Safety Science 110 (2018) 235–248

Contents lists available at ScienceDirect

Safety Science

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

How injury incidence is associated with business cycles? Empirical evidence from Taiwan

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ABSTRACT

Workplace injury incident rates are commonly reported to change in commensurate with economic situation. Although causal mechanisms, such as new employees, pace of work, and injury reporting behaviors have previously been proposed to explain this phenomenon, there is little empirical evidence supporting this relationship. Using monthly Taiwanese insurance payment data from four main sectors during 2002–2014, this paper examines the relationship by relating major and minor occupational injury to several macroeconomic variables. Regressions based on the first-differenced variables are used to explore how various factors related to the business cycles impact the incidences of major and minor injuries. The analysis is then supplemented with the Granger tests to establish the causality. We conclude that employee fatigue and operational errors that arise from increased working hours and intensified work pace during economic boom times contributed to the injury incidence. In addition, our longitudinal analyses also explain the ways in which firms respond to external demand shocks, thereby further illustrating the mechanism underlying the business cycle and injury incidence.

1. Introduction

The association of the incidence of occupational injuries and the business cycle has been reported in prior studies (Robinson, 1988; Boone and van Ours, 2006; Miller et al., 2009; de la Fuente et al., 2014; Fernández-Muñiz et al., 2016). A general finding is that the reported workplace injury incident rate increases during times of economic upturns and decreases during economic downturns. This phenomenon has a significant implication for both academia and industry. That is, workplace safety is affected not only by internal factors within an organization, such as the safety climate or management system, but also by external factors, including economic fluctuations and business cycles.

Understanding how workplace injury incidence correlates with business cycles and the underlying mechanism, therefore, may provide useful information that allows practitioners to enhance safety management. Although factors, including new employees (Kossoris, 1938), work overtime (Schuster and Rhodes, 1985), reporting behaviors (Boone and van Ours, 2006) and others, have been proposed to explain this phenomenon, empirical evidence is still lacking. Moreover, previous studies (e.g., Asfaw et al., 2011; Davies et al., 2009) failed to address why the injury incidence in some industries (e.g., manufacturing, construction) is more sensitive to the business cycle than in others (e.g., transport, trade). In addition, as evident by the 2008 global financial crisis, the impact of the business cycle can be drastic, with a fast pace of changes that could not be detected by data with a coarse temporal resolution. Thus, studies relying upon annual or even quarterly data, which contain limited or inadequate information, would likely fail to explain injuries that occur in response to economic cycles on a smaller time scale.

The purpose of this paper is to utilize unique monthly Taiwanese insurance payment data from the National Health Insurance (NIH) system of four main sectors during 2002–2014, in order to relating major and minor occupational injury to several macroeconomic variables. As all Taiwanese residents are required to participate in the NIH, the data are comprehensive, including all the reported incidences with information collected from three independent sources: occupational injury insurance payment records from the Bureau of Labor Insurance (BLI), industrial output statistics from the Directorate-General of Budget, Accounting and Statistics (DGBAS), and human capital (e.g., the turnover of labor and working hours) input record from the Ministry of Labor. The separation of data-collecting agencies would avoid behaviors of underreporting by small companies, as well as biases introduced by common data sources.

For correctly inferring the above causality, both cross-sectional and longitudinal relations were studied. The results of the cross-sectional analysis indicate that employee fatigue and operational errors that arise from increased working hours and intensified work pace during economic boom times contributed to the injury incidence. In addition, the longitudinal analysis results reveal the way in which firms respond to

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https://doi.org/10.1016/j.ssci.2018.08.014
Received 17 March 2017; Received in revised form 3 May 2018; Accepted 22 August 2018
Available online 30 August 2018
0925-7535/

external demand shocks, thereby further illustrating the mechanism underlying the business cycle and injury incidence. From the empirical results, a conceptual map is proposed that illustrates the interactions and mechanisms between injury incidence and the economic cycle.

2. Literature review and hypotheses

In general, the occurrence of workplace injuries follows a Poisson distribution with the rate of occurrence, defined as number of injuries over a period of time increasing with growth in labor force or population. The occurrence could also be affected by economic upturns, owing to prolonging working hours or hiring additional workers during those times. To avoid bias due to population size or the number of hours worked, the injury incidence rate should be stated as the ratio of accidents or injuries occurring per million worker-hours, thereby avoiding being inflated by business cycles.

In addition, studies, e.g., Kniesner and Leeth, 1989; Wooden, 1989; Fortin et al., 1996, also concluded that the injury incidence rate reported based on the records of the compensation claims and unemployment insurance is also impacted by workers' reporting incentives. In particular, workers are less likely to report a moderate workplace accident if they think the probability of being rejected is high (Boone et al., 2011). As a result, the workplace accidents might seemingly appear to follow a cyclical fluctuation in commensurate with the economy condition while, in reality, it could also, instead, be driven by the underlying reporting bias (Boone and van Ours, 2006).

