# Occupational health effects of recessions: Evidence from panel data on workplace injuries

ERASMUS UNIVERSITY ROTTERDAM
Erasmus School of Economics
Department of Economics

Supervisor: Dr. A.C. Gielen

Name: Erwin Stolze
Student number: 356117
E-mail address: erwin.j.stolze@gmail.com

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**Abstract**

In this thesis the relationship between recessions and occupational injuries is investigated. Panel data on 15 European OECD countries are used to analyze the relationship. The conclusion presented in this paper is that the incidence rate of non-fatal accidents leading to occupational injuries varies pro-cyclically. These pro-cyclical fluctuations are not a result of changes in workplace safety, but a consequence of fewer accident reports by workers who fear more of losing their job during recessions than during economic expansion. Results from additional analyses suggest that the under-reporting of workplace accidents does not occur in countries where it is prohibited to fire employees because of work injuries.

# 1. Introduction

On June 3, 2014, two large explosions caused a big fire at a plant site of Shell in Moerdijk. The explosions could be heard from 20 kilometers away, and caused two workers to sustain burns and blast injuries from propelled objects. This workplace accident triggered the Dutch Safety Board to start an extensive investigation, which concluded that Shell failed to recognize significant risks and that they had insufficiently learnt from previous accidents (Onderzoeksraad voor Veiligheid, 2015). The fact that this accident took place and the conclusions of the report show that these severe accidents are still a phenomenon of the contemporary world, also in advanced countries with strict workplace safety regulations. According to CBS (2014), nearly half a million employees in the Netherlands were involved in a workplace accident in 2012 alone. Although the statistical office's definition of a workplace accident is fairly broad, this means nearly one in fifteen employees is involved in such an accident every year. Workplace accidents have several consequences, in addition to personal affliction. It induces health care costs, because only a small percentage of people involved in a work accident in the Netherlands do not need any medical care before they can continue working (Venema, Den Besten, Van der Klauw, & Ybema, 2013). Furthermore, absence from work is often a result of occupational injuries and may cause new challenges to the employer. Lastly, possible financial work injury compensations are another type of unwanted costs to the employer.

In order to avoid these consequences of occupational injuries, it is important to keep these to a minimum. In the Netherlands, the Inspectorate SZW is responsible for the supervision of working conditions and contributes to workers' safety. Although this institution can supervise many factors that affect the working conditions, it cannot affect all aspects that might influence workplace accidents. Early studies by Kossoris (1938) and Smith (1972) into the subject of workplace accidents suggest that there is an inverse relationship between these accidents and recessions, something the Inspectorate SZW obviously has no influence over. This would mean that the workplace safety worsens during short-term expansions, despite efforts to keep the number of accidents to a minimum.

There are many factors, such as working hours, workloads and job-related stress, which change over the course of a business cycle and could affect the number of work accidents and occupational injuries. Increased working hours and workloads for prolonged periods may cause physical and mental fatigue, which lead to an increased likelihood of accidents. Workers with a high job-related stress level are also more likely to sustain an occupational injury compared to others (World Health Organization, 2004). Another aspect that might be different for various stages of the business cycle is the reporting rate of workplace accidents. Minor accidents may not be reported during recessions, due to a worker's fear of becoming unemployed after reporting an accident (OECD, 1989). This paper aims to investigate the relationship between recessions and occupational injuries and the problem statement for this paper is:

*What is the relationship between recessions and occupational injuries?*

This study uses data on unemployment rates and work accidents for 15 European OECD countries[1] between 1995 and 2012. This allows for combining databases from several sources in order to analyze the relationship. The statistical analysis in this paper accounts for the effects of working hours and the different levels of employment protection between countries by including these in the regression as explanatory variables. The line of reasoning here is that in countries where employment protection is low, employees are less likely to report a small occupational injury, because employers can lay them off more easily than in countries where employment protection is high.

The result of the empirical analysis is that there is an inverse relationship between the unemployment rate and the rate of workplace accidents that lead to occupational injuries. This finding is consistent with previous studies (Boone and Van Ours 2006; Davies, Jones and Nuñez 2009). The explanation for this follows from additional estimation results, which support the theory that under-reporting of accidents occurs more frequently during recessions. This paper adds to existing theories and studies by including data on the level of employment protection. The pro-cyclical pattern in fluctuations of accident reports is not found in countries where it is prohibited to lay

[1] These countries are: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland,

off workers as a result of work injuries. This suggests that the extent of employment protection determines whether injured workers decide to report an accident or to withhold it.

The paper is organized as follows. Section 2 gives an overview of previous studies of the relationship 1) between macroeconomic indicators and health and 2) between recessions and occupational injuries. In Section 3 the data and methodology for this study is outlined, followed by the presentation of the estimation results of the analysis in Section 4. In Section 5 a discussion is presented, and Section 6 concludes this paper.

## 2. Overview of the literature

In order to gain a broader perspective of the relationship between recessions and occupational injuries and to assess the significance of this topic in the existing literature, this section first provides an overview of studies that investigate the link between macroeconomic indicators and public health. The research regarding this link has long been a topic of interest, whereas most of the studies that focus on occupational injuries were performed more recently. The second part of this section provides an overview of these studies.

