



# WORK INSPECTIONS AS A CONTROL MECHANISM FOR MITIGATING WORK ACCIDENTS IN EUROPE

INSPECCIONES  
LABORALES COMO  
MECANISMO DE CONTROL  
DE LA ACCIDENTALIDAD  
LABORAL EN EUROPA

This study analyzes the relationship between work inspections—which are a relevant control mechanism of countries' safety function—and the rate of work accidents in Europe. The empirical application is based on fixed-effects regression models on a sample of 24 European countries for the period 2008-2015. The results confirm the pro-cyclical relationship between the rate of work accidents and economic activity (GDP) among the sampled countries. Additionally, the findings reveal that work inspections are an important control mechanism that significantly contributes to alleviate the rate of work accidents. In line with increased awareness of occupational health and safety (OHS) as a relevant dimension of territories' productive structures, policy implications and future research avenues are discussed.

**KEYWORDS:** Work accidents rate, economic cycle, work safety controls, work inspections, Europe.

## ABSTRACT

Este estudio analiza la relación entre las inspecciones laborales, que son un importante mecanismo de control de la función de seguridad de los países, y la tasa de accidentes laborales en Europa. La aplicación empírica emplea modelos de datos de panel (regresión de efectos fijos) sobre una muestra de 24 países europeos para el período 2008-2015. Los resultados confirman la relación pro-cíclica entre la tasa de accidentes laborales y la actividad económica (PIB) de los países incluidos en el análisis. Además, los resultados revelan que las inspecciones laborales son un importante mecanismo de control que contribuye de forma significativa a reducir la tasa de accidentes laborales. En línea con el creciente interés por la eficiencia de los sistemas de salud y seguridad ocupacional dentro de las estructuras productivas de los territorios, se discuten las implicaciones de este trabajo así como las futuras vías de investigación.

**PALABRAS CLAVE:** Tasa de accidentes laborales, ciclo económico, controles de seguridad laboral, inspecciones laborales, Europa.

## RESUMEN

### Esteban Lafuente

Professor. Universitat Politècnica de Catalunya (UPC Barcelona Tech). Spain.

[esteban.lafuente@upc.edu](mailto:esteban.lafuente@upc.edu)

### Viviana Daza

Master in Construction Building Management. Universitat Politècnica de Catalunya. Spain

[arq.vivianadaza@gmail.com](mailto:arq.vivianadaza@gmail.com)

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## INTRODUCTION

Occupational health and safety (OHS) is a decisive pillar with a direct impact on the appropriate functioning of territories' productive structures. By promoting the development of safer work environments, safety policies help to stimulate social wealth and, consequently, territorial economic outcomes (Piore and Schrank 2018).

Similar to economic outputs linked to positive externalities (e.g., Caselli and Coleman, 2006, Lafuente et al., 2019), it is unquestionable that work safety is a desired aspect to policy makers interested in minimizing one of the most significant negative externalities of economic activity, namely work accidents (e.g., Arrow et al., 1996, Boone et al., 2011).

The academic literature dealing with the analysis of the relationship between fluctuations in economic activity—e.g., variations in the GDP—and the rate of work accidents at country level often assumes that these variables are intrinsically associated over time (see, for example, Boone and van Ours, 2006, Davies et al., 2009, Asfaw et al., 2011, Li et al., 2011, Fernández-Muñiz et al., 2018). Additionally, underlying the analytical framework of prior work in this tradition is the assumption that control mechanisms designed to improve work safety conditions operate uniformly over time and are homogeneous within and between territories. That is, these studies ignore different sources of heterogeneity at the local level that may influence the relationship between work accidents and macroeconomic figures over time.

Nevertheless, the institutional setting governing work safety controls (e.g., regulation and policy actions) does not affect homogeneously territories' work accident rates, and the statistical significance of the relationship between economic cycles and work accident rates represents a test of the effectiveness of work safety regulation and control mechanisms.

This is the focus of this study. The study presented in this paper seeks to evaluate the impact of a strategic control mechanism of countries' occupational safety system—i.e., work inspections—on the rate of work accidents in Europe.

