THE EFFECT OF MINIMUM WAGE SPILLOVERS ON WAGE DISPERSION IN A STRONGLY INSTITUTIONALIZED WAGE BARGAINING SYSTEM.

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The effect of minimum wage spillovers on wage dispersion in a strongly institutionalized wage bargaining system.

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Abstract

Autor, Manning, and Smith (2014) have found that higher minimum wages decrease lower-tail wage inequality and that, unlike in the canonical model of Lee (1999), minimum wages do not cause strong positive spillover effects to higher wage percentiles. Our findings, however, indicate that in Belgium wage *compression* occurs in both tails. Using administrative individual-level wage data for the period 1997-2006 and sector and time variation in minimum wages from sectoral agreements, we show that 1) the observed correlation between minimum wages and both lower-tail and upper-tail wage inequality is strongly negative; 2) using exogenous variation only, minimum wages remain negatively correlated to lower-tail wage inequality but the true effect above the median appears to be compression and not expansion of the wage distribution; 3) the effect of minimum wages on wage inequality in the lower tail does not seem to be an artefact caused by disemployment. This suggests that institutionalized bargaining causes a compensating movement of wages in the upper tail, and that in some sectors more than in others unions can negotiate higher minimum wages as well as lower overall wage dispersion.

1 Introduction

After the introduction of statutory minimum wages in the UK in 1999 and in Germany in 2015, there is a renewed interest in the spillover effects of minimum wages on the entire wage distribution, looking back into institutional explanations (DiNardo, Fortin, & Lemieux, 1996), in contrast to technological explanations (Katz & Autor, 1999; Autor, Levy, & Murnane, 2003). The direction of this effect is not clear. For instance, statutory minimum wages may

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increase the share of low-pay workers as it becomes a going rate in particular industries (Low Pay Commission, 2014), or there may be spillover effects at wage levels where the minimum wage is not binding, in order to maintain relative earnings differentials for different tasks. Our approach builds on the method of Lee (1999), who used cross-state variation in the relative minimum wage (i.e. the Kaitz-index: the ratio of the minimum wage to the median) to demonstrate the relation between minimum wages and wage inequality, arguing that nearly all of the change in wage inequality in the United States during the 1980s has been due to changes in the minimum wage. However, the implausible observation of inequality-increasing spillover effects above the median demands more scrutiny (Autor, Katz, & Kearney, 2008).

Autor et al. (2014) found two sources of bias in Lee's specification. One is the division bias caused by the presence of the median on both sides of the equation. Sampling error in the measurement will then increase the covariance between relative minimum wages and wage inequality. The second source is the violation of Lee's identifying assumption – the orthogonality of median wage levels and wage inequality. To overcome the estimation issues, AMS suggest an IV approach, as well as using state fixed effects. They find weak minimum wage effects and limited spillovers for the US between 1979 and 2012, and are unable to reject the null that this is due to measurement error or disemployment.

This paper addresses these shortcomings. First, contrary to Lee, we do not only exploit variation in the 'bite' of the minimum wage from differences in the median pay levels, but also from negotiated pay levels in sectors based on our own database of collectively agreed wages, making use of the strongly institutionalized system of wage setting in Belgium, where minimum wage floors higher than the national minimum wage exist in all industries[1], and wage indexation and wage increases are coordinated. Second, using administrative panel data on wages we also test whether the findings hold in absence of disemployment effects. This allows us to evaluate three research questions on the institutional effects of minimum wages:

1. is there a relation between minimum wages and wage inequality;
2. is there any effect of minimum wages in the upper tail of the wage distribution;
3. does disemployment create artificial spillovers?

Our findings indicate that higher minimum wages do decrease wage inequality, mostly by increasing low wages. In parts of the upper tail, a surprising *negative* correlation is found. We also find no indication that the minimum wage spillovers are due to disemployment effects, so the wage compression in both tails, including the 'compensating' movement of high wages, presents itself

[1] The official term is the 'guaranteed minimal monthly income' as it includes other payments than the hourly or monthly wage (e.g. end-of-year bonuses). Because very few sectors do not negotiate wages, under 3% of workers in Belgium are paid at the national minimum wage level.

as the alternative possible channel of adjustment for the incurred costs of higher minimum wages, rather than an adjustment of labour demand. Taken together, the cross-sectional correlation between minimum wages and the wage distribution of sectors, in violation of the identifying assumption of the standard model, and the fairly uniform spillover effects indicate that both minimum wages and the overall shape of the wage distribution are part of a largely exogenous process of wage setting.

The structure of this paper is as follows: first we expand on the characteristics of the wage bargaining system in Belgium in section 2. In section 3 we discuss the data and present descriptive statistics guiding the analyses. Section 4 elaborates on the standard institutional model of wage inequality and presents improved estimations. At the end of this section, we evaluate the possibility that disemployment effects artificially create the observed spillovers. Section 6 concludes.

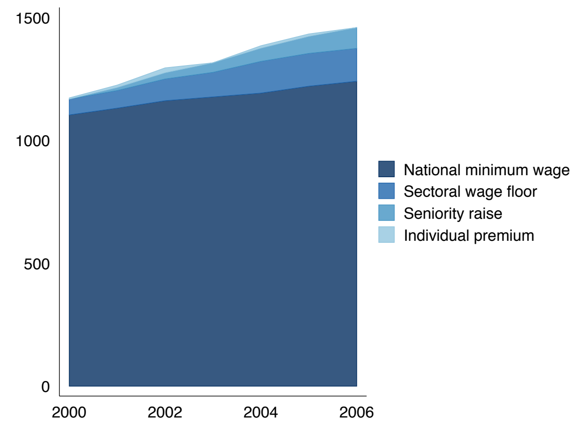
2 Institutional setting

Wage bargaining in Belgium, a medium-sized economy, is strongly institutionalized. There is a two-tier structure consisting of a national minimum wage and minimum pay scales in most sectors. Both are set independently through collective bargaining at multiple levels. As defined by the law of 1968, there can be agreements at the national level, sectoral level, and firm level. At the sectoral level negotiations take place in joint committees, consisting of representatives of the employers and trade unions. The state facilitates their operation by providing a president and social conciliators, but does not participate in the negotiations. Each joint committee covers a group of workers within an industry branch, often separately for white and blue-collar workers. Sectoral collective bargaining agreements cover nearly all employees because of the legal extension of the agreements by the government, and it is assumed that the negotiated wage takes up the largest part of the employee's wage, as individual wage negotiations are not a common practice and mostly limited in scope. Figure 1 illustrates how the different levels add up to form the base salary of a warehouseman in the wholesale pharmaceutical industry. As the drawing shows, on top of the national minimum wage and the (sectoral) wage floor, there is a typical annual 1% seniority pay increase, which can be included in the sectoral collective bargaining agreement, and a limited margin for an individual bonus.

Two particular aspects further shape wage setting in Belgium. The first is that it has an almost universally applied system of automatic cost of living adjustment of wages, called 'indexation'. It is not imposed by law, but through sectoral agreements 98.2% of workers are covered by the mechanism (Babecky et al., 2009). Wage indexation of the national minimum wage and of the sectoral wage floors thus provides a *lower bound* for wage changes. In the figure, all changes in the national minimum wage were due to indexation, as there had not been real minimum wage increases.

