LABOUR ACCIDENTS AND FINANCIAL PERFORMANCE: EMPIRICAL ANALYSIS OF THE TYPE OF RELATIONSHIP IN THE SPANISH CONTEXT

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ABSTRACT

This paper performs an empirical research and finds a negative relationship between accidents in the workplace and financial performance. The relationship is stronger and more persistent on one year ahead performance than on the current year. We find no significant evidence of curvilinear U-shaped or inverted U-shaped relationships. Results are strong across different industries and samples, variable definitions and model specifications. The study contributes to the scarce extant research with reliable data and samples of a wide span of industries. It also contributes methodologically with refined analyses of the curvilinear relationship and providing robust widespread inference for a large number of industries.

Keywords: labour accidents, accidents in the workplace, financial performance, profitability, safety

1. Introduction

Some authors argue that a successful safety program implementation and safety improvement needs managers' active implication and their adequate understanding of what safety is and their economic consequences and rewards [1] [2] [3]. However, economic evaluations of safety, and more precisely of labour accidents are not usually accurately assessed by managers [4]. Managers have vague and little assessment of the economic consequences of labour accidents [5] [6]. Some in-deep surveys conducted with managers [7] [8] report that they are scarcely aware of the costs and economic benefits caused by the implementation of safety programs and/or lack of safety in organizations. According to these studies, managers barely conduct calculations of the costs and benefits of their safety management practices, and when they do it they perform rough calculations. They do not develop systematic accounting techniques and monitoring of costs and income related to safety. However, the ultimate goal of firms is profitability, and economic evaluations are needed to figure out of the economic value of safety to firms' managers, and therefore take appropriate decisions related to safety.

There is a bulk of empirical research analysing the economic consequences of work injuries and illness. According to Weil's [9] and more recent [10] [11] reviews, most of this research analyses the consequences of lack of safety for the whole economy, at a country level. Some other studies [12] [13] analyse the consequences for workers. At a firm level, there is huge business academic research analysing the relationship between different aspects of corporate social responsibility and financial performance, as can be seen in a recent literature review by Kong et al. [14], where work safety deserves limited attention within the different indicators of corporate social responsibility, and work accidents are almost non-existent in these measures. There are also some analytic studies providing models for the evaluation of operational costs caused by work accidents [15] [16] and some empirical studies analysing some different aspects of safety costs and benefits associated to the implementation of safety programs in organizations [17] [18] [19], performed with 159, 37 and 20 responses, respectively, to questionnaires.

There are few empirical studies relating financial performance with safety. Kalemba and Campa-Planas [20] find no significant effect of safety on financial performance in the airline industry. Miller and Saldanha [21] use an opposite approach and find a positive influence of financial performance at year *t*-1 on different measures of safety at year t in the motor carrier industry, but they do not focus on accident rates. Fernández-Muñiz et al. [22] [23] find a positive influence of safety on financial performance with samples of 455 and 131 Spanish firms from different sectors. Similarly, Lee et al. [24] find positive correlation between safety climate and productivity in a sample of 10 firms. These authors base their findings on responses to questionnaires, where the measures of safety and performance are provided by firms' safety officers responses that do not include data on labour accidents. Previous similar studies find no influence [25], or positive influence [26] [27] of financial performance on several measures of carrier safety, including recorded carrier accidents.

Denommee-Gravel and Kim [28]do not find a significant relationship between pipeline accidents and incidents and financial performance in the same year. They find an indirect positive effect when there is environmental consciousness. Kabir et al. [30] perform an event study and find that negative workplace announcements have negative effects on firms' stock prices in various industries in the US. Both studies do not solely analyse the effects of labour accidents, but also different kinds of safety incidents, such as for example fines imposed or criminal liabilities for safety reasons. Therefore, the specific effect of labour accidents is not clearly ascertained in these studies.

Empirical research analysing the specific relationship between accidents in the workplace and financial performance is scarce and the corresponding results non-conclusive. Reiman et al. [31] perform a case study of an energy Finnish company that engaged in a program of occupational safety and health, that over a period of years entailed a reduction of labour accidents, calculate costs and annual savings of this programme and outcome, and find a positive relationship between the reduction in labour accidents and the economic cost-savings balance attained. The study provides interesting insights, but it does not allow statistical inference. Argilés-Bosch et al. [32] find that labour accidents have a significant negative influence in one year ahead financial performance, suggesting that they are disruptors of business operations that handicap value added activities, such as long term coordination and planning. The authors also find a negative relationship between accidents and financial performance in the same year, but it is non-significant. They do not provide information on tests of linear relationships in their study. Using similar methodology Forteza et al. [33] claim to have found an inverted U-shaped relationship between accident rates and financial performance, with a positive relationship between both variables within a first range of accidents until a tipping point from which additional accidents reduce the financial performance of the firm. Given the coefficients of the variable for accident rate and its quadratic term, the maximum of profitability is attained at 96.33% 96.65% and 99.25% of their employees affected by accident rates in their pooled, random and fixed effects estimations respectively[1], accident rates that are obviously out of the distributional range of this variable[2]. It seems implausible that almost 100% of the firms' workers may have an accident in a firm in a given accounting period. Therefore, the corresponding U-shaped relationship do not seem reliable. In this vein, Lind and Mehlum [34] and Argilés-Bosch et al. [35] argue that it is not unusual that studies published in leading economic and business journals conclude inappropriately on the existence of maximum and/or minimum points in the relationships between independent and dependent variables. These authors argue that apart from a significant sign for the coefficient of the squared variable, the existence or U-shaped or inverted U-shaped relationships requires that the maximum or minimum points should lie

[1] See page 70 in [33]

[2] Mean 13% with 12% and 14% confidence interval at 95%, with standard deviation of 0.01.

within the data range of the variable, and that tests should be performed for the slopes of the lower and upper bounds of the variable's range. Consequently, despite the negative sign of the quadratic term in Forteza et al. [33], the relationship between accidents in the workplace and financial performance is actually positive and concave, and the maximum financial performance would be attained far beyond the range of the independent variable labour accidents.

While Argilés-Bosch et al. [32] use a small sample of Catalan firms from three industries, and Forteza et al.'s [33] study is limited to few construction firms in Mallorca, Spain, and their results are opposite, the current study pretends to provide additional and more conclusive empirical evidence on the relationship between accidents in the workplace and financial performance. We perform a replication study with all recorded data on accident rates (instead of a small sample of firms) in the manufacturing, electricity, water supply, construction, wholesale, retail, and transportation sectors in Spain. In this way we contribute to the limited and non-conclusive extant empirical research on this topic.

We use data from a large number of industries and find a persistent negative influence of labour accidents on firm financial performance. The influence is more strong and significant on one year ahead performance, than on current year performance, thus suggesting that when an accident in the workplace occurs the organization is focused on ensuring the fulfilment of daily operations, while strategic tasks are postponed. Labour accidents are disrupting events that produce unintended effects of stressing the short term organizations' focus at the expense of value added activities, with negative long term economic consequences. We find no significant evidence of U-shaped or inverted U-shaped relationships. Results are strong across different industries, section industries, variable definitions and model specifications.

This study contributes to the scarce extant empirical research on the relationship between labour accidents and firm profitability. It also contributes methodologically, with specific robust tests for curvilinear relationships. Finally, it contributes with analysis of a wide span of industries, large samples and reliable data on accident rates and financial performance.

The remaining of the paper is organized as follows. The next section raises hypotheses, we follow with methodology issues, explain results, discuss implications and finish with concluding remarks.

2. Hypotheses development

The objective of this paper is to analyse the relationship between accidents in the workplace and financial performance.

