

Workplace Accidents and Workplace Safety: On Under-reporting and Temporary Jobs

Ali Palali^{1,2} — Jan C. van Ours^{3,4,5,6,7}

Abstract. Statistics on workplace accidents do not always reflect workplace safety because workers under-report for fear of job-loss if they report having had an accident. Based on an analysis of fatal and non-fatal workplace accidents and road accidents in 15 EU-countries over the period 1995–2012, we conclude that there seems to be cyclical fluctuations in reporting of non-fatal workplace accidents. Workers are less likely to report a workplace accident when unemployment is high. Furthermore, analyzing data from Italy and Spain on both workplace accidents and commuting accidents, we conclude that workers on temporary jobs are likely to under-report accidents.

1. Introduction

An accident at work is defined as a discrete occurrence in the course of work which leads to physical or mental harm. Fatal accidents at work are those that lead to the death of the victim within one year. According to Eurostat (2014) in 2012, there were 3.2 million non-fatal and 4,000 fatal workplace accidents in the European Union. Male workers experienced about 2.2 million non-fatal accidents, female workers about 1 million. Construction, manufacturing, transportation, agriculture, forestry and fishing sectors together accounted for just over two thirds of all fatal accidents at work and over half of all non-fatal workplace accidents. There are two types of common injury, namely, wounds and superficial injuries (about 30 per cent of the total) and dislocations, sprains and strains (about 25 per cent). Around one in ten accidents resulted in concussion and internal injuries, while a similar proportion of accidents concerned bone fractures (Eurostat, 2014).

The nature of the labor market is changing. Over the past decades, the share of workers with flexible labor contracts increased in many countries (Dixon *et al.*, 2017). Pouliakas and Theodossiou (2013) in their overview of the literature on occupational safety and

This paper was presented as part of a document entitled ‘Workplace Accidents in Europe’, prepared for the fondazione Rodolfo de Benedetti (fRdB) conference on Health and Work Safety in Ravenna, June 2015. The authors thank Paola Monti and Chiara Serra for help in collecting the data and Paolo Pinotti, participants of the Ravenna fRdB-conference, and an anonymous referee for helpful comments.

¹CPB Netherlands Bureau for Economic Policy Analysis, The Hague, The Netherlands. ²Department of Economics, CentER, Tilburg University, Tilburg, The Netherlands.

³Erasmus School of Economics, Erasmus University Rotterdam, Rotterdam, The Netherlands. ⁴Tinbergen Institute, Amsterdam/Rotterdam, The Netherlands. ⁵Department of Economics, University of Melbourne, Parkville, VIC, Australia. ⁶Centre for Economic Policy Research, London, UK. ⁷IZA – Institute of Labor Economics, Bonn, Germany.

E-mail: vanours@ese.eur.nl

health mention that the nature of the job contract may be important. In times of high aggregate demand firms have no incentive to provide workplace safety training to workers on temporary and casual contracts. Temporary workers may be unfamiliar with characteristics of the workplace and their job, and they are therefore more susceptible to workplace accidents. However, statistics on workplace accidents do not always reflect workplace safety because of under-reporting. This may occur because workers fear they will lose their jobs if they report having an accident. If so, under-reporting will occur more in times of high unemployment and for workers who have temporary contracts.

We present an empirical analysis of the determinants of workplace accidents focusing on their cyclical sensitivity. Furthermore, we analyze the relationship between the nature of the employment contract and the occurrence of workplace accidents. In both cases, we aim to distinguish the effect of reporting behavior from actual workplace safety. Our contribution to the economics literature on workplace accidents is twofold. First, we revisit the cyclical relationship between workplace accidents and unemployment finding that a large part of the cyclicity has to do with reporting behavior and not with actual changes in workplace safety. Second, we investigate to what extent the relationship between employment contract and workplace accidents is driven by reporting behavior. For this, we exploit a difference-in-differences analysis in which information on commuting accidents is used to establish the extent of under-reporting for temporary workers. We find that temporary workers are less likely to report an accident. When it comes to contract-specific workplace safety, the effects are country-specific. In Italy, workers with a temporary contract are not more likely to have a workplace accident while in Spain temporary workers are more likely to be confronted with a workplace accident.

The set-up of our paper is as follows. Section 2 presents an overview of previous studies on workplace accidents to the extent that they are related to cyclicity or nature of the employment contract. In Section 3 we present an analysis of nation-wide aggregate data on workplace accidents in 15 EU-countries over the period 1995–2012. We find that the unemployment rate has a negative effect on workplace accidents while economic growth has a positive effect. We relate the first relationship to reporting behavior of individuals and the second relationship to work-stress. We also study fatal workplace accidents and road accidents finding that these do not vary with unemployment and economic growth. In Section 4, we present an analysis at a lower level of aggregation distinguishing the workplace accident rates by gender, age, industry and type of contract. We perform this analysis for Italy and Spain. The available data allow us to also study smaller workplace accidents that cause an absence from work of 1 to 3 days. We disentangle the effect of under-reporting and workplace safety using commuting accidents as a counterfactual where we assume that differences between temporary and permanent workers are driven by under-reporting only. We find indeed that under-reporting of workplace accidents by temporary workers is substantial. Section 5 concludes.