Additionally, this study highlights the importance of work inspections as a safety control mechanism by quantifying the specific impact of work inspections, in terms of lower rates of work accidents in Europe.

The empirical application employs panel data techniques (fixed-effects models) on a sample of 24 European countries during the period 2008-2015. The European context is attractive for various reasons. First, European governments have allocated considerable resources in order to improve work safety conditions, either through support policies or actions that encourage safety investments among businesses (European Agency for Safety and Health at Work, 2013). Second, the increased awareness of the relevance of work safety has led policy makers to implement specific policies within the EU 2020 strategic plan in order to stimulate safer work conditions (European Commission, 2014). The empirical findings confirm the pro-cyclical relationship between the rate of work accidents and economic activity (GDP) in Europe. Additionally, the results reveal that work inspections are an important control mechanism that significantly contributes to alleviate the rate of work accidents.

The relevance of this work stretches beyond a purely economic discussion and implications for policy makers addressing work safety issues. Occupational accidents as a negative externality of countries' economic activity, and the empirical analysis of the impact of work safety controls (work inspections) on the rate of work accidents offers arguments that further validate the importance of improving the monitoring activity of the countries' safety system over the activity of businesses.

## BACKGROUND LITERATURE AND HYPOTHESES DEVELOPMENT

### *THE RELATIONSHIP BETWEEN THE ECONOMIC CYCLE AND THE RATE OF WORK ACCIDENTS*

This section deals with the analysis of the theoretical connection between economic activity and the rate of work accidents. Echoing the seminal work by Kossoris (1938),

scholars have devoted significant efforts on evaluating the relationship between macroeconomic figures, often linked to GDP levels, and work accident rates (e.g., Lanoie, 1992, Davies et al., 2009, Svensson, 2010, Asfaw et al., 2011, Boone et al., 2011, Song et al., 2011). Within this literature, a common presumption is that the state of the economic cycle (expansion or recession) affects the exploitation of production factors, especially employment, and, therefore, the state of the economy is a significant variable explaining variations in work accident rates across territories and across time.

This economic argument is used to explain the observed variations in the rate of work accidents in periods of economic growth and decline. In periods of economic growth, market agents (businesses) have incentives to increase their operations in order to satisfy customer demands. This process arguably leads to improved employment figures. As a result of this process, two effects may cause an increase in the rate of work accidents. On the one hand, the intensification of the labor input (workers) will likely leads to increased workloads among experienced and new (inexperienced) workers and this work intensification process may produce higher rates of work accident (Nichols, 1989, Asfaw et al., 2011). On the other hand, prior research has documented a notification effect associated to the greater reporting of accidents by workers (Gerdtam and Ruhm, 2006, Davies et al., 2009). It has been argued that, in periods of economic growth, the relatively lower cost of finding a job in the market gives workers incentives to report all minor work accidents (e.g., Boone and van Ours, 2006, Boone et al., 2011, Li et al., 2011, Fernández-Muñiz et al., 2018).

These arguments are reinforced by Nichols (1989) who found that increases in employment figures and improvements in the economic conditions (first stage of economic upturn) are not simultaneous phenomena, that is, businesses take some time before hiring new employees which results in a greater work intensification and in a higher rate of work accidents. This argument is based in a well-known relation between the labor market and the economic cycle: the labor market lags behind the economic cycle.

On contrary, building on the vulnerability approach developed by Nichols (1989), scholars employ behavioral and labor-market arguments to explain the fall in work

THIS STUDY ANALYZES THE RELATIONSHIP BETWEEN WORK INSPECTIONS—WHICH ARE A RELEVANT CONTROL MECHANISM OF COUNTRIES' SAFETY FUNCTION—AND THE RATE OF WORK ACCIDENTS IN EUROPE

accident rates when the economy shrinks. Existing studies highlight that the positive correlation between macroeconomic variables and work accidents (excluding fatalities) in periods of economic downturn is mostly caused by the lower incentives of workers for reporting minor accidents due to fear of losing their job (Boone and van Ours, 2006). Additionally, the properties of labor markets may explain the lower rate of work accidents reported in periods of economic recession. Among businesses, the most widely used mechanism to mitigate the effects of a negative economic cycle is downsizing the workforce. However in most countries, including those in Europe, firing permanent (long-tenure) employees is a costly process, so organizations have strong incentives to fire young workers (with less experience in the business) who arguably have a greater probability to experience work accidents (De la Fuente et al., 2014).