The current research is a replication study of the opposite results by Argilés-Bosch et al. [32] and Forteza et al. [33], trying to provide more conclusive empirical evidence. We therefore formulate the main hypotheses raised in these studies, where detailed arguments about these hypotheses can be found.

On the one hand, safety may increase productivity and firm performance because it has a positive impact on morale, motivation and involvement with firm's objectives, improve the employees' perceived organizational support and their commitment with the organization, reduce absenteeism, etc. with an overall positive impact on firm performance [17] [36] [37] [38]. On the other hand, labour accidents trigger a set of direct costs, such as financial damage, lost time, health expenses, as well as indirect costs such as extra-work required, worsening of production quality, deterioration of industrial relations, etc. with harmful effects on firm performance [39]. Accidents can also disrupt production processes and usual operations, halt production, cause failing to attend delivery dates, confront managers with unwanted and unplanned events, thus causing important costs [5] that reduce financial performance.

Argilés-Bosch et al. [32] argue that unsafe management undermine workers' motivation and that work accidents interrupt the daily operations, damage properties, increase costs, halts production activities, withdraw skilled employees from current operations and jeopardize financial performance. They therefore raise the following hypothesis:

H_1. Work accidents have a negative effect on financial performance in the same year

These authors rely on Corcoran [40] arguing that the true economic influence of work accidents is mostly in the long term, because they disrupt firms' operations diverting employees attention from most value-adding strategic task, such as planning and coordination activities, into ordinary operations. These tasks may include process improvement, research and development, product development, quality assurance, etc. Neglecting such strategic key tasks is detrimental to building firm capabilities that would provide future competitive advantages and in the long term damage firm performance.

There is a wide bulk of research supporting that strategic planning is beneficial for product development, new ventures, value-creating activity and future financial performance [41] [42]. Considering that labour accidents postpone and jeopardize all these long term and planning activities [32], the following hypothesis is formulated:

H_2. Work accidents have a negative effect on financial performance in the following year

Some authors [43] [44] argue that occupational health and safety costs include expenses incurred in prevention costs, which they distinguish from accident costs. As more efforts are made to eliminate risks, these costs increase, but on the other hand the costs caused by labour accidents, both direct and indirect decrease, while in the absence, or low levels, of such prevention labour accidents and their related costs would soar, thus suggesting the existence of an overall pattern of occupational health and safety costs depicting a U-shaped curve. Hallowel [45] found empirical evidence of this relationship, and Bayram et al. [17] found indirect empirical evidence, through a positive association of prevention costs with occupational health and safety (OHS) performance and a positive association of OHS performance with saving in accident costs. This cost behaviour suggests the existence of an opposite inverted U-shaped profit cost function, which allow managers the opportunity to find an optimum profit when they find the appropriate balance of firms' resources devoted to safety and health.

Similarly, Forteza et al. [33] argue on the existence of decreasing prevention/protection costs, matched with increasing accidents costs, as safety improves. The addition of both opposite cost behaviours depicts an overall U-shaped cost function, and its opposite hump-shaped income function. Consequently, the relationship between labour accidents and financial performance is not linear, but curvilinear, depicting an inverted U-shaped where the maximum point of financial performance is attained at a certain crucial level of working accidents. Therefore, they formulate the following hypothesis:

H_3. For low levels of accidents there is an increasing positive effect on firm financial performance in the same year, while for large levels of accidents there is an increasing negative effect on firm performance in the same year.

According to the long-term disruptive effect of labour accidents on firms' operations and financial performance, the most pervasive influence of accidents in cost accidents would be in the long term. Additionally, the implementation and development of safety programs commits investment and future current resources which translate in the incurrence of increasing future prevention costs. Therefore, current accidents and future financial performance would depict an inverted U-shaped relationship, and consequently we raise the following hypothesis:

*H*4. For low levels of accidents there is an increasing positive effect on one year ahead firm financial performance while for large levels of accidents there is an increasing negative effect on one year ahead firm performance.

3. Empirical design.

As mentioned, we replicate the studies by Argilés-Bosch et al. [32] and Forteza et al. [33], and we consequently use the models used in these studies. These models have been widely used in previous business empirical research [46] [47]. Current firm performance depends on past performance, which captures a set of firm characteristics influencing current performance, on current management decisions, which elicit changes in firm efficiency, and on our experimental variable. We therefore formulate the following models:

$$ROA_{i,t} = \beta_0 + \beta_A \cdot ACRATE_{i,\tau} + \beta_R \cdot ROA_{i,t-1} + \beta_C \cdot CHASSETURN_{i,t} + \sum_{i=1}^{m} \beta_S \cdot SECTOR_i + \varepsilon_{i,t} \,, \quad (1)$$

and

$$ROA_{i,t} = \beta_0 + \beta_A \cdot ACRATE_{i,\tau} + \beta_Q \cdot ACRATE2_{i,\tau} + \beta_R \cdot ROA_{i,t-1} + \beta_C \cdot CHASSETURN_{i,t} + \sum_{i=1}^{m} \beta_S \cdot SECTOR_i + \varepsilon_{i,t} \,, \quad (2)$$

where

ROA = return on assets

ACRATE = accident rate

CHASSETURN = change in assets turnover

SECTOR = industry (dummy variables indicating *m* different sectors)

*ACRATE*2 = squared accident rate squared

subscripts *i* and *t* = the observations refer to sector *i* and year *t*

m = number of sectors

β_0, β_A, β_Q, β_R, β_C, and β_S, = parameters (coefficients or slopes) to be estimated for the intercept and different variables.

ε = the error term

τ = either *t* or *t*-1

Each observation refers to sector *i* in a given year *t*. *ROA* is return on assets, the percent of income before taxes and financial expenses to total assets. It measures firms' profitability and it is widely used in business research as a measure of firma financial performance, as can be seen in review studies [42] [48] [49] [50] [51]. We expect a positive relationship between previous and current financial performance. *ACRATE* is accident rate, measured as accidents by 100,000 employees, and *ACCRATE*2 is its corresponding squared term. They are our experimental variables. Significant negative signs for the coefficient of the former and the latter, the corresponding squared form, would provide support for our hypotheses H_1 and H_2, and H_3 and H_4 respectively. *CHASSETURN* approaches changes in firm efficiency introduced by management decisions in the current year, thus complementing characteristics included in past financial performance. It is the difference between assets turnover in a given year and in the previous year, relative to asset turnover in the previous year. The variable was also used in the articles that we replicate with this study. We approach efficiency with assets turnover, the ratio of sales to total assets, commonly used as a measure of efficiency [52] [53]. As positive changes in efficiency should influence higher profitability, we expect a positive sign for this variable. *SECTOR* are dummy variables controlling for industry behaviour and characteristics, considering that there are substantial differences in financial performance and accident rates between industries. We use two-digit industry codes of the Spanish classification of industrial activities. Given that our purpose is to test our hypotheses on the incidence of accident rate in a given year to industry profitability in the same year and to profitability in the following year, τ may be either *t* or *t*-1.

4. Sample and data

The Spanish Ministry of Labour and Social Economy (*Ministerio de Trabajo, Migraciones y Seguridad Social*) offers data on yearly labour accidents by industry. In 2009 Spain adopted the European statistical classification of economic activities, commonly referred to as NACE (for the French term *"nomenclature statistique des activités économiques dans la Communauté européenne"*), and the data series of labour accidents by this new industry classification is available since 2008.