2. Previous studies on workplace accidents

Studies on the economic determinants of workplace accidents often focus on their cyclical nature. Based on an analysis of workplace accidents in 16 OECD countries over the period 1976–2001, Boone and van Ours (2006) conclude that these cyclical fluctuations are related to reporting behavior and are not caused by changes in workplace safety. Boone *et al.* (2011) using data on workplace accidents from an Austrian matched worker-firm dataset find indeed that workers who reported an accident are more likely to be fired later

on. Boone *et al.* (2011) also find that reporting behavior is an important source of cyclical fluctuations in workplace accidents. Davies *et al.* (2009) study cyclical variations in workplace accidents in the UK over the period 1986–2005. They find pro-cyclical accident rates in particular in construction and manufacturing. The cyclical sensitivity in construction has to do with fluctuations in the share of temporary workers. The cyclical sensitivity of workplace accidents in manufacturing is attributed to high work demands. The authors conclude that cyclical fluctuations in workplace accidents are related to varying employment conditions and the tenure composition of the workforce.

Based on an overview of previous studies, the Workplace Safety and Insurance Board (2013) states that under-reporting is a non-trivial issue. Under-reporting by the worker may occur because of fear of job loss or because of peer pressure motivated by the potential loss of a group-based incentive to remain accident-free. Under-reporting may also arise from pressure by the employer through direct intimidation, through the threat of job loss, reassignment to a lower paying job, denial of overtime, denial of promotions or harassment. Firms may want to under-report workplace accidents because inspections by safety authorities are often based on reported accidents. Whether or not a workplace accident is reported may depend on whether the worker has a temporary or a permanent contract. Amuedo-Dorantes (2002) using 1997 Spanish establishment and employee-level data finds that temporary workers are more likely to be confronted with a workplace accident than permanent workers. However, once differences in working conditions are accounted for temporary workers are not more likely to have a workplace accident. The probability of a workplace accident is not so much higher for temporary workers or workers who recently started on their job than it is for their counterparts.

Firm characteristics, occupations and working conditions are more important determinants of workplace accidents. Guadalupe (2003) using Spanish data finds that the workplace accident rates are higher among temporary workers than among permanent contract workers. This could be related to their lack of work experience or because temporary workers put more effort in the work to increase the probability that their temporary contract will be extended. Hernanz and Toharia (2006) analyze the effect of contract type on the rate of work-related accidents in Italy and Spain, using 1999 Labor Force Survey data. The authors find that temporary workers have a higher workplace accident rate in Spain while this is lower in Italy. When job tenure is accounted for the differences between Italy and Spain become insignificant. García-Serrano *et al.* (2010) analyze Spanish Statistics on Accidents at Work for the period 2004–07 finding that temporary help agency workers have a lower workplace accident rate than regular temporary or permanent contract workers. Bender *et al.* (2012) analyze data from 30 European countries in the European Working Conditions Survey (EWCS), conducted in 2000 and 2005 showing that piece-rate workers a higher workplace accident rate. Finally, Bena *et al.* (2013) analyze data from the Work History Italian Panel (WHIP) over the period 1985–2004 merged with data from the Italian Workers Compensation Authority (INAIL) finding that workplace accident rates fall with job tenure.

3. Cyclical fluctuations in workplace accidents

3.1. Data

Our cross-country data on workplace accidents are from the European Statistics on Accidents at Work (ESAW; Eurostat, 2013). Workplace accidents include cases of acute poisoning and wilful acts of other persons, as well as accidents occurring during work but

off the company premises, even those caused by third parties. It excludes deliberate self-inflicted injuries, accidents on the way to and from work (commuting accidents), accidents having only a medical origin and occupational diseases. The phrase ‘in the course of work’ means whilst engaged in an occupational activity or during the time spent at work. This includes cases of road traffic accidents in the course of work. ESAW includes case-by-case data on occupational accidents with more than three days of absence from work and fatal accidents. A fatal accident is defined as an accident which leads to the death of the victim within one year. The ESAW data are provided by national reporting systems.

When comparing incidence rates of non-fatal accidents between countries one has to keep in mind that countries use different data sources. Austria, Belgium, Finland, France, Germany, Greece, Italy, Luxembourg, Portugal, and Spain use data that come from insurance systems. Denmark, Great Britain, Ireland and Sweden use data from Labor Inspectorate reports. Workplace accident data in the Netherlands are collected through the Netherlands Working Conditions Survey. However, in the period 2002–04, the data were based on Labor Force Surveys. Because of this, the number of workplace accidents over the period 2002–04 was substantially lower and therefore this period is removed from the analysis for the Netherlands.

To establish whether indeed cyclical fluctuations in workplace accidents are related to reporting behavior we also study cyclical fluctuations in road accidents. For this analysis, we use information from CARE, the EU road accidents database on the number of injuries in road accidents as a share of the population.

3.2. Descriptive analysis

Information about workplace accidents in Europe over a longer period of time is available for 15 countries, mostly from 1995 to 2012. Table 1 provides information about the data we use in the analysis. The non-fatal accident rate ranges from 0.9 per cent in Greece to 5.0 in Luxembourg with an average accident rate over the 15 countries of 2.5 per cent. The fatal accident rates are about 1 per cent of the non-fatal accident rates. They range from 8 fatal accidents per 100,000 workers in Great Britain to 67 fatal accidents per 100,000 workers in Luxembourg. On average, there were 3.1 fatal accidents per 100,000 workers. The high rates of workplace accidents in Luxembourg are surprising as are the low workplace accident rates in Greece. There does not seem to be a systematic difference in workplace accidents in Northern Europe or Southern Europe. We cannot rule out that some of the cross-country differences in workplace accidents are related to differences in data collection. To avoid drawing erroneous conclusions on the relationship between workplace accidents and labor market indicators on the basis of cross-country differences, in each of our cross-country estimates we include country fixed effects. Thus, any relationship between workplace accidents and labor market indicators is based on within-country developments.

