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Abstract

This study evaluates the impact of the minimum wage on the earnings distribution in France, using an unconditional quantile regression method proposed by Firpo, Fortin, and Lemieux (2009). To address the endogeneity issue due to the specific French revaluation process of the minimum wage, we use a natural experiment. As several minimum wage levels coexisted because of different schedules in the French “35-hour week" application, they were forced to converge to one single level between 2003 and 2005. We find significant effects of the minimum wage on the earnings distribution of male and female employees up to the seventh decile.

Keywords: Minimum wage, earnings distribution, unconditional quantile regressions

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Salaire minimum et effet de diffusion en France : une approche par les régressions de quantile inconditionnel

Résumé

Cette étude évalue l'impact du salaire minimum sur la distribution de salaires en France, en utilisant la méthode de régression de quantiles inconditionnels proposée par Firpo, Fortin et Lemieux (2009). Pour traiter la question de l'endogénéité liée au mode de revalorisation du salaire minimum en France, nous utilisons une expérience naturelle. Alors que plusieurs rémunérations minimales coexistaient du fait de l'application progressive des 35 heures, une convergence vers le haut a été imposée entre 2003 et 2005. Nous trouvons un effet significatif du salaire minimum sur les distributions des salaires des hommes et des femmes, jusqu'au septième décile.

Mots-clés : Salaire minimum, distribution de salaire, régressions de quantiles inconditionnelles

Classification JEL : J31, J38, C18

1 Introduction

This study aims at providing new empirical stylized facts regarding the spillover impact of the minimum wage on the wage distribution during the last decade in France. To model the effect on the wage distribution, we rely on the "unconditional quantile regression" method proposed by Firpo, Fortin, and Lemieux (2009). It allows us to directly estimate the impact of a marginal change in the minimum wage level throughout the overall wage distribution, without changing the distribution of other (observable) characteristics. Our identification strategy uses a change in the French labor market regulation that occurred in the period 2003-2005. During this period, several levels of the minimum wage coexisted and evolved at different exogenous rates. Our results suggest significant, though small, effects of the changes in the minimum wage level that occurred at this period, up to the seventh decile for full-time employees on stable position.[1]

The minimum wage is one of the main state interventions in the labor market. Many developed countries have adopted a minimum wage. Its original aim is to guarantee low skilled workers a "decent" standard of living, but it is also considered as a redistributive tool.[2] The minimum wage could also have intended or unintended consequences on the labor market. For decades, economists have questioned its – still controversial – detrimental impact on employment. More recently, some emphasis has been placed on its potential impact on the reduction of earnings inequalities. Di Nardo, Fortin, and Lemieux (1996) and Lee (1999) for instance conclude that part of the rise in wage inequality observed in the US during the 1980s is due to a decline, in real terms, of the minimum wage level.

The minimum wage could have an impact on the overall earnings distribution through two channels. First it can have a negative impact on employment that could lead to a change in the composition and the size of the labor force, and this could affect the observed earnings distribution. Second, even in the absence of employment effect, an increase in the minimum wage level should shift the bottom of the earnings distribution. Beyond this *mechanical* effect, the wages of workers who earned more than the new minimum wage could also rise as if they benefited from a *global* increase at the bottom of the wage distribution (Katz and Krueger, 1992; Teulings, 2000, 2003). Indeed, firms can be willing to maintain an upward compensation scheme as a way to stimulate the efforts of the employees. In line with

[1] In the whole study, thresholds of the deciles will be denoted "deciles" by abuse of language: here, decile i is the wage such that $10 * i\%$ of employees earn less and $(100 - 10 * i)\%$ earn more.

[2] The French law states that the minimum wage should *"ensure that employees with the lowest wages, have a guaranteed purchasing power, and participate in the Nation's economic development"*.

the tournament model proposed by Lazear and Rosen (1981) and Rosen (1986), Chen and Shum (2010) find that a large part of intra-firm wage differentials could be interpreted as an incentive tool. This intuition is also supported by evidence on experimental data. According to Falk, Fehr, and Zehnder (2006), the minimum wage could modify the agents' perception of the "fair" level of remuneration (consistent with Akerlof and Yellen, 1988). It would therefore have a substantial impact on the employees' reservation wage. This could explain the presence of significant wage increases, even beyond the level imposed by the minimum wage.

On empirical grounds, the identification of these spillover effects is a complicated empirical issue. When the minimum wage is the same for all employees (as it is the case in France), it is generally impossible to distinguish what pertains to its specific increase or to any wage trend or other cyclical effect. Identification can be achieved by spatial or sectoral variations: for the US, Lee (1999) uses state variation in the minimum wage levels and finds that the decrease, in real terms, of the minimum wage, is the main determinant of the growth in inequality in the lower tail of the distribution. Similarly, Dickens, Machin, and Manning (1999) use the coexistence of several sectoral minimum wages in the United Kingdom (until 1993), and find effects of the minimum wage up to the 40th percentile. Teulings (2000, 2003) finds that increases in the minimum wage significantly spread to higher wages in the Netherlands. However, Dickens and Manning (2004) believe that *spreading* effects were probably modest in the United Kingdom in 1999 when a national minimum wage was reintroduced. As far as we know, French studies on the impact of the minimum wage on higher wages are scarce.[3]

For France, the identification issue is complicated by the fact that the legal increase in the minimum wage is yearly adjusted according to the past trend in mean wages (it is indexed to the *blue-collar worker's basic hourly pay*). This makes it highly endogenous. During the period 2003-2005, however, this rule was frozen in order to harmonize the different levels of minimum wages resulting from the gradual implementation of the French Law on workweek reduction between 1998 and 2003. Monthly Guaranteed Wages (GMR) were designed to maintain the monthly wage of the lowest paid employees despite the lower number of hours worked at the time of the switch to the 35-hour week. Each year, during five years, a new GMR was created for the firms that signed an agreement that year. After five years, it had indeed resulted in the coexistence of six levels of the minimum wage in 2003. A convergence mechanism had been designed to put an end to

[3]The only (in French) contributions are from Koubi and Lhommeau (2007) and Goarant and Muller (2011). They both conclude that increases in the minimum wage have a significant impact up to wages as high as twice the minimum wage.

this situation, that resulted in the application of different discretionary increases to the different GMR between 2003 and 2005. This situation provides a natural experiment for an evaluation of the impact of the minimum wage on the wage distribution, as the pace of increase in the level of the minimum wage applying in one or other firm can be considered as exogenous. The identification will rely on the fact that the increase was quite large in firms that did not sign a reduction agreement before 2002, while it was more modest in other firms.

Besides, modeling the overall distribution of earnings requires to use specific tools. In particular, one wants to control for the characteristics of the labor force. Indeed, as an increase in the minimum wage could have an impact on the employment level, it can distort the overall wage distribution of actually employed individuals. It would thus be difficult to separate what stems from this labor force composition effect from a real spillover effect.[4]

A first stream of literature uses parametric specifications (see for instance Teulings, 2000; Meyer and Wise, 1983), but these specifications could be sensitive to the functional form assumed for the distribution of wages (see for instance Dickens, Machin, and Manning, 1998, on a related topic). Over the last decade, many empirical tools have been proposed for a more detailed analysis of the entire wage distribution. Quantile regressions is one of them. It classically deals with the quantiles of the distribution of the variable of interest Y conditional on observable characteristics X (see Koenker and Hallock, 2001). In the same way as linear regressions approximate the conditional expectation of the variable of interest as a linear function of observables, it models the conditional quantile of the variable of interest as a linear function of observables. As both methods deal with conditional quantities, they do not inform directly on the impact of a change in the distribution of observables, from F_X to G_X, on their unconditional counterpart (meaning the expectation or quantile of our variable of interest on the whole population). Firpo, Fortin, and Lemieux (2009) propose a more direct method to deal with unconditional quantities. It relies on the influence functions, and requires only local inversion of the distribution. We use this method in this paper. This allows to disentangle as much as possible the spillover effects from changes in the composition of the labor force resulting from the exclusion of low-productivity workers. We focus on the impact of the minimum wage on the various deciles of the distribution of annual earnings of workers in the private sector, using administrative

[4] As noted by Lee (1999), this could create a mechanical change in the observed distribution. If we denote by F_1 (resp. F_0) the earnings distribution with a minimum wage of $\underline{w}_1$ (resp. $\underline{w}_0$), we would get $F_1(w) = \frac{F_0(w)-F_0(\underline{w}_1)}{1-F_0(\underline{w}_1)}$ for $w > \underline{w}_1$ (zero otherwise). A first-order development gives the expression of the τ^{th} quantile of distribution F_1 related to its counterpart for distribution F_0 as: $q_{1\tau} = q_{0\tau} + (1-\tau)\frac{F_0(\underline{w}_1)}{f_0(q_{0\tau})}$.

business data (the DADS) that provide exhaustive records on yearly earnings of French workers in the private sector. We perform separate analysis for men and women to account for different wage settings according to gender.

Section 2 presents the revaluation mechanisms of the minimum wage with a specific focus on the *convergence* period of the different levels of the minimum wage. The identification strategy and the statistical method are detailed in section 3, then section 4 presents the data along with some descriptive statistics ; finally section 5 gives the results.