### *2.1. Studies investigating macroeconomic indicators and health*

There have been many studies that have investigated the link between health and various macroeconomic indicators, such as unemployment rates, austerity measures, business cycles and income. Some of these studies (e.g. Deaton 2003; Smith 1985; Brenner and Mooney 1983; Stern 1983; Junankar 1991) argue that during economic downturns, public health is affected negatively, while the results of other studies (e.g. Ruhm 2000; Gerdtham and Ruhm 2002; Neumayer 2004) suggest that health worsens during an economic boom, i.e. when employment levels are high.

Recessions can have an impact on health through various pathways and mechanisms. During recessions, real income growth slows down and may turn

negative, unemployment rates rise, and private out-of-pocket spending on health in particular decreases. In some industrialized countries, public spending on health falls during recessions, while others have protected health spending from falling by including specific health care budgets in their policies (World Health Organization, 2009). Occupational injuries also affect the public health, and this paper aims to find the relationship between recessions and these injuries.

*2.1.1. Income and health*

First, I will discuss the mechanism that runs via income. In his comprehensive study of health, inequality and economic development, recent Nobel Prize winner Deaton (2003) shows that there is at least some effect of income on health, which means a loss of income can have adverse effects on the public health. His findings are mostly based on micro data. There are however, numerous confounding factors, such as causality running from health to income, or the level of education a person acquires. One could argue that people who do not invest in the protection of their health are also less likely to invest in education that leads to a higher income. A second effect of an income loss on the individual level is that people might not be able to afford healthy nutrition anymore, contributing to lower health levels.

Focusing on data from a macro level, Karanikolos et al. (2013) show that the response of various European countries to the recent economic crisis differs somewhat, but most countries decreased the extent of the health coverage. The full effects of these austerity measures, which were implemented because of budget cuts, are not entirely clear yet for every country, because of lagged effects and non-availability of data. In countries were the crisis has been most severe, such as Greece, some health outcomes have become available. Kentikelenis, Karanikolos, Papanicolas, Basu, McKee and Stuckler (2011) have shown a significant increase in self-reported health as ‘bad’ or ‘very bad’ in 2009 compared to 2007.

Income inequality could also be a mechanism via which health is affected. During the Great Recession, between 2007 and 2009, a deviation from the trend is found in income inequality. Castells-Quintana, Ramos and Royuela (2015) show that the period of 1996-2007 was characterized by reductions of income inequality within European regions. Between 2007 and 2010 however, inequality increased in 29 out of the 39 regions investigated. Deaton’s findings that there is no direct link between

ill health and income inequality are based on a mix of aggregate and individual level data. Although income inequality, he argues, does not cause the level of public health, it is still important because it means that at least some part of the population lives in poverty, which *does* affect mortality.

### *2.1.2. Unemployment rates and health*

There are several mechanisms that come into play when one becomes unemployed which can cause adverse health effects. Employment, in addition to income, also provides social interactions and relationships which give structure and meaning to life. The consequences of unemployment are thus not limited to a loss of income, but also include a deterioration of relationships. Atkinson, Liem and Liem (1986) observe that blue-collar workers who become unemployed have less frequently contact with their social network. Additionally, these consequences also apply to some extent to the household of the unemployed, which are found to be more often in bad health compared to other households (Smith, 1985). It also causes an increase in stress and anxiety levels of the (households of) unemployed and even working people may have higher stress levels because of a fear of losing their job (Brenner & Mooney, 1983). High levels of unemployment may also lead to an increase of the workload per employed person, required by management for example.

Brenner and Mooney argue that there is an inverse relationship between recessions and health, based on both aggregate and individual level data. Although Stern (1983) is careful in drawing conclusions, his findings regarding the relationship between unemployment and mortality in Britain support the statement that unemployed people are more likely to be of ill health than employed people. He uses data from a cohort study for the period between 1965 and 1975 for men in Britain. Further research by Junankar (1991) provides more support for the inverse relationship. Specifically, he uses time series data on mortality rates and unemployment rates for England and Wales for males. Even after controlling for social class and regional differences, he concludes that unemployment itself has an effect on mortality.

The cost of unemployment on an individual level is not only monetary, in the form of lost salaries, but it is also often linked to unhappiness. Clark and Oswald (1994)

show that the mental health of the unemployed is lower than the employed people. Clark (2006) also shows that an increased duration of the unemployment does not increase the happiness level in the long term, i.e. people do not adjust back to the level of happiness they had when they were still employed. More recent work by Kassenboehmer and Haisken-DeNew (2009) adds evidence that unemployment has a negative effect on the life satisfaction. Interestingly, the change in happiness that is caused by unemployment is linked with the social norms and economic conditions, specifically unemployment rates. The fall of the happiness level of the unemployed person is smaller when his or her social network includes more unemployed people, or when the regional unemployment rate is high (Clark 2003; Clark, Knabe and Rätzel 2010).

The unemployment rate is also directly related to suicide rates, which is consistent with the findings on (un)happiness and unemployment (Oswald, 1997). Evidence from Brenner and Mooney's review of studies supports the statement that unemployment and suicide rates are directly related. Recent studies add to this existing evidence (Karanikolos et al., 2013). Comparing pre-crisis and post-crisis suicide rates in Europe, a clear deviation from the trend can be noticed. Before the crisis, there were on average fewer suicides each next year, whereas the suicide rate since 2007 has risen by ten percent in 2010.