The third column of Table 1 shows the road accidents rates which range from a low 1.4 injury per 1,000 inhabitants in Denmark to a high 6.1 injury per 1,000 inhabitants in Austria. The fourth column of Table 1 shows that the unemployment rates vary a lot between the countries ranging from a low 3.7 per cent in Luxembourg to a high 14.8 per cent in Spain with an average of 7.6 per cent. Annual GDP growth varies a lot too, as illustrated in the fourth column. Average annual GDP growth over the 15 countries and the time period 1995–2012 was 2.2 per cent ranging from a low 0.8 per cent in Italy to a high 4.9 per cent in Ireland. Finally, the sixth column of Table 1 shows the cross-country variation in

Table 1. Workplace accident rates, road accident rates, unemployment rates, annual GDP-growth and share of temporary jobs in 15 EU-countries

	Workplace accidents		Road accidents	U-rate (%)	GDP-growth (%/year)	Temporary job (%)
	Non-fatal	Fatal				
1. Austria	2.5	5.6	6.1	4.3	2.1	8.2
2. Belgium	2.0	2.4	5.9	8.1	1.8	8.2
3. Denmark	2.5	2.2	1.4	5.4	1.3	9.6
4. Finland	2.4	2.0	1.6	9.5	2.7	16.3
5. France	2.7	3.0	2.1	9.1	1.6	14.2
6. Germany	3.2	2.4	5.5	8.5	1.4	13.1
7. Great Britain	1.2	0.8	4.7	6.3	2.2	6.4
8. Greece	0.9	1.6	2.2	11.7	1.3	11.7
9. Ireland	1.0	2.9	2.5	8.0	4.9	7.4
10. Italy	2.7	4.5	5.5	9.0	0.8	10.9
11. Luxembourg	5.0	6.7	2.9	3.7	3.4	5.0
12. Netherlands	2.0	1.1	2.1	4.4	2.0	15.2
13. Portugal	3.2	5.2	5.2	8.5	1.6	19.2
14. Spain	3.9	4.1	3.1	14.8	2.4	30.8
15. Sweden	1.0	1.5	2.6	7.5	2.6	15.7
Average	2.5	3.0	3.6	7.6	2.2	12.6

Notes: Non-fatal accident rate = non-fatal accidents per 100 workers; fatal accident rate = fatal accidents per 100,000 workers; road accident rate = number of injuries in traffic accidents per 1,000 inhabitants; temporary job as percentage-dependent employment; calendar time period 1995–2012 except for Great Britain (1995–2001, 2005–07, 2011–12), Greece (1995–2007, 2011–12) and the Netherlands (1995–2001, 2005–12).

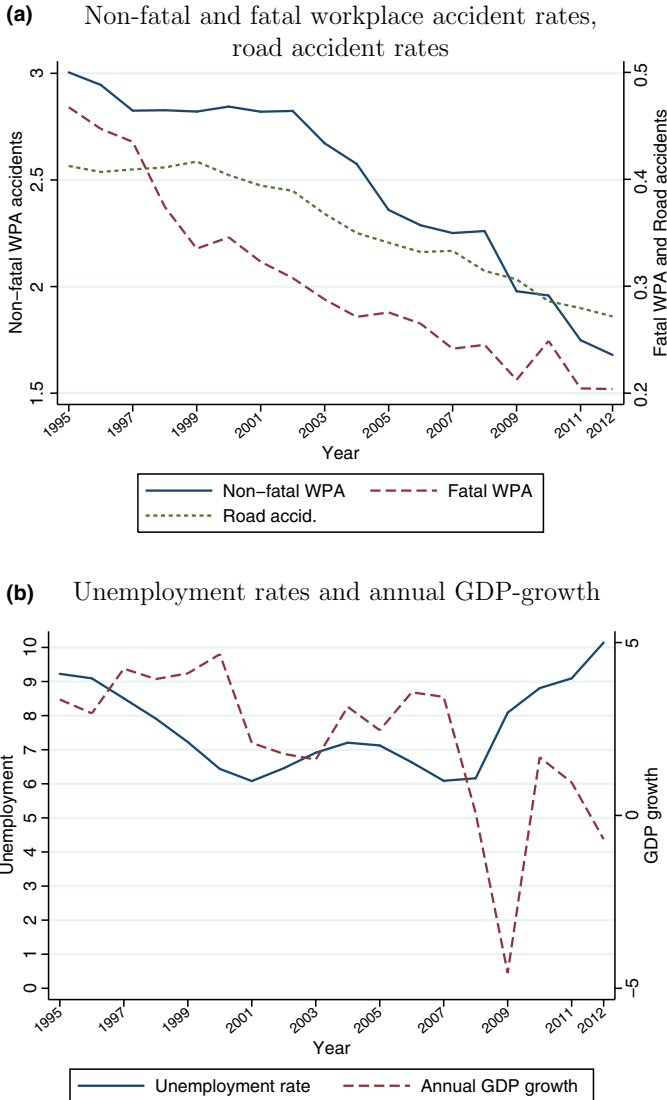
Sources: OECD Labor Force Statistics, European Statistics on Accidents at Work, CARE (EU road accidents database), World Bank.

the share of temporary jobs in employment. Although on average 12.6 per cent of the employed workers had a temporary job, this was only 5 per cent in Luxembourg and as high as 30.8 per cent in Spain.

Figure 1 provides a graphical representation of the main developments in workplace and road accidents and labor market indicators over the period 1995–2012. These are averages over the 15 countries in our sample. The top part of the figure shows the evolution of workplace and road accident rates. Clearly, all accident rates are declining. For non-fatal workplace accidents, the decline is mild but after 2003 the decline is more substantial. From 3 per cent in 1995, the average non-fatal workplace accident rate drops to about 1.7 per cent. The decline of the fatal accident rates is even stronger in relative terms. Although in the beginning of the sample period, the fatal accident rate is about 0.45 per 10,000 workers towards the end this is about 0.20 per 10,000 workers. The drop in the fatal accident rates is a clear indication of increased workplace safety. Some of the decline in fatal accidents may have to do with changes in the industry structure with manufacturing declining and service industries becoming more important. However, since the shares of manufacturing in overall employment did not change that much, the drop in fatal accident rates is too strong to be attributed to changes in the industry structure only. The road accident rates show a similar decline from 1999 onwards.

