Safety Science 152 (2022) 105772

Contents lists available at ScienceDirect

Safety Science

journal homepage: www.elsevier.com/locate/safety

Business performance and occupational injuries trajectories in the construction sector in Sweden

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ARTICLE INFO

Keywords:
Business performance
Occupational injuries
Occupational epidemiology
Public health

ABSTRACT

Objective: To identify patterns in business performance and occupational injuries (OIs) in the Swedish construction sector between 2003 and 2015 and investigate associations between these trajectories.
Methods: Company-level data were gathered from national registers. An open cohort of 13,089 private construction companies were classified by size. Yearly business performance indicators were return on equity, operating margin, and labor-to-revenue ratio. OIs rate was defined as number of injuries divided by number of employees. Group-based trajectory models were performed to identify companies with similar patterns in business performance and OIs rate over time. Associations were investigated with binomial regression models.
Results: The model identified two main patterns (high/low) of injuries and business indicators for all company sizes. Trends in low labor-to-revenue ratio were associated with a high injury rate with a pooled estimate of 1.43 (95% CI 1.22–1.64) with some variation by company size: super small OR 1.3 (95% CI 1.01–1.62), small, OR 1.74 (95% CI 1.39–2.18), medium OR 1.3 (95% CI 0.9–1.8) and large OR 2.1 (95% CI 0.77–5.7). Similarly, low patterns of returns on equity were associated with high injury rate patterns across all company sizes, excluding small enterprises. No associations were found for operating margin patterns.
Conclusions: Low returns on equity and labor-to-revenue ratio were associated with higher OIs rate trajectories in the Swedish construction sector, which has implications for injury prevention as well as targeted surveillance and inspection. Further studies could investigate other economic sectors and possible mechanisms for this association.

1. Introduction

A relationship between economic cycles and occupational injury (OIs) rates has been shown in empirical studies from as early as the 1960s (Catalano, 1979; Kossoris, 1938; Robinson and Shor, 1989; Fabiano et al., 1995; Nichols, 1989). Economic cycles correspond to the fluctuation of the economy between periods of expansion (growth) and contraction (recession), and OIs rates tend to rise during periods of economic growth and decrease during recessions (Catalano, 1979; Robinson and Shor, 1989; Asfaw et al., 2011; Davies et al., 2009; de la Fuente et al., 2014; Fernández-Muñiz et al., 2018; Nielsen et al., 2015). The increase in injury rates during economic upturns is partially explained by an increase in employment of a temporary workforce ito meet higher production targets. Temporary and inexperienced workers may be required to work without appropriate job training (Asfaw et al., 2011; Farina et al., 20182018; Ussif, 2004). A few studies have

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https://doi.org/10.1016/j.ssci.2022.105772
Received 22 April 2021; Received in revised form 28 December 2021; Accepted 31 March 2022
Available online 13 April 2022

investigated the impact of profitability on injuries, but results have been inconclusive (Denommee-Gravel, 2019; Argilés-Bosch et al., 2014). It has further been hypothesized that a company undergoing financial strain, may be more likely to adopt policies that will lead to an increase in safety violations, environmental hazards, and consequently an increase in OIs (Boisjoly, 1996). Two studies conducted in the US in industry sectors other than construction, have empirically tested this hypothesis (Boisjoly, 1996; Asfaw et al., 2013). Weak evidence was found for an effect of business performance on injury experience. One study performed during the late 1970's and early 1980's among trucking and airline industries using several measures of business performance, found weak evidence supporting such a hypothesis and practical implications of the study were few. The other study showed that a 10% increase in real total revenue per hour worked was associated with a 0.9% decrease in incident rates of all reported injuries in coal mining companies between 1992 and 2008 (Asfaw et al., 2013). The dearth of previous research investigating the relationship between changes in economic conditions (and performance) and OIs is probably due to the methodological complexities for studying this. First, it is necessary to consider several indicators and their patterns (i.e., fluctuations) over time for classifying companies having a good or a bad economic performance. Companies are likely to vary considerably in the time before they react to economic up- or downturns and may make decisions based on future projections (taking pre-emptive measures). This would give different time-lag between business performance and how performance may affect OIs. Consequently, single point-in-time measurement of business performance is likely to misclassify some companies with business performance defined according to *a priori* cut-offs misrepresenting the dynamic behavior of the companies' performance over time. We therefore decided on applying novel statistical models to identify patterns not necessarily conceived *a priori: an approach that develops* group-based model trajectories. This method allows identification of companies that present similar patterns of business performance and OIs over time (i.e., constant or fluctuating patterns). Further, in order to facilitate the interpretation and avoid the complexity of handling multiple industries in this initial effort, we chose to explore company level performance in a single economic sector, the Swedish construction sector, as a proof of concept for future studies.

