "s_min" "s_max" "if
> r_mean" "ifr_min" "ifr_max" "ofr_mean" "ofr_min" "ofr_max" "v_tot" "c_tot" {

.         .

. // repeat the program 10 times, use a starting population of 100000 and a sampling rat
> e of 10 percent
. simulate `itemlist', reps(10): smals, obs(100000) prob(.1)

      command:  smals, obs(100000) prob(.1)
       r_mean:  r(r_mean)
         r_sd:  r(r_sd)
       j_mean:  r(j_mean)
        j_min:  r(j_min)
        j_max:  r(j_max)
       s_mean:  r(s_mean)
        s_min:  r(s_min)
        s_max:  r(s_max)
     ifr_mean:  r(ifr_mean)
      ifr_min:  r(ifr_min)
      ifr_max:  r(ifr_max)
     ofr_mean:  r(ofr_mean)
      ofr_min:  r(ofr_min)
      ofr_max:  r(ofr_max)
        v_tot:  r(v_tot)
        c_tot:  r(c_tot)

Simulations (10)
----+--- 1 ---+--- 2 ---+--- 3 ---+--- 4 ---+--- 5
..........

. gene int rep = _n

. order rep, first

. format * %8.3f

. format rep j_* s_* *_tot %2.0f

.
. // show average population size (j), average sample size (s), and the sampling rate (r)
. list rep j_mean s_mean r_mean

     +---------------------------------+
     | rep   j_mean   s_mean   r_mean |
     |---------------------------------|
  1. |   1    50487     4911    0.097 |
  2. |   2    50199     5032    0.100 |
  3. |   3    51239     5142    0.100 |
```

```
  4. |   4    49110     4863    0.099 |
  5. |   5    50435     4999    0.099 |
     |--------------------------------|
  6. |   6    50343     5199    0.103 |
  7. |   7    49579     4849    0.098 |
  8. |   8    50410     4944    0.098 |
  9. |   9    50720     5002    0.099 |
 10. |  10    47823     4784    0.100 |
     +--------------------------------+
```

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