In 2000, Ruhm brings an interesting study forward. This study too, investigates the link between changes in economic conditions and health, specifically mortality rates. His results are directly contrasted to many previous other studies though. Using data on a US state level for mortality rates and unemployment rates for the period between 1972 and 1991, he finds that state unemployment rates are negatively related to total mortality. Additionally, eight out of ten investigated causes of death are also negatively related. The suicide level is, notably, not one of those. Ruhm provides four reasons why fatalities could vary pro-cyclically instead of counter-cyclically. During an economic boom, people enjoy less leisure time. The opportunity cost of undertaking health-increasing activities will thus be higher than during an economic downturn. Secondly, increased job hours, workloads or stress induced by a job may affect health negatively. Furthermore, external sources of death such as work-related accidents and drinking and driving are likely to increase during an

expansion, according to Ruhm. Lastly, migration flows within countries, especially in the United States, tend to increase during economic upturns. This could cause an increase in diseases and road accidents. Gerdtham and Ruhm (2002) find comparable results in their study for 23 OECD countries between 1960 and 1997. Total mortality from various causes of death is found to increase when unemployment rates decrease. Additional evidence comes from Neumayer (2004), who uses data for the states in Germany over the period 1980-2000. He finds that mortality rates are lower during recessions and some specific mortality causes. In July 2015, Ruhm presented a new study in which the relationship between macroeconomic indicators and mortality is once again examined, with the specific aim to investigate whether the relationship has changed over time. Using a data sample for the period between 1976 and 2010, it is concluded that the total mortality is only weakly related to unemployment, compared to the earlier findings of pro-cyclicality. Ruhm's explanation for this change of results is the increased time span that is used, due to some estimates being time sensitive. Stuckler et al. (2009) also find no consistent evidence for the European Union between 1970 and 2007 that mortality rates increase when the unemployment rate rises.

Overall, it appears that most of the early research of the relationship between unemployment rates and health finds support for an inverse relationship, whereas evidence from more recent work supports a direct relationship. This section now further explores the literature on occupational injuries. As a result of occupational injuries, nearly 900,000 medical care treatments[2] were received in 2011 in the Netherlands alone (Rijksinstituut voor Volksgezondheid en Milieu, 2014). This considerable number of treatments represents the significance of the health effects of occupational injuries in terms of both personal and public costs. It is therefore important to understand any fluctuations in these injuries and the possible effects on health care policy.

### *2.2. Studies investigating recessions and occupational injuries*

The first paper to study the relationship between the business cycle and

[2] These treatments include E.R. visits, hospital admissions, general practitioner visits and treatments by physiotherapists.

occupational injuries was published in 1938 by Kossoris. Kossoris used data from the U.S. Bureau of Labor Statistics over the period of 1929-1935 to analyze the trends in industrial injury frequency rates and employment. His findings were that these injuries were pro-cyclical; a decrease in employment was linked with a decrease in the frequency rate of occupational injuries. The relationship persists as time goes on. It was investigated again for post-war period until 1969 (Smith, 1972). Smith's results are similar to the earlier findings of Kossoris, and he even proposes that workplace regulations should be cyclically flexible, becoming increasingly stringent during a boom. In order to stimulate employers to ensure an increasingly safe work environment, a tax on work injuries is suggested, which should increase over time and also during economic upturns. A more recent study by Hines Jr., Hoynes and Krueger (2001) shows that for the period between 1973-1991 in the US, there is a very similar relationship between their result and that of Smith.

Kossoris proposes that this effect is caused by two possible explanations. The first is that during a boom, new and inexperienced workers are making up a larger part of the total number of employees, causing an increase of the occupational injury rate. Adding to this, the level of effort that workers exert is higher during booms, workloads increase and employees may become less careful. So not only newly hired employees contribute to the negative correlation, experienced workers are also a part of the explanation. Secondly, during a recession, employees are more inclined to withhold reports of minor injuries because they cannot afford to work less or fear to lose their job. This also relates to the absenteeism that often follows from a workplace accident. Leigh (1985) provides evidence for the statement that absence-prone employees are more likely to be laid off than other employees. So, for any given state of health, employees have a bigger incentive to avoid being absent during a recession than in a boom, because finding another job is more difficult in a recession. The OECD (1989) also recognizes the possibility of withheld reports of occupational injuries: 'workers may not report injuries because they fear loss of attendance bonuses, or other personal disadvantages, such as becoming prime candidates for redundancy'. It is not very difficult to imagine a situation in which workers face the choice of reporting an occupational injury or to withhold it. A restaurant employee, for example, may cause a light burn serving hot food. Although irritated by the light burn, the worker might still be able to serve food. During times of

high unemployment, the worker might choose to continue working, whereas during good economic times, he or she would take a couple of days off to let it heal.

