Innovation policies and workplace accidents in Europe: a dynamic assessment on external benefits

Angelo Castaldo, Tetyana Furman, Alessia Marrocco

Abstract

Workplace safety has been increasingly receiving attention from institutions, labour organizations, researchers and policy makers (Greer, 2018; da Silva, Amaral, 2019; Liu, 2019; Schulte et al., 2019; Tassinari et al., 2020). Despite the decreasing trend in the number of occupational accidents, in Europe cross-country investigation over this phenomenon highlight an heterogeneous dynamic pattern (Boone and van Ours, 2006; Anyfantis et al., 2018; Ivascu and Cioca, 2019; Lafuente and Daza, 2019; Verra et al., 2019).

The frequency of workplace accidents has been extensively studied in the literature for which, traditionally, it is possible to identify four main groups of factors affecting injuries (see Fabiano et al., 2004): i) individual factors related to workers characteristics (age, gender) and experience, ii) job-related factors, organization of work and environmental conditions, iii) technology used, and iv) economic factors, such as general economic conditions, unemployment rate, labour and social insurance legislation, business cycles. Cornelissen et al. (2017) have provided one of the most comprehensive overviews on the determinants of occupational safety, identifying and clustering several possible determinants of occupational injuries in high-risk industries (i.e., construction, petro-chemistry, warehouses, and manufacturing). The resulting seven clusters constitute a suitable framework to identify the possible determinants of workplaces accidents since Cornelissen et al. (2017) considered both theoretical and empirical studies and included determinants which have received so far little attention in previous models (e.g., external factors).

Based on this strand of literature, this paper presents an empirical investigation on the determinants of workplace accidents and focuses on the extent to which public expenditure on R&D&I affects the workplace accidents trend in Europe, while controlling for production-system characteristics (employment sectoral risk, size of firms, temporary contracts), business cycle and socio-economic factors (GDP, level of investments, unemployment, education) and other territorial features (quality of the institutions, crime index).

We use Eurostat data, and our panel is composed of 27 European countries over the period 2005-2019. Implementing different functional forms and estimation methodologies (pooled OLS, panel fixed and random effects models, system-GMM and semiparametric fixed effects model), we find robust evidence that the overall levels of public support schemes for innovation, while controlling for the productive-system characteristics, the business cycle and

other territorial variables are effective in explaining the evolution over time of the occupational accident rates.

References

Anyfantis I., Boustras G., Karageorgiou A. (2018). Maintaining occupational safety and health levels during the financial crisis – A conceptual model, *Safety Science*, 106, 246–254.

Arellano M., S. Bond (1991). Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations, *Review of Economic Studies*, 58(2): 277-297.

Arellano M., O. Bover (1995). Another look at the instrumental-variable estimation of error- components models, *Journal of Econometrics*, 68: 29-52.

Asfaw A., R. Pana-Cryan, R. Rosa (2011). The business cycle and the incidence of workplace injuries: evidence from the U.S.A., Journal of Safety Research, 42: 1-8.

Baltagi B.H. (2005) *Econometric Analysis of Panel Data*, 3rd Edition, John Wiley & Sons Inc., New York.

Baltagi B.H., Q. Li (2002). On instrumental variable estimation of semiparametric dynamic panel data models, *Economics Letters*, 76: 1-9.

Benavides F.G., J. Benach, C. Muntaner, G.L. Delclos, N. Catot, M. Amable (2006). Associations between temporary employment and occupational injury: what are the mechanisms? *Occupational Environmental Medicine*, 63(6): 416–21.

Blank V., F. Diderichsen, R. Andersson (1996a). Technological development and occupational accidents as a conditional relationship: A study over eighty years in the Swedish mining industry, *Journal of Safety Research,* 27: 137–146.

Blank V., L. Laflamme, F. Diderichsen (1996b). The impact of major transformations of a production process on age-related accident risks: a study of an iron-ore mine, *Accident Analysis and Prevention*, 28: 627–636.

Blundell R., S.R. Bond (1998). Initial conditions and moment restrictions in dynamic panel data models, *Journal of Econometrics*, 87: 115–143.

Bonamore G., F. Carmignani, E. Colombo (2015). Addressing the unemployment–mortality conundrum: Non-linearity is the answer, *Social Science & Medi*cine, 126: 67-72.