The lower part of Figure 1 shows the evolution of average unemployment rates and annual GDP growth rates over the sample period. Unemployment rates initially drop from about 9 per cent in 1995 to an average of 6 per cent in 2001. From 2008 onward, the

Figure 1. Non-fatal and fatal workplace accident rates and economic indicators averaged for 15 EU countries; 1995–2012. (a) Non-fatal and fatal workplace accident rates, road accident rates. (b) Unemployment rates and annual GDP-growth.



Notes: Non-fatal accident rate per 100 workers; fatal accident rate per 10,000 workers; road accident rate per 100 inhabitants.

Sources: OECD Labor Force Statistics, European Statistics on Accidents at Work, World Bank, EU Road Accidents Database.

influence of the Great Recession is clear; there is a sharp increase in the unemployment rates to an average of about 12 per cent in 2012. Annual GDP-growth fluctuates between 2 and 4 per cent from 1995 to 2007. Then, there is a sharp drop at the onset of the Great Recession with an average decline of GDP in 2009 of about 5 per cent. In 2010 and 2011 there is a mild GDP-growth but in 2012 there is again a decline in average GDP.

Figure 2 shows the evolution of workplace accident rates and unemployment rates over time for each of the 15 EU-countries. There seems to be a negative association between unemployment rates and workplace accident rates. There is generally a drop in workplace accidents after 2008. For some countries this is the continuation of a trend, for other countries there is a sharp drop after 2008. This means the Great Recession may have had a negative effect on workplace accidents rates.

3.3. Parameter estimates

To investigate the cyclical sensitivity of workplace accident rates, we estimated the following relationship:

$$\log(ar_{jt}) = \alpha_{1j} + \alpha_{2j}t + \alpha_{3t} + \beta_1 u_{jt} + \beta_2 y_{jt} + \varepsilon_{jt}, \quad [1]$$

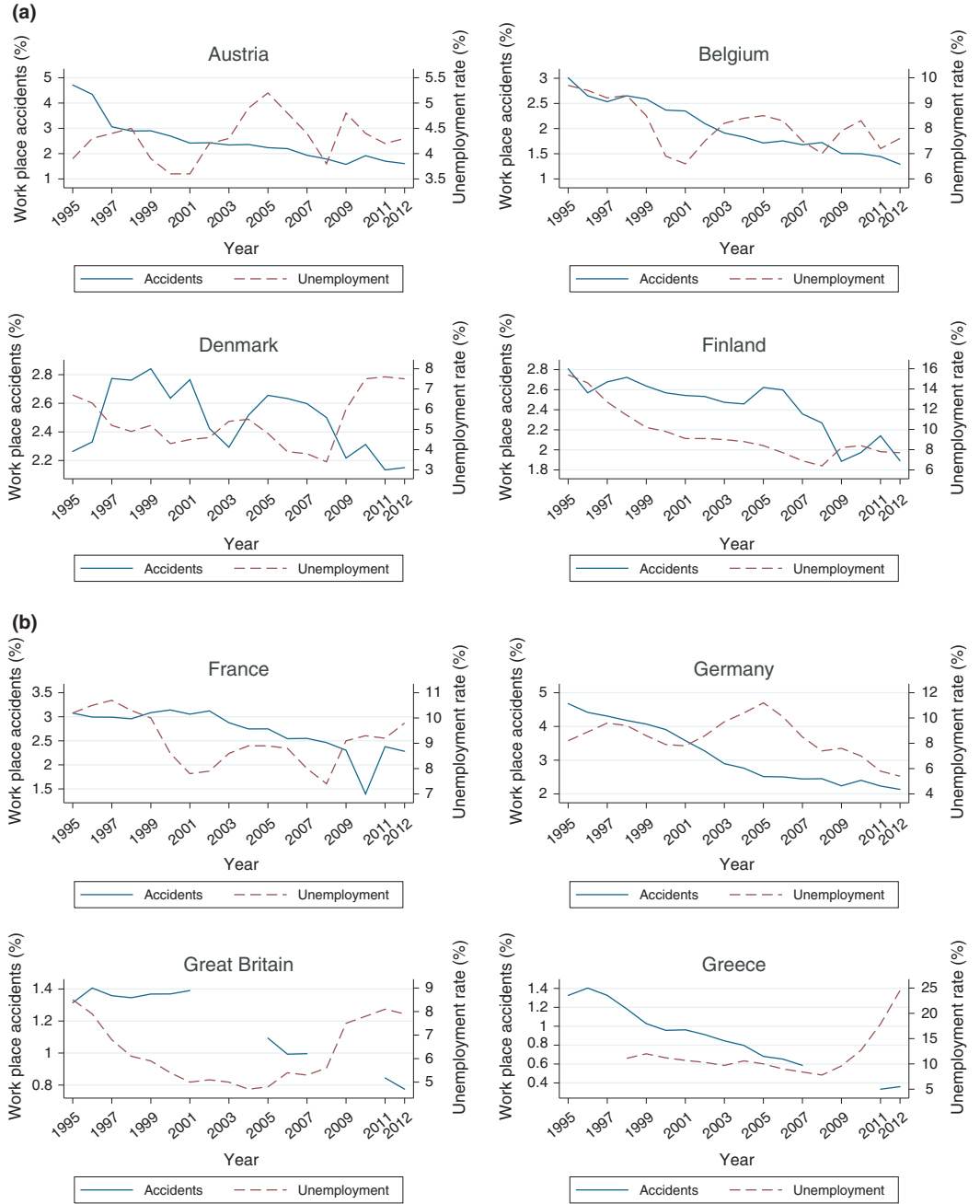
where ar_{jt} is the workplace accident rate of country j in year t , u is the unemployment rate, y is the GDP-growth rate, the α_{1j} are country fixed effects, the α_{2j} represent the effects of country-specific time trends, α_{3t} are calendar year fixed effects, β_1 and β_2 are parameters that measure the effects of the unemployment rate and the GDP-growth rate on the workplace accident rate and ε is an error term. The country fixed effects allow for country-specific differences in measurement of workplace accidents and time-invariant country-specific differences in workplace safety. The country-specific time trends allow for country-specific gradual changes in workplace safety or industrial structure. The calendar year fixed effects allow for country-invariant but common calendar year-specific changes in workplace safety.