Boone and Van Ours (2006), in an attempt to explain the relationship between recessions and occupational injuries, investigate whether workplace safety actually improves during recessions, or that it is a spurious effect caused by fewer accident reports rather than fewer accidents. Using data from 16 OECD countries, they find that the pro-cyclicality of the relationship is caused by a change of reporting behavior of employees and that the workplace safety does not change over the course of a business cycle. Boone, Van Ours, Wuellrich and Zweimüller (2011) confirm that the reporting of an accident by a worker increases the likelihood of being fired afterwards, using detailed data on Austrian workplace accidents. Davies, Jones and Nuñez (2009) investigate the changes in the rate of occupational injuries for the United Kingdom for the period between 1986 and 2005. Their findings support the pro-cyclical relationship for the minor injury rate, but the major injury rate is not affected by economic activity. This seems to support the conclusions of Boone and Van Ours, as employees with a major injury are less likely to be able to withhold an accident report. However, both minor and major injury rates show a correlation with the level of the hiring of new employees, and also with the ratio of the hours that employees actually worked to the hours they usually work. The Dutch National Institute for Public Health and the Environment (RIVM) finds that for the period between 1999 and 2011, the major injury rate fluctuates pro-cyclically. During an economic boom, the frequency is approximately six percent higher than during a recession (Rijksinstituut voor Volksgezondheid en Milieu, 2014).

As Boone and Van Ours (2006) point out in their study, employment protection regulations differ between countries, but it is not included in their research, while others also have not included data on this in their analyses. The legislation of employment protection affects the reporting behavior of workers that experience an occupational injury. It is expected that, in countries where employment protection is better, injured employees are more likely to report the accident, as they are less likely to be laid off as a result of the sustained injury. Correcting for this may result in a clearer image of the relationship. The aim of this paper is thus to add to the

existing literature by using more recent data and by including variables on employment protection.

# 3. Data & Methodology

## *3.1 Data*

This paper uses data on accidents at work for 15 OECD countries[3] over the period of 1995-2012. The fact that these OECD members are also part of the European Union allows for obtaining data from different databases. The data on work accidents are collected in the European Statistics on Accidents at Work (ESAW) database, and are obtained from Eurostat. The methodology for this database of harmonized work accidents was first developed in 1990. An accident at work is defined as 'a discrete occurrence in the course of work which leads to physical or mental harm'. Accidents that occur during commuting to and from work are excluded. Non-fatal accidents are accidents that cause the employee to be absent from work for more than three days. Fatal accidents are those accidents that 'lead to the death of a victim within one year of the accident'. The data are considered to be highly accurate, however, Eurostat does mention that under-reporting of accidents is a known issue. Although the data are harmonized, the source can differ per country between either national labor inspectorates or national insurance systems. The number of accidents and therefore the standardized incidence rates that are used in this analysis can differ between these sources, but the cyclicality of the fluctuations should not be affected by this. The standardized incidence rate denotes the number of accidents per 100,000 workers. In total, this study uses 266 observations.

As an indicator of recessions, the unemployment rate is used as an explanatory variable. If workplace safety is improved during recessions, the unemployment rate should be negatively related with the fatal and non-fatal accident rate. The correction

[3] These countries are: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom.
Boone and Van Ours (2006) include Canada, Switzerland and the United States, but exclude Austria and Luxembourg.

for the level of employment protection in the empirical analysis is done through two different variables. The first variable is the OECD summary indicator of strictness of employment protection for individual dismissals. The indicator is expressed in a scale between zero and six, where a higher number indicates better employment protection. A higher indicator should thus correlate with less cyclical fluctuations of unemployment levels.

The second variable is collected from the Employment Protection Legislation database (EPLex) from the International Labour Organization (ILO).[4] This database allows for collecting data on prohibited grounds of dismissal, including temporary work injury or illness. This means that it is possible to estimate the regression coefficients separately for countries where employers are prohibited by law to lay off personnel because of an occupational injury. It is expected that the cyclicality of the fluctuations of workplace accidents in these countries are less pronounced than in other countries. Considering the results of Davies et al., differences in the workload between countries may be of importance as well. A variable on the ratio of average actual weekly working hours to usual working hours is therefore also included in the analysis. These data are obtained from Eurostat. If the workload affects the accident rate, a positive relationship between these two is expected.

As shown in Table 1, a total of 4,820,451 non-fatal accidents at work took place in 1995 where the accident caused the employee to be more than three days absent from work. The average standardized incidence rate of the 15 countries was 4,266, meaning 4,266 workers per 100,000 workers experienced a workplace accident. The number of non-fatal accidents in Belgium in 1995 was 114,000, which affected 5.6 percent of the workforce. Stated differently, the incidence rate was 5,600. Belgium experienced 142 fatal accidents, which equals an incidence rate of 5.9.

Looking at the most recent data, these numbers have changed significantly. In 2012, the number of accidents dropped to 2,321,045, a decrease from the number of accidents in 1995 of more than 50 percent. The incidence rate in that year fell to 2,073. The variation of both fatal and non-fatal data between countries is quite large and could be explained by several factors other than working conditions. These include the type of national source and differences in share of industries for example.