Forteza et al. [33] performed their study with data of a sample of 272 construction firms from 2004 to 2009, and Argilés-Bosch et al. [32] with data of a sample of 299 firms from 2003 to 2006, belonging to the three industries with the highest accident rates in the old Spanish statistical classification of economic activities (set up in 1993 with the name *clasificación nacional de actividades económicas*: CNAE), coded as divisions 28 (manufacture of metal products, except machinery and equipment), 45 (construction) and 52 (retail trade, except of motor vehicles and motorcycles; repair of personal and household goods).

As the main purpose of this research is to replicate these studies that found opposite results, aiming to cast light on the relationship between labour accidents and financial performance with more conclusive evidence, we start analysing a more representative sample of these three sectors, labelled as divisions in the European Statistical Office (EUROSTAT) [54], and then we enlarge the analysis to all industries belonging to the wide span of economic activities where these sectors with high accident rates are included, namely from manufacturing to construction, trade and transportation. Table 1 displays the main correspondence between these three CNAE 1993 industry divisions and their equivalent in the current NACE classification of economic activities. As the NACE 2009 organised the 17 and 62 divisions of the NACE 1993 into 21 sections and 88 divisions, there is no exact fit between these divisions, but most content of their is common.

Therefore, we perform a first analysis for the three groups of NACE industry divisions showed in Table 1: a first group with divisions 24 and 25, a second group with divisions 41, 42 and 3, and a third one with division 47. In a second stage we expand the analyse to NACE industry sections C to H, including NACE industry divisions 10 to 53. Table 2 offers a full list of these sections and divisions. Accordingly, we analyse the following section industries: C manufacturing (divisions 10 to 33), D energy (division 35), E water (divisions 36 to 39), F construction (division 41 to 43), G wholesale and retail (divisions 45 to 47) and H transportation and storage (divisions 49 to 53). Given the sole division included in section D, we join sections D and E in a single group, energy and water. We exclude the agricultural, extractive, financial, tourism, science, public administration, and other service industries from the analysis, because of its different characteristics or lower levels of accident rates.

(insert Tables 1 and 2 around here)

We download data of labour accident rates by industries from the Spanish Ministry of Labour and Social Economy webpage from 2008 to 2018[3]. We then elaborate the necessary data included in Equations (1) and (2), variables *ROA* and *CHASSETURN*, at industry level with data of firms included the SABI (*sistema de análisis de balances ibéricos*: Iberian balance sheet analysis system) database. SABI is a tool that provides balance sheet information of more than 2.7 million Spanish and more than 800,00 Portuguese companies. For a given industry and year we collect the median values of these variables for all Spanish firms included in the database. We use median instead of mean values, because the former are more representative of sample characteristics than the latter, and is less influenced by extreme values. Table 2 displays descriptive statistics of these variables and the yearly average number of firms with available information in any of these industries. The large number of observations, yearly average 423,502 and 351,264 firms for *ROA* and *CHASSETURN* respectively over the period analysed, and yearly average 10,587.6 and 8,781.6 firms per sector for these variables respectively, warrants that SABI data are representative enough of the financial performance of the firms in these industries, ranging from the lowest yearly average number of 14.2 firms in NACE division 18 (printing and reproduction of recorded media) for variable *CHASSETURN*, to the highest 83,110.3 firms in NACE division 46 (wholesale trade, except of motor vehicles and motorcycles) for variable *ROA*. The lower number of firms for variable *CHASSETURN* than for *ROA* is due to the required lagged values for the calculation of this former variable.

[3] The webpage http://www.mitramiss.gob.es/es/estadisticas/anuarios/2018/index.htm offers accident rates at division industry level (i.e.: two-digit industry code level).

The yearly average median *ROA* and *CHASSETURN* are 2.34% and -1.78% respectively for all industries over the period of the study, and the yearly average accident rate per industry is 4,975.9 labour accidents with time off from work per 100,000 employees in the industry, ranging from the yearly average minimum 1,005.4 in industry division 19 (manufacture of coke and refined petroleum products) to the maximum 8,524.4 in division 25 (manufacture of fabricated metal products, except machinery and equipment), very closed to the figures for division 42 and 41 (civil engineering and construction of buildings respectively).

The low Pearson correlations between the independent variables included in Equations (1) and (2), with the highest -0.314 and significant at $p<0.01$ between *CHASSETURN* and lagged *ACRATE*, suggest that collinearity is unlikely to affect estimations (see Table 3). The high 0.9586 Pearson correlation, significant at $p<0.01$, is between current and lagged *ACRATE*, both variables are never simultaneously included in the same estimation.

(insert Table 3 around here)

5. Results.

5.1. Replication industries.

Given the panel data structure of our data, we run the F-test for the unit-specific error term in panel data estimations, which indicates the convenience of running panel data estimations instead of ordinary least squares (OLS). We then run the Hausman test for the null hypothesis of no correlation between the individual effects and the explanatory variables. However, given that the fixed effects estimation removes for collinearity all variables with the same values over the period analysed, more precisely the dummy variables for industries, we run panel data estimations with fixed and random effects. We also run the Breusch-Pagan/Cook-Weisberg test for heteroscedasticity and apply robust estimations when necessary. The different tables indicate the type of estimations run in any specific case.

Table 4 shows estimations of Equation (1) for the three replication industries (CNAE 1993) included in Table 1, when financial performance depends on labour accidents in the same year. Columns 1 and 2 display fixed and random effects estimations for the total sample with all these sectors, and the remaining columns present results for the metal, building and retail sectors. Estimations for all industries present significant goodness of fit with R^2 above 0.8. All coefficients of *ACRATE* are negative, and significant in all cases at $p<0.05$, with the exception of estimations for the retail industry (column 6), thus providing support for hypothesis H_1. Control variables *CHASSETURN* and lagged *ROA* present the expected positive signs, significant at $p<0.01$ in all cases, with the exception of column 6, where the coefficient of *CHASSETURN* is significant at $p<0.05$. The dummies for industries indicate significant differences in financial performance in most cases. However, the results for fixed and random effects estimations are very similar for the remaining variables.

(insert Table 4 around here)

Table 5 shows the corresponding estimations of Equation (1) for these industries when financial performance depends on labour accidents in previous year. Results are very similar to those of Table 4. With respect to our variable of interest, *ACRATE*, its coefficient is negative and significant in all cases (at $p<0.01$ in columns 1 to 4 and at $p<0.05$ in columns 5 and 6), thus providing support for hypothesis H_2. It should be pointed out that the coefficient of *ACRATE* in the retail industry is significant, despite it is not significant in Table 4 (see columns 6 in Tables 4 and 5).

(insert Table 5 around here)

Table 6 presents results for estimations of Equation (2), testing the curvilinear relationship between labour accidents and financial performance in the three replication industries. We follow the methodology proposed by Lind and Mehlum [34]. As the coefficient of the quadratic form is non-significant (at $p<0.1$) in most estimations (columns 1 to 5), there is no curvilinear relationship in none of these industries, with the exception of the retail sector, where the coefficient of the squared variable is positive and significant, thus indicating the existence of a non-linear relationship. The minimum profitability in the current year is attained at 2,783.8 and 3,263.7 accidents per 100,000 employees in the previous and current years respectively (see column 6). These accident rates are high, given the range values of labour accidents in the retail sector: minimum of 2,183.9 and maximum of 3,869.8 over the period analysed. Most distributional values of the independent variable present a negative relationship with the dependent variable (67.7% and 82.57% for current and lagged accident rates respectively), and the Fieller test indicates the existence of a significant (at $p<0.05$ in panel A and at $p<0.01$ in panel

B) positive slope in the upper range of the distributional values. However, the U-shaped relationship between current labour accidents and financial performance is not consistent enough, as the upper bound of the Fieller interval at 95% (3,897.2) is out of the distributional values of the variable in this industry (a maximum of 3,869.9): see column 6 in panel A. The existence of a minimum point can only be consistently ascertained for the influence of current labour accidents in the following year, but not in the current year. Therefore, these empirical findings do not provide robust support for hypotheses H_3 and H_4 and the subsequent findings of Forteza et al. (2017). On the contrary, there is weak support (only for industry 47) on the existence of an opposite curvilinear relationship between labour accidents and financial performance, U-shaped instead of the inverted U-shaped relationship found by these authors, with the minimal profitability attained at the extreme upper bound of the distributional values of accident rates.