The second particularity is the Law of 1996 *On the safeguarding of competi-*

Figure 1: Components of the wage of a warehouseman in the wholesale pharmacy industry



tiveness and employment. This law puts forward a 'wage norm', to be negotiated every two years, which defines the upper bound for wage increases. The norm is based on the projected wage cost evolutions of France, Germany, and the Netherlands, so that wage increases do not affect the competitive position, and this is supposed to preserve employment. In the period under study, the law stipulated an advisory report on the 'available margin for wage negotiations' to be prepared by the Central Economic Council. In practice, the outcome of this study has almost always lead to the wage norm that was accepted by the social partners. However, during the Great Recession, the government has used its right to declare the wage norm legally enforceable in absence of an agreement, and imposed real wage freezes in a number of consecutive bargaining rounds. Finally, in March 2017, the Law was further solidified, fixing the formula to calculate the wage norm, and introducing automatic compensations if the norm was exceeded in the previous period. In figure 1, the increase of the wage floor is higher than the indexation (the increase in the national minimum wage), but below the wage norm set for every two-year period.

The analysis we will present benefits from the institutional character of wage setting in Belgium. First, the sector-level minimum wages provide considerable cross-sectional variation in order to construct and instrument the relative minimum wage. Second, the legal extension of the agreements ensures that the wage floors apply to all employees. Third, as many sectors have extensive collective bargaining agreements on wages for the different job categories, spillovers are to some extent internalized. The combined effects of high coverage and coordination, extensive pay scales, and limited margins for individual negotiation thus increase the importance of wage agreements. Because of the tight framework, minimum wage increase will cause a chain of reactions, as *'somethings has got* *to give'*. We investigate two of the proposed 'channels of adjustment' (Hirsch, Kaufman, & Zelenska, 2011) to deal with increasing wage costs: disemployment effects in the lower tail, that create artificial spillovers, and wage compression in the upper tail.

3 Data and descriptives

The main data come from the National Social Security Office (NSSO). The wage refers to the gross wage employers register in order to calculate social security contributions and benefits for employees, so it excludes wages costs related to the social contributions of employers. The gross wage consists of a fixed wage component and variable remuneration (e.g. for shift work, heavy work, night work, extra hours, urgent calls, etc.). For white-collar workers, holiday allowances are included, while for blue-collar workers this is estimated at 8% of the annual wage. We use full-time equivalent wages for the main job of a worker.

The data covers one third of the employees working in the private sector between 1996 and 2006. The panel was constructed by selecting 1/3th of the workers that enter the enter the population for the first time, and following them from that point onwards. Sectors are defined by NACE activity, job category, and employer funds when no joint committee was registered. This worked for all years except 1996, where too little information was available. Therefore, the analyses use 1997 as the starting date. We further restricted the population to 21 to 65 year olds, as below the age of 21 youth minimum wages and special statutes (e.g. apprentices) exist or have existed which cannot readily be traced, and the legal retirement age was set at 65 in this period. After cleaning, the final panel counts 1 318 792 employees working in the private sector, allowing the estimation of the wage distribution in all major industries.

The *sectoral* minimum wages refer to the lowest wage floor in each sectoral collective bargaining agreements concluded in joint committees. The information was taken from 505 collective agreements in the period up to 2006 for 35 of the largest joint committees, using the historical knowlegde base on collective agreements of the Belgian HR service provider Acerta. Missing data for the period before 2000 was completed applying the index of negotiated pay raises (ICL) provided by the Ministry of Labour. The final selection includes 16 joint committees for blue-collar workers, 10 for white-collar workers and 9 mixed joint committees, together accounting for 66.41% of the total workforce in the private sector (n = 438 209 in 1997, and 511 232 in 2006).

Following European legislation on discrimination, all sectors in Belgium have changed the existing age-related payment schemes into seniority-related payment schemes in the first decade of the 2000s. This often meant that lower wage floors for workers under 21 were levelled with the 'full' sectoral minimum wage at age 21. In order to follow the same wage category and not have breaks in the trend, we traced back the wage evolution at age 21, or conversely, of workers with 3 years of experience in case the minimum wage was defined at

Table 1: Descriptives statistics for the sample of joint committees (1997, 2006).

	Workforce		Median wage		p50-p10		p90-p50		Min. wage	
Joint Committee	1997	2006	1997	2006	1997	2006	1997	2006	1997	2006
Blue collar										
Gardening (145)	10 038	13 095	7.16	7.39	.17	.21	.17	.19	6.96	7.17
Glas Manufacturing (115)	9 285	7 056	7.52	7.74	.29	.27	.27	.30	7.02	7.23
Textile Manufacturing (120)	32 958	24 861	7.32	7.57	.24	.20	.23	.22	7.04	7.28
Clothing (109)	20 349	11 463	7.07	7.36	.09	.12	.25	.28	7.04	7.28
Paper Industry (136)	7 572	7 692	7.45	7.69	.26	.31	.26	.27	7.06	7.30
Chemical Manufacturing (116)	48 378	47 907	7.59	7.8	.35	.33	.43	.47	7.05	7.33
Food Manufacturing (118)	59 295	59 340	7.36	7.6	.18	.16	.27	.25	7.09	7.33
Food Distribution (119)	31 401	34 008	7.25	7.49	.12	.12	.19	.18	7.11	7.35
Iron (104)	16 911	12 327	7.75	8.00	.28	.23	.24	.16	7.2	7.36
Non-Ferro (105)	6 267	4 848	7.67	7.92	.20	.18	.24	.24	7.15	7.37
Publishing (130)	16 059	12 519	7.56	7.77	.28	.26	.29	.32	7.18	7.39
Cleaning (121)	39 417	44 268	7.22	7.45	.10	.07	.24	.19	7.15	7.40
Metal Related Industries (149)	39 420	47 001	7.37	7.63	.19	.18	.19	.20	7.14	7.40
Car Maintenance (112)	25 122	26 208	7.37	7.64	.22	.21	.18	.19	7.13	7.41
Construction (124)	135 876	154 698	7.45	7.66	.13	.14	.11	.12	7.32	7.55
Cement (106)	7 518	7 287	7.48	7.69	.12	.11	.22	.24	7.38	7.59
White collar										
IIndependant Stores (201)	74 982	81 279	7.09	7.30	.16	.17	.43	.38	6.87	7.09
Food Trade (202)	44 799	47 952	7.33	7.51	.30	.24	.32	.35	6.90	7.13
Metal Industry (209)	73 122	71 481	7.78	8.03	.42	.40	.53	.50	6.94	7.18
Various Service Industries (218)	330 228	446 247	7.57	7.82	.42	.41	.60	.58	6.98	7.22
Food Industry (220)	22 236	24 936	7.71	7.96	.38	.36	.58	.58	7.05	7.23
Chemical Industry (207)	64 731	75 498	7.85	8.11	.49	.47	.58	.56	7.00	7.24
Clothing (215)	5 097	6 213	7.48	7.81	.36	.33	.65	.63	7.01	7.29
Textile Industry (214)	7 392	5 949	7.66	7.93	.36	.32	.50	.53	7.11	7.35
Petrol Industry (211)	5 106	5 565	8.08	8.40	.47	.49	.50	.57	7.41	7.67
Mixed										
Brokers (307)	8 265	9 567	9.83	10.15	.38	.38	.57	.55	9.39	9.63
Large Stores (311)	17 022	31 641	9.68	9.91	.25	.23	.47	.41	9.42	9.66
Farmacies (313)	7 557	9 609	9.83	10.11	.34	.34	.49	.52	9.46	9.66
Large Stores (312)	4 119	10 809	9.84	10.11	.27	.23	.34	.39	9.44	9.68
Institutes (319)	27 324	41 874	10.01	10.28	.32	.32	.33	.34	9.53	9.70
Trade & Distribution Of Drugs (321)	3189	2703	9.83	10.07	.31	.24	.43	.41	9.49	9.71
Savings Bank (308)	5 109	4 371	10.12	10.36	.42	.42	.48	.49	9.58	9.75
Insurances (306)	25 845	24 687	10.22	10.46	.44	.46	.55	.54	9.57	9.76
Accomodation (302)	40 794	56 481	9.61	9.89	.24	.27	.34	.27	9.48	9.79
Banking (310)	57 540	64 014	10.26	10.56	.39	.39	.44	.46	9.61	9.82

Sources: Wages: National Social Security Office (NSSO). Collective agreements: Acerta, Ministry of Labour.

age 21.