In a related manner, empirical studies rooted in this research stream use similar arguments to explain the positive relationship between work accident rates and macroeconomic figures in growth periods. In this case, studies suggest that the higher entry of new workers in periods of economic growth increases the rate of work accidents, and that this causes an increase in the proportion of inexpert newcomers who are more likely to increase the rate of minor accidents (Wright and Lund, 1998, Fernández-Muñiz et al., 2018).

From these arguments and evidence we hypothesize that:

**H1:** *At the country level, there is a positive relationship between macroeconomic results—i.e., GDP per capita—and the rate of work accidents*

## THE WORK SAFETY SYSTEM

It should be noted that empirical studies based on the intensification theory (Kossoris, 1938) and the vulnerability approach (Nichols, 1989) indirectly assume that the institutional framework governing work safety—i.e., the work safety system—is homogeneous over time and that work safety policies have no direct impact on the rate of work accidents. Nevertheless, territories dedicate resource in order to maximize economic outputs (e.g., GDP) and to minimize the negative externalities of economic activity, that is, work accidents. Therefore, it seems plausible to assume that specific work safety policies may help to mitigate work accident rates. From a policy point of view, an analysis that takes into account work safety controls may offer valuable information on the effectiveness of the occupational health and safety (OHS) system.

In this sense, work inspections are a fundamental mechanism that plays a key role in the control of work safety conditions and, consequently, on the rate of work accidents. Work inspections are one of the most important aspects of countries' safety system.

However, territories design and manage their safety system in different ways and two models have been identified in the literature (Piore and Schrank, 2018): a system with high levels of operational decentralization, specialized work inspectors and deterrence-oriented penalization (this model is mostly implemented in the United States); and a more generalist system developed in France, which is characterized by a centralized structure, emphasis on compliance and advice, and high flexibility that allows inspectors to decide which businesses to oversee (Piore and Schrank, 2018, p. 12).

In Europe the institutional bodies involved in the safety system are the European Commission, the European Agency for Occupational Health and Safety, and the European Foundation for the improvement of living and working conditions (see European Commission: <https://ec.europa.eu/social/main.jsp?catId=148&langId=en>). All these agencies work together to ensure clear information, offer advice and promote measures to generate healthy work environments, especially in small businesses with less than 250 employees and with a turnover below 50 million euro (European Commission, 2003). Thus, it can be said that in Europe the generalist safety system inspired in the French inspectorate is the dominant model.

THE RESULTS CONFIRM THE PRO-CYCLICAL  
RELATIONSHIP BETWEEN THE RATE OF WORK  
ACCIDENTS AND ECONOMIC ACTIVITY (GDP)  
AMONG THE SAMPLED COUNTRIES

Small businesses dominate the economic landscape in Europe and around the globe, and their safety practices encompass important challenges mostly because of their relatively low probability of work accidents (regardless the business' economic activity and related work risks) as well as the low visibility of the economic benefits of safety practices (Bianchini, et al., 2017).

Occupational health and safety (OHS) is one of the areas where the European Union has made a great progress as a result of the development of a common framework based on a set of harmonized standards that covers the most relevant aspects of work safety.

More concretely, the European Commission has established directives (EU-OSHA)—the Framework Directive 89/391/EEC—that include fundamental principles and minimum OHS requirements with the objective to encourage improvements in the safety system and, ultimately, in the work safety conditions. Building on this common regulatory framework, European countries have developed specific OHS regulations that seek to promote work safety conditions and to develop an efficient work inspectorate.

In light of the specific features of the safety system developed by European countries and the characteristics of countries' inspectorate, we argue that the safety system is heterogeneous across European countries, and that the capacity of work inspections to reduce work accident rates is the observable outcome of the effectiveness of the countries' safety system.