Alternative estimation methods provide very similar results to those of Tables 4, 5 and 6

(insert Table 6 around here)

5.2. Additional industry analyses.

As mentioned, we enlarge our analysis to a wider span of industries, comprising the three sectors included in the two studies that we replicate in this article, NACE sections C to H, including NACE codes 10 to 53.

Table 7 shows results of the estimations of Equation (1) for these industry sections, when financial performance in current year depend on labour accidents in current year. Results for the construction sectors (section F) are not included in this Table, because they are displayed in Table 4. Estimates for dummies of sectors are also not displayed in the table, for simplicity reasons. As for our variable of interest, *ACRATE*, all coefficients are negative and significant at $p<0.1$, with the exception of column 5. Results provide an overall support for hypothesis H_1, thus reinforcing results in Table 4.

(insert Table 7 around here)

Table 8 shows results for the estimations of financial performance in current year depending on labour accidents of previous year. In all cases the coefficient of *ACRATE* is negative and significant at $p<0.01$ (columns 1, 2, 3 and 5), and at $p<0.1$ (column 4), thus providing reinforced support for hypothesis H_2. As most significances and all absolute values of these coefficients increase with respect to Table 7, these results support the argument that the true and main consequences of labour accidents appear in the long term.

(insert Table 8 around here)

We then test the existence of curvilinear relationships between these variables in these industries. Results, displayed in Table 9 show that the coefficients of squared labour accidents are non-significant in most cases. Only in the relationship in the same year with the whole sample the coefficient is significant at $p<0.1$ (column 1 in panel A), and in the relationship between current financial performance and lagged labour accidents the coefficients are significant (at $p<0.01$) in the whole sample and in the manufacturing sector (columns 1 and 2 in panel B). All coefficients are positive, thus indicating the existence of a possible U-shaped relationship, but the minimum profitability is attained at accident rates at the upper values of the distributional ranges of this variable in the corresponding samples and subsamples (above 95.85%, 98.47% and 99.23% the distributional ranges). We again follow the methodology and tests proposed by [34] to ascertain the existence of an U-shaped relationship. The Fieller test is non-significant (at $p<0.1$) in all cases, indicating that the relationship has no significant positive slope beyond the accident rates where the financial performance is minimal. Moreover, the upper bounds of the Fieller intervals are out of the distributional ranges of the variable *ACRATE* in these samples and subsamples. Altogether, these results indicate that despite the existence of significant positive coefficients of the squared variable for labour accidents in few cases, in none of them exists a plausible U-shaped relationship. The relationship is negative. In few cases it is convex, but merely negative. Moreover, these results fail to provide support for hypotheses H_3 and H_4 corresponding to Forteza et al.'s (2017) findings of inverted U-shaped relationships.

(insert Table 9 around here)

Estimations with alternative estimation methods are very similar to those displayed in Tables 7 to 9, with few non-essential exceptions, such as for example that the coefficient of the lagged value of *ACRATE* in column 5 in panel B in Table 9 is negative and significant at $p<0.1$ in the estimation with random effects.

5.3. Results with standardized values

A possible concern about previous estimations is that the financial performance and accident rates are very different across industries. We standardize all our dependent and independent variables with industry divisions mean and standard deviations over the period of the study, and rerun all estimations. A summary of these results, for the whole NACE industry divisions 10 to 53 and for the three replication industries, are displayed in Table 10. As can be seen in Panel A, all coefficients of *ACRATE* are negative and significant at $p<0.05$ (see columns 1 and 2), thus providing reinforced support for hypothesis H_1. Coefficients of the lagged values of this variable are also negative, with higher absolute values, and increased significance (at $p<0.01$) than the non-lagged variable (see columns 3 and 4), which provide reinforced support for hypothesis H_2 and for the argument that the main negative effect of labour accidents on financial performance is in the long term.

(insert Table 10 around here)

Estimations of Equation (2) are displayed in panels B and C. The significant positive coefficient of the squared term of accident rate (in column 1 in Panel B and column 2 in panel C) indicates the existence of a minimal profitability. According to the Fieller test and interval there is an upper 30.2% of the range of the variable *ACRATE* where the relationship between this variable and profitability is positive, in the estimation for the three replication industries testing the relationship in the same year (column 1 in panel B). On the contrary, results displayed in column 2 in panel C in this table do not provide reliable evidence on the existence of U-shaped relationship between both variables, as the upper bound of the Fieller interval, a standardized value of *ACRATE* of 3.78, is out of the range of this variable in the whole sample, a maximum of 2.77. Therefore, the evidence on the existence of a U-shaped relationship is weak, also with the standardized values of the variables. Only one out of the four possibilities displayed in panels B and C in Table 10 present a reliable relationship. Moreover, only in 3 out of 10 cases (the different estimation with industry section subsamples) the coefficient of the squared term of *ACRATE* is significant, and only in one (section G wholesale and retail, NACE divisions 45 to 47, estimating the relationship in the same year) out of these ten estimations the relationship between *ACRATE* and profitability is reliable (not displayed in the table because of simplicity reasons), because the Fieller test is non-significant, and/or the Fieller interval is out of range. When analysing the three replication industries, only in two (metal industries, NACE codes 25 and 25, when estimating the relationship in the same year, and retail. NACE code 47, when estimating the relationship with one year ahead profitability) out of ten estimations we find a reliable U-shaped relationship. This weak evidence is opposite to the inverted U-shaped relationships raised in hypotheses H_3 and H_4, similarly to the evidence found with non-standardized variables.

Summing up, results in Table 10 reinforce previous support on the existence of a negative relationship between labour accidents and financial performance, stronger when the relationship is tested with lagged accident rates, and find weak anecdotal evidence on the existence of U-shaped relationship, but no evidence of inverted U-shaped relationship.

5.4. Results including control variables of gross domestic product growth and dummies for year.

Forteza et al. [33] found no linear relationship between labour accidents and financial performance, and weaker curvilinear relationship, when they included dummy variables in the model. An additional concern of our analysis is that the period of our sample starts with the outburst of the financial crisis and follows with recovery phase, when firms' profitability declined dramatically and increased respectively. Therefore, in order to prevent biased results by model miss-specification, we rerun estimations of Equations (1) and (2) including control variables for percent of gross domestic product growth (*GDPGROWTH*) and for contextual circumstances: dummies for years 2010 to 2018 (*YEAR*), with 2009 as the default year, indicating with value 1 that an observation belongs to a given year and zero otherwise.

Table 11 displays results with this model specification. While the coefficients of *ACRATE* are not significant at $p<0.1$ in estimations of financial performance depending on labour accidents in the same year (see panel A), thus failing to provide support for hypothesis H_1, they are significant (at $p<0.05$ in column 1 and at $p<0.1$ in columns 2 and 3) in estimations with the lagged variable of *ACRATE* (see panel B), providing support, even with this model specification, for hypothesis H_2 and the argument that the main negative effect of labour accidents on financial performance is in the long term. As no coefficient of the squared terms is significant, as can be seen in panels C and D, these results fail to provide support for curvilinear relationships between the variables, and for hypotheses H_3 and H_4.