Finally, because minimum wages change at different moments of the year, we aggregated the figures on a yearly basis by calculating the time-weighted average of the minimum wages that were in place during each year. This is the minimum for a worker who was employed in the sector all year.[2]

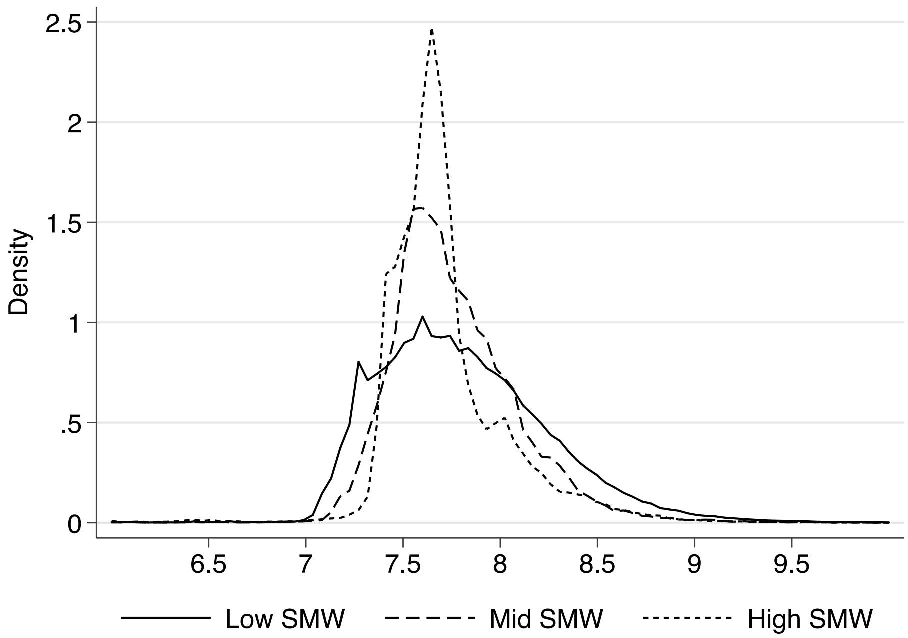
Table 1 shows descriptive statistics for the 35 joint committees in the sample, ranked by the minimum wage in 2006. Wages are expressed as logs of the yearly wage, so differences can be understood as percentage changes (for small changes). As expected, median wages are on average lower for blue-collar workers (the lowest are found in the clothing industry), and higher for white-collar workers (the highest is the petrol industry). The minimum wage, in contrast, is on average higher for blue-collar workers, with 12 out of 16 joint committees paying minimum 7.3 log euros (1480 EUR) in 2006. Also, upper as well as lower-tail wage inequality is substantially lower in blue-collar joint committees than in white and mixed joint committees, so the entire wage distribution is more compressed. Over time however, wage inequality is very stable, but the difference between the change in minimum wages and median pay levels in the blue-collar joint committees is much smaller than in the white and mixed joint committees, indicating growing inter-sector wage differentials, and reflecting also the sluggish growth in the manufacturing sectors where more blue-collar workers are active.

Table 1 provides both a cross-sectional and a longitudinal look at the relationship between minimum wages and wage inequality. Figure 2 addresses the cross-sectional aspect, showing the wage distribution in 2006 for joint committees in three groups based on the level of the minimum wage. The graph illustrates that joint committees with high minimum wages also have a more compressed wage distribution. Wage dispersion is largest in the joint committees with the lowest minimum wages, and higher median and average wage levels. A number of tentative explanations exist: first, the occupational distribution may be more extensive in some sectors, requiring a wider range of skills and schooling. Second, in most white-collar sectors wages increase with seniority, in which case a diverse age structure automatically stretches the wage distribution. This is much less common in blue-collar joint committees with higher minimum wages. Third, some sectors have a wider variety of companies, or decentralized bargaining by companies, so that the sectoral minimum wages is intentionally kept low but at the company level wage increases are possible. In any case, a correlation between inequality and median pay levels is a violation of the identifying assumption in the model of Lee (1999), but can be controlled using fixed effects and group time trends, at the cost of biasing the upper tail estimation upwards (Autor et al., 2014). See appendix for a simulation of this bias.

Figure 3 explores the within-sector correlation between changes in the minimum wage and changes in upper (squares) and lower-tail (circles) inequality from 2000 onwards. The panels distinguish between blue-collar, white-collar, and mixed joint committees. A higher value on the Y-axis indicates an in-

[2] Autor et al. (2014) instead select the longest lasting minimum wage in a given year.

Figure 2: Kernel density estimates of the log wage distribution in 2006, grouped according to sectoral minimum wage tertiles.

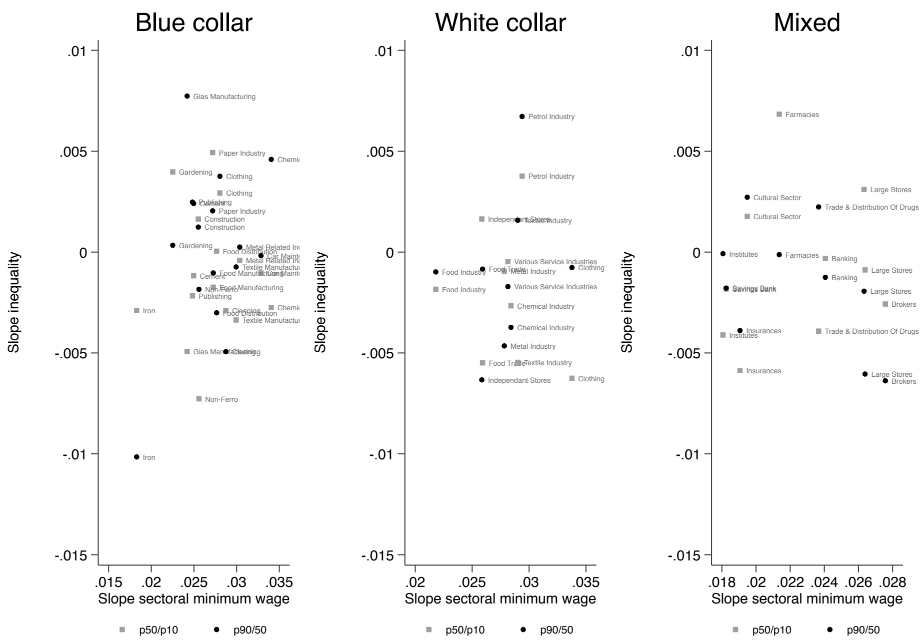


crease in inequality. The overall correlation with time changes in the sectoral minimum wage level is negligible on both sides of the distribution, although there is significant variation in the growth rates of inequalities and minimum wages. Therefore there are either no effects, or there are suppressing trends. Interestingly, in many cases the change in upper and lower-tail inequality are almost equal, which can be read from the graph where the same label is situated closely (e.g. clothing, construction, metal industry, food industry, chemical industry, cultural sector, banking and savings banks). These sectors hence show a symmetric expansion or compression of the wage distribution.