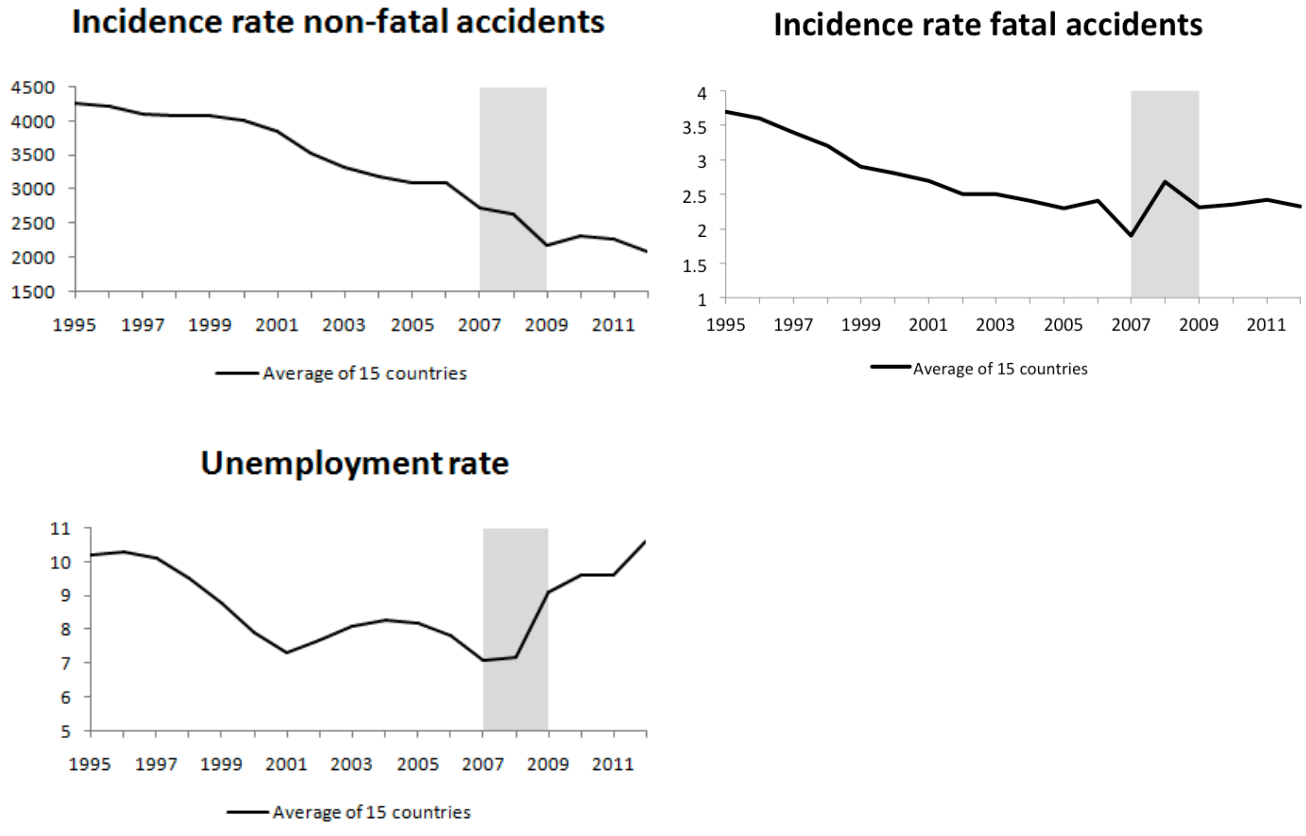
[4] For Ireland, the source is OECD (2013)

Table 1, Non-fatal and fatal accidents and unemployment rates in 1995[a]

| | Non-fatal | | Fatal | | Unemployment rate |
|---|---|---|---|---|---|
| | Number (x1000) | Percentage | Number | Incidence rate | |
| Belgium | 114 | 5.6 | 142 | 5.9 | 9.7 |
| Denmark | 59 | 2.6 | 86 | 3.3 | 6.7 |
| Germany | 1,673 | 5.2 | 1,487 | 3 | 8.2 |
| Ireland | 11 | 0.9 | 77 | 4.2 | 12.3 |
| Greece | 51 | 3.5 | 91 | 4.3 | 11.1 |
| Spain | 547 | 6.0 | 1,088 | 7 | 20.7 |
| France | 677 | 5.1 | 848 | 3.5 | 10.2 |
| Italy | 718 | 4.2 | 1,267 | 4.8 | 11.2 |
| Luxembourg | 9 | 4.9 | 15 | 6.8 | 2.2 |
| Netherlands | 169 | 4.2 | 110 | 3 | 6.5 |
| Austria | 174 | 5.5 | 412 | 6.7 | 4.2 |
| Portugal | 178 | 6.0 | 232 | 7.9 | 7.9 |
| Finland | 59 | 3.6 | 43 | 2.8 | 15.4 |
| Sweden | 39 | 1.0 | 90 | 2.3 | 8.8 |
| United Kingdom | 342 | 1.8 | 242 | 1.6 | 8.5 |
| Total number of accidents | 4,820 | - | 6,229 | - | - |
| Average incidence rates | - | 4,266 | - | 3.7 | - |

[a] Luxembourg 2000, the Netherlands 1997.

Figure 1, Average non-fatal and fatal incidence rates and unemployment rate over time



The graph of non-fatal accident rates in Figure 1 shows a clear downward trend for non-fatal accidents. Fatal accidents also decreased over the 1995-2012 period, from 6,229 to 2,456. The average incidence rate fell from 3.7 to 2.33. The average unemployment rate between 1995 and 2012 is also graphed in Figure 1. The highlighted areas show a possible link between (non-)fatal accidents and the unemployment rate, although the trends within countries can differ from these averages shown.