To determine the underlying causal relationships among these factors, the hypothesis that incidences of workplace injuries are associated with business cycles must first be justified. Only after confirming this hypothesis, the factors contributing to the association can be further investigated. We therefore hypothesize that:

H0: *The incidence of workplace injury is associated with business cycles*.

Human factors and human resource management practices are positively found to be correlated with safety and productivity (Brown et al., 2000; Neumann and Dul, 2010; Zacharatos et al., 2005; Pagell et al., 2014). Regarding how injury incidence is associated with business cycle, we have aggregated these factors into three sets of explanatory variables according to the framework proposed by Asfaw et al. (2011): labor composition (*LC*), working conditions (*WCd*), and industrial and labor relations (*IR*).

2.1. How labor composition contributes to the incidence of workplace injury

The first set of explanatory variables refers to the composition of the workforce, including inexperienced workers, experienced workers and temporary workers. As alluded to in Kossoris (1938) and Robinson (1988), new or inexperienced workers are particularly injury prone as they are less familiar with the working environment and operation (Butani, 1988; Keyserling, 1983). Their presence in the work force is directly affected by the economic cycles. That is, injuries increase with economic upturns and decline during recession or depression, as newly hired workers are subject to the first wave of layoffs when a company decides to lower its expenses. Consequently, changes in the number of inexperienced workers could intensify the association between business cycles and incidences of workplace injury.

Meanwhile, during economic upturns, an outflow of experienced workers is also more likely to occur, as these workers seek jobs with higher compensation or are recruited to better jobs (Boeri, 1996; Montgomery, 1999; Saks and Wozniak, 2011). Workers' experience is a crucial part of human capital that is reported in several studies to be correlated with injury incidence (Chi et al., 2005; Fabiano et al., 2010; Leung et al., 2014; Oh and Shin, 2003). Thus the outflow of experienced workers and turnover of staff also contribute to the association between business cycle and workplace injury.

Reliance on temporary workers[1] is an excellent instrument for employers to adjust the capacity of their workforce to cope with fluctuations in product demand (de Graaf-Zijl and Berkhout, 2007; Jahn and Bentzne, 2012). In addition to their unfamiliarity with the environment, temporary workers are more vulnerable to injuries because they lack a sense of belonging. They might also receive less safety training. All of these factors could result in a greater likelihood and severity of injury compared to permanent workers, if the temporary workers are instructed to do the same activities (Amuedo-Dorantes, 2002; Benavides et al., 2006; Fabiano et al, 2008; Villanueva and Garcia, 2011).

Consequently, business cycles accompanied with variations of labor composition and turnover, including the flow of inexperienced workers, experienced workers and temporary workers, contribute to variations in the rate of workplace injuries. Asfaw et al. (2011) and Fernández-Muñiz et al. (2016) concluded that labor composition and employment both contribute to this association. Considering the causal inference between business cycle and incidence of workplace injury, the first set of hypotheses regarding how injury incidence is associated with business cycle is proposed as follows:

H1-1: "*Labor composition is associated with the incidence of workplace injuries*."
H1-2: "*Changes in the labor composition occur prior to the changes in injury incidence*."

Also alluded to by Davies et al. (2009), the fact that if these hypotheses were not rejected, it would allow the authorities to refine their occupational safety policies to aim at providing training for new employees and temporary workers, or to reduce the turnover of experienced workers.

2.2. How working conditions contribute to the incidence of workplace injury

The term working conditions, broadly defined, is related to workload and production pace. During economic boom periods, the time required to complete a task might decrease under company policy. This in turn, forces workers to work overtime and/or speed up the pace of operations. Working in jobs with overtime schedules or long work hours has been found to be associated with higher injury rates (Dembe et al., 2005, 2007). In contrast, an economic downturn could lead to a reduction in operations, resulting in a decline in working hours or a slower working pace. Increased overtime and longer working hours during an economic upturn could also lead to greater fatigue, thereby undermining employees' safety awareness and health accompanied by an increase in adverse events and errors (Baker, 1985; Fay and Medoff, 1985; Sokejima and Kagamimori, 1998; Olds and Clarke, 2010).

In addition, increased demand during a boom time might lead to an accelerated pace of working, thereby increasing the likelihood of workers' missing required operations and occurrence of injuries (Davies et al., 2009). Asfaw et al. (2011) discuss other issues that might contribute to the increase of injury incidence during boom times, including inadequate time for training, insufficient resting and breaks, as well as an ignorance of safety rules by workers. However, it is difficult to isolate the impacts of the individual factors as they are generally intertwined. We therefore follow the suggestion by Asfaw et al. (2011) referring them jointly as working conditions (*WCd*). The second set of hypotheses is proposed as follows:

[1] Issues of temporary workers are also associated with (or a reflection of) industrial and labor relations (Oh and Shin, 2003; Feldmann, 2006; Davies et al., 2009). We discuss the issue of temporary workers under the classification of labor composition. Industrial and labor relations are also proposed to explain the association.