2 French labor market institutional setting: Minimum wage and workweek reduction

The French minimum wage ("SMIC") was introduced in 1970. Its hourly value is set by the French government for all French employees.[5] It amounts to 9€ per hour in 2011. The minimum wage is updated every year, according to a strict rule. By law, the minimum wage increase cannot be smaller than the inflation rate observed the current year. It even exceeds it, as the annual increase in the purchasing power of the minimum wage corresponds at least to half the annual increase in the *purchasing power of blue-collar worker's basic hourly pay (SHBO hereafter)*.[6] Besides, the French government can add to this strict rule an additional increase ("coup de pouce" or boost).

The nominal rate of the minimum hourly wage can be written:

$$SMIC_t = SMIC_{t-1}\left(p_t/p_{t-1} + \frac{1}{2}\delta_{SHBO_t} + cdp_t\right)$$

where δ_{SHBO_t} corresponds to the growth rate in the purchasing power of blue-collar workers' basic hourly pay and cdp_t represents the discretionary increase beyond the automatic revaluation rule (*boost*). For instance, the SMIC received a *boost* of 0.45 % on July 1, 1998, of 0.29 % on July 1, 2001 and of 0.30 % on July 1, 2006.

The gradual implementation of the new regulations on workweek reduction changed this situation. The 35-hour workweek was enacted in France by the so-called "Aubry Laws" (named after Martine Aubry, Minister of Labor), from a

[5] Rare exemptions concern for instance the catering sector because of the existence of fringe benefits as meals.

[6] A discussion of the consequences of this mechanism can be found in Cette and Wasmer (2010).

previous 39-hour workweek. All firms had to decrease the normal workweek time to 35 hours before January 1, 2000 (January 1, 2002 for the smallest ones) and to pay hours over 35 on an overtime basis. Incentives were provided to firms that negotiated an agreement before this binding limit, and the field implementation of the workweek reduction was thus gradual. Maintaining the hourly wage flat would have created a sharp drop in the monthly remuneration of workers. In order to avoid the loss of income for lowest-wage employees, the law imposed a new regulation for minimal wages. In firms that adopted the 35-hour workweek, a "monthly guaranteed wage" (hereafter GMR) was created. This GMR guaranteed that the monthly minimal remuneration would not be affected by the workweek reduction. In practice, it thus corresponded to a new legal hourly minimum wage for the firms that had signed a workweek reduction agreement. This was made possible by a generous cut in payroll taxes, in order to avoid a detrimental impact on employment.

However, if they guaranteed a maintained monthly remuneration at the time of the switch to the 35-hour week, the GMR did not then follow exactly the same updating rules as the legal hourly minimum wage (that still applied to all firms that had not signed any workweek reduction agreement yet). While the former was updated according to changes in the blue-collar worker's basic *hourly* pay (SHBO), the latter followed the changes in the blue-collar worker's basic *monthly* pay (SMBO). This slight difference had unintended consequences. The monthly wage evolved slower than the hourly wage over the period: most workweek reduction agreements ensured the maintenance of a monthly salary, which mechanically translated into an increase in the hourly wage. From one year to another the GMR thus benefited from lower updates than the hourly minimum wage. For firms negotiating workweek reductions later, the new minimum monthly wage, which would ensure no salary loss, was thus higher than the updated GMR of the previous year (see Appendix A for the precise creation calendar of the different GMR and Koubi and Lhommeau, 2007 for an illustration).

In 2003, the newly elected government put into place an adjustment mechanism in order to retrieve a unique level of minimum wage. From 2003 to 2005, the traditional revaluation rule of the minimum wage was frozen. While the highest hourly minimum wage rate (that applied to firms that had signed a workweek reduction agreement between July and December 2002) simply evolved as the inflation, the other hourly minimum wage levels received differential *boosts* so as to converge in 2005 to a unique hourly rate. The more they initially diverged the higher the *boosts* were during this period (see Table 1). Again, the impact on the labor cost was softened by substantial payroll tax exemptions.

Table 1: Level and evolution of real annual GMR (2002-2005)

	FGMR0	FGMR1	FGMR2	FGMR3	FGMR4	FGMR5
Level of the GMR in real terms (2007 euros)						
2002	13,612	14,463	14,643	14,894	15,078	15,167
2003	14,041	14,629	14,750	14,918	15,041	15,100
2004	14,543	14,849	14,911	14,995	15,058	15,087
2005	15,068	15,068	15,068	15,068	15,068	15,068
Evolution of the GMR in real terms (%)						
2003	3.2	1.1	0.7	0.2	-0.2	-0.4
2004	3.6	1.5	1.1	0.5	0.1	-0.1
2005	3.7	1.5	1.1	0.5	0.1	-0.1

Source: Calculation of the authors
Note: The annual remuneration corresponds to 35h/week i.e. 1820h/year.

3 Econometric Method

Our aim is to estimate the potential spillover effect of an increase in the minimum wage level over the whole distribution of earnings. Our underlying setting states that the individual wage is determined by characteristics of the employee (age, gender, qualification...) and of the firm (business sector, size...), but also partly by the minimum wage applying in this firm. This could be the case if the firm tries to maintain a certain wage hierarchy, for instance as an incentive for its employees (consistent with the wage setting in a tournament model). Very generally, we assume the following relation between wages and characteristics:

$$w_i = \phi(\underline{w}, X_i, \varepsilon_i) \tag{1}$$

where $\underline{w}$ stands for the minimum wage level, X_i for observed characteristics of the firms or the employees, and ε_i for potential unobserved characteristics (for instance productivity). Our empirical question is how the earnings distribution changes with an increase in the minimum wage level, keeping everything else equal.

3.1 Identification

The identification issue primarily comes from the fact that, in general, the minimum wage is the same for all employees. It is thus impossible to distinguish what pertains to the increase in the minimum wage from what pertains to any trend. In addition, the updating rule of the minimum wage according to the basic wage

of a worker is a natural source of endogeneity (this topic is developed for example in Cette, Chouard, and Verdugo, 2012). Indeed, unobserved components such as productivity are likely to be autocorrelated and may thus induce an omitted variable bias : they will indeed be positively correlated not only to current wages but also to past wages, which are themselves positively correlated to the minimum wage through its revaluation rule. The evaluation strategy has to take this source of endogeneity into account.

In this context, the convergence period of the different levels of the minimum wage provides an interesting natural experiment because it is characterized by the coexistence of several levels of the minimum wage with different paces of convergence over the period.

This peculiar situation creates a unique setting where we observe, during a short period of time, different legal minimum wage levels. Besides, these minimum wages exogenously increased at different paces for a three-year period. We will use this specific period for the identification of the impact of the minimum wage on earnings. More specifically, the identification relies on the fact that we observe a steady increase of the minimum wage level in firms that did not sign a reduction agreement before 2002, while this increase was more modest in other firms. The negotiation date of workweek reduction agreements is probably related to the firm's anticipated wage policy. But the convergence period, which serves our identification purposes, was imposed a few years after for most of the firms and without having been anticipated. Therefore it seems plausible to consider this as a source of exogenous variation in the levels of the minimum wage. More specifically, we assume that:

$$\underline{w_{it}} \perp\!\!\!\perp \varepsilon_{ijt} | X_{ijt}, e_t, e_{FGMRj} \tag{2}$$

where e_t represents temporal dummies, e_{FGMRj} dummies for being in a firm where the minimum wage level corresponds to GMR level j, X_{ijt} are observable characteristics of the employee and the firm (age, socio-economic position, seniority, industry, size of the firm).

3.2 Estimation

Since the effects are very likely to differ depending on the position in the wage hierarchy, the goal is to go beyond the average effects to study the impact on the overall distribution. In recent years, new methods to evaluate counterfactual distributions have emerged (a detailed presentation can be found in Fortin, Lemieux, and Firpo, 2010).

The method, which is used here, is the so called *unconditional* quantile regression proposed by Firpo, Fortin, and Lemieux (2009). The distinction with the *conditional* quantile regression has to be highlighted, and the comparison with the case of a standard regression proves useful here. Linear regressions, in the usual sense, deal with the expected value of a variable of interest W conditional on determinants X. One usually assumes:

$$E(W|X) = \beta X$$

Thanks to the law of iterated expectations, one can easily derive from this formulation the impact of a change in the distribution of one covariate (from F_X to G_X) on the (unconditional) expected value of the dependent variable W. Assume for instance that the expectation of X in the former case is $E(X) = \mu_X^F$ while it is μ_X^G in the latter, then $\Delta E(W) = \beta(\mu_X^G - \mu_X^F)$.

Quantile regressions usually rely on the same type of local linear assumption,

$$q_\tau(W|X) = \beta_\tau X$$

However, since quantiles do not have such convenient linear property, it appears much less direct to infer the consequence of a change in the distribution of one covariate X on the quantile of the overall (unconditional) distribution of W. For instance, one can invert the conditional quantiles, integrate the obtained conditional distribution $F_{W|X}$ over both distributions F_X and G_X and finally invert this unconditional distribution to compare unconditional quantiles of W corresponding to both F_X and G_X (see for instance Mata and Machado, 2005).