In the period under study, minimum wage levels have increased in nominal and in real terms, and employment has increased as well. On the aggregate, the correlation would be positive. However, Figure 4 shows no clear employment effects within sectors, which is a standard finding in the literature (Allegretto, Dube, Reich, & Zipperer, 2013).

In conclusion, the correlation between minimum wages, pay levels, and wage dispersion recommends adaptations to Lee's standard model when relying on cross-sectional variation in the median. Exogenous instutional data on minimum wages and longitudinal variation provide additional within-sector information

Figure 3: Annual trends in inequalities in relation to trends in sectoral minimum wages, by joint committee (2000-2006).



to better grasp the effect of minimum wages on inequality and employment.

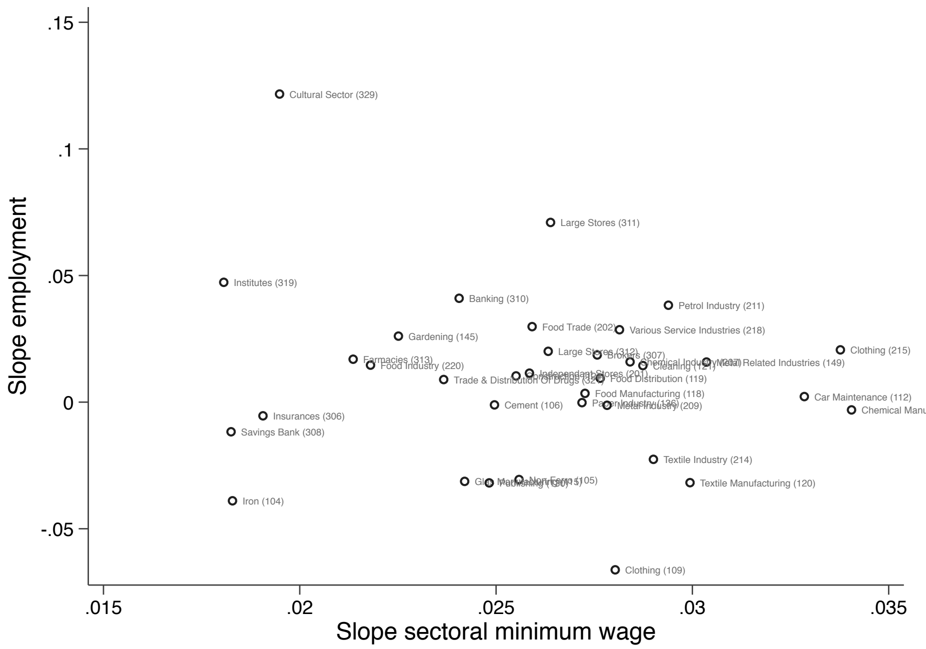
4 Analysis

4.1 The effect of minimum wages on wage inequality

To analyse the effect of the minimum wage on inequality or employment, the challenge is to separate simultaneous time trends from direct effects. Often there is also a shortage of data points to study time trends, and there appears to be no variation at a given point in time. To overcome this, Lee (1999) proposes to create variation using cross-sectional data by defining the relative minimum wage as the difference between the (national) minimum wage w_t^m and the median wage in different regions, according to (1).

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

Figure 4: Annual employment trends (number of jobs) in relation to trends in sectoral minimum wages, by joint committee (2000-2006).



Where s is the region or state. When the median 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 seizable bite out of the wage distribution. On the other hand, when the median is high, the same minimum wage will be low and there is little impact to be expected. The relation between the relative minimum wage and wage inequality across states is therefore a good 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 estimation model of Lee is as follows:

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

Here, $w(p)$ denotes the wage at percentile p, and w_{st}^m is the minimum wage for sector s at time t. Let us define the deviation $\tau_s(p) = w_s(p) - w_s(50)$ such that:

$$\tau_s(p) \geq 0 \text{ if } p \geq 50$$
$$\tau_s(p) \leq 0 \text{ if } p \leq 50$$

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.[3] In this case, an OLS estimate of $\beta(p)$ will be consistent if:

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

Which implies orthogonality. Sufficient conditions for this are:

$$\text{Cov}(-w_{st}(50), \nu_s(p)) = 0 \tag{5}$$
$$\text{Cov}(w_{st}^m, \nu_s(p)) = 0 \tag{6}$$

Where In violation of these conditions, there is an endogeneity bias. We will first discuss the correlations of persistent sectoral inequality with median wages and the minimum wage, and after that also account for time-effects.

Consider equation (5), assuming that in sectors with more latent inequality, the *median wage* is persistently higher. Similar to (3), define $w_{st}(50) = \mu_s + \gamma_t^\mu + \eta_{st}^\mu$, where μ_s is the mean of the median wage over time, γ_t^μ is the time trends, and η_{st}^μ is white noise. Then we have:

Bias 1.1 $\text{Cov}(-\mu_s, \nu_s(p)) > 0$ for $p < 50$ (upward bias of $\beta^{OLS}(p)$)

Bias 1.2 $\text{Cov}(-\mu_s, \nu_s(p)) < 0$ for $p > 50$ (downward bias of $\beta^{OLS}(p)$)

This bias is the first critique on Lee and AMS show evidence for it. The solution they propose is the add 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 mean, time trend, and random noise. We then get:

Bias 2.1 $\text{Cov}(\omega_s, \nu_s(p)) > 0$ for $p < 50$ (upward bias of $\beta^{OLS}(p)$)

Bias 2.2 $\text{Cov}(\omega_s, \nu_s(p)) < 0$ for $p > 50$ (downward bias of $\beta^{OLS}(p)$)

In the main estimation 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

[3] Note that in the *latent* distribution for the LHS, $w_p^* = \mu_{st} + \sigma_{st}F^{-1}(p)$ and $\mu_{st} = w_s(50)$ when wages have a lognormal distribution. In that case, the regressand is the overall dispersion σ_{st} times the inverse normal distribution.

sectoral wage distribution reflects sector-specific occupational heterogeneity and the inequality aversion of unions, as the descriptive data has shown.

Up to now we have considered persistent correlations between latent inequality, median pay levels, and minimum wage levels. The conditions in (4) also apply to sector-time correlation, other than the general time variation captured by each $\gamma_t^{\nu,\mu\omega}$ and controlled by time dummies. To account for sector-time trends, define instead:

$$\begin{aligned}
\varepsilon_{st} &= \nu_s(p)t + \gamma_t^{\nu}(p) + \eta_{st}^{\nu} \\
w_{st}(50) &= \mu_s t + \gamma_t^{\mu} + \eta_{st}^{\mu} \\
w_{st}^{m} &= \omega_s t + \gamma_t^{\omega} + \eta_{st}^{\omega}
\end{aligned}$$

A similar analysis applies as above and sector-time trends should be included in the analysis.