1.1. Aim

The overall aim of this study is two-fold: (i) to distinguish patterns of business performance and OIs of Swedish companies in the construction sector over 2003–2015, and (ii) to investigate associations between poor business performance patterns and high injury rates. We hypothesise that a stable and higher level of business performance over time will be associated with lower OIs.

2. Methods

2.1. Study design

This is a cohort study based on a register of private construction companies registered in Sweden for at least one year between 1 January 2003 and 31 December 2015. This period was noted to include the financial crisis of 2007. Maintaining an open cohort of companies allowed for a real representation over time of the company dynamics of the Swedish construction sector, allowing the development of new companies and failure of existing companies to be considered. The study established a limited set of business indicators to track and then examine the relationship of the changes in these indicators over time to the risk of OIs

2.2. Data sources

Data on company level were collected from the *Longitudinal Integration Database for Health Insurance and Labour Market Studies* (LISA), while data on reported OIs were obtained from the *Information System on Occupational Injuries* (ISA). Under Swedish law OIs are required to be reported directly by the employee to the employer. The employer, in turn is mandated to report the injury to the Swedish Social Insurance Agency where the data are entered into the ISA register. Each individual as well as company in Sweden is identified by a unique identification number through which register information was linked. Exclusion criteria were:

(i) micro enterprises (companies $<$ 10 employees) because of their volatile growth (Calvino et al., 2018) and the higher OIs underreporting observed among smaller companies (Orellana et al., 2020); (ii) companies having outlier values in any of the business indicators studied.

2.3. Study variables

2.3.1. Key business performance indicators

We began by narrowing a wide range of indicators down to three key indicators of business performance that were used in this study: the rationale for choosing these three business indicators was justified by the relationship between level of business performance and how it affects room for manoeuvring and the direction of management decisions.

- Returns on equity: This was operationalized as a ratio expressed as a percentage, calculated as net income over share-holders' equity. Because shareholders' equity is equal to a company's assets minus its debt, returns on equity is considered the return on net assets. It is used as the overall return measure, representing the return that owners of the business receive.
- Operating margin: This was operationalized as a ratio expressed as a percentage obtained by dividing a companýs earnings by its revenues. It measures how much profit a company makes after a company pays for variable costs of production (wages, raw material etc.). Also, it is related to changes in the overall economy and the markets that the firm is operating in.
- Labor-to-revenue ratio: This was operationalized as a ratio expressed as a percentage and calculated as personnel costs over net sales. This indicator is a measure of efficiency or exploitation depending on perspective. A low rate means that the business is performing well.

2.3.2. Occupational injuries (OIs)

- OIs rates: these were calculated as number of reported injuries over total number of employees within each company for each year.
- OIs severity level: categorized as injuries that lead to, a) no sickness absence from work, b) between 1 and 3 days of sickness absence, c) between 4 and 14 days of sickness absence, d) $>$14 days of sickness absence and e) fatal injuries.
- Injuries occurring during transit to or from work as well as occupational diseases were excluded since they are included in the traffic injuries register.

2.3.3. Co-variables

- Company size (according to number of employees): after excluding microenterprises, companies were classified when entering the cohort as very small (10–19), small (10–49), medium (50–249), and large companies ($\geq$250) (OECD, 2017). Although company size can be classified by different criteria, we have chosen to use the most common one, which is number of individuals employed by the company (OECD, 2017).
- Construction trade: companies were classified using the three digit level Swedish adaptation of the Statistical Classification of Economic

Activities in the European Community (NACE, 2002) into five groups: a) demolition, test drilling and boring; b) construction of buildings, roads, motorways, railways, erection of sheet metal roof covering, construction of water projects, other; c) installation of electrical wiring and fittings, heating and sanitary, ventilation, refrigeration; other plumbing; d) plastering, joinery installation, floor and wall covering, painting, glazing, other; and, e) renting of construction or demolition equipment with operator. Because our time frame includes a shift in the classification of the trades in 2007, companies with a 2007 code were recoded to harmonize with those with a 2002 code.

