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Workers Compensation Insurance: Incentive Effects of Experience Rating on Work-related Health and Safety

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Sommaire

Workers Compensation Insurance: Incentive Effects of Experience Rating on Work-related Health and Safety

Pascale Lengagne[a]

Abstract: This article examines Workers Compensation Insurance experience rating premiums setting, a common financial incentive tool existing in several countries. Premiums paid by firms are experience rated, which may encourage them to reduce work-related injuries and disabilities. This article provides a literature review on effects of experience rating on work-related health and safety, and empirical results on the French jurisdiction, using sectorial data from industry and construction sectors in 2005. Results are consistent with the hypothesis that this policy tool is a lever that contributes to improve working conditions and reduce work-related injuries rates.

JEL codes: J28; I13; I18.

Keywords: Workers' Compensation, experience rating, working conditions, work-related injuries.

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Assurance des risques professionnels : les effets incitatifs d'une tarification individualisée

Pascale Lengagne[a]

Résumé : L'assurance des risques professionnels couvrant les salariés du Régime général est financée sur la base de cotisations patronales dépendantes de la sinistralité passée de l'entreprise. Ce système de tarification peut, ainsi, contribuer à sensibiliser les employeurs à l'intérêt de développer des démarches préventives. Cet article propose une synthèse de la littérature empirique étudiant cet effet incitatif, puis présente une mesure de la relation entre les taux de cotisation et l'effort de prévention des entreprises, les conditions de travail et les accidents du travail, à partir de données françaises au niveau sectoriel, dans l'industrie et la construction. Selon nos résultats, l'augmentation des taux de cotisation est associée à une amélioration des conditions de travail et un moindre taux d'accidents du travail, toutes choses égales par ailleurs.

Codes JEL : J28; I13; I18.

Mots clés : assurance des risques professionnels, tarification individualisée, conditions de travail, accidents du travail.

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1. Introduction

In several countries, many policy tools were introduced in order to promote a better health and safety at work, in a way to prevent incapacities and improve life-long health. This article examines workers compensation insurance experience rating premiums setting, a financial incentive tool existing in many countries (Kankaanpää, 2010). In those schemes, the principle is that premiums paid by firms are experience rated, which may encourage them to reduce work-related injuries and disabilities. Empirical evaluations of those employers financial incentives to invest more extensively in workplace hazard prevention are relatively few (Tompa *et al.*, 2007 and 2012). However, the development of knowledge on the effects of these schemes is nevertheless essential as a means of informing public policy aimed at implementing or reforming these systems. In France, incentives were reinforced in 2012.

This system may be insufficiently incentive insofar as a large part of the cost of work-related health problems is not internalized through its rules; indeed a substantial part of work-related health problems, such as psychosocial factors affecting employees health status, are unrecognized and a sizeable part of occupational injuries and illnesses may be underreported (Boone and Van Ours, 2006; Biddle *et al.* 1998). Furthermore, several other firms' behaviours in reaction to that system are suspected: other practices have been documented in the literature (Veljanoski, 1982 ; Ison,1986 ; Spieler, 1994; Kralj, 1994; Hyatt and Kralj, 1995; Thomason and Pozzebon, 2002; Yakolev and Russel, 2010; Askenazy, 2005; Tompa *et al.*, 2012) such as monitoring and challenging claims, substitute more capital for labor, but also occupational risks externalization, zero injuries practices and workers selection. Moreover, insurer's annual reports outline an important number of contentious procedures.

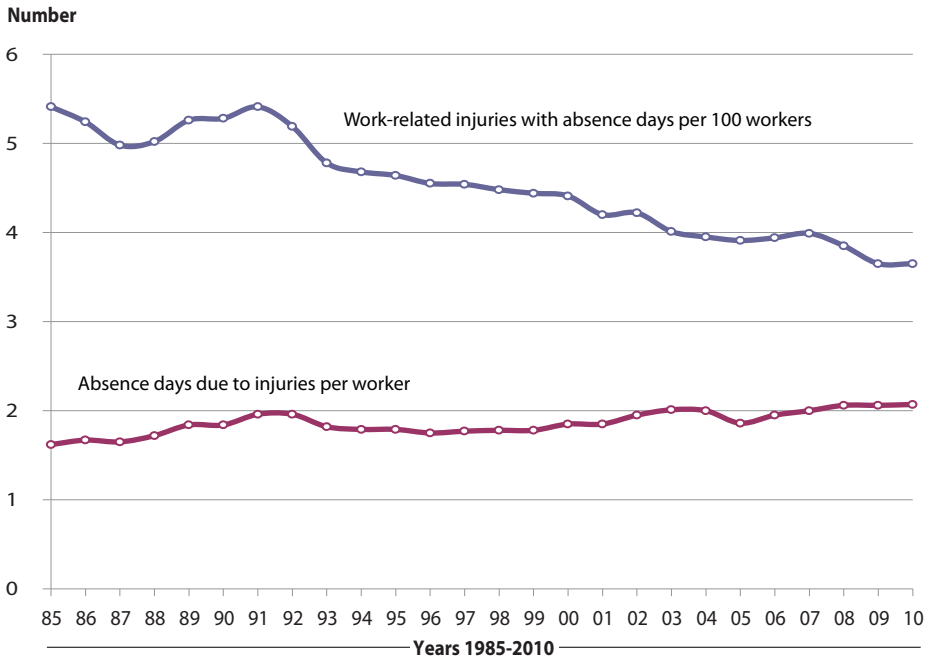
According to published literature reviews on that subject (Shapiro, 2000; Askenazy, 2005; Tompa *et al.*, 2007, 2012; Esler *et al.* 2010), mpirical studies are relatively few. The question has not been investigated in France. This article presents an overview of the literature on prevention incentive effect of experience rating on work-related health and safety. Then, it provides a measurement of the relationship between premiums changes and working conditions, employers' prevention efforts toward reducing workplace hazards and work-related injuries, using French sectorial data from the annexes to the decrees published annually in the *Journal Officiel* and the French survey on working conditions carried out in 2005.

The paper is organized as follows. First, we present the workers' compensation public Insurance system in France. Second, we present theoretical considerations and an empirical literature review. Then, we present data, empirical results, and we discuss and conclude.

2. Workers compensation and experience rating in France

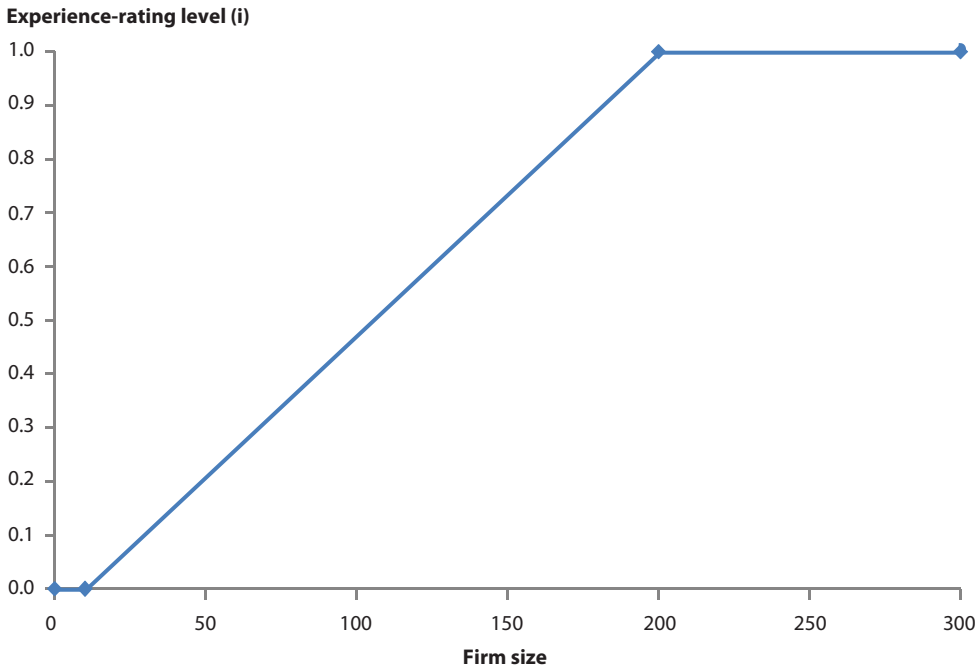
In the 19th Century, employers were in general not liable in the case of workplace injury. The financial and non-financial consequences of workplace injuries were borne entirely by the employee concerned and their households. The Law of April 9th 1898

Figure 1. Evolution of work-related injuries and absence days due to injuries between 1985 and 2010



Source : French workers compensation public insurance: Eco-Santé France 2013.
Scope: Private sector.