Table 2 presents the parameter estimates. The dependent variables are the non-fatal accident rates in panel (a), the fatal accident rates in panel (b) and the road accident rates in panel (c). The first row of panel (a) shows that there is a negative and at the 10 per cent level a significant effect of unemployment on non-fatal accident rates while there is a significant positive effect of GDP-growth on non-fatal accident rates. In the second specification we include country-specific time trends. Now, the effect of unemployment is substantially larger and highly significant. The effect of economic growth is still significantly positive although the parameter estimate is substantially smaller than in the first row. If in addition to country fixed effects and country-specific time trends we also include calendar year fixed effects the parameter estimates hardly change. In conclusion, unemployment has a significant negative effect on workplace accident rates while economic growth has a significant positive effect. The negative effect of unemployment has most likely to do with reporting behavior, the positive effect of economic growth with work-stress.

Panel (b) of Table 2 shows the parameter estimates for fatal accidents. Except for the first row, the effect of unemployment is never significantly different from zero which supports the idea that unemployment influences reporting behavior and not actual workplace safety. In the first two specifications the effect of economic growth is positive suggesting that indeed this works through workplace safety. Only when we include calendar year fixed effects, economic growth is no longer significant.

Panel (c) of Table 2 shows the parameter estimates for road accidents. In none of the specifications unemployment has a significant effect while the effect of economic growth is significant only in the first specification. This too suggests that the negative effect of unemployment on workplace accidents is related to reporting behavior.

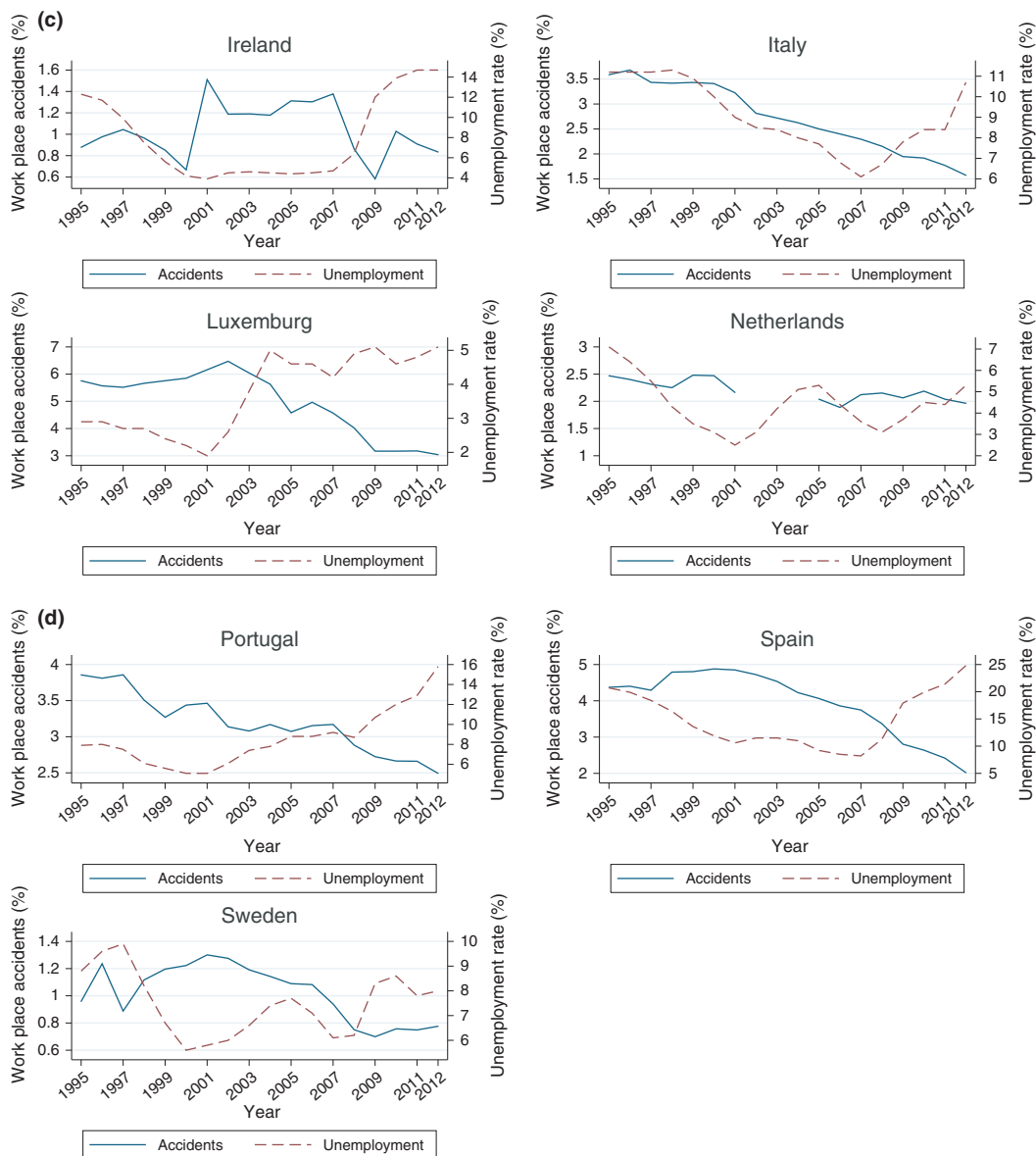
Figure 2. Workplace accidents and unemployment rates across 15 EU-countries.