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 the division bias:

Bias 3 Estimates for $\beta(p)$ are upward biased for all p. (7)

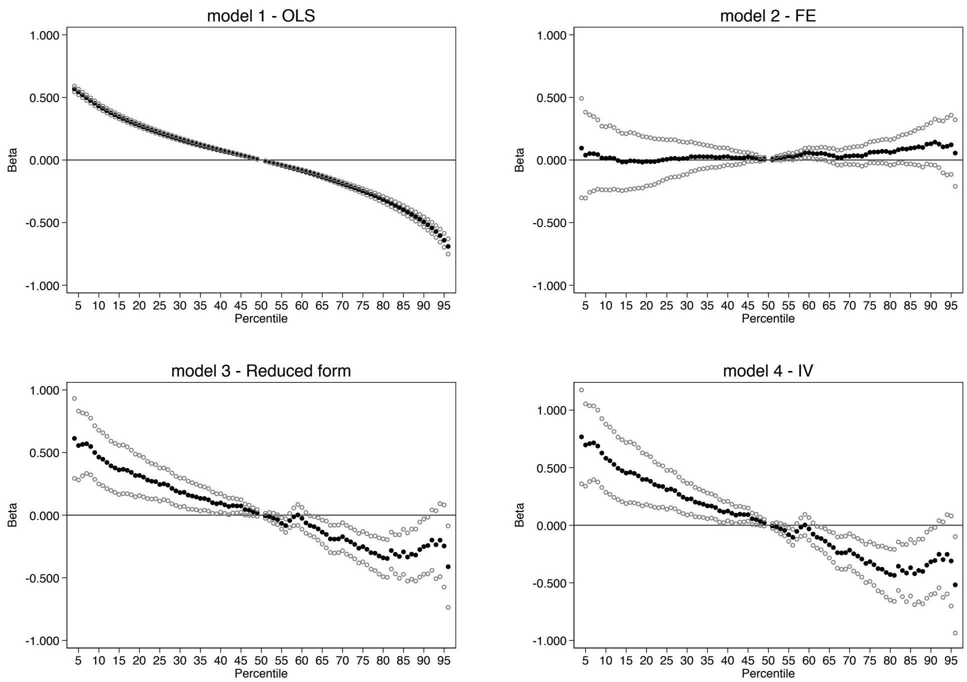
The solution proposed in AMS is to use w_{st}^m as an instrument for $w_{st}^m - w_{st}(50)$ in equation (2) using IV.

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 (including time trends) 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 in the wage distributions over sectors as the main unit of analysis instead of states or regions. Second, the minimum wage is set at the sector level as found in wage agreements. Third, 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.

Figure 5 shows four models to consecutively check the biases. The first model is the original OLS estimation for equation (2), showing the change in wage inequality for a change in the relative minimum wage. The effect is around .50 at the 5th percentile and -.50 at the 90th percentile. Recall that the sign has a different interpretation on both sides of the median: below the median, a positive sign of the coefficient means that an increase in the relative minimum wage causes a decrease in wage inequality. Above the median, the opposite holds. Remarkably, Lee's model applied to the Belgian data suggests that an increase in the relative minimum wage *compresses* the upper tail of the wage distribution. This shows the endogeneity biases 1 and 2 (non-orthogonality, omitted variable bias), due to persistent latent inequality in sectors that correlates with median pay levels and minimum wage levels, linked to the occupational heterogeneity and the diversity of firms within joint committees.

Figure 5: Regression of wage inequality on the sector minimum wage, by wage percentile.



Note: Robust standard errors. The 95% confidence interval is given by the gray markers and topped at -1 and 1.5.

Following Autor et al. (2014), the second model includes time and sector (instead of state) fixed effects (D_t and D_s), as well as state-year trends (D_st), in order to capture $\nu_{s\times t}$, $\mu_{s\times t}$, and $\omega_{s\times t}$. The model then becomes:

$$w_{st}(p) - w_{st}(50) = \beta w_{st}^k + D_s + D_t + D_s t + \varepsilon_{st} \tag{8}$$

The graph shows that the within effects are entirely absent across the wage distribution, although the effect size becomes positive in the upper tail, as found in AMS. However, the errors in this model do not support any rejection of the null. One way to think of this effect, is that inflation causes $w(10)$ and

Models 3 and 4 tackle the division bias issue, which causes a positive correlation in the pooled OLS estimate and perhaps in the upper tail of the FE model, by either substituting the relative minimum wage w_{st}^k by the absolute minimum wage (reduced form, model 3), or using the latter as an instrument in a 2SLS IV estimation (model 4).

In both models, we find that the OLS estimates in the lower tail are recovered, and that the effects in the upper tail are again negative and significant.

This should be due to driving out the effect of the median on both sides of the equation, which had stalled the regression in model 2.

Table 2 shows the regression coefficients from each of the four models at the 10th, 20th, 80th, and 90th percentile. In the OLS model, we find that the correlation between the median wage levels and the shape of the sectoral wage distribution drives the strong observed effects. The FE in contrast is mainly driven by changes in the median over time which have no effect on in equality. Model 3 is the reduced form in which the relative minimum wage is replaced by the actual minimum wage. The reduced form differs from the IV estimate by a factor which is the first stage coefficient. As the correlation between the actual minimum wage and the relative minimum wage is very strong, the over-estimation of the minimum wage effect in model 3 is limited. Model 4 shows the final IV estimation, using only exogenous variation in w^k_{st}. We find strong effects which only weaken near the 90th percentile, but there appear to be wage compression above the median, outside of the cross-sectional relation between minimum wages and persistent inequality or persistent trends in inequality. In comparison to AMS, we find less of an upward bias under the median, but there is evidence of a downward bias under the median. However, in our model, there is still significant wage compression rather than expansion. For robustness, we have estimated model 2 and model 4 at the individual level using quantile regression.Although the effect size is smaller, the 2SLS quantile estimation confirms the two-sided wage compression effect (see appendix).

Table 2: Regression of wage inequality on the relative minimum wage at p10, p20, p80 and p90: OLS, fixed effects, reduced form, and 2SLS-IV models.

	(1)	(2)	(3)	(4)
	OLS	FE	RF	2SLS
β_{10}	0.431***	0.014	0.464***	0.581***
R^2	0.798	0.986	0.986	0.981
β_{20}	0.277***	-0.012	0.317***	0.397***
R^2	0.723	0.985	0.986	0.980
β_{80}	-0.315***	0.060	-0.341***	-0.427***
R^2	0.546	0.992	0.992	0.987
β_{90}	-0.494***	0.130	-0.251*	-0.318*
R^2	0.518	0.993	0.993	0.991

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5 Are spillovers due to disemployment?

It is often suggested that, because of downward sloping labour demand, a minimum wage increase should automatically and unavoidably imply job losses: *"the direct unemployment [effect of increasing minimum wages] is substantial and certain"* (Stigler, 1946). Since the 1990s however, there is a growing consensus that disemployment effects are not substantial (Card & Krueger, 1994; Dube, Lester, & Reich, 2010; Allegretto et al., 2013). Even if the sign of the effect is still contested (Neumark, Salas, & Wascher, 2014a, 2014b), strong effects are not expected among the regular working-age population.