Figure 2. Level of experience-rating noted (*i*) according to firm size



on workers' compensation for workplace injuries instituted employer no-fault liability. A work-related accident was thereby defined as any accident, whatever its cause, that occurred in the workplace. Injured employees were no longer required to prove the work-relatedness of an injury. The basic foundations of the workers' compensation system as it exists today were established in 1946 (Social Security History Committee, 1997; Viet and Ruffat, 1999). The legislation instituted a pricing system linking the cost of employers insurance premiums to their claims history, whilst making provision for a partial risk-pooling mechanism (essentially for small companies, the construction sector…). Workplace risk prevention was the primary motive in introducing this system. After 1946, several reforms modified the levels of experience-rating (notably in 1972, 1976, 1995 and 2010) and benefits. The creation of new tables of occupational diseases corresponding to musculoskeletal diseases extended the scope of benefits. In 1993, an increase in sick leave benefits for workplace injuries and illnesses further increased compensation levels. Those various changes may have had implications on incentives to invest in workplace hazard prevention.

Over the course of the last thirty years, the number of work-related injuries per 100 workers decreased (Fig. 1), linked with the automation, the disappearance of very high-risk work activities and investments in workplace hazard prevention. However, on the other hand, the number of work-related absence day per worker (*i.e.* ratio of the total number of work-related absence day of the year on total number of workers of the year) has tended to increase, this can be partially explained by an overall deterioration of working conditions during the last decades (studied notably by Green and Mcintoch (2001) and Valeyre (2004)), workers ageing and labour force composition effect notably related to ageing (insofar as age is a strong determinant of work-related sickness absence (Smith and Berecki-Gisolf, 2014)).

The cost of workers' compensation for firms is a percentage of total covered payroll insurance calculated as follows. Firms counting from one to ten[1] employees pay a flat premium rate by type of risk class (collective pricing). The different homogenous risk classes – more than 600 in 2005 (year of our study) – are established by the public insurer. Premium rates for companies with over 200[2] employees are set according to the observed cost of claims in previous years (experience rating). Medium-sized companies are subject to a mixed pricing mechanism in which the premium rate is only partially based on their previous claims history, depending on their size (*cf.* Fig. 2). Different levels of experience-rating are thus determined by firm size: no experience-rating (collective pricing), individualised pricing equal to one (experience rating) or individualised pricing proportional to the size of the company (mixed pricing).

As mentioned, the annual premium rate for a company under the collective pricing mechanism is determined by the aggregated claims for the entire risk class to which the firm belongs. This premium rate is calculated according to risk class claims history in t-2, t-3 and t-4. The premium rate is calculated as follows:

$$r_{collective} = \frac{C^{Class}(t\text{-}2) + C^{Class}(t\text{-}3) + C^{Class}(t\text{-}4)}{P^{Class}(t\text{-}2) + P^{Class}(t\text{-}3) + P^{Class}(t\text{-}4)}$$

1 In 2012, this threshold was changed to include firms with one to twenty employees.

2 In 2012, this threshold was changed to include firms with more than 150 employees.

With:

- C^{Class}: total claims costs attributable to all firms within the risk class
- P^{Class}: total payroll in that risk class

If the firm is subject to experience-rating, the premium rate will be determined by the firm's results. For each establishment section making up the company, the premium rate takes the value:

$$r_{experiencerating} = \frac{c^{establishment}(t\text{-}2) + c^{establishment}(t\text{-}3) + c^{establishment}(t\text{-}4)}{p^{establishment}(t\text{-}2) + p^{establishment}(t\text{-}3) + p^{establishment}(t\text{-}4)}$$

With:

$c^{establishment}$: claims costs attributable to the establishment

$p^{establishment}$: total payroll of the establishment

If the firm is subject to mixed pricing with experience-rating (i), then for each establishment making up the firm, the premium rate takes the value:

$$r_{mixt} = ir_{experience\text{-}rated} + (1-i)r_{collective}$$

The final annual rate applied for a given establishment is expressed as follows.

$$R = [ir_{experience\text{-}rated} + (1-i)r_{collective} + M_1](1+M_2) + M_3$$

The coeficient M_1 aims at evenly distributing the cost of commuting injuries across all the firms. The coeficient M_2 covers insurance administrative expenditures. The coeficient M_3 corresponds to the different transfers (underestimation of workplace injuries and diseases, Compensation Fund for Asbestos Victims...) and occupational disease costs that are difficult to attribute. Premiums vary considerably according to risk class – construction and industry having the highest premium rates level – and vary across time also, as presented below (see section 4).

3. Theoretical prevention model and previous empirical evidence

Economic literature gives arguments in favour of individualised rating systems that introduce individual financial incentives, in the field of workplace health and safety (Carmichael, 1986; Bruce and Atkins, 1993; Diamond, 1977), more generally in economic analysis of civil liability systems (Shavell 1987, 2004) and pigovian tax theory. Diamond theoretical model of the role of employer no-fault liability system compares this system to an alternative system in which employees are strictly liable and bear all the costs. A compulsory workers' compensation system funded by the employer is a form of insurance as it transfers the risk factor to which risk adverse employees are subject, onto the employer. The latter can either opt for self-insurance or private insurance. Both employees and employers are able to vary the level of risk by adjusting the allocation of resources to accident prevention; the occurrence of an accident would thus depend on both employers' behaviour in terms of risk prevention investment *(x)* and that

of employees *(y)*. Employer investment in workplace risk prevention *(x)* is noted *A(x)*; and employee investment is noted *B(y)*. For a given level of investment in workplace risk prevention *(x; y)*, the expected cost of workplace injuries and illnesses is expressed as *C(x, y)*. The social cost of workplace injury *CS(x, y)* is equal to the sum of employees' and employers' investments in risk prevention and the expected cost of workplace injuries and illnesses: CS(x, y) = A(x) + B(y) + C(x, y). If the firm bears the cost of workers compensation (no-fault liability for employers), it will invest in risk prevention (*x**) minimising the social cost of workplace injury for a given level of employer investment (*y*); employee investment is minimal (*y0*). In this case, the situation is not optimal: employee investment in safety is below the optimal level required (*y**) to minimise social costs. This result comes back to the literature on liability systems: liability rules for the agent are socially optimal only if the injured party is unable to influence the probability of injury. A compulsory workers' compensation system funded by the employer minimizes the social costs of work-related injuries, assuming that employees realize efforts that do not affect their health status. Furthermore, employers investments in safety measures may reduce injuries costs more effectively than employee investments because of scale economies.

However, as mentioned in the introduction, negative collateral effects of experience rating are suspected. Employers should not choose safety or health improvements theoretically if lower cost methods exist for reducing premiums: other options like pressure on employees not to file claims, costs contestation or workers selection (on age or health criteria). Employers may react also to higher compensation costs by engaging in political activity to reduce the level of benefits for injuried workers, as observed by Spieler (1994).

Empirical literature on the incentive effects of experience-rating in the field of work-related health and safety provide further insights. Over the last decades, several countries have adopted a rating dependent on the extent of a firm's past insurance claims. These regulatory changes may have been the subject of empirical 'before and after' evaluations measuring the effects of these systems on firms' safety. Other methodology consists in measuring the impact of temporal premium variations interacted with firms size (insofar as experience rating vary according to firms size) on outcomes, in order to examine if higher compensation costs are associated with a decrease in injuries in large firms as compared to smaller firms.

Bruce and Atkins (1993) measure the effects of the 1984 transition from a flat-rated system to an experience-rated system in the Ontario forestry and construction industries. Their results show that the new system led to a 41% reduction in the rate of fatal injuries in the forestry industry and a 20% reduction in the construction industry. Kralj (1994) examines the same natural experiment but bases estimation on a retrospective survey conducted among 500 employers in 1989. The authors compare three employer situations: the premium rate increased; the premium rate remained stable; the premium rate decreased. Employers subject to a premium rate increase, compared with those whose rate remained unchanged, self-reported having changed their health and safety at work management practices as a result.

Kötz and Shäffer (1993) examine the consequences of introducing an experience rating system in the German sugar industry in 1996 (variation in the premium rate of plus or

minus 50% according to firms' accident claims records) to reach the conclusion that workplace injuries were significantly reduced as a result.

In the United States, firms are under the obligation to purchase workplace risk indemnity insurance from either a private or public insurance agent, or can be self-insured. A minimum compensation rate, fixed at State level, must be guaranteed for each employee. Insurance premiums are generally experience-rated and the level of experience-rating increases the larger the size of the firm. Using this characteristic, Chelius and Smith (1983, 1993) do not confirm any experience rating effect. But results found by Worrall and Butler (1988) indicate that reported injuries declined more in large firms than in small ones when compensation costs increased. Krueger (1990) uses company data from a Minnesota insurance portfolio and data on self-insured firms. The method consists in comparing the duration of sick leave for work-related injuries among employees working in self-insured companies with those working in companies with private insurance contracts. The hypothesis examined is as follows: companies subscribing to private insurance contracts pay insurance premiums imperfectly dependent on their accident claims records contrary to self-insured companies. The results indicate that employees on sick leave return to work more rapidly in self-insured companies, all other things being equal. In addition, by observing the accident rate before and after a change in sick leave compensation rates in 1986, the author finds a positive elasticity of sick-leave duration relative to benefit level for employees in firms with private insurance contracts, and a negative elasticity for self-insured firms. These results suggest that firms paying the totality of injured workers' compensation benefits are more reactive to costs. Studies conducted by Ruser (1985 and 1991), Moore and Viscusi (1989) and Asfaw *et al.* (2009) adopt similar methods to that used by Krueger. Their conclusions also support the hypothesis that experience-rating induce a diminution of injuries rates. Durbin and Butler (1998) study workplace fatality rates changes at the state level for the period 1983-92 associated with regulation changes consisting in the introduction of deductibles and experience-rating programs. The results indicate significant reduction of workplace fatality rates following those regulation changes.