Sources: OECD Labor Force Statistics, European Statistics on Accidents at Work.

Finally, in panel (d), we show the relevant parameter estimates if we reduce the period of analysis from 2002 to 2012. Again, only for the non-fatal accident rates we find that unemployment has a significant negative effect. Fatal workplace accidents and road accidents are not related to unemployment.

Figure 2b. Continued



4. Workplace accidents and temporary work

4.1. Temporary jobs

Temporary jobs are predominantly for young workers. In Italy, the share of temporary jobs at around 5 per cent is low among old workers (age 54–65), slightly higher among prime workers, i.e. about 10–12 per cent and slightly above 50 per cent for young workers.

Table 2. Parameter estimates cyclical fluctuations in workplace accidents; 15 EU countries

	Unemployment rate (%)	GDP growth rate (%/year)	Country FE	Country time trends	Calendar year FE
(a) Non-fatal WPA; 1995–2012					
1	-0.013 (1.9)*	0.036 (3.8)***	Yes	No	No
2	-0.025 (7.0)***	0.010 (6.2)***	Yes	Yes	No
3	-0.020 (3.3)***	0.009 (1.9)*	Yes	Yes	Yes
(b) Fatal WPA; 1995–2012					
1	0.015 (1.7)*	0.053 (5.1)***	Yes	No	No
2	-0.002 (0.3)	0.012 (3.2)***	Yes	Yes	No
3	-0.006 (0.5)	-0.003 (0.2)	Yes	Yes	Yes
(c) Road accidents; 1995–2012					
1	-0.004 (0.7)	0.038 (4.2)***	Yes	No	No
2	-0.012 (1.5)	-0.002 (0.7)	Yes	Yes	No
3	0.003 (0.3)	-0.000 (0.0)	Yes	Yes	Yes
(d) Accidents 2002–12					
1. Non-fatal WPA	-0.014 (1.9)*	0.019 (3.6)***	Yes	Yes	Yes
2. Fatal WPA	0.002 (0.2)	0.036 (2.6)**	Yes	Yes	Yes
3. Road accidents	-0.001 (0.1)	0.009 (0.6)	Yes	Yes	Yes

Notes: WPA = Workplace accidents. Absolute *t*-statistics based on robust standard errors in parentheses. *, ** and *** are for statistical significance at 10 per cent, 5 per cent and 1 per cent, respectively.

In Spain, for old workers the share of temporary jobs is about 15 per cent, for prime age workers about 30 per cent and for young workers about 65 per cent.

To investigate the relationship between the nature of the employment contract and workplace safety, we present an analysis at a lower level of aggregation distinguishing the workplace accident rates by gender, age, industry, and type of contract. We have data on workplace accidents for Italy from 2009 to 2013 and for Spain from 2012 to 2013.¹ The available data allow us to study the determinants of workplace accidents in more detail. However, the calendar time dimension is too short to study cyclical fluctuations. The data are available aggregated by gender, age groups (15–24, 25–34, 35–44, 45–54, 55–64), severity of the accident (absence of 1 to 3 days, absence more than 3 days)², sectors (manufacturing, construction, others) and contract types (temporary or permanent).

The first four columns of Table 3 show the average workplace accident rates for each country and for each category of the available variables. In both countries, the rate for small workplace accidents is low. In Spain, there are more workplace accidents among workers with temporary contracts, whereas in Italy more workplace accidents take place among workers under permanent contracts. The rate of workplace accidents goes down with the age of the worker. For example, while severe workplace accidents rate among young workers (15–24) in Italy is 2.3 per cent, it is 1.6 per cent for the age group 25–34. For Italy these numbers are 3.4 and 2.8 respectively. Distinguished by industry, accidents are most likely to occur in construction. In both Spain and Italy, workplace accidents are more likely to occur for male workers. For them, the average rates of serious workplace accidents are 4.0 and 2.0 while for female workers this is 2.1 and 1.1 respectively.

The last four columns of Table 3 provide information about commuting accidents. As shown, also for commuting, small accidents are not very likely to occur. Both in Italy and Spain, commuting accidents are more common among workers with a permanent contract. Age has a negative effect on commuting accidents while these accidents are most likely to

Table 3. Average workplace accident rates in Italy and Spain

Days of absence	Workplace accidents				Commuting accidents			
	Italy		Spain		Italy		Spain	
	1-3	3+	1-3	3+	1-3	3+	1-3	3+
Contract type								
Temporary	0.21	0.97	0.46	3.26	0.34	2.16	0.28	3.57
Permanent	0.30	1.73	0.40	2.92	0.39	3.10	0.53	6.58
Ages								
15-24	0.55	2.27	0.58	3.42	0.76	4.66	0.62	7.17
25-34	0.33	1.60	0.46	2.82	0.53	3.45	0.49	5.68
35-44	0.28	1.58	0.42	2.94	0.36	2.89	0.36	4.53
45-54	0.24	1.58	0.40	3.34	0.27	2.57	0.37	4.94
55-64	0.19	1.45	0.33	3.35	0.20	2.26	0.38	5.63
Sectors								
Construction	0.46	2.85	0.90	5.59	0.30	2.53	0.25	3.53
Manufacturing	0.45	1.90	0.36	2.76	0.36	2.77	0.24	3.33
Others	0.25	1.40	0.57	3.72	0.40	3.06	0.46	5.69
Gender								
Male	0.36	2.02	0.58	3.97	0.44	3.27	0.34	4.26
Female	0.20	1.11	0.25	2.05	0.34	2.71	0.50	6.29
Total	0.29	1.61	0.43	3.07	0.38	2.96	0.42	5.21
Period	2009-13		2012-13		2009-13		2012-13	

Notes: Commuting accidents are in 1,000. Workplace accidents are in 100.