This theory and empirical evidence lead us to formulate our second hypothesis:

*H2: At the country level, work inspections have a positive impact on work safety outcomes, in terms of lower work accident rates*

## DATA, VARIABLE DEFINITION AND METHOD

### DATA

The data used in this study come from multiple sources. First, data on macroeconomic figures related to GDP, capital stock, labor, and human capital (based on the work by Barro and Lee (2016)) was obtained from the International Monetary Fund (IMF) databases.

Second, the information on the number of work accidents was collected from the EUROSTAT databases, while the data on the number of work inspections was obtained from the International Labor Organization (ILO).

The final sample contains information for 24 European countries at all stages of development over the period 2008-2015: Austria, Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Finland, France, Germany, Hungary, Ireland, Latvia, Lithuania, Malta, Norway, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, and the United Kingdom.

### VARIABLE DEFINITION

**Dependent variable.**—The dependent variable is the rate of work accidents defined as the total number of accidents at work (including injuries and fatal accidents) divided by the total number of workers in the economy. At this point it is worth mentioning that, due to data availability, the number of work accidents is the sum of all accidents during the course of work that imply more than three calendar days of absence from work and fatalities (accidents that lead to the death of the employee) (further details can be found at the EUROSTAT website: [https://ec.europa.eu/eurostat/statistics-explained/index.php/Accidents\\_at\\_work\\_statistics](https://ec.europa.eu/eurostat/statistics-explained/index.php/Accidents_at_work_statistics)). That is, work accidents that do not imply absence from work are not included in the analysis. Descriptive statistics are presented in Table 1. In addition, Figure 1 shows a downward trend in the rate of work accidents and that the reported fall in this ratio was more pronounced during the first years of the economic crisis that hit most economies (between 2008 and 2010).

**Economic activity.**—This study employs the level of GDP per worker to capture the countries' economic output. This variable—which is a proxy variable of labor productivity at country level—has been extensively used in economic studies dealing with economic performance



Figure 1. Rate of work accidents in Europe (2008-2015).

(e.g., Caselli and Coleman, 2006; Lafuente et al., 2019). Note that, to ensure estimation accuracy, GDP values are expressed in billions of constant 2011 international dollars.

**Capital-to-labor ratio.**—Similar to prior work evaluating the effect of capital accumulation on countries' performance (e.g., Kumar and Russell, 2002; Lafuente et al., 2019) our models include the capital-to-labor ratio, measured as the ratio of the capital stock (K: Private capital stock in the economy estimated through the perpetual-inventory method and expressed in billions of constant 2011 international dollars) divided by the number of workers (L).

**Labor inspections per worker.**—In line with the arguments presented in section 2.2, we introduce in our models the rate of labor inspections per worker as a measure of the monitoring intensity of the inspectorate among the sampled countries. Labor inspections are defined as the visits (physical presence) of a labor

inspector in a workplace in order to carry out a work inspection which is duly documented as required by national legislation.

**Human capital.**—Finally, we control for the level of human capital at country level. We use the human capital metric developed by Barro and Lee (2013) which measures the proportion of the population aged between 15 and 64 years old (active population) with tertiary studies.

### ESTIMATION STRATEGY

In line with the arguments that underpin this study—which emphasize a relationship between economic activity, work inspections and the rate of work accidents at the country level—the model used to test the study hypotheses empirically is based on a standard Cobb-Douglas production function with the following form:

$$(i) Y=AG^{\alpha}K^{\beta}L^{\gamma}S^{\delta} \exp^{\lambda T+\epsilon}$$

Table 1. Descriptive statistics for the selected variables (2008-2015)

	Mean	Standard deviation	Minimum	Maximum	Obs.
<b>PANEL A: VARIABLES IN LEVELS</b>					
Number of work accidents (thousands)	94.5724	179.5099	0.9000	782.2500	192
GDP (billion of euro)	596.47	893.29	9.35	3,618.30	192
Capital stock (billion of euro)	991.78	1,498.16	16.96	5,726.52	192
Labor (thousands of workers)	8,534.56	11,437.77	169.64	42,780.92	192
Number of work inspections	91.279.51	186,074.60	757	963,443	192
<b>PANEL B: VARIABLES IN RATIOS</b>					
Work accident rate (accidents per worker)	0.0083	0.0064	0.0003	0.0263	192
GDP per worker	63,598.82	22,311.60	31,160.59	129,176.10	192
Work inspections per worker	0.0102	0.0063	0.0005	0.0359	192
Capital / labor ratio	108,016.40	46,883.97	30,796.02	201,137.40	192
Human capital	0.2144	0.0677	0.0934	0.4420	192

Note: GDP and capital stock values are expressed in billions of constant 2011 international dollars.