Hyatt and Thomason (1998) used a survey carried out in British Columbia firms. They examine employers' decisions to adopt safety measures aimed at reducing the number of injuries over three years (1994, 1995 and 1996). Those measures are of two kinds: (1) the reduction of workplace hazards *via* advice from specialised health and safety at work consultants, safety training, protective clothing and equipment, the creation of risk surveillance teams, the introduction of penalties/bonuses paid to managers or employees according to their results and the recruitment of specialised health and safety personnel; (2) accident reporting and claims surveillance calling on specialists in the field. In order to identify the effects of *experience-rating* on these two types of indicator, the statistical method used consisted in comparing employers' aware of this premium-setting system based on companies' previous claims history, with those claiming they had not been informed. The proportion of employers investing in risk prevention was 26 percentage points higher among employers aware of the system compared with those who were not. The proportion of employers operating accident reporting and claims controls was higher by 19 percentage points.

Thomason and Pozzebon (2002) used data from a survey carried out in 1996 in Québec. Three pricing mechanisms were applied: risk pooling (premium rates calculated on the

aggregate accident rate for each homogenous risk class), mixed pricing mechanism (combining risk pooling with experience rating) and entirely experience-rated pricing mechanism calculated on each company's accident rating. In each homogeneous risk class, companies' assignation to one or other of these systems was calculated according to its payroll and the collective rate for the group. Firms were contacted by telephone and the survey carried out with the person identified as being responsible for health and safety issues within the company. The results indicate a link between experience-rating and company practices in terms of risk prevention, accident reporting and claims surveillance by controlling for several observed characteristics (company size, premium rate, wage levels, trade-union representation, exports, age of the company and business sector).

Koning (2009) provides an empirical measure of the effect of the experience rating system introduced in 1998 in the Netherlands on the inflow into disability insurance. Using panel data (2000, 2001 and 2002), the author uses a difference-in-differences approach to identify the impact of premiums changes on the inflow into the firm's disability insurance. The authour measures a substantial decrease of disabilities inflow rates related to experiecne rating. Besides, the since 1998 to 2007, the important drop of disability inflow observed in the Netherlands may be partly attributed to the introduction of experience rating in 1998.

To our knowledge, Tompa *et al.* (2012) present the most recent results. Using canadian longitudinal administrative micro-level data, the authors measure a significant relationship between the level of experience-rating and sick leave duration but they do not find any significant association between level of experience-rating and the number of injuries declared. The results indicate that the level of experience rating may have a greater effects on employers practices in terms of secondary prevention (such as the adaptation of workers activities in order to allow a return-to-work as soon as possible) than primary prevention (ex ante measures to reduce work-related injury risks).

To conclude, several studies indicate that experience rating has an effect in reducing the frequency of workplace injuries and the duration of injury-related sick leave. These results can be described as indirect effects insofar as that they identify a relationship between experience rating and observed accident rates without analysing the causal chain behind. Other studies suggest results on this causal chain: employers react to experience rated premiums by employing different methods to control their accident frequency rate. Other than increasing employers' prevention efforts to reduce risk (workplace health and safety training, adaptation of jobs after an accident, calling on specialised consultants…), experience rating provides an incentive to control compensation claims and claims costs. Besides, we identify three categories of empirical strategies used in this literature: (1) comparing the effect of premium variations on outcomes among groups of firms that are experienced-rated or partially experience-rated (differences between firms size), (2) comparing before and after institutional changes and (3) comparing employers who declare they do not know the existence of experience rating to those that are well-informed. The following empirical sections present an empirical analysis based on a methodology derived from the first category. We measure the influence of premium variations on different outcomes at the aggregated sector level, in the French context in 2005.

4. Data and econometric strategy

4.1. Aggregated sectorial data on premium rates and work-related health and safety

Data used in this study were taken from two sources: (1) annexes to the French decrees published annually in the *Journal Officiel* setting collective premium rates for each risk class from 1999 to 2005 and (2) the French 2005 Working Conditions survey. We matched those two data sources in order to generate a sectorial database that informs on sectorial premium rates changes, declared adverse working conditions of workers, socio-demographic covariates and firms characteristics.

As indicated in section 2, collective premium rates are defined as the ratio of work-related injury and illness costs on total payroll for the whole risk class. We use this collective premium rate as a sectorial indicator of premium rates of all firms (under experience or collective rating).

The first step of data matching was to collect collective premiums for 609 risk classes (from source (1)).

Risk classes are identified by a five char code made up of the first three figures of the French activity classification followed by two characters attributed by the insurer. Those two characters provide a more precise description of employees' activities and risk levels. For example, for companies manufacturing paper or cardboard products (activity code 212), the insurer distinguishes five classes of risk: the manufacture of corrugated cardboard and corrugated cardboard products (212AA), the manufacture of cardboard boxes or paper bags (212BB), paper processing (carbon paper, stencils) (212GA), the manufacture of stationary products (212GB) and the manufacture of diverse paper or cardboard products (212LB). We select 665 class risks in 2005. 56 risk classes being entirely subject to collective insurance premiums were not included in the analysis. This special regime is explained by the low occupational injury rates in these classes or their low number of employees, and covers an extremely disparate range of activities. Those low-risk classes notably include national telecommunications companies, insurance companies, accountants and financial analysts, general activities related to social security other property management employees, etc.

The second step uses survey data (2) to calculate aggregated indicators of workplace health and safety. We matched those indicators to the first step database. Thus we obtained an aggregated sectorial database for studying the impact of premiums on indicators of workplace and health safety.

For each five char coded risk class, we extracted the first three chars corresponding to the sector code. We count 169 different three figure sector codes. These three chars constitute the match key between risk class and data taken from the 2005 French Working Conditions survey. Indeed, the French activity classification is available in this survey. The survey provides self-reported information for more than 10,400 workers in the private sector on their working conditions, security formation and socioeconomic characteristics. We aggregated this information at the sector level.

The database structure is represented in the diagram below. As an example, in boiler making, there are four different risk classes. In the 2005 Working Conditions survey,

Figure 3. Database structure

(1) Annexes to the French decrees published annually in the Journal Officiel setting collective premium rates for each risk class						(2) Working Conditions Survey 2005					
Risk class	Corresponding activity	Premium rate for 2004	Premium rate for 2005	Activity code (3 characters code)	Title	Number of workers in the survey	Men	Repetitive work	Permanent contracts	Safety training provided by the firm	…
283CC	Manufacture of routine boiler-making products	4.6	4.8	283	Boiler-making	57	91.2%	40.0%	91.3%	27.1%	…
283CD	Soldering	4.9	4.7	283	Boiler-making	57	91.2%	40.0%	91.3%	27.1%	…
283CE	Manufacture of products generally under pressure from sheet metal 50mm thick or the manufacture of nuclear boilers	4.7	5.0	283	Boiler-making	57	91.2%	40.0%	91.3%	27.1%	…
283CB	Manufacture of boiler-making products in stainless steel and non-ferrous metals	4.0	4.2	283	Boiler-making	57	91.2%	40.0%	91.3%	27.1%	…
…	…	…	…	…	…	…	…	…	…	…	…

57 surveyed employees worked in this sector. Of these, 91.2% are men. Around 40% declared performing highly repetitive tasks. We ensured that, for each three figures sector code, there were over 30 surveyed employees in the sample.

We realize separated first analyses on industrial and construction sectors and on services sectors, because, in services sectors, premium levels and variations are lower. It is explained mainly by low injuries and illnesses registrations. Data sample on services was too small to allow us realizing multivariate analyses presented in the next section. Thus, in this article we present only results restricted to industrial and construction sectors; the database is constituted of 396 risk sectors that correspond to 106 distinct industrial or construction aggregated sectors.