*3.2 Methodology*

In the methodology for the empirical analysis, fixed differences between countries are accounted for. Fixed differences account for time-invariant differences, such as the share of industries that employs workers. It is likely that the work accident rate is affected by differences between industries and their share in the number of accidents. Construction workers are more likely to experience a workplace accident than real estate agents, for example (Eurostat, 2010). Additionally, a trend caused by influences that affects all countries is also added to the analysis by including a time trend. An example of such a trend is the improvement of workplace safety as a result of the introduction of more stringent workplace regulations by the European Union. Country-specific trends could also affect the relationship and are thus also taken into account. These trends control for any differences in time trends between countries, e.g. a decrease in the share of construction workers in a country as a result of new national policy to increase the VAT on construction materials. Following the framework of Boone and Van Ours (2006) to estimate the effect of unemployment on the number of non-fatal accidents, the following parameters are estimated:

$$\ln(a_{i,t}) = \beta_{0i} + \beta_{0t} + \beta_{1i}\tau + \beta_2 \ln(u_{i,t}) + \varepsilon_{i,t} \qquad (1)$$

where $a$ is the non-fatal accident rate as defined earlier, $\tau$ denotes a trend in time, $u$ is the unemployment rate, $i$ is the subscript for a country, $t$ is the subscript for time and $\varepsilon$ is the error term. In this first regression, the unemployment rate is thus the only explanatory variable of interest; there are no other control variables besides the fixed

differences and (country-specific) time trends. The natural logarithm of the incidence rate is used to reduce skewness of the incidence rate distribution and to simplify the interpretation of the estimation results. In the second and third regression, the level of employment protection is introduced, denoted by $\lambda$, and the ratio of actual to usual working hours, denoted by $wh$:

$$\ln(a_{i,t}) = \beta_{0i} + \beta_{0t} + \beta_{1i}\tau + \beta_2 \ln(u_{i,t}) + \beta_3 \lambda_{i,t} + \varepsilon_{i,t} \quad (2)$$

$$\ln(a_{i,t}) = \beta_{0i} + \beta_{0t} + \beta_{1i}\tau + \beta_2 \ln(u_{i,t}) + \beta_3 wh_{i,t} + \varepsilon_{i,t} \quad (3)$$

The level of employment protection and ratio of actual to usual working hours are introduced sequentially as opposed to simultaneously. This makes it possible to assess the explanatory value of these variables separately. Potential heteroscedasticity in the data is accounted for by calculating cluster-robust standard errors at the country level. In addition to estimating the effects on the non-fatal accident rates ($\ln(a_{i,t})$), estimations for the fatal accident incidence rate ($\ln(fa_{i,t})$) as an independent variable are presented. If it is true that workers withhold reports of workplace accidents, $\beta_2$ in regression (1) should be significantly smaller than zero. Following the assertion that the level of employment protection controls for the effect of changes in reporting behavior, it is expected that $\beta_2$ does not differ significantly from zero in regression (2). This would imply that the unemployment rate is not related to the accident rate, but rather the level of employment protection. If the workload has an effect on the accident rate, $\beta_3$ in regression (3) should be significantly higher than zero. When estimating the regression with the fatal accident rate as a dependent variable, the $\beta_2$ coefficient should not differ significantly from zero, since workers obviously cannot change their reporting behavior anymore. As a result of the far-reaching consequences of a fatal accident, under-reporting should be virtually nonexistent.

## 4. Results

The results from the estimation of regression (1) are shown in Table 2 for the non-fatal as well as the fatal incidence rate as dependent variable. The first row contains the estimations where the natural logarithm of the unemployment rate is the only

explanatory variable. The elasticity of non-fatal accidents with respect to the unemployment rate is the first estimated coefficient and is equal to -0,18 and is significantly smaller than zero. This indicates that a 1 percent increase of the unemployment rate is linked to a decrease in the incidence rate of 0,18 percent. The coefficient for fatal accidents does not differ significantly from zero, which implies that the unemployment rate is not related to the incidence rate of fatal accidents. These results support the notion that workers report accidents less frequently during recessions, since the incidence rate of non-fatal accidents is affected by unemployment whereas the fatal incidence rate is not. As this rate is not sensitive to reporting behavior, it approximates the true workplace safety and the probability of sustaining an occupational injury. This finding is similar to that of Boone and Van Ours (2006), although the effect they find is even stronger. This could be explained by a number of factors, such as the difference in countries, data source and period used.

In the second estimation, the level of employment protection is introduced in addition to the unemployment rate. The estimated $\lambda$ coefficient does not differ significantly from zero for both fatal and non-fatal estimations and thus does not improve the model. The interpretation of this result is that the level of employment protection does not explain the fluctuations of the accident rate, besides the effect of the unemployment rate. This is contrary to what is expected from previous statements. Possible explanations are discussed further below in this section. Adding the level of employment protection to the estimation for fatal accidents causes the unemployment rate coefficient to be significant. By performing an F-test, the additional explanatory value of the level of employment protection can be determined. The F-statistic is 1,45, which is not significant at the 10% level. The

Table 2, Non-fatal and fatal estimation results[a]

| | | Non-fatal | | Fatal | |
|---|---|---|---|---|---|
| | | Coefficient | Std. Error | Coefficient | Std. Error |
| (1) | Log unemployment | -0,18** | 0,06 | 0,13 | 0,09 |
| (2) | Log unemployment | -0,23** | 0,07 | 0,22** | 0,09 |
| | Employment protection | -0,14 | 0,12 | 0,26 | 0,21 |
| (3) | Log unemployment | -0,18** | 0,06 | 0,16* | 0,09 |
| | Ratio actual to usual hours | 0,60 | 0,69 | 3,32** | 1,28 |

[a] As indicated in the main text, the estimations include fixed effects per country, time trend effects per year and time trends per country. * indicates significance at the 10% level, ** at the 5% level.

employment protection provides no additional explanatory value, and the model specification of regression (1) is therefore preferred.