(insert Table 11 around here)

6. Discussion and conclusions.

Summing up, our results provide support for the existence of a negative effect of labour accidents on financial performance. Despite this negative effect may itself manifest immediately, managers and employees try to reinforce their efforts to minimize this immediate effect. The results strongly support that the most important negative influence of labour accidents on financial performance is in the long term, thus suggesting that when accidents in the workplace occur, the whole organization is focused on solving the disruption that the incident produces on business operations, redirect the efforts on ensuring that daily operations continue, while strategic value adding activities such as coordination, planning and control are postponed and set aside. Therefore, the negative effects of labour accidents on the long term are less efficiently overcome that their short-term effects. The empirical evidence of curvilinear relationships is weak. In the few cases that it exists, the relationship is U-shaped, instead of inverted U-shaped, with the maximum points of profitability at the upper bounds of the distributional ranges of accident rates, or out of these distributional ranges, indicating an actual negative concave or convex relationship. Results are strong across different industries, group industries or aggregated samples, variable definitions and model specifications. Overall our results are consistent with Argilés-Bosch et al. [32], but not with Forteza et al. [33], the two only extant studies fully addressing these relationships. They are also in accordance with most studies addressing similar relationships [26] [27] [21] [29], and are different from other studies that do not find significant relationships between financial performance and safety [28] [20] [25]. All these studies used limited samples of firms from single or few industries.

We do not use small or limited samples of firms, but actual reliable data of labour accidents in all Spanish manufacturing, water and energy supply, construction, trade and transportation industries (all industries ranging from sections C to H in NACE industry classification), as well as representative data on the financial performance of these industries. We apply reliable tests for curvilinear relationships.

An important implication of our research is that it provides an understanding of the economic benefits of avoiding labour accidents. The strong negative relationship between labour accidents and firm profitability is not likely to be realized by firms' managers. Organizations often fail to act rationally in managing safety [55], because they do not know the precise costs and negative consequences of unsafety behaviour. Firms may be tempted to reduce their prevention costs or minimize them to the minimal requirements by current regulations, because they are just aware of the costs that they record in their financial statements, but they are unable to accurately calculate the full costs, direct and indirect, current and future, of labour accidents, and more precisely, to calculate the gains to be made from preventing risks and accidents and from implementing safety policies, as some studies reveal [5] [7].

As Tappura et al. [8] argue, the economic benefits of expenses and investments in safety are hard to calculate. There is a wide array of indirect consequences and costs elicited by labour accidents which are difficult to calculate, measure and forecast [56] [57]. In this vein, an additional implication of our research is that it recalls on the importance of implementing appropriate management accounting procedures, because they may play a key role to support more efficient decision-making in the area of health and safety, which in the long term will result in more efficient economic organizations [44]. Full cost calculation of labour accidents may provide a sound basis on which measure the rewards on safety management and improvements. Recording and disclosure of labour accidents are key issues and fundamental information for supporting firms' and stakeholders' decision processes. Knowledge and economic assessment of labour accident effects may provide information to activate the key triggers to strengthen and improve firms' safety management.

The study contributes to the few extant research on this issue providing more conclusive empirical evidence, using reliable data for a wide span of industries and refined methodology. However, it has also limitations. As there are no available statistics of labour accidents at firm level our study uses accident rates at industry level, matched with median performance industry data. A study with large samples of accident rates at firm level for a wide span of industries, refining the relationship between labour accidents and financial performance at firm level, is still an avenue for future research.

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Table 1. Equivalence of CNAE industry divisions used in Argilés et al [32] with current NACE industry divisions

CNAE 1993 industry divisions	NACE 2009 industry divisions
28. Manufacture of metal products, except machinery and equipment	24. Manufacture of basic metals
	25. Manufacture of fabricated metal products, except machinery and equipment
45. Construction	41. Construction of buildings
	42. Civil engineering
	43. Specialised construction activities
52. Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods	47. Retail trade, except of motor vehicles and motorcycles

Note: correspondence based on the Spanish Ministry of Labour and Social Economy's report "*Correspondencia entre códigos de CNAE-93 Rev.1 y los actuales CNAE-2009 según RD 475/2007, BOE 28/4/2007*" http://www.mitramiss.gob.es/es/sec_trabajo/ccncc/C_Registro/CCNCC_Correspondencia_Codigos_CNAE93_2009.pdf ; CNAE = *clasificación nacional de actividades económicas*; NACE = *nomenclature statistique des activités économiques dans la Communauté européenne*

Table 2. Sample characteristics by two-digit NACE 2009 industry divisions. Mean number of firms in SABI data base providing the median industry values for return on assets and change in assets turnover, and industry accident rates (accidents by 100,000 employees in the industry) provided by the Spanish *Instituto Nacional de Estadística*.

	ROA (average 2008-2018)		*CHASSETURN* (average 2009-2018)		*ACRATE* (average 2008-2018)
NACE industry divisions	number of firms	median values (in %)	number of firms	median values (in %)	overall INE values
C. Manufacturing					
10 - Manufacture of food products	10,754.5	2.57	9,655.5	-0.58	6,399.5
11 - Manufacture of beverages	2,836.4	1.16	2,471.5	1.10	4,298.0
12 - Manufacture of tobacco products	23.6	2.05	18.8	1.46	2,237.2
13 - Manufacture of textiles	2,723.2	2.17	2,416.0	-2.11	4,075.5
14 - Manufacture of wearing apparel	2,478.2	1.54	2,109.1	-3.90	1,738.9
15 - Manufacture of leather and related products	2,140.6	3.51	1,865.4	-2.58	2,285.3
16 - Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	4,379.5	1.65	3,892.1	-3.27	7,365.5
17 - Manufacture of paper and paper products	1,174.8	3.19	1,066.8	-0.70	5,024.3
18 - Printing and reproduction of recorded media	6,089.5	2.13	5,460.0	-2.06	3,717.2
19 - Manufacture of coke and refined petroleum products	18.0	3.58	14.2	-3.78	1,005.4
20 - Manufacture of chemicals and chemical products	2,749.3	3.12	2,463.7	-1.33	3,453.0
21 - Manufacture of basic pharmaceutical products and pharmaceutical preparations	354.9	4.14	306.2	-0.67	2,453.9
22 - Manufacture of rubber and plastic products	3,072.3	3.35	2,783.2	-1.32	5,675.7
23 - Manufacture of other non-metallic mineral products	4,885.4	0.62	4,311.6	-4.23	6,020.3
24 - Manufacture of basic metals	1,527.2	2.52	1,365.4	-1.54	7,869.8
25 - Manufacture of fabricated metal products, except machinery and equipment	15,582.7	2.43	13,997.4	-2.83	8,524.4
26 - Manufacture of computer, electronic and optical products	1,141.3	2.78	998.2	-2.34	1,897.7
27 - Manufacture of electrical equipment	1,515.2	2.52	1,343.2	-2.72	3,824.4
28 - Manufacture of machinery and equipment n.e.c.	4,729.5	3.36	4,294.6	-1.91	5,591.8
29 - Manufacture of motor vehicles, trailers and semi-trailers	1,321.3	2.64	1,191.4	-1.51	4,161.4
30 - Manufacture of other transport equipment	513.3	2.05	429.9	-1.71	7,669.7
31 - Manufacture of furniture	4,728.7	0.76	4,146.5	-4.39	5,521.5
32 - Other manufacturing	2,366.9	2.59	2,059.7	-2.78	2,835.7
33 - Repair and installation of machinery and equipment	5,442.4	3.30	4,834.3	-2.98	5,784.2
D - Electricity, gas, steam and air conditioning supply					
35 - Electricity, gas, steam and air conditioning supply	11,455.6	2.23	9,122.8	7.67	2,191.7
E - Water supply; sewerage; waste management and remediation activities					
36 - Water collection, treatment and supply	674.3	2.47	584.3	-0.28	3,729.1
37 - Sewerage	173.8	3.68	153.8	0.24	6,431.5
38 - Waste collection, treatment and disposal activities; materials recovery	1,366.5	2.98	1,160.0	-1.28	7,983.2
39 - Remediation activities and other waste management services	216.2	2.99	174.3	-1.16	6,586.1
F - Construction					
41 - Construction of buildings	73,981.9	0.14	46,849.2	-4.20	8,017.3
42 - Civil engineering	2,795.8	1.96	2,317.8	-4.73	8,457.7
43 - Specialised construction activities	49,262.8	1.95	42,471.3	-4.65	7,294.8