2.4. Statistical Methods

2.4.1. Rationale for statistical approach

There is no well-established statistical approach to study the interaction of the dynamic behavior of companies and OIs. We considered utilizing some version of time-series regression analysis with varying time-lags but abandoned this approach due to (i) the complexities in the classification of what is and when can a company be considered to have a good or a bad economic performance and (ii) the possible misclassification of companies when single time-point measurements of business performance are considered. We chose instead a statistical method capturing behaviors of companies and injuries over time without the need to specify *a priori* cut-offs or *a priori* temporal relationships, i.e., we focus on the changes in level of business performance. We opted for a data-driven approach, applying a group-based trajectory models (GBTM's), a likelihood-based statistical method, to model the average trajectory of an outcome variable of interest (OI) in any given performance trajectory group (Nagin and Odgers, 2010). Moreover, GBTM's allow to include companies existing only for one year.

2.4.2. Statistical analysis

GBTMs were constructed separately for each of our three business indicators and OI rates stratified by the four categories of company size, to identify patterns among groups of companies that presented with similar trajectories over the study period (2003–2015). The OIs rates were modeled with the zero-inflated Poisson distribution, and the business indicators were modeled with the censored normal distribution. Separately for each business indicator and OI rate, we estimated the probability for each company to be in any given trajectory group. The steps and justification for choosing the final number of groups are detailed in Supplementary Material 1. The association between the assigned business indicator trajectory group and the OI rates trajectory group was investigated with binomial regression models, obtaining odds ratios (ORs) with their 95% confidence intervals (95% CI). Due to lack of statistical power, we could not identify trajectories of companies according to severity of the OI. Instead, we used severity to describe OI by company size and by construction trade. All analyses were performed separately according to company size to account for differential underreporting due to company size. The number of years of activity varied across companies and number of companies belonging to each trajectory are presented in Supplementary Material 2. We performed a sensitivity analysis considering only companies that were active for at least 3 years, and another analysis including companies only active for the entire follow up period 2003–2015 (data not shown). Data management was performed using SAS version 9.4. The analysis was conducted in Stata version 16.

3. Results

A total number of 13,089 construction companies were included in this study, of which 8,397 were very small (10 to 19 employees), 3,689 were small (20 to 49 employees), 908 were medium- size (50–249 employees) and 95 were large (≥250 employees). Among all companies, one third (4,360) reported having at least one injury between 2003 and 2015, with a total of 46,506 injuries (Supplementary material 3).

3.1. Trajectories of business performance and OIs

Results from the GBTM for the three business indicators and for injury rates by company size suggested either two or three different trajectories over the study period for each of the indicators. Therefore, we estimated each model in two separate sets of analyses: one with two and one with three trajectory groups. Because the latter analyses did not improve the goodness of fit significantly nor suggest a different understanding of the trajectories, we report the results of the two-group analysis (Supplementary Material 1). In general, low trajectories included companies consistently reporting none or very few injuries over the time-period (mean injury rate < 0.2), while the "high" trajectories included the other companies, those that experienced more than a few injuries over the study period (mean injury rate > 0.4). Two different patterns (groups) of OIs were observed according to size (Fig. 1):

- Very small and small companies: (i) decreasing high injury rate trajectory, (ii) constant low injury rate trajectory.
- Medium companies: (i) increasing high injury rate trajectory, (ii) slow-increasing low injury rate trajectory.
- Large companies: (i) decreasing high injury rate trajectory, (ii) increasing low injury rate trajectory.

Besides the differences in the patterns over time across company size, the two injury trajectories in each size group largely remained parallel and did not intersect at any point in time (Fig. 1).