Finally, the third row introduces $wh$ as an explanatory variable, which is the ratio of actual to usual working hours. This is an indication for an increased workload and is bigger than 1 if workers, on average, work more than usual, and is smaller than 1 if they work less then usual. Although this ratio does not have an additional effect on non-fatal accidents, its effect on fatal accidents is significant. An increase of 1 in the ratio, i.e. working twice as much as normally, is associated with an increase in the fatal incidence rate of more than 300 percent. The inclusion of this ratio also slightly increases the unemployment rate coefficient to 0,16 compared to 0,13 in regression (1), which differs significantly from zero on a 10% level, but not on a 5% significance level.

Overall, the incidence rate of non-fatal accidents appears to be negatively related to the unemployment rate, which would mean that during a recession relatively less accidents take place. Neither the level of employment protection nor the ratio of actual hours to usual working hours affects the accident rate. However, the fact that fatal incidence rates are largely unaffected by the unemployment rate implies that the cyclicality of the fluctuations in non-fatal accidents is a result of under-reporting during recessions, and not a consequence of increased workplace safety during recessions.

The results from Table 2 show no significant effect of the level of employment protection. However, the OECD summary indicator of strictness of employment protection for individual dismissals is based on several items, some of which may not affect the decision to report a workplace accident.[5] It could therefore be that the indicator does not provide a satisfactory representation of the employment protection specifically for the consequences of reporting a workplace accident, which primarily consist of occupational injuries.

In order to improve the estimation results from Table 2, additional estimations are performed and presented in Table 3. The independent variable in these estimations is the non-fatal accident rate ($\ln(a_{i,t})$). First, in addition to the unemployment rate ($\ln(u_{i,t})$), the fatal accident incidence rate ($\ln(fa_{i,t})$) is introduced as an explanatory

[5] Items such as procedural inconvenience of dismissal and length of notice period are examples.

variable. Assuming that it is nearly impossible to change the reporting of fatal accidents due to the serious nature and strict reporting regulations, it is exogenous. The results from Table 2 support this notion. This rate can thus be used as an approximation of the probability of sustaining an occupational injury. It is therefore expected that the fatal accident rate is positively linked to the non-fatal rate. The estimation results of the effects of the unemployment rate and fatal accident incidence rate on non-fatal accidents are shown on row 1. It shows that in addition to the unemployment rate, the fatal incidence rate also has explanatory value. The positive coefficient of 0,07 suggests that a high fatal accident incidence rate also corresponds to a high non-fatal accident incidence rate, which could be explained by the level of workplace safety. When workplace safety is low, both fatal and non-fatal accidents are more likely to happen compared to safer working conditions.

Second, the coefficients are estimated for different subsamples, specifically aimed at improving the accuracy of the OECD indicator of employment protection for this study. The subsample is based on data from the EPLex database. This contains the prohibited grounds for dismissals by country, including the ground of work injury or illness. In five countries[6] it is prohibited by law to lay workers off because of a work injury or illness. It is expected that in these countries, the unemployment rate does not have a significant effect on the non-fatal accident incidence rate, because workers who report an accident should be protected from being fired. For countries where it is not specifically prohibited, the opposite result is expected. The results of

Table 3, Non-fatal estimation results[a]

| | | Non-fatal | |
|---|---|---|---|
| | | Coefficient | Std. Error |
| (1) | Full sample | | |
| | Log unemployment | -0,23** | 0,06 |
| | Log fatal accident rate | 0,07* | 0,04 |
| (2) | Prohibited ground | | |
| | Log unemployment | -0,40 | 0,28 |
| | Log fatal accident rate | 0,02 | 0,09 |
| (3) | Allowed ground | | |
| | Log unemployment | -0,18** | 0,06 |
| | Log fatal accident rate | 0,10** | 0,05 |

[a] As indicated in the main text, the estimations include fixed effects per country, time trend effects per year and time trends per country. * indicates significance at the 10% level, ** at the 5% level.