Boone J., J.C. van Ours (2006). Are recessions good for workplace safety? *Journal of Health Economics*, 25 (6): 1069-1093.

Brooker A. S., J. Frank, V.S. Tarasuk (1997). Back pain claim rates and the business cycle, *Social Science and Medicine*, 45(3): 429−439.

Cioni M., M. Savioli (2016). Safety at the workplace: accidents and illnesses, *Work, employment and society*, 30(5): 858-875.

Cornelissen P.A., J.J. Van Hoof, M.D. De Jong (2017). Determinants of safety outcomes and performance: A systematic literature review of research in four high-risk industries, *Journal of Safety Research*, 62, pp.127-141.

D'Ambrosio A., R. Leombruni, T. Razzolini (2022), Trading of wage for workplace safety? Gaps between immigrants and natives in Italy, *Economia Politica*, 39: 903–960.

da Silva S.L.C., F.G. Amaral (2019). Critical factors of success and barriers to the implementation of occupational health and safety management systems: A systematic review of literature, *Safety Science* 117: 123–132.

Davies R., P. Jones, I. Nuñez (2009). The impact of the business cycle on occupational injuries in the UK, *Social Science and Medicine*, 69: 178-182.

de La Fuente V.S., M.A. Camino López, I.F. Fontaneda González, O.J. Alcántara, D.O. Ritzel (2014). The impact of economic crisis on occupational injuries, *Journal of Safety Research*, 48: 77-85.

De Merich D., M.G. Gnoni, A. Guglielmi, G.J. Micheli, G. Sala, F. Tornese, G. Vitrano (2022). Designing national systems to support the analysis and prevention of occupational fatal injuries: Evidence from Italy, *Safety Science*, 147, 105615.

Dorman P. (2000). *If Safety Pays, Why Don't Employers Invest in it?* in K. Frick, P. Jensen, M. Quinlan, and T. Wilthagen (eds.), Systematic Occupational Health and Safety Management: Perspectives on an International development, Pergamon, Amsterdam, pp. 351–365.

Dupré D. (2001). *Accidents at Work in the EU – 1998-1999. Statistics in Focus: Population and Social Conditions*, Eurostat Theme 3 – 16/2001, Luxembourg: Publications Office of the European Union.

Eurofound (2012). Fifth European Working Conditions Survey, Publications Office of the European Union, Luxembourg.

European Commission (2002). *Adapting to Change in Work and Society: A New Community Strategy on Health and Safety at Work 2002–2006*, DG Employment. Luxembourg: Publications Office of the European Union.

European Commission (2007). *Improving Quality at Work: Community Strategy 2007–2012 on Health and Safety at Work. Improving the Quality and Productivity at Work*, DG Employment. Luxembourg: Publications Office of the European Union.

Fabiano B., F. Currò, A.P. Reverberi, R. Pastorino (2008). A statistical study on temporary work and occupation accidents: specific risk factors and risk management strategies, *Safety Science,* 46(3): 535-44.

Fabiano B., F. Currò, R. Pastorino (2004). A study of the relationship between occupational injuries and firm size and type in the Italian industry, *Safety Science*, *42*(7): 587-600.

Fabiano B., F. Currò, R. Pastorino (2001). Occupational injuries in Italy: risk factors and trend over the long period, *Journal of Occupational and Environmental Medicine,* 58 (5): 330–338.

Fabiano B., I. Parentini, A. Ferraiolo, R. Pastorino (1995). A century of accidents in the Italian industry: relationship with the production cycle, *Safety Science* 21(1): 65–74.

Farina E., Giraudo M., Costa G., Bena A. (2018). Injury rates and economic cycles in the Italian manufacturing sector, *Occupational Medicine*, 68:459–463.

Ferguson J., M. McNally, R. Booth (1985). Accidental injuries among naval personnel by occupation, duty status, and pay-grade, *Accident Analysis and Prevention*, 17: 79–86.

Fortin B., P. Lanoie, C. Laporte (1996). Unemployment insurance and the duration of workplace accidents, *The Canadian Journal of Economics*, 29: 17-24.