As for the three business indicators, the two patterns for each indicator and company size were labelled as low (poorer) and high (better) business performance. They also showed some variation over time by size but, with one early exception, they did not intersect at any point in time. The trajectories for labor-to-revenue ratio were stable over time, with little variation and the two trajectories remained parallel. As for the other two business indicators, operating margin and returns on equity, it was possible to see an increase in both indicators previous to 2007 and some decrease or flattening after 2007. Higher and lower performance trajectories diverged during this period, and the companies belonging to the higher trajectory increased the gap by varying amounts between high and low performing companies, a difference that was surprisingly maintained in the years following the financial crisis. This pattern was seen for all companies except the large ones, where operating margins started to converge again after the crisis. Another observation was that smaller companies in the higher trajectory had higher operating margins and lower returns on equity than larger ones and vice versa.

3.2. Associations between trajectories

Table 1 displays the associations between business performance and OIs trajectory patterns according to company size. When looking at returns on equity, companies that performed economically poorer during 2003–2015 following trajectories of low returns on equity, with the exception of very small companies had higher likelihood of belonging to the trajectory of high injury rates (ORs > 1.2). As to the labor-to-revenue indicator, companies following trajectories of low labor-to-revenue ratio presented a higher likelihood of belonging to the trajectory of high injury rates for all company sizes (ORs > 1.3). Even though associations were statistically significant only for small and very small companies and labor-to-revenue trajectories, the patterns were consistent: trajectories of low returns on equity and low personnel costs were generally associated with a trajectory of high injury rates (Wasserstein et al., 2019). Ultimately, within the low operating margins indicator, the trajectory of low operating margins was not associated with the trajectory of high injury rates. Sensitivity analysis (on companies that were active for at least 3 years, and companies active for the entire follow up period)