For the present purpose we are concerned with the possible impact of worker flows on the wage distribution and on the observed spillovers due to minimum wage increases – one source of measurement artefacts that Autor et al. (2014) could not rule out. If, due to minimum wage increases, workers quit from the tails, the extreme percentiles will shift towards the median relatively farther than the median itself as the density of the distribution around the median, in a normal distribution, is higher. As a result, even if the minimum wage does nothing to the wage distribution except censoring, it will appear to cause wage compression.

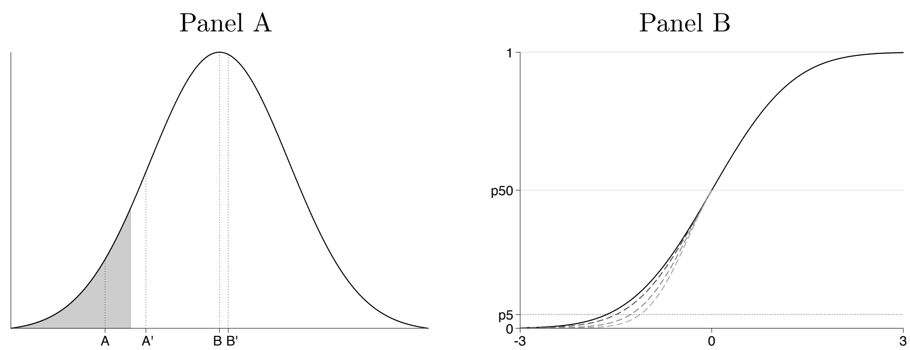
The findings above indicate that minimum wages correlate negatively with wage inequality, at least in the lower tail, and may cause wage compression in the upper tail. Wage compression may indeed be a compensating effect for the wage cost incurred by the increase in the minimum wage. A second channel of adjustment is disemployment, which we will investigate to add credibility to the wage compression hypothesis. The logic is to falsify the existence of disemployment effects from a *reductio ad absurdum* – stating that they do exist in our sample.

We assume that disemployment (by ways of firing or not hiring) because of increasing minimum wages does not affect all workers over the full wage distribution, but rather only those employees earning wages close to the minimum wage, in the lower tail. In this case, the observed effect on wage inequality might be artificial: if one takes a slice of ten percent at the lower tail of a normal distribution, the inequality from the now moved tenth percentile relative to the moved median will be smaller in bell-shaped distributions. Panel A in fiqure 6 illustrates how the shift from point A, which represents the 5th percentile, to A' after the introduction of a minimum wage at the 10th percentile and dismissing the employees making up the shaded part of the distribution, is larger than the shift from point B to B', which represents the median before and after the introduction of the minimum wage.

Panel B in figure 6 demonstrates the same effect of disemployment on the cumulative wage distribution. When low-paid employees drop out of the sample, the lower part of the curve become first flat and then steeper, as there are fewer (or no) workers with very low wages. The plot shows the fifth percentile of the wage distribution, which moves closer to the (standardized) median as the bite of the minimum wage increases (dashed lines). The 'spillover' can be estimated by taking the difference between the observed wage and the latent wage at a given percentile. It could be due to disemployment or to effective minimum wage effects. The latter spillovers may go beyond the mechanical lifting of wage whose latent value is below the minimum, for instance through extensive pay scales.

We can estimate the spillovers and compare the sample used for the analysis in the previous section with a 'stable' sample that excludes entrants in the

Figure 6: Hypothetical disemployment effects from minimum wage increases on estimated spillovers in a density and cumulative density function.

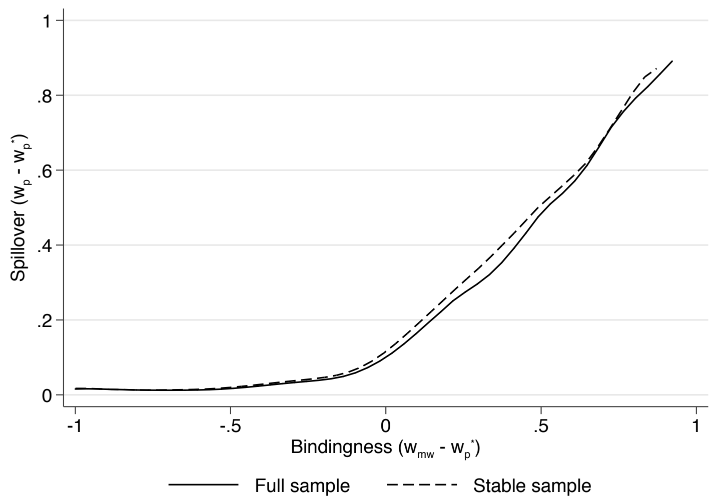


branch or quitters in any given year. This is a way to alleviate the sample selection bias that causes the presumed artificial spillovers. We have simulated this strategy (see appendix) and showed that it removes about half of the bias - increasing the exclusion by using a fixed sample for the whole period, would entirely overcome the bias, but at the cost of not having a sample that is smaller and not representative for the population. According to the hypothesis, the stable sample should have smaller spillovers that have a weaker correlation with minimum wages compared to the full sample where minimum wages take a larger bite out of the distribution because of disemployment.

As wage percentiles can be defined as $w(p) = \mu_w + F^{-1}(p)\sigma_w$, AMS suggest measuring spillovers by estimating a latent wage distribution. We construct the latent wage distribution based on a regression of wages between the 65th and the 90th percentile, allowing the mean wage μ_w and the standard deviation σ_w to vary by sector and following a time trend. We assume that in this quarter of the population of wage earners, the observed wage distribution is closest to the latent wage distribution. Using the parameters μ and σ of this distribution, we define the latent distribution for all percentiles by sector. The implicit assumption is that the latent wage distribution is lognormal, most importantly in the lower tail. However, as the falsification of the disemployment hypothesis relies on a comparison of estimates, and both samples are subject to the same bias, this assumption is relaxed as long as the distributions in the upper tail of the stable sample and the full sample are similar enough.

Figure 7 summarizes the data in the stable and the full sample using local polynomials of the first degree. The spillovers $(w(p) - w^*(p))$ are on the y-axis, the bindingness of the minimum wage $(w^m - w^*(p))$ is on the x-axis. When the bindingness is larger than 0, the observed wage distribution will start to deviate from the latent wage distribution. We see that for both samples this is the case, but contrary to expectations, the spillovers are slightly larger for the stable sample. In part this could be due to more ability in this sample with less worker flows, but this does not explain why the increase of spillovers

Figure 7: Deviation from the estimated latent wage distribution: local polynomial through sector-year-percentile units.



is stronger up to a bindingness of .5 than in the full sample. The steeper curve or higher correlation implies that minimum wages have a stronger effect on the wage distribution of workers that are 'insiders' in the branch, benefiting more from increasing minimum wages. Another explanation is that instead of causing disemployment, increasing minimum wages in the full sample attract minimum wage workers, so the reverse hypothesis would be true. However, the visual difference is small.

We verify these findings by replicating the regressions of section 4, adding controls for worker outflows from a sector. The panel structure of the micro data lets us track individual flows in and out of work and between sectors. Table 3 first repeats model 4 above for the time range 1998-2005, to be compared with model 5 that includes the lagged number of quits (in thousands) and model 6 which is the IV regression (model 4) in the stable sample.