G - Wholesale and retail trade; repair of motor vehicles and motorcycles					
45 - Wholesale and retail trade and repair of motor vehicles and motorcycles	24,066.9	1.41	21,463.0	-2.56	4,829.3
46 - Wholesale trade, except of motor vehicles and motorcycles	83,110.3	2.54	71,922.6	-3.20	3,519.9
47 - Retail trade, except of motor vehicles and motorcycles	65,927.2	1.40	57,259.9	-3.30	2,658.8
H - Transporting and storage					
49 - Land transport and transport via pipelines	19,928.1	2.66	17,416.4	-0.88	5,029.9
50 - Water transport	497.9	1.68	413.4	-0.69	4,851.7
51 - Air transport	175.5	0.92	135.4	-0.34	4,811.5
52 - Warehousing and support activities for transportation	6,561.9	2.62	5,657.7	-1.35	5,814.4
53 - Postal and courier activities	759.6	2.43	667.9	-1.84	7,397.5
Average sectors	10,587.6	2.34	8,781.6	-1.78	4,975.9
Total firms	423,502.7		351,264.5		

Note: *ACRATE* = accident rates; *CHASSETURN* = change in assets turnover; NACE = *nomenclature statistique des activités économiques dans la Communauté européenne*; *ROA* = return on assets.

Table 3. Pearson correlations between independent continuous variables

	ROA_{t-1}	$CHASSETURN_t$	$ACRATE_t$	$ACRATE_{t-1}$
ROA_{t-1}	1			
$CHASSETURN_t$	-0.0533	1		
$ACRATE_t$	-0.0495	-0.1603***	1	
$ACRATE_{t-1}$	-0.0578	-0.314***	0.9586***	1

*** p<0.01, ** p<0.05, * p<0.1.

Note: *ROA* = return on assets; *CHASSETURN* = change in assets turnover; *ACRATE* = accident rates.

Table 4. Influence of labour accident rates on financial performance (ROA_t) in the same year in the metal, building and retail sectors. 28, 52 and 45 CNAE sector divisions (current 24, 25, 47, 41, 42 and 43 NACE sector divisions).

VARIABLES	(1) Total metal, construction and retail industries (current 24, 25, 41, 42 and 47 NACE sector divisions) Fixed effects	(2) Total metal, construction and retail industries (current 24, 25, 41, 42 and 47 NACE sector divisions) Random effects	(3) Metal (current 24 and 25 NACE sector divisions) Fixed effects	(4) Metal (current 24 and 25 NACE sector divisions) Random effects	(5) Construction (current 41, 42 and 43 NACE sector divisions) OLS	(6) Retail (current 47 NACE sector divisions) OLS
$ACRATE_t$	-0.000245***	-0.000245***	-0.000336***	-0.000336***	-0.000225**	-0.000370
	(5.86e-05)	(5.86e-05)	(8.54e-05)	(8.54e-05)	(9.32e-05)	(0.000295)
ROA_{t-1}	0.963***	0.963***	0.975***	0.975***	0.975***	0.995***
	(0.0564)	(0.0564)	(0.0730)	(0.0730)	(0.0995)	(0.154)
$CHASSETURN_t$	0.0746***	0.0746***	0.0875***	0.0875***	0.0627***	0.0670**
	(0.00564)	(0.00564)	(0.00816)	(0.00816)	(0.00836)	(0.0231)
*SECTOR*25		0.326**		0.406***		
		(0.143)		(0.141)		
*SECTOR*41		0.183				
		(0.197)				
*SECTOR*42		0.279*			0.0545	
		(0.152)			(0.205)	
*SECTOR*43		0.208			0.0114	
		(0.141)			(0.259)	
*SECTOR*47		-1.030***				
		(0.288)				
Constant	1.969***	1.975***	2.838***	2.635***	1.949**	1.193*
	(0.347)	(0.374)	(0.612)	(0.588)	(0.707)	(0.591)
Observations	60	60	20	20	30	10
Number of sectors	6	6	2	2	1	1
R^2 overall	0.8012***	0.9440***	0.9019***	0.9404***		

Adjusted R^2	0.9310***	0.8956***

*** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses.
Note: *ACRATE* = accident rates; *CHASSETURN* = change in assets turnover; CNAE = *clasificación nacional de actividades económicas;* NACE = *nomenclature statistique des activités économiques dans la Communauté européenne*; OLS = ordinary least squares estimation; *ROA* is return on assets; *SECTOR* = dummies for industries.

Table 5. Influence of labour accident rates on one-year-ahead financial performance (ROA_t) in the metal, building and retail sectors. 28, 52 and 45 CNAE sector divisions (current 24, 25, 47, 41, 42 and 43 NACE sector divisions).

VARIABLES	(1) Total metal, construction and retail industries (current 24, 25, 41, 42 and 47 NACE sector divisions) Fixed effects	(2) Total metal, construction and retail industries (current 24, 25, 41, 42 and 47 NACE sector divisions) Random effects	(3) Metal (current 24 and 25 NACE sector divisions) Fixed effects	(4) Metal (current 24 and 25 NACE sector divisions) Random effects	(5) Construction (current 41, 42 and 43 NACE sector divisions) OLS	(6) Retail (current 47 NACE sector divisions) OLS
$ACRATE_{t-1}$	-0.000252***	-0.000252***	-0.000311***	-0.000311***	-0.000182**	-0.000522**
	(4.23e-05)	(4.23e-05)	(4.20e-05)	(4.20e-05)	(7.81e-05)	(0.000198)
ROA_{t-1}	0.943***	0.943***	0.923***	0.923***	0.919***	1.058***
	(0.0444)	(0.0444)	(0.0448)	(0.0448)	(0.0840)	(0.114)
$CHASSETURN_t$	0.0473***	0.0473***	0.0463***	0.0463***	0.0471***	0.0290
	(0.00728)	(0.00728)	(0.00826)	(0.00826)	(0.0121)	(0.0254)
*SECTOR*25		0.286**		0.320***		
		(0.124)		(0.0865)		
*SECTOR*41		0.0192				
		(0.158)				
*SECTOR*42		0.136			0.121	
		(0.125)			(0.196)	
*SECTOR*43		0.0500			0.116	
		(0.128)			(0.233)	
*SECTOR*47		-1.217***				
		(0.243)				
Constant	2.031***	2.152***	2.822***	2.662***	1.613**	1.448***
	(0.257)	(0.300)	(0.329)	(0.323)	(0.588)	(0.389)
Observations	60	60	20	20	30	10
Number of sectors	6	6	2	2		
R^2 overall	0.7912***	0.9557***	0.9496***	0.9741***		

Adjusted R^2	0.9301***	0.9389***

*** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses.
Note: *ACRATE* = accident rates; *CHASSETURN* = change in assets turnover; CNAE = *clasificación nacional de actividades económicas;* NACE = *nomenclature statistique des activités économiques dans la Communauté européenne*; OLS = ordinary least squares estimation; *ROA* is return on assets; *SECTOR* = dummies for industries.