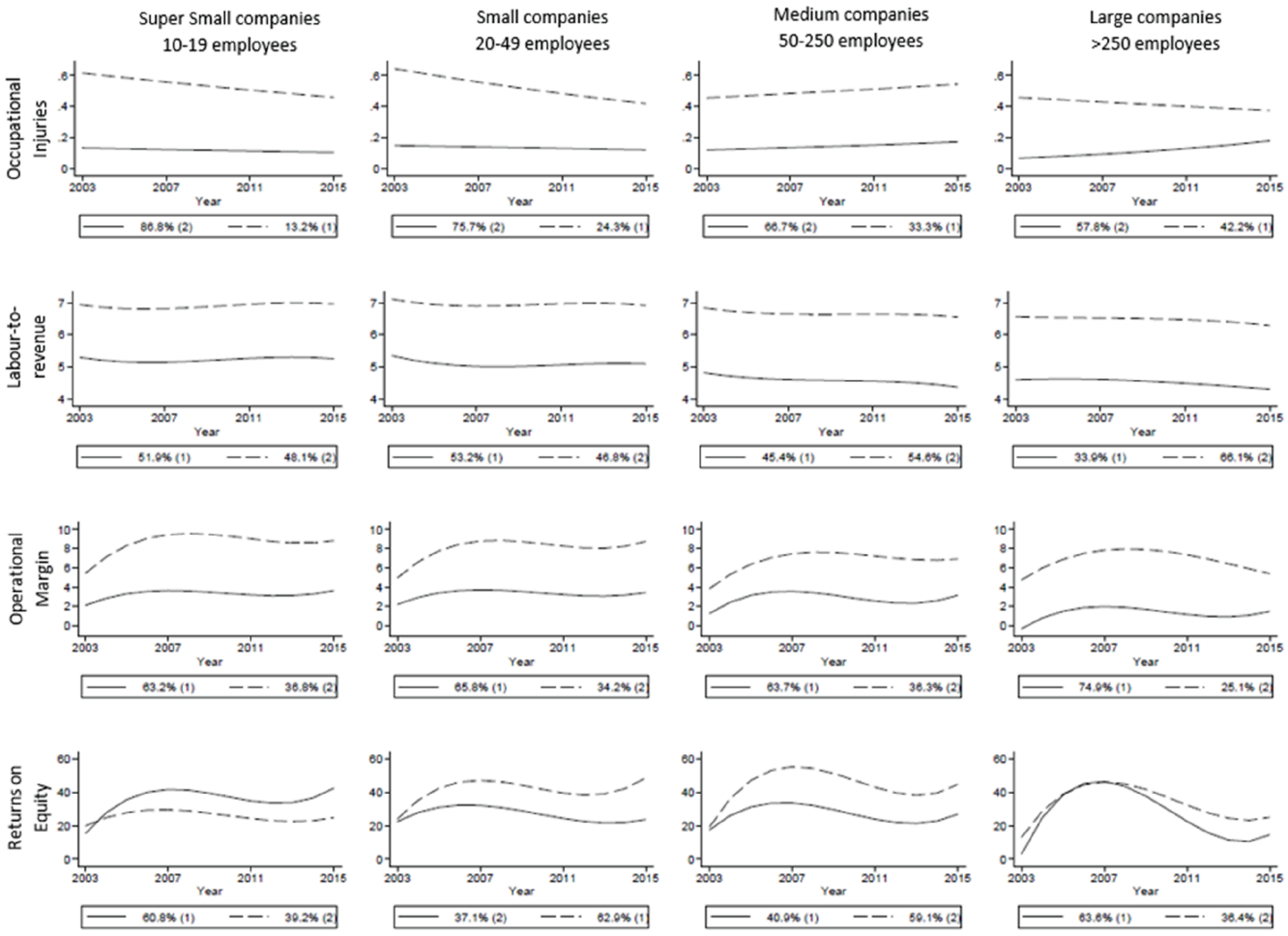

Fig. 1. Group-based trajectories of occupational injuries and business performance indicators. Lowest trajectories for injuries indicate that the companies had low injury rates while for performance the lowest trajectories indicate the companies that were performing the poorest. The legend attached to each graph presents the percentage of companies belonging to each trajectory. The vertical axis for the occupational injuries displays the mean occupational injury rate (number of occupational injuries by number of employees in the company).

Table 1
Associations between business indicators trajectories and high occupational injuries trajectories between 2003 and 2015.

	High occupational injury rate trajectory							
	Super Small companies 10–19 employees		Small companies 20–49 employees		Medium companies 50–249 employees		Large companies >=250 employees	
	N (%)	OR (95% CI)	N (%)	OR (95% CI)	N (%)	OR (95% CI)	N (%)	OR (95% CI)
Returns on equity								
low performing trajectory	129 (3.58)	0.99 (0.78–1.25)	169 (11.40)	1.20 (0.97–1.50)	74 (18.45)	1.26 (0.88–1.8)	11 (33)	1.6 (0.6–4)
high performing trajectory	170 (3.54)	ref	207 (9.36)	ref	75 (14.79)	ref	13 (21)	ref
Labour-to-revenue ratio								
low performing trajectory	174 (3.96)	1.3 (1.01–1.62)	130 (7.51)	1.74 (1.39–2.18)	76 (18.63)	1.3 (0.9–1.8)	11 (35.48)	2.1 (0.77–5.7)
high performing trajectory	125 (3.11)	ref	246 (12.54)	ref	73 (14.60)	ref	13 (20.31)	ref
Operating Margin								
low performing trajectory	208 (3.57)	1.2 (1.01–1.62)	269 (10.26)	1 (0.8–1.27)	110 (17.24)	1.16 (0.77–1.73)	18 (23)	0.6 (0.17–1.7)
high performing trajectory	91 (3.52)	ref	107 (9.97)	ref	39 (14.44)	ref	6 (33)	ref

suggested same conclusions compared to our main analysis (data not shown).

3.3. Occupational injuries by severity and company size

As noted, there was not enough power to model trajectories of companies according to severity of the OI. Table 2, therefore, stratifies injury severity by company size. As expected, OIs that did not lead to any sickness absence were more common than more severe injuries almost double for medium and large companies (injuries leading to +14 days of sickness absence). Injuries in small companies were only 25% more common for those with no absence from work than for those with more

Table 2
Number of Occupational Injuries by severity and company size 2003–2015.