Descriptive statistics are presented in tables 1 (a) and (b) below. A majority of workers are men working in firms of 50 to 500 workers. Adverse working conditions and injuries are relatively prevalent, which characterizes construction and industrial sectors. Firms' prevention training and information cover sectors heterogeneously. However, workers contact with workplace health and safety institutions (occupational physicians

Table 1 (a). Descriptive statistics

		Mean	1st quartile	Median	3rd Quartile
Workplace health and safety institutions (excluding the employer)					
Percentage of workers	working in a company covered by a Workplace Health and Safety Committee	0.654	0.509	0.657	0.791
	having consulted an occupational physician over the last two years	0.960	0.947	0.958	0.981
	whose work unit has been visited by an occupational physician over the course of the last 12 months	0.272	0.216	0.273	0.333
	having received information concerning work-related risks from worker delegates, occupational physicians, colleagues, others excluding the employer, over the course of the last 12 months	0.337	0.226	0.313	0.372
Workers and firms characteristics					
Percentage of men		0.739	0.634	0.768	0.865
Percentage of workers	on fixed-term contracts	0.038	0.018	0.029	0.061
	on temporary work contracts	0.043	0.026	0.041	0.055
Percentage of non-skilled blue collar workers		0.181	0.114	0.172	0.232
Percentage of workers working in a firm	with less than 10 workers	0.040	0.023	0.032	0.054
	with 10 to 19 workers	0.123	0.031	0.097	0.169
	with 20 to 49 workers	0.080	0.048	0.070	0.123
	with 50 to 199 workers	0.401	0.282	0.398	0.472
	with 200 to 499 workers	0.184	0.107	0.157	0.263
	with 500 to 999 workers	0.086	0.023	0.071	0.123
	with 1000 workers or over	0.085	0.010	0.049	0.095

Table 1 (b). Descriptive statistics

	Mean	1st quartile	Median	3rd quartile
Firms prevention				
Safety training: Percentage of workers who received health and safety training provided by the company over the course of the last 12 months	0.292	0.214	0.257	0.371
Information training: Percentage of workers who received concerning work-related risks provided by the firm over the course of the last 12 months	0.595	0.488	0.603	0.696
Adverse workplace organization, working conditions and environment				
Repetitive work: Percentage of workers whose work consists in performing highly repetitive movements	0.367	0.247	0.375	0.464
Keeping eyes on work: Percentage of workers whose work involves consistently keeping one's eyes on work	0.406	0.338	0.425	0.491
Tiring positions: Percentage of workers whose work involves having to stand for long periods in uncomfortable or tiring positions	0.379	0.291	0.351	0.472
Tiring movements: Percentage of workers whose work involves carrying out painful or tiring movements	0.427	0.321	0.400	0.518
Dust or smokes exposure: Percentage of workers exposed to dust or smokes	0.525	0.400	0.535	0.396
Exposure to toxic products: Percentage of workers whose work involves manipulating toxic products	0.403	0.313	0.396	0.479
Injuries				
Percentage of workers who self-report having had one (or several) workplace injuries, even minor, and needing care during the course of the last 12 months	0.096	0.054	0.094	0.127

Scope: 396 risk sectors from industry and construction sectors.
Source: Complementary Employment Survey: Working Conditions 2005 - (2005) [electronic file], Insee [producer], Centre Maurice Halbwachs (CMH) [diffuser].
Reading: On average, the sectorial percentage of employees who benefitted from health and safety training provided by the firm over the course of the last 12 months is 29.2%.

Table 2. Evolution of premium rates between 1999 and 2005 (in %)

Years	Mean	1st quartile	Median	3rd quartile	Last decile
1999	3.24	1.9	2.3	3.6	5.9
2000	3.20	1.9	2.3	3.5	5.8
2001	3.19	1.9	2.4	3.5	6.1
2002	3.22	1.9	2.4	3.6	6.3
2003	3.23	2.0	2.5	3.6	6.1
2004	3.29	2.0	2.6	3.6	5.5
2005	3.43	2.1	2.7	3.7	5.6
Growth between 2004 and 2005	+3.7	+0	+3	+7.3	+12.6

Scope: 396 risk sectors from industry and construction sectors.
Source: Official Journal.

at least) are relatively widespread as declared by workers, that suggest a high potential access to workplace prevention from occupational physician notably.

Table 2 provides descriptive statistics on premium rates; it correspond to the final premium rate presented in section 2, noted R. The average premium was 3.43% of the total payroll in 2005 in industrial and construction sectors. Premium rates are superior to 5% in high risk sectors. Premium rates variations between 2004 and 2005 indicate an average increase of +3.7% between 2004 and 2005, the highest increase over the observed period. It corresponds to a substantial rise of costs paid by firms. Furthermore, premium rates increase between 2004 and 2005 in more than 75% of risk sectors (first quartile of premium rates variation variable is +1%). We used those indicators in order to measure the influence of financial incentives on workplace health and safety.

4.2. Econometric strategy

Our method consists in measuring the relationship between annual premium rate changes and several indicators of firms' prevention efforts, working conditions and injuries. We examine the following hypothesis: for firms subject to mixed or experienced rating, a substantial increase in premiums between 2004 and 2005 should may have an effect on employers behaviours, notably greater prevention efforts such as training, organizational changes that induce less repetitive work and reduce expositions to adverse environment and workplace injuries. On the contrary, a drop or maintenance in premium rates is likely to result in less effort in terms of risk prevention or at the very least the maintenance of existing efforts. Consequently, outcomes may be influenced by premium variation according to a non-linear effect.

We retain nine dependent outcomes corresponding to the outcomes categories presented in table 1 (b): firms prevention efforts, adverse physical working conditions and harmful environment and work-related injuries. They reflect various dimensions that are potential levers for employers (training, information, work pace, adverse positions or movements, adverse environment), that relate to organizational policies and practices on workplace and may influence work-related health and safety, and also injuries rate. Investment efforts into those different work dimensions are obviously more or less expensive for firms. Studies of employers organizational policies and practices indicate that this employer level matters: they find preventing and resolving work disability are strongly linked with those policies and practices implemented by employers (Habeck *et al.*, 1998 ; Amick *et al.*, 2000; Tveito *et al.*, 2014).

Our estimation is based on a binary treatment model with heterogeneous response to treatment. For each outcome, a linear equation model is considered that allows for potential heterogeneous effects of premium variations interacted with firms size. Furthermore, we suppose a non-linear effect of premiums changes on outcomes, following the above-mentioned hypothesis. The variable "premium rate variations between 2004 and 2005" is divided into three groups of treatment: (1) sectors where premium rates increase slowly (less than 2%) or decrease (40% of the sample), coded with the dummy $treat^{<2\%}$ (that take the value 1 for those sectors and 0 otherwise); (2) premium rates growth from 2% to 5% (including median, 20% of the sample); (3) premium rates growth of 5% or more (40% of the sample), coded with the dummy $treat^{>5\%}$. The outcome is noted y with three derived outcomes:

y_1: outcome if sectors premium rate growth is more than 5%

y_{-1}: outcome if sectors premium rate growth is less than 2%

y_0: outcome if sectors premium rate growth is included between 2% and 5%

With:

$y_1 = y$ *if* $Treat^{>5\%} = 1$

$y_{-1} = y$ *if* $Treat^{<2\%} = 1$

$y_0 = y$ *if* $Treat^{<2\%} = 0$ & $Treat^{>5\%} = 0$

Let's consider the following equations:

(1) $\ln(y_1) = a_1 + F\beta_1 + X\gamma + u_1, E(u_1|F, X) = 0$

(2) $\ln(y_0) = a_0 + F\beta_0 + X\gamma + u_0, E(u_0|F, X) = 0$

(3) $\ln(y_{-1}) = a_{-1} + F\beta_{-1} + X\gamma + u_{-1}, E(u_{-1}|F, X) = 0$

Where $a_0\, a_1\, a_{-1}$ are constants; F is a vector for firms size sectors; X are covariates; $u_1\, u_0\, u_{-1}$ are error terms. Control variables X include health and safety at work measures taken by other agents than the employer (worker delegates, occupational physicians, Work Inspectorate and others), percentage of workers under fixed-term contracts, men age, temporary or fixed-term workers and non-skilled workers.

The potential non-linear effect assumed in our approach is formalized through the introduction of the three parameters: $a_1\, a_0\, a_{-1}$. We examine also the hypothesis that the influence of premium variations (<2%, [2%;5%] and >5%) on outcomes may be heterogeneous according to different sectorial firms size. Sectors with an important proportion of small firms are consequently more often subject to collective rating, thus the treatment effect may be low compared with sectors that concentrate firms with more than 200 workers (fully experience rated firms). This heterogeneity due to firms size is formalized in those equations: we introduce a vector F that includes sectorial proportions of firms with less than 50 workers (collective or quasi-collectives rates), 50 to 199 (partially experience rated firms) and 500 or more (where the reference is 200 to 499 workers).

The outcome is written:

(4) $\ln(y) = \ln(y_0) + Treat^{>5\%}(\ln(y_1) - \ln(y_0)) + Treat^{<2\%}(\ln(y_{-1}) - \ln(y_0))$

Using (1), (2) and (3), we have the two following equations:

(5) $\ln(y) = a_0 + (a_1 - a_0)Treat^{>5\%} + F\beta_0 + Treat^{>5\%} * F(\beta_1 - \beta_0) + X\gamma + u_0 + Treat^{>5\%}(u_1 - u_0)$
if $Treat^{<2\%} = 0$

(6) $\ln(y) = a_0 + (a_{-1} - a_0)Treat^{<2\%} + F\beta_0 + Treat^{<2\%} * F(\beta_{-1} - \beta_0) + X\gamma + u_0 + Treat^{<2\%}(u_{-1} - u_0)$
if $Treat^{>5\%} = 0$

Our interest parameters are the two average treatment effects:

$ATT^1 = a_1 - a_0$: average effect of a premium growth of 5% or more on the outcome, compared with a slow increase of 2% to 5%

$ATT^{-1} = a_{-1} - a_0$: average effect of a drop or maintenance on the outcome, compared with a slow increase of 2% to 5%

The coefficients $\beta_1 - \beta_0$ reflect the influence of firm size on ATT^1 and ATT^{-1}. It aims at taking into account that, the more the firms size sectors are important, the more sectors are experience-rated, the more variation premiums may influence the outcomes.