Table 6. Curvilinear relationship between labour accident rates and financial performance (ROA_t) in the metal, building and retail sectors (standard errors in parentheses). 28, 52 and 45 CNAE sector divisions (current 24, 25, 47, 41, 42 and 43 NACE sector divisions). Only estimates for *ACRATE* and its quadratic form (*ACRATE*2) are displayed

VARIABLES	(1) Total metal, construction and retail industries (current 24, 25, 41, 42 and 47 NACE sector divisions) Fixed effects	(2) Total metal, construction and retail industries (current 24, 25, 41, 42 and 47 NACE sector divisions) Random effects	(3) Metal (current 24 and 25 NACE sector divisions) Fixed effects	(4) Metal (current 24 and 25 NACE sector divisions) Random effects	(5) Construction (current 41, 42 and 43 NACE sector divisions) OLS	(6) Retail (current 47 NACE sector divisions) OLS
Panel A: Influence in the same year						
$ACRATE_t$	-0.0006**	-0.000635**	-0.00248	-0.00248*	-0.000880	-0.0101**
	(0.00031)	(0.000313)	(0.00141)	(0.00141)	(0.000561)	(0.00346)
$ACRATE2_t$	2.46e-08	2.46e-08	1.35e-07	1.35e-07	4.11e-08	1.82e-06**
	(1.94e-08)	(1.94e-08)	(8.83e-08)	(8.83e-08)	(3.47e-08)	(6.43e-07)
Observations	60	60	20	20	30	10
Number of sectors	6	6	2	2	3	1
ACRATE with minimal performance						2,783.8
Fieller test (t-value)						2.56**
Fieller interval at 95% extreme point						out of range
Centile						>67.7
Panel B: Influence on one-year-ahead ROA						
$ACRATE_{t-1}$	-0.000367**	-0.000367**	-0.000715**	-0.000715**	-0.000804*	-0.00344***
	(0.000162)	(0.000162)	(0.000299)	(0.000299)	(0.000414)	(0.000351)
$ACRATE2_{t-1}$	6.76e-09	6.76e-09	2.35e-08	2.35e-08	3.74e-08	5.28e-07***
	(9.19e-09)	(9.19e-09)	(1.72e-08)	(1.72e-08)	(2.45e-08)	(6.26e-08)
Observations	60	60	20	20	30	10
Number of sectors	6	6	2	2	3	1
ACRATE with minimal perfomance						3,263.7

Fieller test (t-value)	4.30***
Fieller interval at 95% extreme point	in range
Centile	>82.57

*** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses.
Note: *ACRATE* = accident rates; *ACRATE*2 = the square of accident rates; *CHASSETURN* = change in assets turnover; CNAE = *clasificación nacional de actividades económicas*; NACE = *nomenclature statistique des activités économiques dans la Communauté européenne*; OLS = ordinary least squares estimation; *ROA* is return on assets; *SECTOR* = dummies for industries.

Table 7. Influence of labour accident rates on financial performance in the same year (*ROA_t*) in NACE section industries C to H (divisions 10 to 53). Column 1 also includes the construction sectors (section F, divisions 41 to 43), which results are displayed in Table 4.

VARIABLES	(1) Total NACE sections (C to H: divisions 10 to 53) Fixed effects	(2) Total NACE sections (C to H: divisions 10 to 53) Random effects	(3) Manufacturing (NACE section C, divisions 10 to 33) OLS	(4) Energy&Water (NACE sections D and E, divisions 35to 39) OLS	(5) Trade (NACE section G, divisions 45 to 47) Robust OLS	(6) Transportation (NACE section H, divisions 49 to 53) OLS
$ACRATE_{t-1}$	-0.000129***	-0.000129***	-0.000108*	-0.000102	-0.000281**	-0.000283*
	(4.17e-05)	(4.17e-05)	(6.13e-05)	(0.000107)	(0.000102)	(0.000141)
ROA_t	0.795***	0.795***	0.754***	0.804***	0.977***	0.851***
	(0.0321)	(0.0321)	(0.0427)	(0.114)	(0.0683)	(0.0869)
$CHASSETURN_t$	0.0739***	0.0739***	0.0747***	0.0811***	0.0803***	0.0499*
	(0.00471)	(0.00471)	(0.00615)	(0.0134)	(0.0124)	(0.0248)
SECTOR		Yes	Yes	Yes	Yes	Yes
Constant	1.269***	1.429***	1.285***	0.317	1.560***	1.911**
	(0.188)	(0.201)	(0.398)	(0.379)	(0.454)	(0.733)
Observations	400	400	240	50	30	50
Number of sectors	40	40	24	5	3	5
R^2 overall	0.7897***	0.8433				
Adjusted R^2			0.8153***	0.6287***		0.7539***
R^2					0.9572***	

*** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses.

Note: *ACRATE* = accident rates; *CHASSETURN* = change in assets turnover; NACE = *nomenclature statistique des activités économiques dans la Communauté européenne*; OLS = ordinary least squares estimation; *ROA* is return on assets; *SECTOR* = dummies for industries.

Table 8. Influence of labour accident rate on one-year-ahead financial perfromance (*ROA_t*) in NACE section industries C to H (divisions 10 to 53). Column 1 also includes the construction sectors (section F, divisions 41 to 43), which results are displayed in Table 5.

VARIABLES	(1) Total NACE sections (C to H: divisions 10 to 53) Fixed effects	(2) Manufacturing (NACE section C, divisions 10 to 33) Fixed effects	(3) Energy&Water (NACE sections D and E, divisions 35to 39) Fixed effects	(4) Trade (NACE section G, divisions 45 to 47) Fixed effects	(5) Transportation (NACE section H, divisions 49 to 53) Fixed effects
$ACRATE_{t-1}$	-0.0002***	-0.0002***	-0.000152*	-0.000376***	-0.000410***
	(3.06e-05)	(4.27e-05)	(8.44e-05)	(7.93e-05)	(0.000108)
ROA_{t-1}	0.789***	0.756***	0.792***	1.013***	0.803***
	(0.0299)	(0.0399)	(0.108)	(0.0563)	(0.0789)
$CHASSETURN_t$	0.0610***	0.0607***	0.0779***	0.0477***	0.0118
	(0.00535)	(0.00736)	(0.0130)	(0.0129)	(0.0256)
Constant	1.484***	1.485***	1.462***	1.534***	2.814***
	(0.154)	(0.195)	(0.541)	(0.225)	(0.633)
Observations	400	240	50	30	50
Number of sectors	40	24	5	3	5
R^2 overall	0.7759***	0.7804***	0.4256***	0.8529***	0.7023***

*** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses. Results with random effects (with dummies for sectors), removed from the table for simplicity reasons, are very similar to those of fixed effects.

Note: *ACRATE* = accident rates; *CHASSETURN* = change in assets turnover; NACE = *nomenclature statistique des activités économiques dans la Communauté européenne*; *ROA* is return on assets.

Table 9. Curvilinear relationship between labour accident rates and financial performance (ROA_t) in NACE section industries C to H (divisions 10 to 53).