In equation (1),  $Y$  is the rate of work accidents,  $A$  is the constant term,  $T$  is the set of variables capturing time-related effects  $\lambda$ , and  $\varepsilon$  is the stochastic error term. For the variables GDP ( $G$ ), capital ( $K$ ), labor ( $L$ ), and work inspections ( $S$ ) the terms  $\alpha$ ,  $\beta$ ,  $\gamma$  and  $\delta$  are, respectively, the parameters to be estimated.

We deflated the variables linked to GDP, capital and inspections by the number of workers in order to impose constant returns to scale on the production function. The resulting log-linearized Cobb-Douglas augmented function employed in this study to test our hypotheses follows:

(2) In Rate of work accidents<sub>it</sub> =  $A + \alpha \ln \text{GDP per worker}_{it} + \beta \ln \text{Capital-to-labor ratio}_{it} + \delta \ln \text{Inspections per worker}_{it} + \psi \ln \text{Human capital ratio}_{it} + \lambda T_t + n_i + \varepsilon_{it}$

In equation (2)  $T$  is a set of ( $T-1$ ) dummy variables that rule out potential time effects linked to unobserved changes in economic and environmental conditions that are common to all countries ( $i$ ), while the error term has two components: a time-invariant effect controlling for country-specific unobserved heterogeneity that is uncorrelated with parameters ( $n$ ), and a normally distributed error ( $\varepsilon$ ) that varies cross-countries and cross-time ( $t$ ).

We employ panel data techniques to estimate equation (2). Pooling repeated observations on the same unit violates the assumption of independence of observations, resulting in autocorrelation in the residuals. First-order autocorrelation occurs when the disturbances in a time-period are correlated with those in the previous time-period, resulting in incorrect variance estimates, rendering ordinary least squares (OLS) estimates inefficient (Wooldridge, 2002).

Therefore, equation (2) is estimated via fixed-effects models with robust standard errors to correct for autocorrelation of errors due to constant country-specific effects (Greene, 2003).

## RESULTS

This section presents the results of the empirical analysis. Table 2 contains the results for the proposed

labor-deflated model emphasizing the relationship between economic activity (GDP), work inspections and the rate of work accidents (equation (2)). In the table, model 1 includes the variables GDP per worker, the capital-to-labor ratio, and the rate of work inspections per worker as independent variables, while model 2 incorporates into the analysis the human capital variable.

The results for the time dummies confirm the descriptives presented in Figure 1: the rate of work accidents has fallen among the sampled European countries between 2008 and 2015, and the reported fall is statistically significant.

Concerning the key variables analyzed in this study, the results for the coefficient linked to the (ln) GDP per worker indicate that economic activity is positively correlated to the rate of work accidents. The coefficients for the GDP per worker are large, stable and highly significant, ranging from 2.0377 (model 2) to 2.0413 (model 1). From the result in model 2 it can be deduced that a rise (fall) of 1% in the GDP per worker is associated with an increase (decrease) in the work accident rate of  $\Delta Y = \Delta X^\beta \Delta Y = 1.01^{2.0377} = 2.05\%$  (-2.05%).

The pro-cyclical relationship between macroeconomic figures and work accident rates has been documented in previous studies (e.g., Boone and van Ours, 2006, Svensson, 2010, Asfaw et al., 2011, Boone et al., 2011, Fernández-Muñiz et al., 2018). Based on the logic that work accidents can only take place within work environments, this result confirms that work accidents are a negative externality (unintended consequence) of the countries' economic activity. Therefore, we find support for our first hypothesis (**H1**) that states that, at the country level, there is a positive relationship between macroeconomic results—i.e., GDP per capita—and the rate of work accidents.