The estimator of Firpo, Fortin, and Lemieux (2009) allows for a more direct measure of how a marginal change in the level of one variable (in our case, the minimum wage) will affect the distribution of wages in the population, keeping the distribution of other characteristics equal. More specifically, it provides a measure of the impact of a small location shift in the distribution of covariates X, from F_X to G_X, on some distributional statistic of a variable W, maintaining the conditional distribution of W given X unaffected. Firpo, Fortin, and Lemieux (2009) prove that this impact depends on the integration of the so-called recentered influence function over the difference of distributions G_X to F_X (details are provided in Appendix C). They call this notion "unconditional partial effect."

To be more specific, for a parameter or characteristic $\nu(F_W)$ of the distribution of wages W (*e.g.* a quantile), let us define the influence function of observation w (with distribution F_W) regarding statistic ν :

$$IF(w; \nu, F_W) = \left.\frac{\partial \nu(F_{W,t\Delta_w})}{\partial t}\right|_{t=0} = a(w) \tag{3}$$

where Δ_w is the distribution that assigns probability 1 to point w and $F_{W,t\Delta_w}$ is the mixing distribution $F_{W,t\Delta_w} = (1-t)F_W + t\Delta_w$ (more details are provided in the appendix).

$IF(w_i;\nu,F_W)$ provides a measure of how ν changes when the distribution slightly changes towards the value w_i taken by the variable of interest. It can also be interpreted as the influence of an observation i on the empirical estimation of the distribution parameter $\nu(F_W)$. The recentered influence function (RIF) is defined as $RIF(w_i;\nu,F_W) = \nu(F_W) + IF(w_i;\nu,F_W)$.

Under some assumptions, the vector α of partial derivatives representing the change in the distributional statistic ν of W with respect to a small location shift in the distribution of the covariates X is such that:

$$\alpha(\nu) = \int \frac{dE(RIF(W,\nu)|X=x)}{dx} dF(x) \tag{4}$$

In the case of a τth order quantile, the RIF is notably simple, as:

$$E(RIF(W,q_\tau)|X=x) = q_\tau + \tau F_W'^{-1}(\tau) + F_W'^{-1}(\tau)P(W > q_\tau|X=x). \tag{5}$$

q_τ and $F_W'^{-1}(\tau)$ are constant and independent of X and can be easily estimated. While the former is standard, the latter can for instance be approximated by an infinitesimal change around the quantile $\frac{F^{-1}(\tau+h)-F^{-1}(\tau-h)}{2h}$, with h small. An expression of the optimal window can be found in Koenker (2005) and verifies (under certain conditions): $h_n = n^{-1/5}\left(\frac{4.5\phi^4(\Phi^{-1}(t))}{(2\Phi^{-1}(t)^2+1)^2}\right)^{1/5}$ where ϕ and Φ^{-1} respectively represent the pdf and the inverse of the cdf of the normal distribution and n is the sample size.[7] We note $c_{1,\tau} = F'^{-1}(\tau)$ and $c_{2,\tau} = q_\tau + \tau F'^{-1}(\tau)$.

We focus here on changes in the deciles dec_j, $j \in [1,9]$:

$$RIF(y_i;dec_j,F_Y) = c_{1,dec_j}P(y_i > dec_j|X=x) + c_{2,dec_j} \tag{6}$$

Once the dependence of $P(Y > q_\tau|X=x)$ in x is specified, the impact on $\nu(F_W)$ of a modification in X is obtained by differentiation of $P(W > q_\tau|X=x)$ with respect to X and integration over the distribution of X.

In practice, we use the method designed as RIF-Logit in Firpo, Fortin, and Lemieux (2009), that uses a logit specification for $P(W > q_\tau|X=x)$. We thus apply a two-step procedure that consists in:

[7] An alternative solution, proposed in Firpo, Fortin, and Lemieux (2009) comes from the fact that $F'^{-1}(q_\tau) = 1/f_W(q_\tau)$, which is the inverse of the pdf estimated at $F^{-1}(\tau) = q_\tau$. This density can be estimated by a kernel method, but this procedure is more computer intensive.

1. Estimating the probabilities $\hat{T}_{idec_j}$ from the Logit specifications for $P(W > dec_j|X = x)$;

2. Estimating the average impact of one covariate X_k on the decile j as:

$$\hat{\alpha} = \hat{c}_{1dec_j}\hat{\beta}^k_{dec_j}\frac{1}{N}\sum_i \hat{T}_{idec_j}(1 - \hat{T}_{idec_j})$$

where $\hat{\beta}^k_{dec_j}$ is given by first step estimation.

Proofs of the convergence of this estimator can be found in Firpo, Fortin, and Lemieux (2009). Confidence intervals are obtained by bootstrap.

The estimated coefficients of the model can then be interpreted directly in terms of effects of each variable on the overall quantile. If $w_i = \phi(\underline{w}, X_i, \varepsilon_i)$, it can be shown under an assumption of independence (2) and provided that h is monotonic in ε that the vector of partial impact of a marginal change in the minimum wage for a quantile q_τ (the parameter $\alpha(q_\tau)$ defined above), which Firpo, Fortin, and Lemieux (2009) call the "unconditional quantile partial effect" (UQPE), corresponds to the integration over the distribution of covariates of a weighted partial derivative of h with respect to $\underline{w}$:[8]

$$\alpha_{\underline{w}}(q_\tau) = E_{\underline{W},X_1}\left[\omega_\tau(\underline{w}, x_1)\frac{\partial h(\underline{w}, x_1, \varepsilon)}{\partial \underline{w}}\right] \tag{7}$$

with $\omega_\tau(\underline{w}, x_1) = \frac{f_{W|\underline{W},X_1}(q_\tau,\underline{w},x_1)}{f_W(q_\tau)}$.

4 Description of the sample and evidence in favor of our identification strategy

4.1 The DADS panel

We use the DADS panel (1/25th sample) over the period 2003-2005. This administrative business database starts in 1976 and provides data on gross earnings for all workers in the private sector.[9] We restrict the sample to full-time employees aged 18 to 65, having worked all year in the same firm. This last choice is explained firstly by that of the variable of interest. Indeed, the number of hours worked is

[8] An adaptation to our case, of the proof given in Firpo, Fortin, and Lemieux, 2009, is provided in Appendix C.

[9] We limit the sample to companies and exclude self-employed persons.

available in the DADS as of 1994 but the quality of this variable is sometimes questionable. The reconstruction of an hourly wage would thus be difficult. To reduce these measurement problems, we choose to estimate the distribution of gross annual earnings (expressed in euros of 2007). For these annual amounts to be comparable, the sample is restricted to full-time employees who worked full year.

In the end, we have a panel of over 157,000 firms (among which about 77,000 were present all along between 2003 and 2005) and around 425,000 employees.

4.2 Characteristics of the firms and wage evolution according to the GMR group

As detailed in Section 2, because of the successive workweek reduction agreements, six levels of GMR coexisted between July 2002 and July 2005. Beside the five GMR, the hourly minimum wage (which by abuse of language will be denoted by GMR 0) applied in firms which did not sign any workweek reduction agreement. More than half of the firms were in that case, but these were mainly small firms, so that the hourly minimum wage concerned only a third of all employees (Table 2). Very few firms signed workweek reduction agreements after mid 2002, as evidenced by the low number of employees belonging to FGMR 5 in our sample.

Table 2: Number of firms and employees for each GMR group in 2003

	FGMR0	FGMR1	FGMR2	FGMR3	FGMR4	FGMR5	Total
Firms							
Number	69,490	2,954	15,414	9,598	15,432	1,563	114,451
Share (%)	60.7	2.6	13.5	8.4	13.5	1.4	100
Employees							
Number	111,422	17,481	96,575	45,387	25,569	3,054	299,488
Share (%)	37.2	5.8	32.2	15.2	8.5	1.0	100

Source: DADS panel, 1/25th sample.
Field: employees from firms of the private sector aged 18 to 65, working full-time, full-year, excluding interns and apprentices.

It is worth emphasizing that most wage earners are employed in firms that did not sign a workweek reduction agreement (FGMR0) or in firms that signed one early (FGMR2).

The signing date of a workweek reduction agreement is obviously not exogenous: in fact, the law was more restrictive for larger firms, which explains why they are overrepresented among those who contracted an agreement soon. Thus, while more

than three-quarters of the firms with less than 10 employees (and 63% of the firms with 10 to 49 employees) had not signed an agreement in June 2002 (FGMR 0 and 5), it was the case for only 16% of the firms with more than 500 employees. In addition, 60% of the firms with more than 500 employees had signed an agreement before June 30, 2000 (FGMR 1 or 2) and 80% before June 30, 2001 (FGMR 1, 2 or 3), while for firms with 50 to 499 employees, the respective proportions are 41% and 58%. Ultimately, in our sample, nearly 56% of the firms belonging to FGMR 1 and 2 employ more than 50 employees while this is the case for only 11% of the firms from FGMR 4 and 5 (Table 3). In terms of industry, in accordance to what is observed with the size, manufacturing industry is over-represented in FGMR 1, 2 and 3 while construction, agriculture and trade belong more often to FGMR 0 (no agreement signed) or FGMR 4 and 5 (late signing date).