The coefficients of model 4 here are similar to the ones in 2, but even stronger. We find a positive effect below the median and a negative effect above the median. Model 5, including the number of quits in the preceding year, shows that quits might indeed reduce inequality, but the effect is small and not significant below the median except at the 20th percentile. However, at the 10th and 20th percentile, the controlled effect of minimum wage changes is also larger than in the baseline model, suggesting that minimum wages correlate negatively with quits. Finally, in the stable sample, the effects below the medium are more moderated, except for the effect at the 5th percentile that is larger than in the baseline model. Above the median, we find no compression at the 95th per-

Table 3: Baseline IV regression (model 4), IV regression with worker flows (model 5) and IV regression for the stable sample (model 6)

	p5	p10	p20	p80	p90	p95
β_{full}	0.711***	0.690***	0.474***	-0.486***	-0.511**	-0.542*
R^2	0.977	0.979	0.977	0.988	0.991	0.991
β_{comp}	0.654**	0.740**	0.575**	-0.340*	-0.190	0.029
lquit	0.003	0.004	0.004+	-0.003+	-0.000	0.004+
R^2	0.984	0.985	0.979	0.991	0.994	0.994
β_{stable}	0.771***	0.519***	0.352***	-0.267**	-0.210+	0.037
R^2	0.984	0.991	0.993	0.994	0.995	0.993

$^{+}$ $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 4: For comparability of the estimates with the stable sample, the time range was reduced to 1998-2005 in all estimates.

centile. As a whole, these models do not support the hypothesis that minimum wage spillovers are artificial and caused by disemployment.

6 Conclusion

In this paper we discussed the effects of minimum wages on wage inequality using data from Belgium, a country that has a strongly institutionalized wage bargaining system. The margins for wage growth are set by sector minimum wages and wages indexation on one side, and by the wage norm defining the upper limit of growth on the other. It appears that as a result, wage inequality is at a low and stable overall level.

We applied Lee's (1999) model for testing minimum wage effects using cross-sectional variation in wage levels, wage inequality and the minimum wage. Without controls, we found an extremely high degree of wage compression on both sides of the wage distribution. Controlling for sector fixed effects, this effect largely vanished, indicating a positive correlation between median wages and inequality. Moreover, when the median is low, the minimum wage tends to be higher, further contributing to the observed wage equality. We hypothesize that institutional arrangements between sectors have a very strong effect on wage inequality, and minimum wages are set in accordance with a given degree of wage dispersion. This may correlate with unionization and union preferences for wage compression.

Within sectors, however, the effect of a change in the (sectoral) minimum wage is in line with earlier research. Using a 2SLS IV estimation with the actual minimum wage as an instrument for the relative minimum wage, we found that a 10% increase in the minimum wage relative to the median compresses wage inequality in the lower tail with more than 5% at the 10th percentile. Also, there is robust evidence of significant wage compression in the upper tail of the wage distribution.

Finally, we investigated the possibility that disemployment effects cause artificial minimum wage spillovers. For this, we calculated spillover effects through the estimation of a latent wage distribution for both the full sample and a stable sample. No evidence was found for strong disemployment effects in the former group. To the contrary, even larger spillovers were observed in the stable sample.

We conclude that minimum wages appear to have a compressing effect on the wage distribution, which is unambiguous in the lower tail and resembles earlier findings. Disemployment does not appear to be a driving force behind decreases in wage inequality due to minimum wage increases. Instead, higher minimum wages correlate with wage compression in the upper tail. The institutional setting may facilitate this wage compression, as we find that the top of the wage distribution – employees with high, individually negotiated wages, are not affected. This may be interesting for research on minimum wage effects for labour market outsiders at the low-pay end of the distribution such as migrants and young workers, who appear to face disemployment contrary to the general workforce (Brown, 1999). Not being part of a negotiation group that performs a balancing act may cause unemployment to vent the pressure of higher wages.

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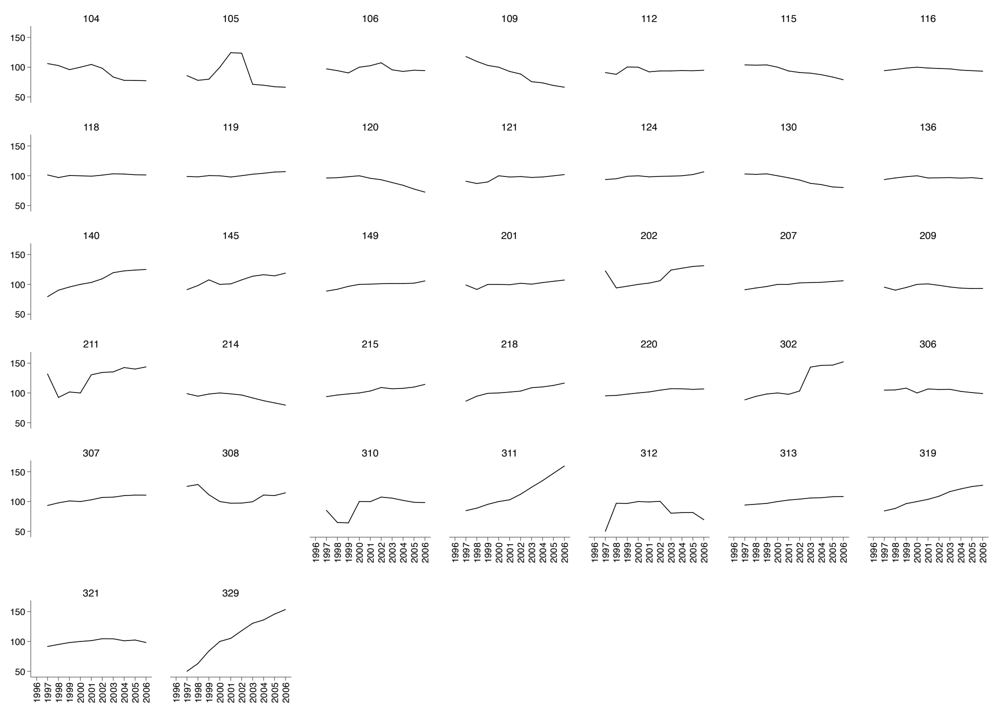
7 Appendix

7.1 Annex to section 3: assigning joint committees

From 1996 to 2002, the joint committee was not a mandatory field to be completed in the social security administration form. In order to complete the data, we have determined the most likely joint committee under which the worker resorts, based on groups defined by worker class (white or blue collar), the 5-digit NACE classification of economic activities, and a social security number used for funding unemployment benefits, that is linked to the joint committee.

Visual inspection of graph 8 shows that the employment evolution is restored in most sectors, so that it becomes possible to connect sector minimum wages to individual employees using the estimated joint committee.