VARIABLES	(1) Total NACE sections C to H (divisions 10 to 53)	(2) Manufacturing (NACE section C, divisions 10 to 33)	(3) Energy&Water (NACE sections D and E, divisions 35to 39)	(4) Trade (NACE section G, divisions 45 to 47)	(5) Transportation (NACE section H, divisions 49 to 53)
Panel A: influence of labour accident rate on ROA (in the same year)					
	Fixed effects	OLS	OLS	Robust OLS	OLS
$ACRATE_t$	-0.0004***	-0.0003*	-0.000340	-0.000398	-0.000422
	(0.00013)	(0.00018)	(0.000370)	(0.000393)	(0.000592)
$ACRATE2_t$	1.76e-08*	1.78e-08	2.06e-08	1.31e-08	1.10e-08
	(9.73e-09)	(1.31e-08)	(3.07e-08)	(4.42e-08)	(4.54e-08)
ACRATE with Minimal performance	10,185.36				
Fieller test (t-value)	0.88				
Fieller interval at 95% extreme point	out of range				
Centile	>95.85				
Panel B: influence of labour accident on one-year-ahead ROA					
	Fixed effects	Fixed effects	OLS	Fixed effects	Fixed effects
$ACRATE_{t-1}$	-0.000406***	-0.000439***	-4.18e-05	-0.000646***	-0.000696
	(8.59e-05)	(0.000111)	(0.000295)	(0.000216)	(0.000421)
$ACRATE2_{t-1}$	1.65e-08***	1.85e-08***	-9.14e-09	2.81e-08	2.14e-08
	(5.58e-09)	(6.76e-09)	(2.33e-08)	(2.09e-08)	(3.04e-08)
ACRATE with Minimal performance	12,307.7	11,865.46			
Fieller test (t-value)	0.65	0.79			
Fieller interval at 95% extreme point	out of range	out of range			

Centile	>99.23	>98.47

*** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses. Estimates for control variables not displayed for simplicity reasons.

Note: *ACRATE* = accident rates; *ACRATE*2 = the square of accident rates; *CHASSETURN* = change in assets turnover; NACE = *nomenclature statistique des activités économiques dans la Communauté européenne*; OLS = ordinary least squares estimation; *ROA* is return on assets.

Table 10. Influence of labour accidents on financial performance (ROA_t). Standardized variables with industry divisions mean and standard deviations.

VARIABLES	(1) Total metal, construction and retail industries (current 24, 25, 41, 42 and 47 NACE sector divisions) OLS	(2) Divisions 10-53 OLSrobust	(3) Total metal, construction and retail industries (current 24, 25, 41, 42 and 47 NACE sector divisions) OLS	(4) Divisions 10-53 OLSrobust
Panel A: Linear relationship				
$ACRATE_t$	-0.210**	-0.113**		
	(0.0868)	(0.0540)		
$ACRATE_{t-1}$			-0.358***	-0.213***
			(0.0607)	(0.0534)
ROA_{t-1}	0.888***	0.801***	0.942***	0.801***
	(0.0611)	(0.0353)	(0.0453)	(0.0328)
$CHASSETURN_t$	0.589***	0.493***	0.373***	0.377***
	(0.0453)	(0.0347)	(0.0545)	(0.0530)
SECTOR	Yes	Yes	Yes	Yes
Constant	-0.119	-0.135	-0.0529	-0.113
	(0.100)	(0.186)	(0.0801)	(0.166)
Observations	60	400	60	400
R^2	0.887***	0.717***	0.925***	0.741***
Adjusted R^2	0.8695***		0.9134***	
Panel B: Curvilinear influence in the same year				
$ACRATE_t$	-0.197**	-0.0942*		
	(0.0804)	(0.0510)		
$ACRATE2_t$	0.296***	0.111		
	(0.0953)	(0.0751)		
ACRATE at minimal	0.332			

performance		
Fieller test (t-value)	2.67**	
Fieller interval at 95% extreme point	in range	
Centile	69.8	
Panel C: Curvilinear influence on one-year-ahead		
ACRATE$_{t-1}$	-0.346***	-0.267***
	(0.0612)	(0.0453)
*ACRATE*2$_{t-1}$	-0.0400	0.102***
	(0.0341)	(0.0299)
ACRATE at minimal performance		1.31
Fieller test (t-value)		1.66**
Fieller interval at 95% extreme point		out of range
Centile		88.04

*** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses. Estimates for control variables not displayed in panels B and C for simplicity reasons.

Note: *ACRATE* = accident rates; *ACRATE*2 = the square of accident rates; *CHASSETURN* = change in assets turnover; NACE = *nomenclature statistique des activités économiques dans la Communauté européenne*; OLS = ordinary least squares estimation; *ROA* is return on assets; *SECTOR* = dummies for industries.

Table 11. Estimations controlling by gross domestic product growth and dummies for years.

VARIABLES	(1) Total metal, construction and retail industries (current 24, 25, 41, 42 and 47 NACE sector divisions) Robust OLS	(2) Total NACE sections C to H (divisions 10 to 53) Fixed effects	(3) Total NACE sections C to H (divisions 10 to 53) 10-53RE
Panel A: same year influence			
$ACRATE_t$	-0.000130	9.07e-06	9.07e-06
	(9.05e-05)	(5.27e-05)	(5.27e-05)
ROA_t	0.938***	0.486***	0.486***
	(0.0802)	(0.0422)	(0.0422)
$CHASSETURN_t$	0.0730***	0.0502***	0.0502***
	(0.0140)	(0.00549)	(0.00549)
$GDPGROWTH_t$	0.0216	0.0954***	0.0954***
	(0.0475)	(0.0234)	(0.0234)
YEAR	Yes	Yes	Yes
SECTOR	Yes		Yes
Constant	1.138*	1.525***	2.533***
	(0.672)	(0.287)	(0.228)
Panel B: one-year-ahead influence			
$ACRATE_{t-1}$	-0.000190**	-7.41e-07*	-7.41e-07*
	(9.03e-05)	(4.07e-07)	(4.07e-07)
ROA_t	0.910***	0.506***	0.506***
	(0.0726)	(0.0425)	(0.0425)
$CHASSETURN_t$	0.0550***	0.0519***	0.0519***
	(0.0132)	(0.00550)	(0.00550)
$GDPGROWTH_t$	0.00556	0.0909***	0.0909***
	(0.0384)	(0.0209)	(0.0209)
YEAR	Yes	Yes	Yes
SECTOR	Yes		Yes
Constant	1.811***	1.532***	2.292***
	(0.645)	(0.135)	(0.252)
Panel C: curvilinear influence in the same year			
$ACRATE_t$	-0.000190	1.42e-06	1.42e-06
	(0.000516)	(1.72e-06)	(1.72e-06)
$ACRATE2_t$	3.08e-09	-1.26e-12	-1.26e-12
	(2.61e-08)	(2.13e-12)	(2.13e-12)
Panel D: curvilinear influence one-year-ahead			
$ACRATE_{t-1}$	-5.92e-06	5.06e-07	5.06e-07
	(0.000412)	(1.95e-06)	(1.95e-06)
$ACRATE2_{t-1}$	-8.02e-09	-1.69e-12	-1.69e-12
	(1.69e-08)	(2.57e-12)	(2.57e-12)

*** $p<0.01$, ** $p<0.05$, * $p<0.1$. Standard errors in parentheses. Estimates for control variables not displayed in panels C and D (because of simplicity reasons).
Note: *ACRATE* = accident rates; *ACRATE*2 = the square of accident rates; *CHASSETURN* = change in assets turnover; *GDPGROWTH* = the percent growth of gross domestic product; NACE = *nomenclature statistique des activités économiques dans la Communauté européenne*; OLS = ordinary least squares estimation; *ROA* is return on assets; *SECTOR* = dummies for industries; *YEAR* = dummies for years.