Table 3: Characteristics of firms in each GMR group (2003 to 2005)

	FGMR0	FGMR1	FGMR2	FGMR3	FGMR4	FGMR5	Total
Number of employees (in %)							
less than 10	42.5	7.0	4.0	10.8	39.1	41.8	33.3
10 to 49	46.1	38.7	39.1	43.8	50.6	41.3	45.3
50 to 499	11.0	47.4	49.5	40.6	9.6	15.5	19.5
500 to 4999	0.5	6.6	7.0	4.6	0.7	1.3	1.9
over 5000	0.0	0.3	0.4	0.2	0.0	0.0	0.1
Gender							
Share of women	31.1	29.0	33.9	32.6	31.7	31.1	32.9
Industry							
Agriculture	2.2	1.5	1.2	0.6	1.6	2.3	1.8
Manufacturing industry	20.2	36.5	34.0	35.6	24.2	21.4	24.3
Construction	16.4	9.4	8.1	8.3	14.1	12.1	14.0
Trade	25.5	21.5	21.5	26.3	24.6	27.4	24.8
Services	35.8	31.1	35.3	29.1	35.6	36.7	35.0

Source: DADS panel, 1/25th sample.
Field: employees from firms of the private sector aged 18 to 65, working full-time, full-year, excluding interns and apprentices.

The median annual gross wages vary strongly from one GMR group to another (see Figure 1). These differences can also be partly explained by size and industry effects, as well as by differences in total amount of worked hours. In 2005 the effective workweek in firms which had signed an agreement was close to 35 hours (around 1,820 yearly hours, see Figure 2). It is slightly higher in firms that never signed any agreement before the 2002 deadline (FGMR 0): the yearly amount is around 1,900 hours per year in 2005, that corresponds to 36 hours per week (above

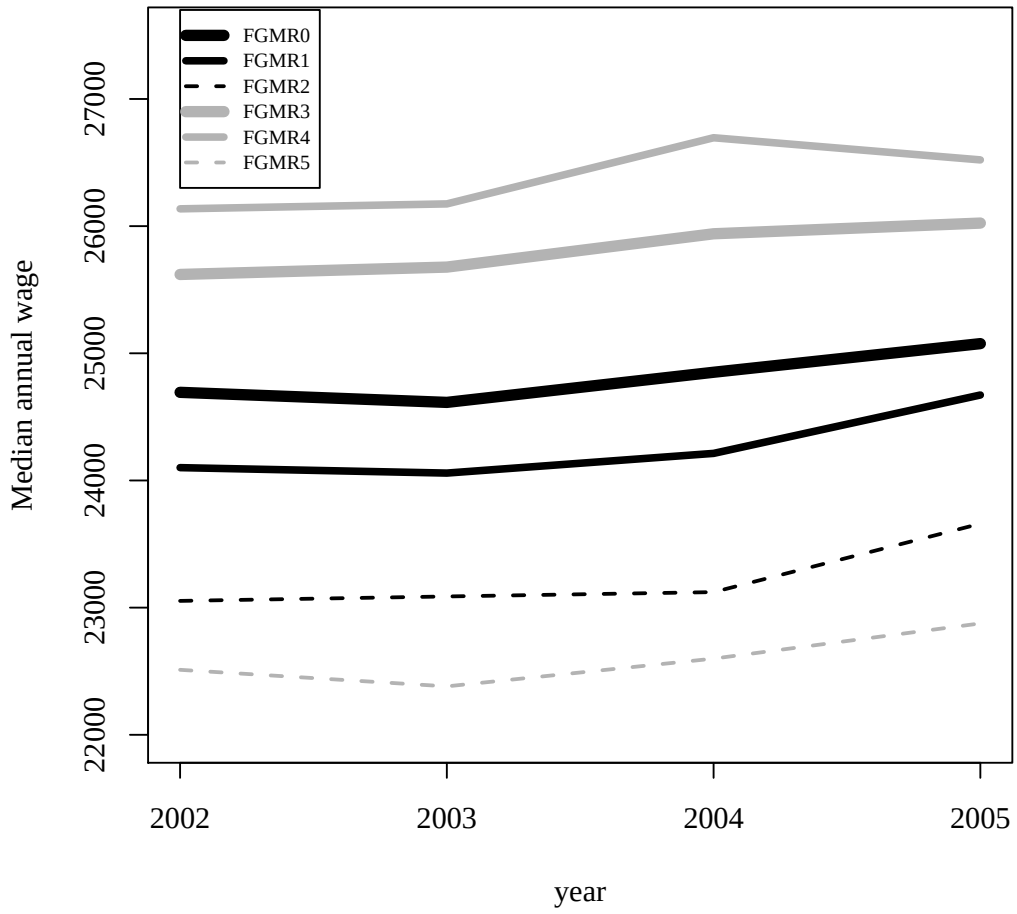


Figure 1: Median wages in each GMR group (2002-2005)
Source: DADS panel, 1/25th sample.
Note: Wages are in euros of 2007.
Field: employees from firms of the private sector aged 18 to 65, working full-time, full-year, excluding interns and apprentices.

this level, additional hours have to be paid at a higher rate).
Besides, workweek reduction had an impact on effective workweek in firms that signed an agreement between 1997 and 2002, but it appears stable over our estimation period (2003-2005).

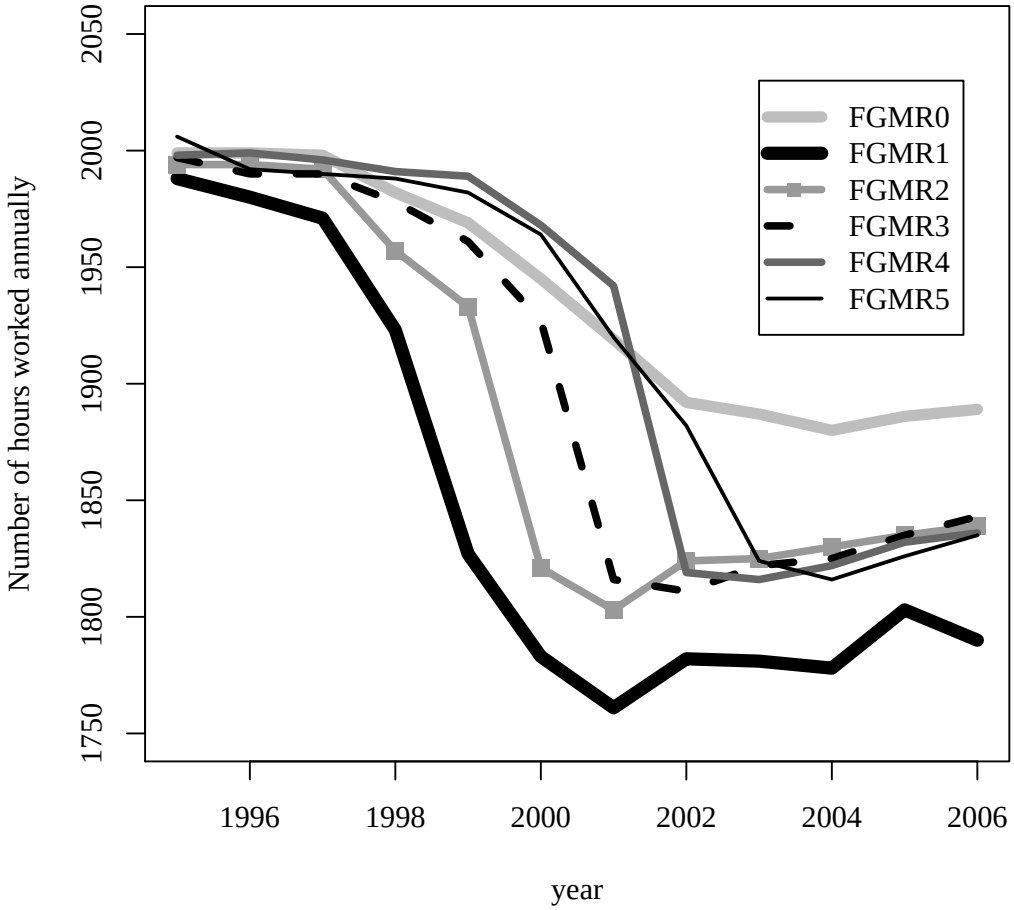


Figure 2: Mean hours worked according to the GMR level (1995-2006)
Source: DADS panel, 1/25th sample.
Field: employees from firms of the private sector aged 18 to 65, working full-time, full-year, excluding interns and apprentices.

4.3 Employment effects according to the GMR

We do not observe any clear trend in the employment level in firms depending on the pace of increase in the minimum wage level they experiment, nor in the proportion of employees who are not employed in the same firm or the proportion of hirings in these firms (see Table 4). While the increase in the minimum wage applying in FGMRi is all the more important that the index i is smaller, one could thus expect to observe less hirings and/or more layoffs in firms belonging to FGMR0 than in firms belonging to FGMR5. On the contrary, no clear correlation can be observed between the ratio of the number of workers disappearing between periods $t-1$ and t over the number of workers in period $t-1$ and the increase in the minimum wage level. The layoff rate is very homogeneous around 24% in almost all groups in 2003 and no such pattern emerges. The pattern of the number of workers appearing between periods t and $t-1$ over the number of workers in period $t-1$ is noisier, but there is no monotonic relation either with respect to the GMR level.