Columns for 3 + days show the average workplace and commuting accident rates where the accident either results in the absence more than 3 days or death of the employee.

Source: European Labor Force Surveys.

occur in other industries than manufacturing and construction. In Italy female workers are less likely to report a commuting accident while in Spain female workers are more likely to do so.

4.2. Determinants workplace accidents

Statistics on workplace accidents may be biased due to reporting behavior. This may be related to the nature of the employment contract. Workers with a permanent contract may be less reluctant to report a workplace accident than temporary workers who may fear for example that their contract is not renewed should they report a workplace accident. However, workers with a permanent contract will also be workers with more experience than workers with a temporary contract. So, they may be less likely to have a workplace accident. To distinguish between reporting behavior and actual workplace accidents we use information on commuting accidents. The reporting of commuting accidents may be subject to the same under-reporting bias as regular workplace accidents. However, the occurrence of commuting accidents will not be related to workplace safety.

To study potential determinants of the workplace accidents we perform separate estimates for Italy and Spain and for small and large accidents. The unit of analysis is the average accident rate over a group (a 'cell') of workers distinguished by age, sector, gender and year. We assume the following relationship at the cell level between the accident rate

in accidents category k ($k = 0, 1$, i.e. commuting accidents and workplace accidents) for workers with employment contract type s ($s = 0, 1$, i.e. workers with temporary and permanent jobs) in year t :

$$\log(a_{kst}) = \beta_k X + \mu k + \gamma s + \delta sk + \varepsilon_{kst}, \quad [2]$$

where the observed characteristics X are a set of dummy variables for age, gender and industry, β_1 and β_2 indicate the effect of the observed characteristics on the two accidents rate, μ indicates the difference between workplace accidents and commuting accidents, γ represents reporting behavior related to having a temporary compared to a permanent contract and ε is an error term. The main parameter of interest is δ which represents the difference-in-differences estimate, i.e. the true effect of having a permanent contract on workplace accidents after correcting for reporting behavior. Our identifying assumption is that the reporting effect of having a temporary contract does not depend on the nature of the accident. If workers on a temporary contract under-report with a certain probability they do so both for workplace accidents and commuting accidents.³

Table 4 presents the parameter estimates. Reporting behavior is the same in both countries: workers with a permanent contract are less reluctant to report an accident. When it comes to contract-specific workplace safety, there are clear differences between the countries. In Italy, conditional on age, industry and gender, workers with a permanent contract

Table 4. Determinants of accident rates

Days of absence	Italy		Spain	
	1–3	3+	1–3	3+
(a) Employment contract and type of accident				
Permanent	0.481 (7.4)**	0.582 (11.0)**	0.352 (2.3)**	0.365 (2.6)**
WPA	3.949 (30.5)**	3.631 (32.2)**	7.968 (25.2)**	7.057 (24.1)**
(b) D-i-D estimates				
Permanent × WPA	0.199 (2.3)**	0.029 (0.4)	−0.537 (2.5)**	−0.569 (2.9)**
(c) Workplace accidents				
25–34	−0.724 (7.5)**	−0.586 (7.3)**	−0.364 (2.6)**	−0.226 (1.7)*
35–44	−1.090 (11.3)**	−0.708 (8.9)**	−0.485 (3.5)**	−0.177 (1.3)
45–54	−1.189 (12.3)**	−0.632 (7.9)**	−0.428 (3.1)**	0.007 (0.1)
55–64	−1.271 (13.1)**	−0.580 (7.2)**	−0.842 (6.0)**	−0.191 (1.4)
Manufacturing	−0.049 (0.7)	0.028 (0.5)	0.076 (0.7)	−0.064 (0.6)
Construction	0.191 (2.5)**	0.358 (5.7)**	0.197 (1.8)*	0.052 (0.5)
Female	−0.502 (8.2)**	−0.569 (11.2)**	−1.156 (13.1)**	−1.028 (12.2)**
(d) Commuting accidents				
25–34	−0.670 (7.0)**	−0.609 (7.1)**	−0.329 (1.0)	−0.234 (0.8)
35–44	−1.252 (12.9)**	−0.951 (11.1)**	−0.669 (2.1)**	−0.503 (1.8)*
45–54	−1.410 (14.0)**	−1.054 (12.2)**	−0.675 (2.1)**	−0.581 (2.1)**
55–64	−1.591 (15.6)**	−1.033 (11.8)**	−0.842 (2.6)**	−0.820 (2.9)**
Manufacturing	0.024 (0.3)	−0.065 (1.0)	2.214 (8.8)**	2.047 (9.5)**
Construction	0.263 (3.3)**	0.131 (2.0)**	4.708 (19.9)**	4.597 (21.3)**
Female	−0.588 (9.3)**	−0.489 (8.9)**	0.312 (1.6)	0.233 (1.3)
R^2	0.944	0.953	0.924	0.919
Obs	571	592	230	240

Notes: WPA = Workplace accidents. Constants not reported; absolute t -statistics based on robust standard errors in parentheses. * and ** are for statistical significance at 10 per cent and 5 per cent, respectively.