Sickness Absence	Super Small companies 10–19 employees		Small companies 20–49 employees		Medium companies 50–249 employees		Large companies >=250 employees	
	Injuries n. (%)	Companies[1] n.	Injuries n. (%)	Companies[1] n.	Injuries n. (%)	Companies[1] n.	Injuries n. (%)	Companies[1] n.
0 days	2069 (32%)	1091	3706 (35%)	1086	4202 (40%)	418	8541 (44%)	59
1–3 days	817 (13%)	603	1469 (14%)	715	1484 (14,2%)	349	2817 (14,9%)	57
4–14 days	1408 (21,8%)	973	2355 (22,8%)	1015	2323 (22,2%)	397	3922 (20%)	58
>14 days	2143 (33%)	1398	2961 (28%)	1188	2444 (23,53%)	409	4040 (21%)	59
Fatal Injuries	16 (0,2%)	14	20 (0,2%)	20	8 (0,07%)	8	22 (0,1%)	10
Total	6453 (100%)	2303	10,471 (100%)	1554	10,461 (100%)	446	19,343 (100%)	57

[1] Number of companies with reported occupational injuries in the sample. Companies may appear in more than one severity category. The total represents the total number of unique companies with reported injuries.

than 14 days of absence. Very small companies, however, had more injuries with long-term work absence than with no absence. Fatal injuries were rare events for all size categories but most frequent across small companies, where they accounted for 0.4% of the total, while accounting for only 0.07% and 0.1% in in medium and large companies, respectively. The same severity patterns were found when looking at construction sub-trades (Supplementary Material 3).

4. Discussion

In this study we examined associations between patterns of business indicators and occupational injuries in the construction sector in Sweden from 2003 to 2015. Our results suggest that companies cluster into good or bad economic performance patterns and that there is a generally clear relationship between the level of business performance and OIs. Regardless of company size, companies that performed economically poorer according to two business indicators -low returns on equity and low personnel costs- had higher likelihood of experiencing high injury rate trajectories. This pattern was consistent except for the association between the trajectory of low returns on equity and high injury rates among the smallest companies (10–19 employees). Low operating margins showed a less clear association with the trajectory of high injury rates regardless of the size of the company. Similar associations were found in the US coal mining industry between profitability and OIs rates, where results showed least profitable coal mines reporting 26% higher incidence rates of all injuries compared to most profitable mine between 1992 and 2008 (Asfaw et al., 2013). In that study, profitability was measured as revenue per hour worked, and OIs were modeled as incidence rate for hour worked. Even if our results are performed in a different economic sector, using several business indicators to best identify business performance indicates that multiple factors other than revenue or profitability, play a role within a company.

Less profitable companies and companies that find themselves in constant financial distress over time, may not be able to afford investment in preventive measures or health and safety or training courses, and may not see the short-term benefits of these, even though they have been shown to be an effective measure of safety in the long run (Asfaw et al., 2013; Argilés-Bosch et al., 2020). Thus, it is reasonable to believe that less profitable companies have a higher risk of under-reporting, leading to an underestimation of the impact of business performance on workplace injuries. In the last decades, the construction sector has increased the outsourcing of labor through subcontractors, leading to an increase in workforce among small and very small companies, and an increase in the proportion of the workforce being employed temporarily (Aderaw et al., 2011; ILO, 2001). Subcontracting chains are often difficult to track, (whether large companies subcontracting to medium or small ones, or medium subcontracting to small ones, etc.) making it difficult to assess who has or should have primary responsibility for prevention of poor working environments and eventual workplace injuries (Weil, 2014). Furthermore, the increase of precarious employment arrangements places workers' protection at risk, especially among less profitable companies.

Berglund et al. (Berglund, 2019) cross-sectionally analyze OIs in Sweden in the construction sector and call on the need to look longitudinally at injury statistics among different construction trades (Berglund, 2019). When we examined this question in a preliminary fashion, we did not find major differences in injury rates across construction trades from 2003 to 2015 (data not shown). We also found negligible differences in injury rates by company sizes, in contrast with previous findings of specific trades and smaller companies at higher risk of occupational injuries (Berglund, 2019; Holte et al., 2015; Morse et al., 2004). These differences may be due to small numbers of medium and large companies in our cohort. When looking at the severity of the injuries, no matter the size of the company, injuries were almost evenly split between those that did not require any absence from work, and injuries that lead to more than 14 days of absence from work. Nevertheless, smaller companies present a higher share of severe injuries compared to larger companies. Larger companies are more likely to have in-place work environment committees and better intervention strategies on how to tackle workplace injuries, as well as they are more likely to have union representation, circumstances leading to a lower proportion of severe injuries compared to smaller companies (Morse et al., 2004). Owners of smaller companies are likely more focused on the working and managerial tasks and end up lacking specialized and dedicated health and safety resources (Berglund, 2019; Holte et al., 2015). Finally, there is a lack of studies differentiating results by company size, missing on possible differential mechanisms happening between business performance, workplace injuries and small, medium and large companies. Company size may be a risk factor in terms of different behaviors as to safety measures, training, reporting characteristics, employment quality (Holte et al., 2015), making all these even more complex in those that constantly under-perform over time. Orellana et al. (Orellana et al., 2020), show that an estimated one in four OIs are not reported in the official statistics in Sweden in 2013, and that such under-reporting differed by several factors at organizational level, with a 23.2% under-reporting among smaller companies (50 to 99 employees), 20.5% underreporting among the medium size companies (100–249 employees) and 17.4% under-reporting in larger companies (≥250 employees).