Table 4: Creation and destruction rate according to the GMR level (2002-2005)

Year	FGMR 0	FGMR 1	FGMR 2	FGMR 3	FGMR 4	FGMR 5	Total
(Workers in firms at $t-1$ and not t)/ (workers in firms at $t-1$) (in %)							
2003	25.2	25.4	24.5	22.0	23.7	29.0	24.4
2004	22.4	20.7	17.5	17.2	20.9	23.8	19.9
2005	22.8	25.3	19.2	19.2	23.1	23.5	21.4
(Workers in firms at t and not $t-1$)/ (workers in firms at $t-1$) (in %)							
2003	22.4	19.7	17.1	15.3	22.1	37.7	19.6
2004	26.5	25.2	21.6	18.8	22.4	34.7	23.5
2005	29.6	24.0	21.6	19.9	23.0	27.3	24.8

Source: DADS panel, 1/25th sample.
Field: employees from firms of the private sector aged 18 to 65, working full-time, full-year, excluding interns and apprentices.

5 Results

5.1 Unconditional quantile partial effect of the minimum wage

As earnings distribution and wage negotiation could differ for male and female workers, we perform separate analyses. We focus on the deciles of log yearly wages. Several variables are added to take into account possible composition effects: besides the characteristics of the employees (age, socio-economic position, seniority) and the firms (size, industry), we introduce fixed effects for the different groups of GMR to capture systematic differences of wage policies in the different firms, as well as year fixed effects. The impact of the minimum wage is therefore identified by the fact that we use several time periods, and that the levels of the different groups of GMR evolved at different rates. Otherwise, it would be difficult to separate the effect of the different levels of the minimum wage from what comes from the different wage policies in the different groups of firms. It is worth emphasizing that most of the identification relies on the fact that the minimum wage steadily increased in some specific firms (the "FGMR0") by contrast with other firms, where much smaller increases in the minimum wage level applied.

We use the minimum wage level lagged by one year. Indeed, until 2010 the annual update of the legal minimum wage rate took place in July,[10] while wage negotiations usually take place at the end of the calendar year. Avouyi-Dovi, Fougère, and Gautier (2010) indeed observe that collective wage bargaining agreements usually take place at the end of the year and apply in the first months of the following year. We can see an example of this in Koubi and Lhommeau (2007) and more recently in Goarant and Muller (2011) : the analysis of quarterly effects shows a large peak of wage growth in the first quarter. With our annual data, it is thus more appropriate to use the level of the minimum wage in July of the previous year rather than the contemporary level. As we measure yearly earnings, that means that the level of minimum wage we use for the estimation was the actual legal reference only for the first half of the year in question. This means that at the very bottom of the distribution (for workers whose earnings correspond to the minimum wage level), the estimated coefficient could be undervalued (by a factor 2). We come back to this point later. For the rest of the distribution however, because of the usual timing of wage bargaining in French firms, it appears more relevant.

For the sake of simplicity, we present detailed results for men only, on the whole

[10] Except if the inflation rate was above 2%, but that did not happen during the studied period.

sample (Tables 5 and 6). Recall that our results measure the impact of a marginal change in the distribution of observable characteristics on each decile.

The minimum wage has a significant impact on the distribution of men's and women's log-wages up to the seventh decile (see Figure 3). A one percent increase in the minimum wage level in July of year $t-1$ has an effect on the deciles of the distribution of the annual earnings of year t always below 0.2%. For the sake of comparison, note that the first decile (respectively seventh decile) corresponds roughly to 1.2 times (resp. 2 times) the average minimum wages at this time (see Table 8 in Appendix B). The first decile is thus clearly higher than the minimum wage: while one expects a mechanical increase of earnings for employees at the level of the minimum wage of at least one half (as the minimum wage level of the previous year applied for half of the year only) at the bottom of the distribution,[11] our results suggest that the impact fades rapidly. Another reason for this smaller impact at the bottom of the distribution can be due to the fact that, in our sample, a not so negligible part of the earnings are below the minimum wage (around 2% for the male employees, 5% for the female employees). This is partly explained by the nature of the earnings available in our data, that do not exactly correspond to the legal definition used for the application of the minimum wage regulation. First, the minimum wage applies on an hourly basis, while we use yearly earnings. As we exclude part-time employees from the sample, this should be innocuous, but hours are measured with noise in our data and we may thus keep a few part-timers whose reported hours were mistakenly overestimated by the employer. Besides, a few benefits other than the sole earnings declared in these administrative data enter the legal definition of the minimum wage (see Appendix B for details), and it is thus possible that some of the reported earnings fall below the minimum rate. Finally, one cannot rule out that earnings are measured with noise. For all these reasons, we perform a robustness check excluding earnings below the minimum wage (see below).

[11] With a different methodology Goarant and Muller (2011) and Koubi and Lhommeau (2007) obtain that a 1% increase in the minimum wage results in an increase of 0.4% in wages ranging from 1 to 1.1 times the minimum wage level.

Table 5: RIF-Logit estimation for deciles (Men, 2003-2005)