are more likely to be confronted a small workplace accident. In Spain, temporary workers are more likely to be confronted either small or serious workplace accidents. Comparing the other parameter estimates with the unconditional differences in Table 3 it is clear that some of the unconditional differences are caused by a convolution of age, gender and industry. However, since our data are not informative on for example tenure and work experience, some of the differences in the workplace accident rates by contract status may be related to on-the-job experience. For many of the other variables, the results are consistent across both countries. For workplace accident rates, as age increases accident rates decrease. Compared to other sectors, construction sector has the highest workplace accidents rates. Females are less likely to be confronted with a workplace accident. For commuting accident rates it is clear that as age increases, accidents rates go down. Compared to other sectors, the construction sector has the highest commuting accidents rates. Females are less likely to be confronted with a commuting accident in Spain. We have estimated the same equation including time trends. However, conditional on type of contract, age, sector and gender there is no trend-like development in the accident rates.

5. Conclusions

Over the past decades, in many European countries the share of temporary jobs has increased substantially. The consequences of this development for workplace safety are unclear. Potential under-reporting of workers who are on a temporary contract is an important problem. In our paper we perform two sets of analysis. First, we confirm earlier findings that there are cyclical fluctuations in under-reporting. For this we use data on workplace accidents and road accidents in 15 EU-countries over the period 1995–2012. Then, we explore the relationship between the nature of the employment contract and workplace safety by analyzing data on workplace accidents and commuting accidents from Italy and Spain. We use commuting accidents as a control group in which the differences between workers on a temporary job and those on a permanent job are related to reporting behavior and not to differences in workplace safety. Assuming that the contract-specific reporting behavior is similar for both types of accidents, we disentangle the effects of workplace safety from the reporting bias. Our estimates show that reporting behavior is the same in both countries: workers with a permanent contract are less reluctant to report an accident. When it comes to contract-specific workplace safety, there are differences between the countries. In Italy, workers with a temporary contract are not more likely to have a workplace accident. In Spain, temporary workers seem to be more at risk to be confronted with a workplace accident than workers on a permanent contract. It is not clear whether this has to do with experience of the worker or with the type of work. At the level of the individual worker, a temporary job may have temporary additional risks involved. If the worker gains more experience or is transferred to a different type of job risk may go down. However, at an aggregate level, a higher share of temporary workers may harm workplace safety.

Notes

¹For Italy we use data on workplace accidents from 2009 onwards from INAIL (Italian Workers' Compensation Authority) in combination with Labor Force Survey data on the number of workers

in the various categories. For Spain we obtained workplace accidents data from their National Statistics of Accidents are Work in combination with Spanish Social Security data on the number of workers in the various categories. For Spain the “bottleneck” in the data availability is in employment by type of contract which is available only since 2012.

²Non-fatal workplace accidents in international statistical overviews are most often related to accidents that cause absence from work for more than three days.

³In other words, our identification strategy fails if workers are more reluctant to report a workplace accident than they are to report a commuting accident.

References

- Amuedo-Dorantes C. (2002) ‘Work Safety in the Context of Temporary Employment: The Spanish Experience’, *Industrial and Labor Relations Review* 55(2): 262–272.
- Bena A., Giraudo M., Leombruni R. and Costa G. (2013) ‘Job Tenure and Work Injuries: A Multivariate Analysis of the Relation With Previous Experience and Differences by age’, *BMC Public Health* 13(869): 1–9.
- Bender K. A., Green C. P. and Heywood J. S. (2012) ‘Piece Rates and Workplace Injury: Does Survey Evidence Support Adam Smith?’, *Journal of Population Economics* 25: 569–590.
- Boone J. and van Ours J. C. (2006) ‘Are Recessions Good for Workplace Safety?’, *Journal of Health Economics* 25: 1069–1093.
- Boone J., van Ours J. C., Wuellrich J. P. and Zweimuller J. (2011) ‘Recessions are bad for Workplace Safety’, *Journal of Health Economics* 30: 764–773.
- Davies R., Jones P. and Nunez I. (2009) ‘The Impact of the Business Cycle on Occupational Injuries in the UK’, *Social Science and Medicine* 69: 178–182.
- Dixon R., Lim G. C. and van Ours J. C. (2017) ‘Revisiting the Okun Relationship’, *Applied Economics* 49, in press, <http://www.tandfonline.com/doi/full/10.1080/00036846.2016.1245846>
- Eurostat. (2013) *European Statistics on Accidents at Work (ESAW): Summary Methodology*. Luxembourg: Publication Office of the European Union.
- Eurostat. (2014) *Key Figures on Europe*, Pocketbooks 2014 Edition. Luxembourg: European Union.
- García-Serrano C., Hernanz V. and Toharia L. (2010) ‘Mind the gap, Please! The Effect of Temporary Help Agencies on the Consequences of Work Accidents’, *Journal of Labor Research* 31 (2): 162–182.
- Guadalupe M. (2003) ‘The Hidden Costs of Fixed Term Contracts: The Impact on Work Accidents’, *Labor Economics* 10(3): 339–357.
- Hernanz V. and Toharia L. (2006) ‘Do Temporary Contracts Increase Work Accidents? A Microeconomic Comparison Between Italy and Spain’, *Labor* 20(3): 475–504.
- Pouliakas K. and Theodossiou I. (2013) ‘The Economics of Health and Safety at Work: An Interdisciplinary Review of the Theory and Policy’, *Journal of Economic Surveys* 27(1): 167–208.
- Workplace Safety and Insurance Board (2013) *Workplace Injury Claim Suppression: Final Report*. Technical Report, Prism Economics and Analysis. Toronto: Workplace Safety and Insurance Board.