The vector F is composed of two variables: logged centred percentage of firms with less than 50 workers ($\ln(\%firmsize < 50) - \ln(0.24)$) and logged centred percentage of firms with 200 workers or more ($\ln(\%firmsize \geq 200) - \ln(0.36)$).

OLS regression results provide a first set of estimations. However treatment exogeneity is a strong hypothesis. We used a second empirical approach based on instrument variables. We adopt a binary treatment model with instrumental variables and heterogeneous response to treatment, following the methodology of Wooldridge (2010) and Cerulli (2014). A variable for each equation that satisfies the two conditions is required: the variable should be correlated with the treatment and it should not be correlated with the outcome variable y. We note *Z* a vector of instruments. The variable *Z* retained is a categorical index of the sectorial premium rate in 1999. Premium rate levels in 1999 is a proxy of work-related injuries and illnesses during the period 1995 to 1997; during this period, new occupational pathologies were better administratively recognized favoured by a better communication and awareness on occupational musculoskeletal disorders among workers population and healthcare professionals. This new context during this period may have implied more prevention efforts from different levels (state, activity sectors, unions, insurers and firms) inducing a diminution of the probability of a high premium growth between 2004 and 2005 (we remind that premium rates in 2004 and 2005 are calculated on the base of workplace injuries and illnesses of the past period 1999 to 2003; see section 2). We assume that premium levels in 1999 do not influence directly our outcomes in 2005 insofar as, first, premium levels in 1999 reflect a very distant situation (premiums in 1999 are calculated on the base of workplace injuries and illnesses of the past period 1995 to 1997) and, second, in the regressions, we control for institutional prevention efforts in 2005. We specify the following first step Probit models:

$$Treat^{>5\%}* = \varphi_0 + X\varphi_1 + Z\varphi_{2+}\varepsilon \quad if \quad Treat^{<2\%} = 0$$

$$Treat^{>5\%} = \begin{cases} 1 & if \quad Treat^{>5\%}* \geq 0 \\ 0 & if \quad Treat^{>5\%}* < 0 \end{cases}$$

$$Treat^{<2\%}* = \kappa_0 + X\kappa_1 + Z\kappa_{2+}v \quad if \quad Treat^{>5\%} = 0$$

$$Treat^{>5\%} = \begin{cases} 1 & if \quad Treat^{<2\%}* \geq 0 \\ 0 & if \quad Treat^{<2\%}* < 0 \end{cases}$$

We use a probit two-stage least square (probit-2SLS) estimation, as developed in Cerulli (2014). Estimations for those two equations are reported in Annex. We found that the more the sectorial premium rate in 1999 is high, the more the probability of premium increase between 2004 and 2005 is low. And we found that the more the sectorial premium rate in 1999 is high the more the probability of premium increase between 2004 and 2005 is low, which suggest that safety and health efforts in those sectors induce a relative stabilisation of premium rates but do not allow a diminution.

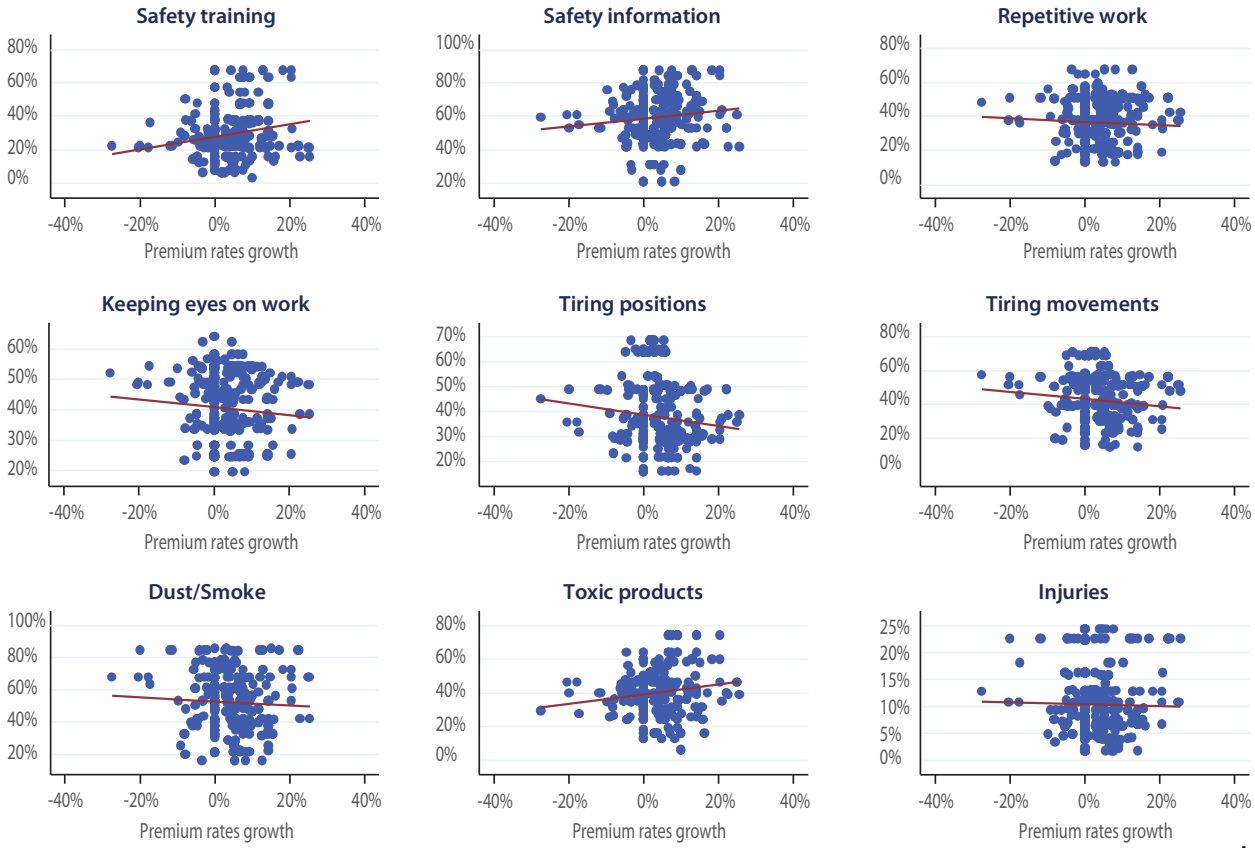
In all our estimations, standard errors are calculated using bootstrap (1,000 replications), that allows not specifying the structure of variance-covariance matrix.

5. Results

5.1. Effects of premium variations on outcomes

Figure 4 reports graphical results on correlations between each outcome in 2005 and premium variations between 2004 and 2005. They suggest that safety training and safety information provided by employers are more developed when sectorial premium rates increase and less frequent when they decrease. Moreover, when premium rates increase, adverse working conditions and work-related injuries are less frequent; and when premium rates decrease, adverse working conditions and work-related injuries seem to be more important. An exception is observed for the outcome "toxic products exposure": this exposure is higher in risk sectors where premium rates increase. Toxic products exposures seem to be an inherent sectorial characteristic of work and firms activity, which might not be changed without structural changes in firms' equipment and production process. Thus this outcome is associated with premium variations and does not seem to be a lever for improving safety.

Figure 4. Correlation between outcomes and premium variations between 2004 and 2005



Scope: 396 risk sectors from industry and construction sectors
Red line: linear regression line

Table 3 reports OLS regression results examining the hypothesis of a non-linear correlation between outcomes and premium variations, controlling for covariates. Table 4 reports IV regression results. In each table, estimation results for equations 5 and 6 are presented. We comment, first, results for the equation 5 that provides estimations of the effect of a premium rates increase on outcomes. Then we comment results for the equation 6 that provides estimations of the effect of premium rates maintenance or drop on outcomes.