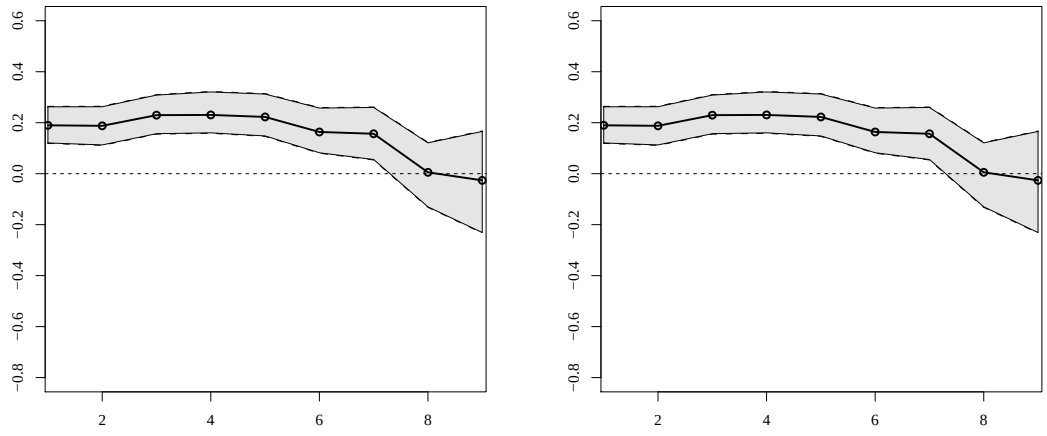
	1st decile	2nd decile	3rd decile	4th decile
Minimum wage (log)	$1.90e-01^{***}$	$1.88e-01^{***}$	$2.30e-01^{***}$	$2.31e-01^{***}$
	$(3.60e-02)$	$(3.73e-02)$	$(3.95e-02)$	$(3.96e-02)$
Age	$2.19e-02^{***}$	$2.51e-02^{***}$	$2.81e-02^{***}$	$3.08e-02^{***}$
	$(3.55e-04)$	$(3.33e-04)$	$(3.43e-04)$	$(3.90e-04)$
Age^2	$-2.46e-04^{***}$	$-2.71e-04^{***}$	$-2.94e-04^{***}$	$-3.16e-04^{***}$
	$(4.44e-06)$	$(4.04e-06)$	$(4.14e-06)$	$(4.56e-06)$
Year Dummy				
2002	*ref.*	*ref.*	*ref.*	*ref.*
2003	$-1.86e-02^{***}$	$-1.39e-02^{***}$	$-1.16e-02^{***}$	$-8.78e-03^{***}$
	$(1.84e-03)$	$(1.74e-03)$	$(1.85e-03)$	$(1.83e-03)$
2004	$-1.29e-02^{***}$	$-9.50e-03^{***}$	$-7.64e-03^{***}$	$-6.66e-03^{***}$
	$(1.35e-03)$	$(1.27e-03)$	$(1.34e-03)$	$(1.28e-03)$
Socio-economic position				
CEO	$2.07e-01^{***}$	$2.99e-01^{***}$	$3.90e-01^{***}$	$4.41e-01^{***}$
	$(7.41e-03)$	$(7.09e-03)$	$(6.97e-03)$	$(5.86e-03)$
Professionals, managers	$4.67e-01^{***}$	$5.78e-01^{***}$	$6.72e-01^{***}$	$7.06e-01^{***}$
	$(7.70e-03)$	$(6.25e-03)$	$(5.44e-03)$	$(4.88e-03)$
Technicians and associate professionals	$1.99e-01^{***}$	$2.50e-01^{***}$	$2.88e-01^{***}$	$3.02e-01^{***}$
	$(2.32e-03)$	$(2.03e-03)$	$(1.73e-03)$	$(1.55e-03)$
Office clerks and service workers	$-3.93e-02^{***}$	$-3.92e-02^{***}$	$-2.62e-02^{***}$	$-2.25e-03$
	$(1.29e-03)$	$(1.34e-03)$	$(1.42e-03)$	$(1.61e-03)$
Skilled and unskilled workers	*ref.*	*ref.*	*ref.*	*ref.*
Industry				
Agriculture	$-5.16e-02^{***}$	$-6.00e-02^{***}$	$-6.93e-02^{***}$	$-6.04e-02^{***}$
	$(3.26e-03)$	$(3.47e-03)$	$(4.04e-03)$	$(4.17e-03)$
Manufacturing industry	$3.97e-02^{***}$	$3.68e-02^{***}$	$4.02e-02^{***}$	$4.66e-02^{***}$
	$(1.34e-03)$	$(1.22e-03)$	$(1.26e-03)$	$(1.23e-03)$
Construction	$1.78e-04$	$-4.71e-03^{***}$	$-9.64e-03^{***}$	$-9.93e-03^{***}$
	$(1.46e-03)$	$(1.46e-03)$	$(1.48e-03)$	$(1.52e-03)$
Trade	$-2.71e-02^{***}$	$-4.67e-02^{***}$	$-6.12e-02^{***}$	$-6.21e-02^{***}$
	$(1.33e-03)$	$(1.31e-03)$	$(1.35e-03)$	$(1.31e-03)$
Services	*ref.*	*ref.*	*ref.*	*ref.*
GMR group				
GMR 0	*ref.*	*ref.*	*ref.*	*ref.*
GMR 1	$-1.47e-02^{***}$	$-1.59e-02^{***}$	$-1.31e-02^{***}$	$-8.47e-03^{**}$
	$(2.96e-03)$	$(3.03e-03)$	$(3.10e-03)$	$(3.04e-03)$
GMR 2	$1.02e-02^{***}$	$5.47e-03^{**}$	$4.85e-03^{*}$	$4.86e-03^{**}$
	$(2.26e-03)$	$(2.32e-03)$	$(2.40e-03)$	$(2.38e-03)$
GMR 3	$1.96e-02^{***}$	$1.33e-02^{***}$	$1.37e-02^{***}$	$1.10e-02^{***}$
	$(2.23e-03)$	$(2.12e-03)$	$(2.15e-03)$	$(2.12e-03)$
GMR 4	$-2.14e-02^{***}$	$-2.95e-02^{***}$	$-3.55e-02^{***}$	$-4.17e-02^{***}$
	$(1.93e-03)$	$(2.04e-03)$	$(2.13e-03)$	$(2.06e-03)$
GMR 5	$-8.34e-03^{**}$	$-1.51e-02^{***}$	$-2.10e-02^{***}$	$-2.23e-02^{***}$
	$(3.87e-03)$	$(3.90e-03)$	$(4.51e-03)$	$(4.67e-03)$
Size of the firm				
Size	$3.57e-06^{***}$	$5.41e-06^{***}$	$6.08e-06^{***}$	$6.38e-06^{***}$
	$(2.76e-07)$	$(2.04e-07)$	$(1.88e-07)$	$(1.84e-07)$
$Size^2$	$-8.97e-12$	$-5.51e-11^{***}$	$-7.30e-11^{***}$	$-7.83e-11^{***}$
	$(6.25e-12)$	$(4.30e-12)$	$(3.92e-12)$	$(3.84e-12)$
$Size^3$	$-4.26e-17$	$1.99e-16^{***}$	$2.94e-16^{***}$	$3.00e-16^{***}$
	$(3.14e-17)$	$(2.14e-17)$	$(1.97e-17)$	$(1.90e-17)$
Seniority				
Seniority	$1.75e-02^{***}$	$1.66e-02^{***}$	$1.59e-02^{***}$	$1.40e-02^{***}$
	$(3.73e-04)$	$(3.14e-04)$	$(3.26e-04)$	$(3.14e-04)$
$Seniority^2$	$-8.94e-04^{***}$	$-8.39e-04^{***}$	$-7.85e-04^{***}$	$-6.75e-04^{***}$
	$(3.75e-05)$	$(3.21e-05)$	$(3.21e-05)$	$(3.03e-05)$
$Seniority^3$	$1.53e-05^{***}$	$1.48e-05^{***}$	$1.38e-05^{***}$	$1.18e-05^{***}$
	$(9.75e-07)$	$(8.25e-07)$	$(7.96e-07)$	$(7.42e-07)$
Intercept	$-3.28e-01^{***}$	$-4.98e-01^{***}$	$-6.68e-01^{***}$	$-8.31e-01^{***}$
	$(6.67e-03)$	$(6.68e-03)$	$(7.16e-03)$	$(8.33e-03)$

Source: DADS panel, 1/25th sample.
Field: Male employees from the private sector aged 18 to 65, working full-time, full-year, excluding interns and apprentices
Reading: a 1 % variation of the minimum wage lowers by 0.190 % the difference in the first decile of the distribution of log wages.
Note: confidence intervals at the level of 5% between brackets.

Table 6: RIF-Logit estimation on deciles (Men, 2003-2005)