Fotta B., G. Bockosh (2000). The aging workforce: an emerging issue in the mining industry, National Safety for Occupational Safety and Health (NIOSH), Mining Safety and Health Research, https://www.cdc.gov/niosh/mining/works/coversheet1199.html

Giraudo M., Bena A., Mosca M., Farina E., Leombruni R., Costa G. (2018). Differences in work injury risk between immigrants and natives: changes since the economic recession in Italy, *BMC Public Health*, 19 (836).

Greer S. L. (2018). Labour politics as public health: how the politics of industrial relations and workplace regulation affect health, *European Journal of Public Health*, 28(3): 34-37.

Hall A. (2016). Trust, uncertainty and the reporting of workplaces hazards and injuries. *Health, Risk & Society* 18:7-8: pp. 427-448.

Hämäläinen P., K.L. Saarela, J. Takala (2009). Global trend according to estimated number of occupational accidents and fatal work-related diseases at region and country level, *Journal of Safety Research*, 40(2): 125-139.

Hartwig R.P., W.J. Kahley, T.E Restrepo, R.C. Retterath (1997). Workers' compensation and economic cycles: a longitudinal approach, Proceedings of the Casualty Actuarial Society, 84, 660−700, https://www.casact.org/sites/default/files/database/proceed_proceed97_97660.pdf

Haslam R., S. Hide, A. Gibb, D. Gyi, T. Pavitt, S. Atkinson, A. Duff (2005). Contributing factors in construction accidents, *Applied Ergonomics,* 36: 401-415.

Hausman J.A. (1978). Specification tests in econometrics, *Econometrica*, 46: 1251-1271.

Ivascu L., L.I. Cioca (2019). Occupational Accidents Assessment by Field of Activity and Investigation Model for Prevention and Control, *Safety*, 5, 12.

Jeong B. (1999). Comparisons of variables between fatal and nonfatal accidents in manufacturing industry, *International Journal of Industrial Ergonomics*, 23: 565–572.

Khanzode V.V., J. Maiti, P.K. Ray (2012). Occupational injury and accident research: a comprehensive review, *Safety Science*, 50: 1355-1367.

Khanzode V., J. Maiti, P. Ray (2011). A methodology for evaluation and monitoring of recurring hazards in underground coal mines, *Safety Science*, 49: 1172–1179.

Kletz T.A. (1993). Accident data - the need for a new look at the sort of data that are collected and analyzed, *Safety Science*, 16 (3,4): 407-415.

Ko K., J. Mendeloff, W. Gray (2010). The role of inspection sequence in compliance with the US Occupational Safety and Health Administration's (OSHA) standards: Interpretations and implications, *Regulation & Governance*, 4: 48-70.

Kossoris M. (1938). Industrial injuries and the business cycle, *Monthly Labor Review*, 61: 579-595.

Kubicek A., R. Bhanugopan, G. O'Neill (2019). How does cultural intelligence affect organisational culture: the mediating role of cross-cultural role conflict, ambiguity, and overload, *The International Journal of Human Resource Management*, 30(7): 1059-1083.

Lafuente E., Daza V. (2019). Work Inspections as a Control Mechanism for Mitigating Work Accidents in Europe. *Tec Empresarial*, 14(1): 26-37.

Leigh J., H. Mulder, G. Want, N. Farnsworth, G. Morgan (1990). Personal and environmental factors in coal mining accidents, *Journal of Occupational Accidents*, 13: 233-250.

Leigh J. P. (1989). Firm size and occupational injury and illness incidence rates in manufacturing industries, *Journal of Community Health*, *14*(1): 44-52.

Lenaerts K., W. Waeyaert, D. Gillis, I. Smits, H. Hauben (2022). Occupational Safety and Health in Digital Platform Work: Lessons from Regulations, Policies, Actions and Initiatives, European Agency for Safety and Health at Work (EU-OSHA).

Liu K. (2019). Regulating health and safety at the workplace: Prescriptive approach vs goal-oriented approach, *Safety Science*, 120: 950-961.

Lombardi M., M. Fargnoli, G. Parise (2019). Risk profiling from the European statistics on accidents at work (ESAW) accidents′ databases: a case study in construction sites, *International Journal of Environmental Research and Public Health*, 16: 4748.

Lopez M.A.C., D.O. Ritzel, I. Fontaneda, O.J.G. Alcantara (2008). Construction industry injuries in Spain, *Journal of Safety Research*, 39(5): 497-507.