4.1. Strengths and limitations

This research is the first longitudinal study using company level data in order to identify how business performance over time affects OIs experience. A significant strength of our study is the use of register data, which allowed us to access specific data on company size, create business indicators and be able to link individual employee data on their OIs, especially when it comes to small companies which are usually hard to reach. Our method of choice, group-based trajectories, also represents a strength in this study, since it allows us to explore patterns and clusters in our sample without setting *a priori* values to what high/low business indicators and OIs may have. Also, using group-based trajectories

allowed us to include companies existing only one year as they were considered important to allow for a real representation over time of the company dynamics in the construction sector. Categorizing our companies in terms of their size also represents a strength as to deepening an understanding of the underlying dynamics across construction companies. This also has proved to be a limitation when it comes to the number of medium and large companies present in this study, which are outnumbered by small companies. These small numbers may be the reason why we do not see differences in injury rates across the construction trades, as well as for the wide CI in the analysis of the medium and large companies. Small numbers also hinder identifying trajectories of companies according to OI severity. Furthermore, it was not possible in this study to take into consideration the magnitude of possible workplace injury under-reporting, causing a possible underestimation of the number of injuries in this sector. Also, it was not possible to measure our exposure in a more accurate way, such as considering number of hours worked. Finally, there is no information as to subcontracting and foreign companies nor does the registry used allow us to examine the informal sector, so we do not know how these factors may affect both our exposure and outcome

5. Conclusion

Much of the literature on the impact of health and safety measures on workplace injuries and the relationship with business performance in the short and long term have found negative or inconclusive results (Nielsen et al., 2015; Boisjoly, 1996; Asfaw et al., 2013). Our findings add new understanding of the importance of business performance on OIs. We found that construction companies with constant-lower business performance are associated with higher OIs rates. The results presented in this study cannot be generalized to companies operating in other economic sectors. Further studies examining business performance and OIs across other economic sectors in Sweden and other countries are needed in order to target economically at-risk companies. Studies should also look at how the employer-employee relationship and precarious employment could be affected by the level of business performance. Lastly, we call on policy makers to build a register of reliable data on subcontracting in the construction sector, as well as in other economic sectors, to enable efficient tracking of the real magnitude of OIs and chains of responsibility for occupational health and safety across companies.

Funding

This manuscript was supported by a grant from The Swedish Research Council for Health, Working Life and Welfare (FORTE) [grant number 2015-00933 and 2016-00315]. The founding source had no involvement in any of the research stages of this research project.

Authors' Contributions

BK was responsible for data management, data analysis, drafting the manuscript. MB performed data analysis together with BK and NMS. TB was the PI of the project and was involved in all aspects of the study. All other authors were involved in interpreting results and drafting of the manuscript. All authors gave approval of the final version and agreed to be accountable for all aspects of published work. Authors' declarations of interest: none.

Authors contribution

TB, BB, TH, DHW were responsible for conceptualization of the study and funding acquisition and were invovled in all the rest of the steps of the study. TB was further responsible for resources and supervision. BK was responsible for project administration and software, data curation, writing-original draft, writing-review &editing, visualization, investigation, validation. BK, NMS and TB conceptualized the study design. BK, NMS and MB developed the methodology and MB performed the main analysis and BK the descriptive analysis. All co-authors were actively part of all steps, especially in the reviewing and editing the manuscript.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssci.2022.105772.

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