5th decile	6th decile	7th decile	8th decile	9th decile	
Minimum wage (log)	$2.23e-01^{***}$	$1.64e-01^{***}$	$1.57e-01^{***}$	$5.35e-03$	$-2.62e-02$
	$(4.16e-02)$	$(4.40e-02)$	$(5.16e-02)$	$(6.43e-02)$	$(1.03e-01)$
Age	$3.46e-02^{***}$	$3.80e-02^{***}$	$4.49e-02^{***}$	$5.52e-02^{***}$	$7.98e-02^{***}$
	$(4.41e-04)$	$(4.79e-04)$	$(6.38e-04)$	$(8.35e-04)$	$(1.48e-03)$
Age^2	$-3.46e-04^{***}$	$-3.73e-04^{***}$	$-4.31e-04^{***}$	$-5.16e-04^{***}$	$-7.24e-04^{***}$
	$(5.17e-06)$	$(5.60e-06)$	$(7.33e-06)$	$(9.35e-06)$	$(1.61e-05)$
Year Dummies					
2002	*ref.*	*ref.*	*ref.*	*ref.*	*ref.*
2003	$-7.35e-03^{***}$	$-7.78e-03^{***}$	$-6.89e-03^{***}$	$-1.38e-02^{***}$	$-2.41e-02^{***}$
	$(1.92e-03)$	$(2.02e-03)$	$(2.41e-03)$	$(2.97e-03)$	$(4.80e-03)$
2004	$-5.02e-03^{***}$	$-5.34e-03^{***}$	$-5.53e-03^{***}$	$-1.24e-02^{***}$	$-2.13e-02^{***}$
	$(1.32e-03)$	$(1.51e-03)$	$(1.78e-03)$	$(2.24e-03)$	$(3.54e-03)$
Socio-economic position					
CEO	$5.12e-01^{***}$	$5.65e-01^{***}$	$6.59e-01^{***}$	$8.64e-01^{***}$	$1.51e+00^{***}$
	$(5.29e-03)$	$(4.52e-03)$	$(4.94e-03)$	$(6.76e-03)$	$(1.66e-02)$
Professionals, managers	$7.59e-01^{***}$	$7.83e-01^{***}$	$8.29e-01^{***}$	$9.46e-01^{***}$	$1.43e+00^{***}$
	$(4.33e-03)$	$(3.57e-03)$	$(3.97e-03)$	$(6.09e-03)$	$(1.53e-02)$
Technicians and associate professionals	$3.29e-01^{***}$	$3.48e-01^{***}$	$3.82e-01^{***}$	$4.53e-01^{***}$	$6.93e-01^{***}$
	$(1.62e-03)$	$(1.59e-03)$	$(2.26e-03)$	$(4.07e-03)$	$(1.27e-02)$
Office clerks and service workers	$2.77e-02^{***}$	$5.89e-02^{***}$	$8.46e-02^{***}$	$1.29e-01^{***}$	$2.05e-01^{***}$
	$(1.82e-03)$	$(2.17e-03)$	$(3.13e-03)$	$(5.75e-03)$	$(2.15e-02)$
Skilled and unskilled workers	*ref.*	*ref.*	*ref.*	*ref.*	*ref.*
Industry					
Agriculture	$-4.91e-02^{***}$	$-2.81e-02^{***}$	$9.97e-03$	$1.36e-02$	$-8.74e-03$
	$(5.22e-03)$	$(6.29e-03)$	$(7.95e-03)$	$(1.18e-02)$	$(2.27e-02)$
Manufacturing industry	$6.13e-02^{***}$	$6.78e-02^{***}$	$6.26e-02^{***}$	$3.81e-02^{***}$	$-1.74e-02^{***}$
	$(1.37e-03)$	$(1.38e-03)$	$(1.61e-03)$	$(1.99e-03)$	$(3.08e-03)$
Construction	$-3.84e-03^{**}$	$6.86e-04$	$-9.37e-03^{***}$	$-2.75e-02^{***}$	$-8.84e-02^{***}$
	$(1.60e-03)$	$(1.90e-03)$	$(2.41e-03)$	$(3.19e-03)$	$(5.62e-03)$
Trade	$-5.68e-02^{***}$	$-4.35e-02^{***}$	$-3.00e-02^{***}$	$-1.39e-02^{***}$	$-2.49e-02^{***}$
	$(1.41e-03)$	$(1.59e-03)$	$(1.76e-03)$	$(2.43e-03)$	$(3.58e-03)$
Services	*ref.*	*ref.*	*ref.*	*ref.*	*ref.*
GMR group					
GMR 0	*ref.*	*ref.*	*ref.*	*ref.*	
GMR 1	$-8.74e-03^{***}$	$-1.61e-02^{***}$	$-2.46e-02^{***}$	$-2.97e-02^{***}$	$-2.60e-02^{***}$
	$(3.40e-03)$	$(3.74e-03)$	$(4.33e-03)$	$(5.35e-03)$	$(8.50e-03)$
GMR 2	$5.97e-03^{**}$	$4.38e-03^{*}$	$2.18e-03$	$2.03e-04$	$8.73e-03$
	$(2.52e-03)$	$(2.74e-03)$	$(3.25e-03)$	$(3.98e-03)$	$(6.21e-03)$
GMR 3	$6.01e-03^{***}$	$-2.94e-03$	$-6.94e-03^{**}$	$-1.15e-02^{***}$	$-1.53e-03$
	$(2.35e-03)$	$(2.54e-03)$	$(2.95e-03)$	$(3.73e-03)$	$(5.74e-03)$
GMR 4	$-4.55e-02^{***}$	$-4.60e-02^{***}$	$-4.54e-02^{***}$	$-5.86e-02^{***}$	$-8.12e-02^{***}$
	$(2.33e-03)$	$(2.56e-03)$	$(3.13e-03)$	$(4.11e-03)$	$(6.61e-03)$
GMR 5	$-2.73e-02^{***}$	$-3.18e-02^{***}$	$-4.42e-02^{***}$	$-4.87e-02^{***}$	$-8.92e-02^{***}$
	$(5.18e-03)$	$(5.56e-03)$	$(6.90e-03)$	$(8.45e-03)$	$(1.51e-02)$
Size of the firm					
Size	$6.72e-06^{***}$	$5.29e-06^{***}$	$5.32e-06^{***}$	$5.39e-06^{***}$	$5.32e-06^{***}$
	$(1.91e-07)$	$(1.97e-07)$	$(2.11e-07)$	$(2.48e-07)$	$(4.10e-07)$
$Size^2$	$-8.55e-11^{***}$	$-6.17e-11^{***}$	$-7.43e-11^{***}$	$-9.48e-11^{***}$	$-1.09e-10^{***}$
	$(3.99e-12)$	$(4.13e-12)$	$(4.49e-12)$	$(5.28e-12)$	$(9.07e-12)$
$Size^3$	$3.07e-16^{***}$	$1.75e-16^{***}$	$2.37e-16^{***}$	$3.65e-16^{***}$	$4.34e-16^{***}$
	$(1.91e-17)$	$(1.98e-17)$	$(2.17e-17)$	$(2.57e-17)$	$(4.54e-17)$
Seniority					
Seniority	$1.23e-02^{***}$	$1.03e-02^{***}$	$9.21e-03^{***}$	$6.66e-03^{***}$	$2.66e-03^{***}$
	$(3.45e-04)$	$(3.47e-04)$	$(4.18e-04)$	$(4.75e-04)$	$(8.27e-04)$
$Seniority^2$	$-5.47e-04^{***}$	$-4.32e-04^{***}$	$-4.49e-04^{***}$	$-4.69e-04^{***}$	$-4.83e-04^{***}$
	$(3.17e-05)$	$(3.14e-05)$	$(3.71e-05)$	$(4.25e-05)$	$(6.95e-05)$
$Seniority^3$	$9.04e-06^{***}$	$6.38e-06^{***}$	$7.01e-06^{***}$	$8.98e-06^{***}$	$1.06e-05^{***}$
	$(7.50e-07)$	$(7.43e-07)$	$(8.39e-07)$	$(9.72e-07)$	$(1.50e-06)$
Intercept	$-1.04e+00^{***}$	$-1.25e+00^{***}$	$-1.60e+00^{***}$	$-2.12e+00^{***}$	$-3.50e+00^{***}$
	$(9.61e-03)$	$(1.05e-02)$	$(1.46e-02)$	$(2.11e-02)$	$(4.08e-02)$

Source: DADS panel, 1/25th sample.
Field: Male employees from the private sector aged 18 to 65, working full-time, full-year, excluding interns and apprentices
Reading: a 1 % variation of the minimum wage lowers by 0.223 % the fifth decile of the distribution of log wages.
Note: confidence intervals at the level of 5% between brackets.



(Men) (Women)

Figure 3: Impact of the minimum wage on the different deciles

5.2 Robustness checks

We perform several robustness checks. First, we check that our results are not sensitive to the logistic specification used for the estimation. Second, in order to avoid potential measurement errors in earnings we exclude all hourly wages below the hourly minimum wage. Third, we check the robustness of our results to employment effects by restricting the sample to "stable" employees. All specifications give similar results.

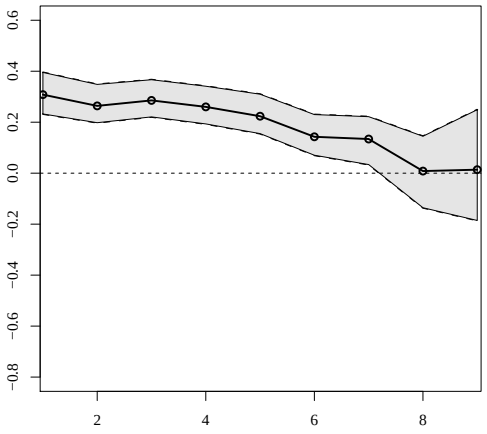
First, one can argue that using a logistic specification to model $P(y_i > dec_j|X = x)$ is more relevant than a linear one as we model a probability, but it is also less consistent with our difference-in-differences strategy. Estimates using a linear specification are very similar to the ones obtained with the logit specification (see Figure 4, linear specification). Firpo, Fortin, and Lemieux (2009) already emphasized the robustness of the approach to the choice of the model for $P(y_i > dec_j|X = x)$.

Second, the presence of earnings below the minimum wage level can be due to measurement errors and may induce some bias in the estimates. We thus check that excluding hourly earnings below the hourly minimum wage does not change our results (Figure 4, sample (a)). The results are qualitatively the same: a significant impact up to the seventh decile. The profile is more decreasing than with the whole sample: it is close to 0.4 for the first decile and is lower than 0.1 at the

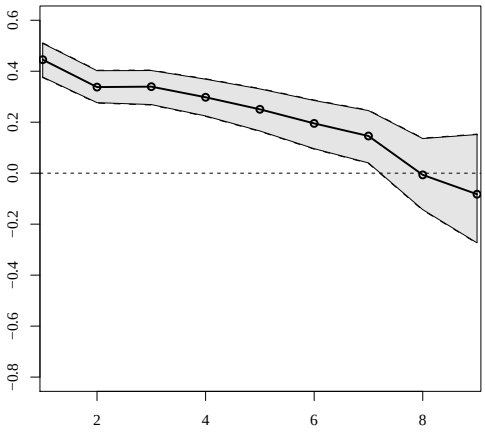
seventh decile.

Finally, although the natural experiment we use here has clear advantages to help us solve the usual endogeneity issue related to the rise in the minimum wage, we cannot totally rule out the possibility of other concomitant effects which could disturb our analysis. The main risk is the presence of simultaneous employment effects that could induce changes in the labor force that would not be totally controlled for with our set of covariates. As stated before, the employment levels as well as the creation and destruction rates do not seem to be related to the changes in the minimum wage induced by the convergence mechanism. Still, in order to test the robustness of our results, we perform the same analysis on a restricted sample of workers who stayed in the same firm for at least two years in a row. More specifically, we consider the following two samples: (1) employees who already worked in the same firm the year before and (2) employees who are still in the same firm the year after (these samples are named (b) and (c) hereafter). This approach focuses on more *stable* workers and therefore limits the changes in the wage distribution that come from creations and destructions of firms or jobs. The results obtained for the impact of the minimum wage level are presented in Figures 4 (samples (b) and (c)) and show very similar results to the ones obtained on the full population.

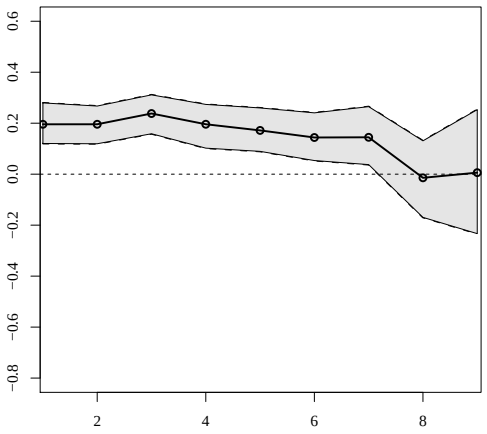
It is worth emphasizing that these results were obtained on a specific population. Indeed, the full-time employees who have worked all year long are in a rather stable position and they may thus have higher bargaining power: they can obtain more easily that their wage is rescaled according to a new minimum wage level. As a consequence, the effects could be smaller for the entire wage earners population. Besides, the impact was estimated on the very specific period when the minimum wage increased at an unusually high pace in a few (rather small) firms. The external validity of these results can thus be compromised.