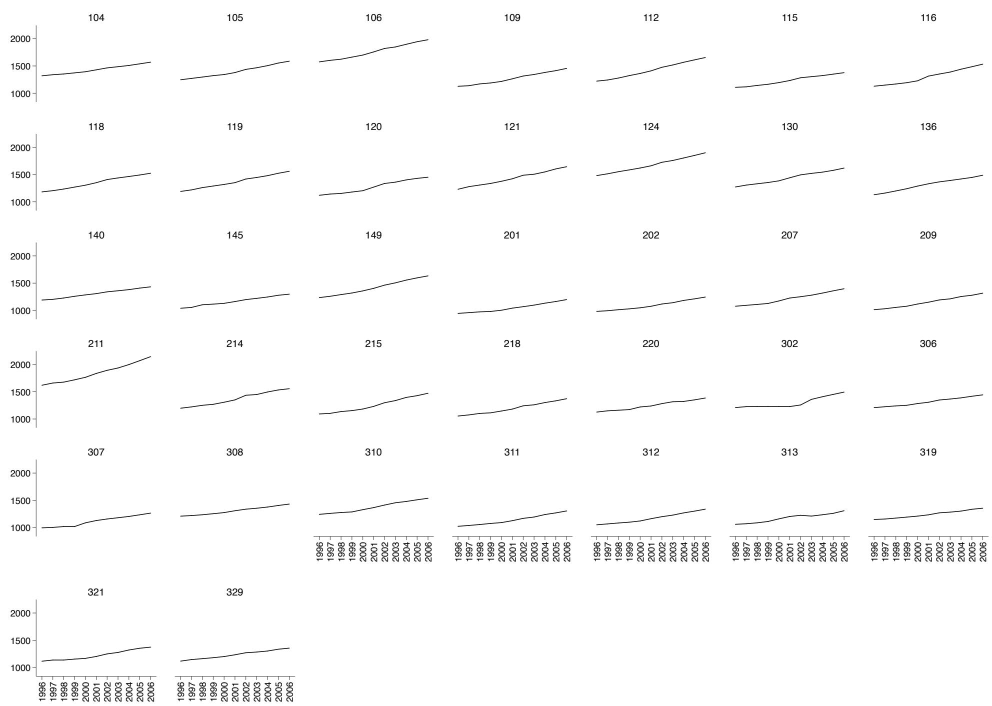
Figure 8: Employment evolution by joint committee



7.2 Annex to section 3: minimum wages

Figure 9 shows the minimum wage trends from the Belgian Minimum Wage database for the joint committees in this analysis.

Figure 9: Employment evolution by joint committee (original and imputed)



7.3 Annex to section 4: quantile regression

To check the robustness of the analyses at the sector level, we estimate the effect at the individual level in a quantile regression. The OLS equation mimics model 2 from (8), and the IV equation mimics 4. In Because of computational limitations, sector-year effects are excluded, and a 10% random subsample was used. Note that the change of level of analysis changes the interpretation of the effects. The regressand is now the individual difference to the sector median wage, of which we will estimate the magnitude at the p-th percentile. The regressor is the relative minimum wage in the sector, as before. A positive beta means that the p-th percentile difference between the log wage and the log median is larger. This implies a reduction of inequality below the median and and expansion for wages above the median. Hence we can read the table in a similar way as 2.

Table 5: Quantile regression of wage inequality at the individual level on relative minimum wages.

	OLS		2SLS	
β_{p10}	0.011		0.127	*
β_{p20}	-0.009		0.072	
β_{p80}	0.046		-0.180	*
β_{p90}	0.182	**	0.103	

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: models include sector and year dummies.
The 2SLS instrument is the minimum wage.

Table 5 shows the results. The OLS-results are widely off compared to the first findings. Recall that the OLS effect at the sector level was mainly driven by the non-orthogonality of the median and wage dispersion. The IV model on the other hand does confirm model 4 from table 2 and figure 5, although the only at the 10th and 80th percentile we find a significant effect, and it is much weaker in the lower tail compared to the estimation based on sectoral quantiles.

7.4 Annex to section 5

7.5 Simulations

To illustrate the different sources of bias in the estimation of $\mathrm{Cov}(w_p - w_5 0, w_m - w_5 0)$, we have provided simulations. The syntax can be downloaded from https://hiva.kuleuven.be/sites/ipswich/. We summarize the findings briefly in the do-files.

Figure 10: Average difference between the observed wage distributions of the stable and the full sample (1996-2006).

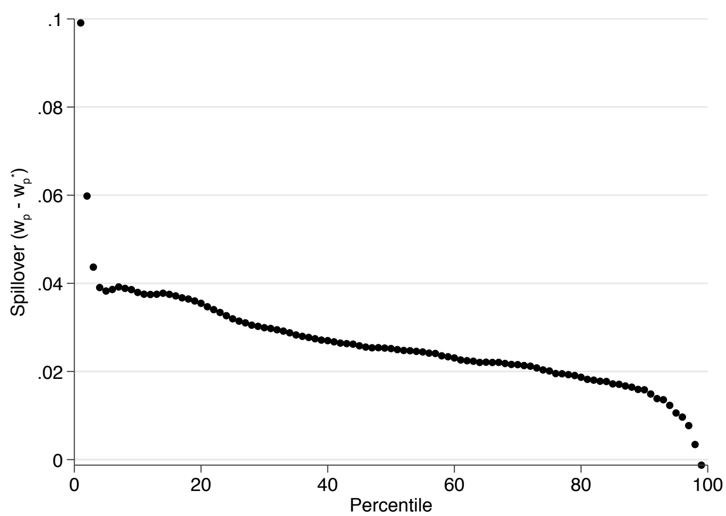
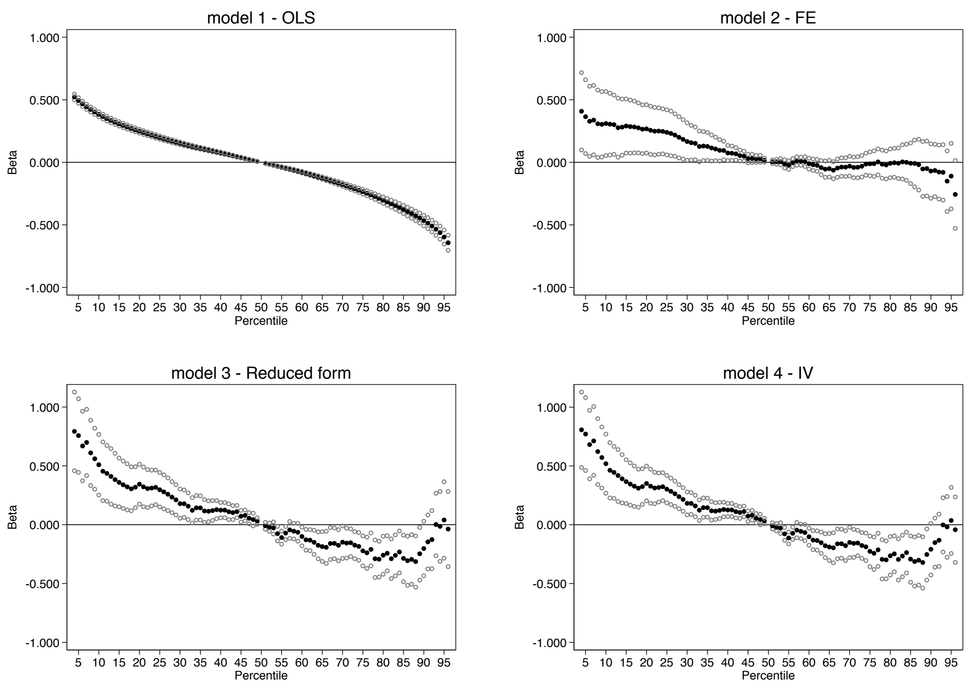


Figure 11: The effect of sector minimum wages on wage inequality by percentile (stable sample, 1997-2005).



Note: Robust standard errors. The 95% confidence interval is given by the gray markers. The upper limit was set to 1.5, the lower limit to -1 to maintain the scale of the graphs.