Maiti J., S. Chatterjee, S. Bangdiwala (2004). Determinants of work injuries in mines: an application of structural equation modelling, *Injury Control and Safety Promotion*, 11: 29-37.

Maiti J., A. Bhattacherjee, S. Bangdiwala (2001). Loglinear model for analysis of cross-tabulated coal mine injury data, *Injury Control and Safety Promotion*, 8: 229–236.

Maiti J., A. Bhattacherjee (1999). Evaluation of risk of occupational injuries among underground coal mine workers through multinomial logit analysis, *Journal of Safety Research,* 30: 93-101.

Nichols T. (1991). Industrial injuries in British manufacturing industry and cyclical effects: continuities and discontinuities in industrial injury research, *The Sociological Review,* 39: 131-139.

Picchio M., J.C. van Ours (2017). Temporary jobs and the severity of workplace accidents, *Journal of Safety Research*, 61: 41-51.

Rasmussen J. (1987). Reasons, causes and human errors, in: *New Technology and Human Error*, Wiley and Sons Ltd., UK: 293–303.

Robinson J. (1988). The rising long-term trend in occupational injury rates, *American Journal of Public Health,* 78: 276-281.

Salminen S. (1993). The effect of company size on serious occupational accidents, in R. Nielsen & K. Jorgensen (eds.), *Advances in Industrial Ergonomics and Safety* (vol. 5., pp. 507–514). London: Taylor & Francis.

Salminen S. (1998). Why do small company owners think larger companies have fewer accidents? *Journal of Occupational Health & Safety – Australia and New Zealand*, 14(6): 607-614.

Sari M., H. Duzgun, C. Karpuz, A. Selcuk (2004). Accident analysis of two Turkish underground coal mines, *Safety Science,* 42: 675-690.

Schulte P. A., Delclos G., Felknor S. A., Chosewood L. C. (2019). Toward an Expanded Focus for Occupational Safety and Health: A Commentary, *International Journal of Environmental Research and Public Health*, 16: 4946.

Takala, J. (2019). *Burden of Injury due to Occupational Exposures*. In: Bültmann, U., Siegrist, J. (eds) Handbook of Disability, Work and Health. Handbook Series in Occupational Health Sciences, vol 1. Springer, Cham. https://doi.org/10.1007/978-3-319-75381-2_5-1.

Tassinari A., R.E. Chesta, L. Cini (2020). Labour conflicts over health and safety in the Italian Covid19 crisis. *Interface*, vol. 12(1): 128-138.

Theorell T. (2022). *Handbook of Socioeconomic Determinants of Occupational Health. From Macro-level to Micro-level Evidence*. Cham (Switzerland): Springer.

Toch M., C. Bambra, T. Lunau, et al. (2014). All Part of the Job? The Contribution of the Psychosocial and Physical Work Environment to Health Inequalities in Europe and the European Health Divide, *International Journal of Health Services*, 44(2):285-305.

Ussif A.A. (2004). An international analysis of workplace injuries, *Monthly Labor Review*, 127: 41-51.

Verra S. E., A. Benzerga, B. Jiao, K. Ruggeri (2019). Health Promotion at Work: A Comparison of Policy and Practice Across Europe. *Safety and Health at Work*, 10: 21-29.

Virtanen M., M. Kivimäki, M. Joensuu, P. Virtanen, M. Elovainio, J. Vahtera (2005). Temporary employment and health: a review, *International Journal of Epidemiology,* 34(3): 610–22.

Viscusi W. (1986). The impact of Occupational Safety and Health regulations, 1973-1983, *RAND Journal of Economics*, 17(4): 567-580.

Vredenburgh A.G. (2002). Organizational safety: which management practices are most effective in reducing employee injury rates? *Journal Safety Research,* 33: 259–276.

Wadsworth E., D. Walters (2014). The Determinants of Workplace Health and Safety Practice in the UK, *Policy and Practice in Health and Safety*, 12(2): 3-22.

Weil D. (1996). If OSHA Is So Bad, Why Is Compliance So Good? *The RAND Journal of Economics*, vol. 27(3): 618-40.

Zambon I., A. Piergentili, L. Salvati, D. Monarca, P. Matyjas-Łysakowska, A. Colantoni (2018). Applied Research for a Safer Future: Exploring Recent Job Accidents in Agriculture, Italy (2012-2017), *Processes,* 6: 87.