OLS regressions indicate that, in risk sectors subject to a rise in premium rates superior to 5% (Equation 5, coefficients estimated for ATT^{1}), the prevalence safety information provided by employers is higher when premium rates increase (+7.9%[3]) in comparison with risk sectors in which there is flat premium variations; the intensity of the coefficient is higher (but not significantly) when sectors firms size are higher. IV regression provides the same result but the estimated coefficients are not significant. Repetitive work is not significantly higher when premium rate increases; however it depends on firms size: a high proportion of firms with less than 50 workers induce a significantly higher level of repetitive work proportion (estimated coefficient: +0.147**). IV results do not provide significant results. The prevalence of tiring postures is significantly lower when premium rates increase. And the more the sectorial proportion of firms with 200 workers or more (that are fully experience-rated) is important, the more the prevalence of tiring postures is low (the estimated coefficient is -0.292**). Besides, we find also that the more the sectorial proportion of firms with less than 50 workers (under collective or quasi-collective rating) is important, the more the prevalence of tiring postures is low (the estimated coefficient is -0.132*); it is not expected however a collective action of small firms in reaction to important premium rates may potentially explain this result; IV results do not confirm this hypothesis. The percentage of workers exposed to tiring movements, dust or smoke and injuries rate are lower when premium rates increase. IV regression results confirm those significant relationships for those four outcomes.

Those regression results, obtained for industrial and construction sectors, are consistent with the hypothesis that premium rates increases induce work-related health and safety improvements, *via* organisational changes and reduction of physical risks and environmental risks, which lead to reduction in injuries rates.

Regressions results for the equation 6 compare risks sectors subject to a maintenance or drop in premium rates to risk sectors where premium rates increase slowly [+2%;+5%]. Coefficients estimated for ATT^{-1} indicate a higher percentage of information safety by employers (but not confirmed by IV regression), in risks sectors subject to a maintenance or drop in premium rates, compared with a slow increase. Regressions indicate lower percentages of workers keeping eyes on work, exposed to tiring positions and movements. Thus, a premium rates decrease does not seem to be a negative signal to firms that lead to relax efforts; quite the reverse, it seems to encourage them.

Firms appear to be reactive to upward variations premiums. And, when premiums go down, firms does not less invest in work reorganisation and risk prevention, or are not less proactive in terms of controlling workplace injury declarations. We conjecture that financial incentives due to the costs of adverse working conditions internalized by firms

[3] Outcomes are logged variables. Thus, for continuous variables, coefficients are elasticities and, for the treatment dummy variable, coefficients correspond to the following average effect ratio: 1.079=exp(0.0763) *i.e.* an increase of 7.9%.

Table 3. OLS Regression results

	Firms prevention efforts				Adverse working conditions and injuries													
	% Safety training (ln)		% Safety information (ln)		% Repetitive work (ln)		% Keeping eyes on work(ln)		% Tiring positions (ln)		% Tiring movements (ln)		% Dust or smoke (ln)		% Toxic products (ln)		% Injuries (ln)	
	Eq 5	Eq 6	Eq 5	Eq 6	Eq 5	Eq 6	Eq 5	Eq 6	Eq 5	Eq 6	Eq 5	Eq 6	Eq 5	Eq 6	Eq 5	Eq 6	Eq 5	Eq 6
ATT^{1}	0.0268		0.0763**		0.0406		-0.0427		-0.134***		-0.0589*		-0.150**		-0.0241		-0.246***	
	(0.0530)		(0.0333)		(0.0505)		(0.0516)		(0.0406)		(0.0357)		(0.0676)		(0.0574)		(0.0931)	
ATT^{1} # % Firms size <50 (ln)	-0.0167		-0.00585		0.147**		0.0342		-0.132*		-0.0313		-0.0835		0.0210		-0.268***	
	(0.0711)		(0.0354)		(0.0690)		(0.0889)		(0.0737)		(0.0570)		(0.0976)		(0.0727)		(0.0994)	
ATT^{1} # % Firms size >=200 (ln)	0.0420		0.0615		-0.0455		-0.151		-0.292**		-0.133		-0.377		0.175		-0.570***	
	(0.139)		(0.0653)		(0.145)		(0.205)		(0.143)		(0.124)		(0.257)		(0.152)		(0.215)	
% Workers receiving safety information from actors other than employer (ln)	0.381***	0.449***	0.131***	0.159***	-0.00912	0.0514	0.185***	0.210***	0.140***	0.154***	0.118***	0.140***	0.103***	0.0958***	0.293***	0.234***	0.255**	0.124
	(0.0717)	(0.0567)	(0.0236)	(0.0222)	(0.0537)	(0.0455)	(0.0427)	(0.0377)	(0.0342)	(0.0339)	(0.0344)	(0.0347)	(0.0385)	(0.0329)	(0.0550)	(0.0491)	(0.120)	(0.110)
% Men (ln)	0.379*	0.442***	0.331***	0.404***	-0.237**	-0.489***	-0.0809	-0.0283	0.0749	0.321***	0.102	0.289***	0.655***	0.797***	0.689***	0.532***	0.539**	0.828***
	(0.198)	(0.117)	(0.0690)	(0.0696)	(0.0979)	(0.103)	(0.0965)	(0.0894)	(0.0938)	(0.0788)	(0.0690)	(0.0692)	(0.121)	(0.0829)	(0.150)	(0.149)	(0.228)	(0.201)
% Workers aged: from 16 to 29 (ln) (ref: 30 to 49 years old)	-0.0329	-0.00455	-0.0429	-0.0430	-0.0933	-0.00950	-0.0962	-0.129**	-0.00169	-0.0920***	0.0949**	0.0567	0.00101	0.0238	0.0792	0.100	0.149*	0.0589
	(0.0626)	(0.0541)	(0.0320)	(0.0344)	(0.0735)	(0.0531)	(0.0609)	(0.0508)	(0.0465)	(0.0354)	(0.0443)	(0.0405)	(0.0586)	(0.0486)	(0.0575)	(0.0611)	(0.0776)	(0.0877)
% Workers aged: from 50 to 65 (ln) (ref: 30 to 49 years old)	0.167**	0.317***	-0.0609*	-0.0470	-0.217***	-0.148*	-0.00458	0.0295	0.0940*	0.0729	0.00198	0.0849	0.132	0.197**	-0.0870	-0.00161	0.158	0.376***
	(0.0673)	(0.0609)	(0.0344)	(0.0343)	(0.0760)	(0.0834)	(0.0648)	(0.0743)	(0.0517)	(0.0578)	(0.0522)	(0.0604)	(0.101)	(0.0856)	(0.0800)	(0.0739)	(0.122)	(0.112)
% Temporary workers (ln)	-0.00738	0.0424	-0.0344*	-0.0753***	0.0694	-0.0290	-0.00680	0.00154	0.218***	0.171***	0.106***	0.0904***	-0.0278	-0.0731**	0.0651*	-0.00841	-0.256***	-0.137*
	(0.0355)	(0.0353)	(0.0178)	(0.0176)	(0.0506)	(0.0431)	(0.0387)	(0.0311)	(0.0368)	(0.0308)	(0.0283)	(0.0260)	(0.0421)	(0.0329)	(0.0373)	(0.0365)	(0.0750)	(0.0749)
% Unskilled blue-collar workers (ln)	-0.0211	-0.0286	0.0799*	0.107***	0.508***	0.456***	0.220***	0.181***	0.207***	0.233***	0.305***	0.264***	0.0862*	0.226***	-0.0804	0.0602**	0.297***	0.0739*
	(0.0371)	(0.0189)	(0.0451)	(0.0302)	(0.0550)	(0.0390)	(0.0412)	(0.0296)	(0.0309)	(0.0217)	(0.0364)	(0.0276)	(0.0455)	(0.0273)	(0.0512)	(0.0299)	(0.0512)	(0.0419)
% Firms size: <50 (ln) (ref: firms size [50;199[)	-0.0957	-0.00848	-0.0391	-0.0279	-0.156***	-0.185***	0.0159	0.0638	0.133**	0.171***	0.160***	0.185***	-0.0450	0.0269	-0.0853	-0.0899**	0.378***	0.257***
	(0.0596)	(0.0470)	(0.0287)	(0.0227)	(0.0534)	(0.0383)	(0.0746)	(0.0531)	(0.0616)	(0.0569)	(0.0457)	(0.0350)	(0.0732)	(0.0419)	(0.0571)	(0.0371)	(0.0730)	(0.0935)
% Firms size: >=200 (ln) (ref: firms size [50;199[)	0.388***	0.500***	0.193***	0.206***	-0.177**	-0.190***	-0.0947	0.00236	-0.178**	-0.139***	-0.148*	-0.0905***	-0.306**	-0.194***	-0.167	-0.167***	0.115	0.0766
	(0.0995)	(0.0421)	(0.0527)	(0.0220)	(0.0853)	(0.0326)	(0.149)	(0.0457)	(0.0750)	(0.0386)	(0.0817)	(0.0252)	(0.151)	(0.0408)	(0.105)	(0.0381)	(0.116)	(0.0712)
ATT^{-1}		-0.0870		0.0613**		0.0539		-0.0886**		-0.0780**		-0.102***		-0.0327		-0.0426		-0.103
		(0.0565)		(0.0305)		(0.0474)		(0.0421)		(0.0313)		(0.0313)		(0.0422)		(0.0476)		(0.0895)
ATT^{-1} # % Firms size <50 (ln)		-0.0493		0.00579		0.0334		-0.197***		-0.118*		-0.158***		-0.0231		0.0162		0.0474
		(0.0573)		(0.0297)		(0.0547)		(0.0719)		(0.0642)		(0.0470)		(0.0533)		(0.0504)		(0.107)
ATT^{-1} # % Firms size >=200 (ln)		-0.0619		0.0493		-0.0692		-0.380***		-0.157**		-0.225***		-0.135		-0.0365		-0.184
		(0.0812)		(0.0525)		(0.105)		(0.147)		(0.0720)		(0.0820)		(0.0929)		(0.0841)		(0.150)
Constant	-0.652***	-0.0862	-0.441***	-0.416***	-0.614**	-0.710***	-0.518**	-0.497***	0.324*	0.163	0.360**	0.409***	-0.0863	0.254	-0.352	-0.266	-1.307***	-1.370***
	(0.221)	(0.159)	(0.144)	(0.125)	(0.287)	(0.224)	(0.226)	(0.177)	(0.165)	(0.138)	(0.181)	(0.143)	(0.229)	(0.165)	(0.227)	(0.187)	(0.378)	(0.256)
Observations	238	238	238	238	238	238	238	238	238	238	238	238	238	238	238	238	238	238
R-squared	0.813	0.810	0.797	0.758	0.662	0.661	0.453	0.485	0.687	0.766	0.774	0.771	0.492	0.676	0.679	0.512	0.468	0.350