The parameter estimates for the variable work inspections are negative and statistically significant in both model specifications: model 1 =  $\delta = -0.1903$  and  $p$ -value < 5%, model 2 =  $\delta = -0.1774$  and  $p$ -value < 5%. Based on the coefficients estimated for the full model (specification 2), the result suggests that a 10% increase (decrease) in the rate of inspections per worker is associated with a fall (rise) of 1.68% in the rate of work accidents. These results are in accordance with our second hypothesis (**H2**) that states that, at the country level, work inspections have a positive impact on work safety outcomes, in terms of lower work accident rates.



Although our model does not control for country-specific differences in OHS regulation and the management of the safety system across Europe (Piore and Schrank, 2018), the results in this study highlight the decisive role played by work inspections as control mechanism to monitor work safety conditions and, ultimately, contribute to reduce the rate of work accidents.

Additionally, we estimated an additional model based on the log-linearized Cobb-Douglas function presented in equation (1) to further validate the robustness of our estimations. Results for this model, estimated in levels, are presented in Table A1 of the Appendix. The findings of this supplementary model (Table A1) indicate that economic activity (ln GDP) and work inspections (ln inspections) are significantly correlated with the (ln) total number of work accidents. Similar to the findings reported in Table 2, the positive association between economic activity (GDP) and work accidents is in line with prior work highlighting the

pro-cyclical relationship between these two variables (e.g., Asfaw et al., 2011, Fernández-Muñiz et al., 2018). Also, the negative result for the coefficient of the work inspections variable further corroborates the relevance of this monitoring mechanism for reducing the number of work accidents in Europe.

## CONCLUSIONS, IMPLICATIONS AND FUTURE RESEARCH LINES

### CONCLUDING REMARKS

In this study we asked whether work inspections—as part of the countries' safety system—are a relevant control mechanism that contributes to mitigate work accidents in 24 European countries during 2008-2015. Finding an

**Table 2. Fixed-effects regression results: The connection between economic activity, work inspections and the rate of work accidents in Europe**

	Dependent variable = ln rate of work accidents	
	Model (1)	Model (2)
ln GDP per worker (Eq. (2): $\alpha$ )	2.0413 (0.5674)***	2.0377 (0.5529)***
ln Capital-to-labor ratio (Eq. (2): $\beta$ )	-0.0483 (0.3347)	0.0017 (0.3166)
ln Inspections per worker (Eq. (2): $\delta$ )	-0.1903 (0.0797)**	-0.1774 (0.0856)**
ln Human capital (active population with tertiary studies) (Eq. (2): $\psi$ )		0.3957 (0.4207)
Time = 2009	-0.0988 (0.0535)*	-0.1010 (0.0532)*
Time = 2010	-0.1101 (0.0376)***	-0.1789 (0.0777)**
Time = 2011	-0.2101 (0.0468)***	-0.2786 (0.0842)***
Time = 2012	-0.2344 (0.0465)***	-0.3025 (0.0743)***
Time = 2013	-0.2683 (0.0495)***	-0.3363 (0.0945)***
Time = 2014	-0.3406 (0.0783)***	-0.4077 (0.1234)***
Time = 2015	-0.4014 (0.0881)***	-0.5237 (0.1804)***
Constant	-2.7832 (0.5797)***	-2.7617 (0.5499)***
F-test (model significance)	18.56***	16.63***
R2 (within)	0.4076	0.4181
Observations (countries)	192 (24)	192 (24)

Robust standard errors adjusted by heteroskedasticity are presented in parentheses. \*, \*\*, \*\*\* indicates that parameters are significant at the 10%, 5% y 1%, respectively.

answer to this question is relevant considering the large stock of empirical work devoted to the analysis of the connection between economic activity and work accidents under the assumption that the safety system has no direct impact on this relationship (e.g., Boone and van Ours, 2006, Asfaw et al., 2011).

Work accidents are a negative externality of economic activity, and our main claim is that the relationship between work inspections and the unintended consequences of economic activity—i.e., work accidents—sheds light of the effectiveness of the safety system—i.e., the institutional setting designed to improve work conditions—at the country level.