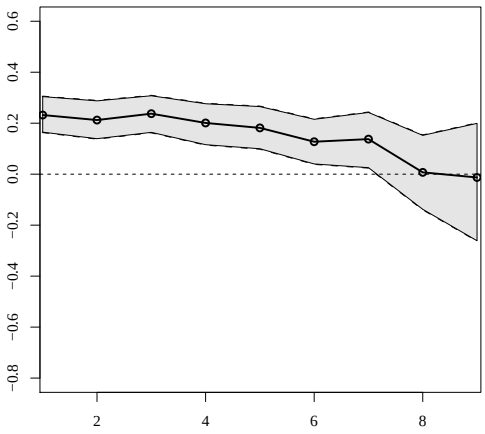
Linear specification



Sample (a)



Sample (b)



Sample (c)

Figure 4: Robustness checks: Estimation results with different specifications and different samples

Appendix A Schedule for the creation of different GMR

Table 7: Definition of the monthly guaranteed wage (GMR)

GMR	Date of the RTT agreement
GMR1	Between June 15, 1998 and June 30, 1999
GMR2	Between July 1, 1999 and June 30, 2000
GMR3	Between July 1, 2000 and June 30, 2001
GMR4	Between July 1, 2001 and June 30, 2002
GMR5	After July 1, 2002

Appendix B Data description

Note that even when restricting ourselves to full-time employees, who worked full year, we observe that the gross annual remuneration of certain employees falls below the annual minimum wage. Several possibilities can explain that. First, the minimum wage regulations do not apply to all occupations (*e.g.* in the case of employees whose working time is difficult to measure, such as some traveling salesmen). Moreover, the strict definition of the minimum wage also includes some fringe benefits that are not always valued in the DADS. Besides, this can result from error measurement in full-time status. This variable is not directly reported by employer in the original administrative database: employer only reports the number of hours worked during the year by each employee. The full-time status is then calculated by Insee, depending on a yearly reference in working time defined by activity and size of the firm. As yearly working hours may vary across firms, an employee's full-time status can be miscalculated if the yearly working hours in her firm are different from the average observed in firms in the same industry and with the same size. Finally, we cannot exclude reporting problems, for instance unearned bonuses from one year to another, or problems in the number of days worked during the year.

Note that, conversely, because of overtime or additional bonuses that do not enter the definition of the minimum wage, some employees whose basic hourly wage is the minimum wage can *in the end* have annual earnings above the annual minimum wage.[12]

[12]According to Faur and Demailly (2008), a quarter of the employees directly concerned by

We restrict the analysis to the private sector and exclude a few formerly state-owned firms whose legal status changed during the period studied here. Namely we drop France Telecom, EDF and GDF.

Table 8: Sample variations of real earnings distribution (2003-2005)

Decile (*)	Main Sample	Sample excluding employees below hourly minimum wage (Sample (a))	Employees already in the same firm the year before (Sample (b))	Employees still in the same firm the year after (Sample (c))
Min	10,968	10,969	10,968	10,968
1	14,812	17,682	16,303	16,046
2	17,130	19,460	18,390	18,147
3	19,015	21,224	20,219	19,975
4	20,966	23,158	22,159	21,914
Median	**23,189**	**25,420**	**24,346**	**24,094**
6	25,913	28,288	27,052	26,767
7	29,633	32,268	30,777	30,454
8	35,439	38,600	36,590	36,143
9	47,273	51,644	48,360	47,714
Max	8,142,398	8,142,398	5,833,864	5,833,864

Source: DADS panel, 1/25th sample.
Note: The wages are in euros of 2007.
Field: employees from the private sector aged 18 to 65, working full-time, full-year, excluding interns and apprentices.

a rise in the minimum wage earned in fact over 1.3 SMIC in 2002, after taking into account all elements of remuneration.

Appendix C Definition of the Influence Function

This appendix is a summary of Firpo, Fortin, and Lemieux (2009).

For a parameter or characteristic $\nu(F_Y)$ of the distribution of wages Y, the recentered influence function (RIF) is defined as:

$$RIF(y;\nu,F_Y) = \nu(F_Y) + IF(y;\nu,F_Y)$$

where $IF(y,\nu,F_Y)$ is the influence function of point y on the distribution parameter $\nu(F_Y)$:

$$IF(y;\nu,F_Y) = \left.\frac{\partial \nu(F_{Y,t\Delta_y})}{\partial t}\right|_{t=0} = a(y)$$

where $F_{Y,t\Delta_y}$ is the mixing distribution $F_{Y,t\Delta_y} = (1-t)F_Y + t\Delta_y$.

Let us now consider the impact of changing the distribution of characteristics X from F_X to G_X, letting the conditional distribution unchanged. More precisely, we are interested in a small change in the distribution of the minimum wages. This distribution is discrete (it can be written as a mixture of several Dirac distributions):

$$f_{W_0}(w_0) = \sum_{k=0}^{6} \pi_k \delta_{GMR_k}(w_0)$$

with π_k representing the proportion of employees in each GMR group, that we consider as constant over the period.

Firpo, Fortin, and Lemieux (2009) show that the vector of the partial derivative resulting from a change in the distribution of one covariate from X_j to $X_j + t$ corresponds to

$$\alpha(\nu) = \int \frac{dE(RIF(Y;\nu,F_Y)|X=x)}{dx} dF_X(x)$$

provided that the density function f_X is null on the boundary of its support. This condition does not hold for the minimum wages, that is distributed as a mixture of Dirac distributions. Following Firpo, Fortin, and Lemieux (2009), we can show however that this equality still holds assuming that conditional densities of covariates X_1 $f_{X_1|W_0}(x_1|w_k)$ is null on the boundary of their supports, for each value of the minimum wage w_k.

Firpo, Fortin, and Lemieux (2009) provide a formal proof of Equation (7) in section 3.2, provided the strict monotonicity of h in ε, and independence of w_0 to this unobserved component. In our case we rely on weaker assumption of conditional independence (2), but the proof can be adapted without difficulty. As h is monotonic in ε, for each value of q_τ, and couple of observables ($X_1 = x_1, W_0 =$

w_0) a unique value of ε is defined. We thus derive:

$$\begin{aligned} P(Y \leq q_\tau | X_1 = x_1, W_0 = w_0) &= F_{\varepsilon|X_1,W_0}(h^{-1}(X_1, W_0, q_\tau | X_1 = x_1, W_0 = w_0) \\ &= F_{\varepsilon|X_1}(h^{-1}(X_1, W_0, q_\tau | X_1 = x_1) \end{aligned}$$

the second line is given by conditional independence of ε and W_0 (Assumption 2).
Deriving the identity $h(x_1, w_0, h^{-1}(x_1, w_0, q_\tau)) = q_\tau$ and using the implicit function theorem we deduce that:

$$\frac{\partial h^{-1}}{\partial w_0} = -\frac{\partial h}{\partial w_0} / \frac{\partial h^{-1}}{\partial q_\tau}$$

It is also useful to notice that:

$$\frac{\partial P(Y \leq q_\tau | X_1 = x_1, W_0 = w_0)}{\partial q_\tau} = f_{\varepsilon|X_1}(\varepsilon_\tau(x_1, w_0)|X_1 = x_1) \frac{\partial h^{-1}(x_1, w_0, q_\tau)}{\partial q_\tau}$$

We have:

$$\begin{aligned} &\frac{\partial P(Y \leq q_\tau | X_1 = x_1, W_0 = w_0)}{\partial w_0} \\ &= f_{\varepsilon|X_1}(\varepsilon_\tau(x_1, w_0)|X_1 = x_1) \frac{\partial h^{-1}(x_1, w_0, q_\tau)}{\partial w_0} \\ &= -f_{\varepsilon|X_1}(\varepsilon_\tau(x_1, w_0)|X_1 = x_1) \frac{\partial h^{-1}(x_1, w_0, q_\tau)}{\partial q_\tau} \frac{\partial h(x_1, w_0, \varepsilon_\tau(x_1, w_0))}{\partial w_0} \\ &= -\frac{dF_{\varepsilon|X_1}}{dq_\tau} \frac{\partial h(x_1, w_0, \varepsilon_\tau(x_1, w_0))}{\partial w_0} \\ &= -f_{Y|X_1,W_0}(q_\tau, x_1, w_0) \frac{\partial h(x_1, w_0, \varepsilon_\tau(x_1, w_0))}{\partial w_0} \end{aligned}$$

As

$$\alpha_{w_0}(q_\tau) = -\frac{1}{f_Y(q_\tau)} \int \frac{\partial P(Y \leq q_\tau | X_1 = x_1, W_0 = w_0)}{\partial w_0} dF_{X_1,W_0}(x_1, w_0)$$

we finally derive equation (7).

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