Bootstrapped standard errors into brackets (1,000 replications); significance levels: * 10%; ** 5%; *** 1%.

Table 4. IV Regression results

	Firms prevention efforts				Adverse working conditions and injuries													
	% Safety training (ln)		% Safety information (ln)		% Repetitive work (ln)		% Keeping eyes on work(ln)		% Tiring positions (ln)		% Tiring movements (ln)		% Dust o r smoke (ln)		% Toxic products (ln)		% Injuries (ln)	
	Eq 5	Eq 6	Eq 5	Eq 6	Eq 5	Eq 6	Eq 5	Eq 6	Eq 5	Eq 6	Eq 5	Eq 6	Eq 5	Eq 6	Eq 5	Eq 6	Eq 5	Eq 6
ATT^{t}	0.0642		0.0775		0.0414		0.0159		-0.192*		-0.232*		-0.326*		0.00459		-0.492*	
	(0.157)		(0.0594)		(0.182)		(0.153)		(0.112)		(0.130)		(0.186)		(0.156)		(0.267)	
ATT^{t} # % Firms size <50 (ln)	-0.0292		-0.00657		0.120		0.00791		-0.0772		0.0460		0.0103		0.00173		-0.107	
	(0.121)		(0.0506)		(0.129)		(0.143)		(0.0963)		(0.119)		(0.166)		(0.117)		(0.202)	
ATT^{t} # % Firms size >=200 (ln)	0.0359		0.0612		-0.0589		-0.164		-0.265*		-0.0955		-0.331		0.165		-0.492**	
	(0.154)		(0.0719)		(0.171)		(0.225)		(0.140)		(0.142)		(0.265)		(0.159)		(0.219)	
% Workers receiving safety information from actors other than employer (ln)	0.375	0.438***	0.131***	0.158***	-0.0220	0.0832*	0.173***	0.219***	0.166***	0.192***	0.154***	0.162***	0.147***	0.114***	0.284***	0.191***	0.330***	0.175
	(0.0671)	(0.0627)	(0.0257)	(0.0265)	(0.0609)	(0.0505)	(0.0496)	(0.0448)	(0.0386)	(0.0438)	(0.0399)	(0.0409)	(0.0564)	(0.0420)	(0.0669)	(0.0633)	(0.119)	(0.127)
% Men (ln)	0.392**	0.462***	0.332***	0.405***	-0.207*	-0.544***	-0.0526	-0.0441	0.0157	0.256***	0.0189	0.251***	0.554***	0.765***	0.709***	0.606***	0.366	0.740***
	(0.190)	(0.134)	(0.0650)	(0.0702)	(0.117)	(0.118)	(0.115)	(0.0980)	(0.107)	(0.0974)	(0.0939)	(0.0858)	(0.153)	(0.0928)	(0.176)	(0.166)	(0.231)	(0.246)
% Workers aged: from 16 to 29 (ln) (ref: 30 to 49 years old)	-0.0386	-0.0282	-0.0433	-0.0446	-0.106	0.0578	-0.108	-0.110	0.0235	-0.0114	0.130**	0.103*	0.0439	0.0631	0.0704	0.00926	0.223**	0.166
	(0.0684)	(0.0833)	(0.0336)	(0.0464)	(0.0818)	(0.0802)	(0.0694)	(0.0698)	(0.0544)	(0.0658)	(0.0614)	(0.0605)	(0.0763)	(0.0680)	(0.0656)	(0.0953)	(0.0910)	(0.134)
% Workers aged: from 50 to 65 (ln) (ref: 30 to 49 years old)	0.156*	0.281**	-0.0615	-0.0494	-0.240**	-0.0451	-0.0262	0.0593	0.139**	0.196	0.0655	0.156*	0.209*	0.257**	-0.103	-0.140	0.291*	0.541***
	(0.0895)	(0.115)	(0.0445)	(0.0565)	(0.103)	(0.124)	(0.0863)	(0.0995)	(0.0690)	(0.123)	(0.0802)	(0.0882)	(0.115)	(0.118)	(0.0911)	(0.134)	(0.154)	(0.183)
% Temporary workers (ln)	-0.00290	0.0618	-0.0342*	-0.0740**	0.0793	-0.0842	0.00265	-0.0145	0.198***	0.105*	0.0781**	0.0522	-0.0615	-0.105**	0.0720*	0.0661	-0.314***	-0.225**
	(0.0424)	(0.0563)	(0.0198)	(0.0290)	(0.0599)	(0.0586)	(0.0469)	(0.0487)	(0.0386)	(0.0542)	(0.0353)	(0.0485)	(0.0589)	(0.0526)	(0.0432)	(0.0667)	(0.0916)	(0.114)
% Unskilled blue-collar workers (ln)	-0.0177	-0.0198	0.0801*	0.107***	0.515***	0.431***	0.227***	0.173***	0.192***	0.203***	0.284***	0.247***	0.0603	0.212***	-0.0751	0.0938**	0.253***	0.0341
	(0.0396)	(0.0285)	(0.0415)	(0.0305)	(0.0575)	(0.0446)	(0.0456)	(0.0332)	(0.0364)	(0.0350)	(0.0426)	(0.0311)	(0.0499)	(0.0316)	(0.0545)	(0.0367)	(0.0659)	(0.0565)
% Firms size: <50 (ln) (ref: firms size [50;200[)	-0.0855	0.00297	-0.0385	-0.0271	-0.133	-0.217**	0.0373	0.0543	0.0886	0.132	0.0977	0.163**	-0.121	0.00781	-0.0697	-0.0458	0.247	0.204
	(0.112)	(0.121)	(0.0460)	(0.0385)	(0.107)	(0.104)	(0.128)	(0.0702)	(0.0800)	(0.0936)	(0.106)	(0.0743)	(0.144)	(0.0783)	(0.0981)	(0.119)	(0.185)	(0.175)
% Firms size: >=200 (ln) (ref: firms size [50;200[)	0.390***	0.487***	0.193***	0.206***	-0.171*	-0.151***	-0.0898	0.0137	-0.188**	-0.0926	-0.163	-0.0634	-0.323*	-0.171***	-0.163	-0.220***	0.0852	0.139
	(0.113)	(0.0646)	(0.0595)	(0.0269)	(0.0915)	(0.0586)	(0.170)	(0.0509)	(0.0883)	(0.0572)	(0.108)	(0.0446)	(0.178)	(0.0519)	(0.104)	(0.0715)	(0.145)	(0.114)
ATT^{t}		0.0390		0.0579		-0.236		-0.0615		-0.379*		-0.231		-0.175		0.361		-0.552
		(0.236)		(0.112)		(0.207)		(0.186)		(0.207)		(0.169)		(0.192)		(0.251)		(0.389)
ATT^{-1} # % Firms size < 50 (ln)		-0.0718		0.00424		0.0977		-0.178*		-0.0408		-0.113		0.0144		-0.0706		0.150
		(0.140)		(0.0524)		(0.125)		(0.0942)		(0.111)		(0.0893)		(0.0977)		(0.147)		(0.203)
ATT^{-1} # % Firms size >=200 (ln)		-0.0763		0.0483		-0.0282		-0.368**		-0.108		-0.197**		-0.111		-0.0918		-0.119
		(0.121)		(0.0670)		(0.133)		(0.147)		(0.0967)		(0.0871)		(0.104)		(0.161)		(0.207)
Constant	-0.680***	-0.197	-0.442***	-0.423**	-0.676**	-0.394	-0.577**	-0.405	0.448**	0.541*	0.534**	0.628***	0.125	0.439	-0.395	-0.692**	-0.944**	-0.865*
	(0.248)	(0.305)	(0.166)	(0.181)	(0.338)	(0.359)	(0.260)	(0.272)	(0.209)	(0.308)	(0.239)	(0.226)	(0.266)	(0.274)	(0.257)	(0.353)	(0.417)	(0.482)
Observations	238	238	238	238	238	238	238	238	238	238	238	238	238	238	238	238	238	238
R-squared	0.813	0.803	0.797	0.758	0.658	0.563	0.444	0.468	0.658	0.594	0.723	0.709	0.432	0.632	0.677	0.252	0.380	0.229