Overall, the results corroborate the positive association between macroeconomic figures (GDP per worker) and work accidents reported in prior work (e.g., Davies et al., 2009, Asfaw et al., 2011, Boone et al., 2011, De la Fuente et al., 2014, Fernández-Muñiz et al., 2018). Additionally, it was found that a model that includes safety mechanisms—in our case, work inspections—into the economic function offers important insights about the effectiveness of the countries' safety system.

## IMPLICATIONS

Relevant policy lessons can be extracted from the proposed analysis of the role of economic activity and work inspections on work accident rates. In an increasingly competitive economic environment, policy makers struggle between competing demands by different stakeholders—e.g., businesses and workers—and the design of coordinated policies that contribute to achieving collective goals.

Occupational health and safety (OHS) critics argue that OHS inspections and regulation destroys jobs and correlate with lower labor productivity (e.g., Gray, 1987). On contrary, OHS supporters claim that work inspections as a valid control mechanism that save lives at a very low cost to businesses, and that a strong safety system constitutes a vital tool for reducing work-related accidents (e.g., Haviland et al., 2010, Levine et al., 2012). Our results underlining the strong and significant positive effect of work inspections on safety outcomes (lower rate of work accidents) are in line with OHS advocates that support the social role of work inspections and OHS regulation (Levine et al., 2012).

The observed fall in work accidents between 2008

and 2015 in Europe is unquestionably good news; however, the prevalence of a positive relationship between macroeconomic figures and the rate of work accidents reveals a less positive case. From an economic view, the low or null correlation between the rate of work accidents and macroeconomic figures can be considered evidence of the quality of the safety system. At the country level, this logic implies that policy decisions affecting the mechanisms that govern countries' safety system should be unconnected both to the state of the economy and to changes in the economic cycle.

Therefore, the recommendation for policy makers is to prioritize the development of safety policies that promote the efficient allocation of resources and the implementation of safety controls, regardless of the characteristics of the economic cycle. In this sense, efficient OHS policy controls—i.e., inspections or the efficient selection of inspected businesses—jointly with the implementation of incentives—e.g., lower insurance premiums for firms with highly positive safety records—may constitute effective actions to promote safer work environments.

## FUTURE RESEARCH LINES

As with any study, the findings presented in our work are open to future verification. First, and similar to prior research on the relationship between macroeconomic figures and work accident rates (see, e.g., Ruhm, 2000, Davies et al. 2009, Asfaw et al. 2011, Fernández-Muñiz et al. 2018), the data used in our study do not allow the direct analysis of both the selection process of businesses subject to inspections and the responsiveness of businesses to work inspections. Further research can address this issue by analyzing the response to incentives created by the public administration.

Second, OHS regulation and monitoring mechanisms are heterogeneous across countries (Piore and Schrank, 2018). In this sense, the reported effect of work inspections on work accident rates may well result from the specific characteristics of countries' safety system. Future comparative studies should evaluate the effectiveness of different safety systems, distinguishing countries with a safety system similar to the US model from countries whose safety system is closer to the generalist French model.

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## APPENDIX

**Table A1.** Fixed-effects regression results: The connection between economic activity, work inspections and the rate of work accidents in Europe (variables in levels)

	Dependent variable = ln total number of work accidents
ln GDP (Eq. (1): G)	1.9147 (0.5086)***
ln Capital stock (Eq. (1): K)	-0.6457 (0.4871)
ln Workers (Eq. (1): L)	-2.2318 (0.9934)**
ln Work inspections (Eq. (1): S)	-0.1831 (0.0651)***
Time = 2009	-0.0820 (0.0552)
Time = 2010	-0.0870 (0.0390)***
Time = 2011	-0.1884 (0.0441)***
Time = 2012	-0.2031 (0.0517)***
Time = 2013	-0.2323 (0.0450)***
Time = 2014	-0.2937 (0.0632)***
Time = 2015	-0.3439 (0.0704)***
Constant	16.8958 (9.4956)***
F-test (model significance)	19.25***
R2 (within)	0.4105
Observations (countries)	192 (24)

Robust standard errors adjusted by heteroskedasticity are presented in parentheses. \*, \*\*, \*\*\* indicates that parameters are significant at the 10%, 5% y 1%, respectively.