[6] There countries are: Belgium, Denmark, Finland, France and the Netherlands.

the estimation using the subsample of countries where employers cannot fire injured employees are shown on the second row. For this subsample, no significant effect of the unemployment rate is found, which would suggest that the unemployment rate does not affect the non-fatal accidents rate in these countries. There is however a fairly large standard error of 0,28, caused in part by the smaller number of observations ($n = 87$) in this sample. On row three, estimation results are presented for the subsample of countries where work injury is not a prohibited ground of dismissal. Here, a significant effect of the unemployment rate of -0,18 is estimated. Comparing the results of row two and three, a difference in the relationship between unemployment and accidents is found. In countries where workers are protected after a work injury, the unemployment rate does not seem to affect the incidence rate, whereas in other countries the unemployment rate does affect the incidence rate. As mentioned, the uncertainty of the effect of the unemployment rate is relatively large for the first group of countries. The result suggests that the reporting behavior of workers is based on the employment protection and explains the cyclicality of non-fatal accidents. During times of high unemployment rates, some workers in countries where they can be fired for a work injury withhold their accident reports because of fear of losing their job. In countries where they can't be fired for this reason, they fear less for losing their job and thus do not change their reporting behavior.

## 5. Discussion

Some limitations apply to this study. First, the results are estimated only for European members of the OECD and the time span is relatively short compared to more well-known areas of academic interest, such as the relationship between unemployment and mortality rates. It is therefore not possible with the data used in this study to test whether the results are sensitive to a change in the time span that is investigated. Changing the starting or ending years of this data sample by more than a few years would likely lead to unreliable outcomes due to an insufficient number of observations. The results from this study are in line with evidence from previous studies though, so the relationship between recessions and occupational injuries does seem insensitive to changes in the starting or ending years.

Second, the data on non-fatal accidents include only those accidents which lead to an absence of more than three days. These are likely to be relatively major accidents. Since minor accidents are more easily withheld, the difference between the number of reported accidents during economic contraction and the reported number during expansion is likely to be bigger in reality than is represented in the data. Therefore the estimated effects of the unemployment rate could be underestimated. Another limitation of the data is the lack of specific categories of industries. The effects of unemployment or employment protection may differ between industries. Although the estimation results account for country-specific effects, they do not provide insight into the effects per industry. It could also be useful to know what the relationship between occupational injuries and recessions is on a more detailed level of injuries. Some types of injuries might occur more often during economic expansions as a result of an increase in the number of inexperienced workers, for example. Furthermore, the findings are based on aggregate level data, so the actual considerations that workers face after experiencing an accident are not included in this paper.

The estimation results in Table 3 regarding the effect of employment protection on the non-fatal accident incidence rate could also be the result of the effect of employment protection on the unemployment rate, which is not further investigated in this paper. One could argue that in countries where the level of employment protection is high, the cyclical fluctuations of the unemployment rate are less pronounced than in countries where employment protection is relatively low. The employers' ability to lay off and hire workers is more restricted in countries included in the first subsample than those included in the second subsample. If this is the case, employment protection affects the unemployment rate rather the reporting behavior of workers.

Additional research into this topic using individual level data could enhance the understanding of the consequences of employment protection for injured workers. In addition to the inclusion of the aforementioned data on minor accidents, industries and type of injury, different *kind* of data would also contribute to understanding the investigated relationship. Customs and habits concerning labor and the level of trust in governmental bodies that administer employment protection may differ per country and may affect the propensity of workers to report an accident. Including this kind of

data in future studies would further increase our insights and the implications of the relationship.

## 6. Conclusions

The rate of non-fatal accidents leading to occupational injuries varies pro-cyclically. During recessions, relatively fewer accidents are reported than during economic booms. At first glance, it thus seems that recessions have a positive effect on the safety of workers and decrease the probability of sustaining an occupational injury. This would not be in line with recent research into the effects of macroeconomic indicators on public health, which suggest that health is only weakly or not at all affected by economic conditions (Stuckler et al. 2009; Ruhm 2015). The cyclicality of fluctuations in the accident rate could be caused by improved workplace safety during recessions, or alternatively by the under-reporting of workers who experienced a workplace accident during recessions. Workers might fear for losing their job when reporting an accident. Previous studies have found evidence supporting this theory (Boone and Van Ours 2006; Boone et al. 2011). This study uses data from European OECD countries to investigate the relationship between unemployment rates and workplace accidents.

The inverse relationship between non-fatal accidents and the unemployment rate is the first finding of this paper. The second is that the fatal accident rate is not affected by the unemployment rate. If one assumes that the fatal accident rate is insusceptible to under-reporting, the combination of these findings imply that the actual workplace safety does not improve during busts, but rather that workers report fewer accidents. Furthermore, the workload has no effect on the non-fatal accident rate, but it does affect the fatal accident rate.

Additional empirical analyses provide insight into the role of the level of employment protection and add to the existing literature. In countries where work injury is a prohibited ground of dismissal, workers fear less for losing their job as a result of reporting an accident, compared to countries where companies can lay off workers with work injuries. The market labor conditions as indicated by the unemployment rate have no effect on the non-fatal accident rate in protected countries. This form of

employment protection thus seems a decisive factor for workers in their consideration whether to report a workplace accident or to withhold it.

The implication for policy makers is that employment protection, specifically the inclusion of work injury as a prohibitive ground of dismissal, is an effective measure to ensure that workplace accidents are reported independently from labor market conditions. The results also mean that workplace safety does not fluctuate (pro-) cyclically and that additional measures to improve working conditions during economic upturns are not necessary per se. To improve the accuracy of the data on accident reports, especially during recessions in countries where work injury is not a prohibited ground of dismissal, policy makers should improve the employment protection. A recommendation purely focused on stimulating workers to report accidents would likely fail due to workers' fear of being fired.

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