Bootstrapped standard errors into brackets (1,000 replications); significance levels: * 10%; ** 5%; *** 1%.
Lecture: Coefficients reported in Table 3 and 4 are elasticities.
In table 3, the coefficient 0.381 estimated for the logged proportion of workers receiving safety information from actors other than employer indicates that an increase of 10% of this proportion is correlated with an increase of 3.8% of the sectorial proportion of workers receiving training formation from the employer.
Coefficients estimated for the dummy ATT^{t} are interpreted as follows. In table 3, the coefficient -0.134*** in equation 5 for the outcome "logged proportion of tiring positions" indicate that this proportion is 12.5% (calculated as follows: 0.125=1-exp(-0.134)) lower in treated sectors compared with the control group.

matter in a "good" way, insofar as they induce more awareness when costs increase but do not induce relaxing efforts when costs decrease.

5.2. Results for covariates

Table 3 and 4 provide also covariates coefficients estimations. According to those results in sectors with a high percentage of men, employer's safety training and information are more frequent than in sectors with high women percentage. This may partly be linked to work characteristics of men – higher exposures prevalence to dust, smoke, toxic and injuries among men than women–, but also among women a lower access to work-related prevention because of more precarious jobs, and women face certain type of painful working conditions: notably they are strongly exposed to work-related psychosocial factors (Norlund, 2010). Besides, the more prevention actors (employer excluded) are involved in safety information, the more employers are involved also; indeed, as expected, prevention actors efforts are more concentrated on activity sectors with frequent and visible adverse working conditions and injuries. The more sectors concentrate small firms, the more injuries and adverse working conditions are frequent. And, firms with more than 200 workers provide more access to safety training and information and are less concerned by adverse working conditions compared with firms of 50 to 200 workers. Finally, as expected, the sectorial proportion unskilled blue-collar workers and temporary workers are associated positively with higher prevalence of adverse working conditions and injuries, compared with sectors where the proportion of those workers is lower.

6. Conclusion

In this article, we provided an overview of the literature on incentive effects of experience rating on work-related health and safety, and a measurement of the relationship between premium rates changes and working conditions, employers prevention toward reducing work-related injuries, using sectorial French data.

Empirical literature studies analysing the effects of experience rated pricing mechanisms on work-related health and safety remain relatively scare. Results (mainly from the United States, Canada and Germany) suggest that firms respond in different ways to control insurance claims records: prevention effort including safety training, adaptations after injuries, specialised consultants and control of injuries claims. They highlight also effects in terms of reduction of injuries rates and periods of sickness absences. Besides, we identify empirical methods used in this literature based on three kinds of strategy: (1) comparing the effect of premium variations on outcomes among groups of firms that are experienced-rated or partially experience-rated (due to differences between firms size), (2) comparing before and after institutional changes and (3) comparing employers who declare they do not know the existence of experience rating to those that are informed. Regarding this last method it is interesting underline the importance of employers' awareness on experience rating as a factor of its incentive efficiency.

Then we provided a measurement of the relationship between experience rating in the French jurisdiction and several employers' investments in prevention, working condi-

tions and work-related injuries, using sectorial data for industry and construction sectors in 2005. Our results are consistent with the hypothesis according to which this policy tool contributes to improve working conditions and reduce injuries rates. Our results are globally coherent with empirical results found in other countries. We measure a reduction of tiring postures and movements, dust or smoke exposures and injuries rates, following a sectorial premium rate increase. Those results are coherent with Krajl (1994) notably. High premium levels and financial costs due to work-related disabilities seem to constitute a signal perceived by employers that encourage them to heighten the incorporation of work-related health and safety issues in decisions. Moreover, our results suggest that firms do not adapt their effort when premiums decrease. Thus firms appear to be reactive mainly to upward variations premiums. When premiums go down, firms do not less invest in work reorganisation and risk prevention. We conjecture that financial incentives due to the costs of adverse working conditions internalized by firms matter in a "good" way, insofar as they induce more awareness when costs increase but do not induce relaxing efforts when costs decrease.

The empirical approach in this article adds to the literature in two ways. It adds a study based on the French workers' compensation system. It uses sectorial administrative data matched with survey data, which enriches the understanding of behaviour outcomes insofar as survey data allow us examining working conditions outcomes (and not only workplace injuries outcomes). A shortcoming is that data are aggregated, which limits what can be discerned about individual firm behaviours.

Other empirical methods aimed at measuring causal effects of experience rating on work-related health and safety should be developed. Subsequent studies will go deeper through micro data analysis. In France, a new pricing mechanism was adopted in 2012, instituting a more easily identified repercussion of work-related injuries and illnesses on premium rates and an increase in the level of experience rating, that may influence firms practices. We are implementing currently an evaluation program using a quasi-experimental design and panel administrative micro data in order to investigate this issue. Besides, qualitative research is needed also in a way to understand behaviours and complete those empirical analyses. Furthermore, this article was focused only on work-related health and safety outcomes. Other behaviours are suspected such as underreporting, contesting costs and workers selection, as we mentioned in this article. Further research will go deeper in understanding those potential collateral effects of experience rating.

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Annex

IV regression: first step equation results

		Premium rates growth			
		>5% *versus* [2%;5%]		<2% *versus* [2%;5%]	
Premium rates in 1999 :]1.9% ; 2.3%] (Ref : Premium rates in 1999 ≤ 1.9%)		-0.269	**	-0.0871	
		(0.115)		(0.0786)	
Premium rates in 1999 :]2.3% ; 3.6%] (Ref : Premium rates in 1999 ≤ 1.9%)		-0.455	***	-0.340	***
		(0.0843)		(0.0803)	
Premium rates in 1999 :]3.6% ; 5%] (Ref : Premium rates in 1999 ≤ 1.9%)		-0.273	***	-0.185	*
		(0.0895)		(0.0951)	
Premium rates in 1999>5% (Ref : Premium rates in 1999 ≤ 1.9%)		-0.473	***	-0.238*	
		(0.155)		(0.122)	
% of workers receiving safety information from actors other than employer (ln)		0.310	***	0.212	**
		(0.0788)		(0.0830)	
% of men (ln)		-0.229		-0.250	
		(0.176)		(0.165)	
% of workers	aged from 16 to 29 (ln) (ref: 30 to 49 years old)	0.178	**	0.166	**
		(0.0848)		(0.0799)	
	aged from 50 to 65 (ln) (ref: 30 to 49 years old)	0.269	**	0.306	***
		(0.119)		(0.110)	
% of temporary workers (ln)		-0.107		-0.215	***
		(0.0886)		(0.0786)	
% of unskilled blue-collar workers (ln)		-0.00729		-0.0214	
		(0.0642)		(0.0553)	
% of firms	size < 50 (ln) (ref: firms size [50;199[)	-0.00983		-0.0249	
		(0.0436)		(0.0492)	
	size > 200 (ln) (ref: firms size [50;199[)	0.127	*	-0.0359	
		(0.0664)		(0.0696)	
Constant		1.934	***	1.114	**
		(0.466)		(0.455)	
Observations		238		238	
Ajusted R-squared		0.274		0.195	

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Workers Compensation Insurance: Incentive Effects of Experience Rating on Work-related Health and Safety

Assurance des risques professionnels : les effets incitatifs d'une tarification individualisée

Pascale Lengagne

This article examines Workers Compensation Insurance experience rating premiums setting, a common financial incentive tool existing in several countries. Premiums paid by firms are experience rated, which may encourage them to reduce work-related injuries and disabilities. This article provides a literature review on effects of experience rating on work-related health and safety and empirical results on the French jurisdiction, using sectorial data from industry and construction sectors in 2005. Results are consistent with the hypothesis that this policy tool is a lever that contributes to improve working conditions and reduce work-related injuries rates.

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L'assurance des risques professionnels couvrant les salariés du régime général est financée sur la base de cotisations patronales dépendantes de la sinistralité passée de l'entreprise. Ce système de tarification peut, ainsi, contribuer à sensibiliser les employeurs à l'intérêt de développer des démarches préventives. Cet article propose une synthèse de la littérature empirique étudiant cet effet incitatif, puis présente une mesure de la relation entre les taux de cotisationset l'effort de prévention des entreprises, les conditions de travail et les accidents du travail, à partir de données françaises au niveau sectoriel, dans l'industrie et la construction. Selon nos résultats, l'augmentation des taux de cotisation est associée à une amélioration des conditions de travail et un moindre taux d'accidents du travail, toutes choses égales par ailleurs.

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