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# ABSTRACT

# Unsafe Temperatures, Unsafe Jobs: The Impact of Weather Conditions on Work-Related Injuries*

We estimate the impact of temperatures on work-related accident rates in Italy by using daily data on weather conditions matched to administrative daily data on work-related accidents. The identification strategy of the causal effect relies on the plausible exogeneity of short-term daily temperature variations in a given spatial unit. We find that both high and cold temperatures impair occupational health by increasing workplace injury rates. The positive effect of warmer weather conditions on work-related accident rates is larger for men, in manufacturing and service sectors, and for workplace injuries. Colder temperatures lead to a substantial increase in commuting accidents, especially during rainy days.

**JEL Classification:** J28, J81, Q52, Q54

**Keywords:** climate change, temperatures, weather conditions, work-related accidents, job safety

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# 1 Introduction

In the past decade, global warming has given rise to a rapidly growing body of scientific literature interested in the impact of weather conditions on several economic outcomes (Dell et al., 2014), such as labor productivity (Neidell, 2017), well-being, and allocation of time (Connolly, 2018). Connolly (2018) found that warmer summer temperatures are likely to reduce well-being by shifting leisure activities indoors and to have a negative effect on labor productivity. Adhvaryu et al. (2020) determined that worker productivity increases when temperatures in the workplace are reduced by the use of low-heat LED lighting. Somanathan et al. (2021) estimated reduced worker productivity and increased absenteeism on hot days. Noelke et al. (2016) studied the effect of increasing ambient temperature on emotional well-being in the US population, finding reduced happiness and increased stress, anger and fatigue, especially among less-educated and older people.

A second strand of the literature has focused on the relationship between exposure to temperature extremes and health. In this case, the outcome variable has usually consisted of mortality rate (see e.g. Deschênes and Moretti, 2009; Deschênes and Greenstone, 2011; Adélaïde et al., 2022; Liao et al., 2023; Helo Sarmiento, 2023), low birth weight (Deschênes et al., 2009; Cil and Kim, 2022), and hospitalization rate (see e.g. Piver et al., 1999; Schwartz et al., 2004; White, 2017; Masiero et al., 2022; Rizmie et al., 2022). Deschênes (2014) reviewed both the economic and epidemiological literature and concluded that temperature extremes lead to significant reductions in health, generally measured with excess mortality. More specifically, heat impacts on mortality are more immediate, whereas cold temperature exposure leads to mortality impacts that tend to accumulate over time.

A limited number of studies have instead investigated the relation between changing climatic conditions and occupational health, although exposure to excessive heat limits workers' physical functions and capabilities, thereby increasing the risk of injury (ILO, 2019). The recent comprehensive meta-analysis in Fatima et al. (2021) is based on 22 studies, most of which: i) analyze the association between temperature and workplace safety and health in particular local areas and/or sectors; ii) are time-trend analyses, "impairing the possibility to make any causal inference from the study results" (Bonafede et al., 2016). Nevertheless, understanding the causal effect of rising temperatures on workplace health and safety is important for policy-makers, not only in regard to designing effective public health policies, but also from the economic perspective, given the costs caused by work-related injuries and illnesses and their importance for labor productivity. Our paper contributes to this strand of the literature by estimating the causal effect of temperatures on work-related injuries in Italy.

Only three studies have analyzed the causal effect of temperatures on work-related injuries: Marinaccio et al. (2019), Dillender (2021), and Park et al. (2021) relied on plausibly exogenous short-term variations of temperatures in a given spatial unit, so that their estimates were not driven by potential endogenous changes in labor inputs (Park et al., 2021). The results for Texas in Dillender (2021) indicated that both high and low temperatures increased injury rates and that high temperatures had more severe adverse effects in warmer climates. Using data on workplace accidents in California, Park et al. (2021) found that hotter temperatures increased the likelihood of injury on the job in both indoor and outdoor settings, whereas they found no evidence for significant impacts of extreme cold temperature. Their results also suggested that temperature exposure increased labor market inequality, because lower-wage or younger workers experienced greater injury rates, and that there are adaptation potentials because the effect of temperature on work-related injuries fell over time. The epidemiological study by Marinaccio et al. (2019) estimated, for each Italian province from 2006 to 2010, the association between temperatures and the number of injuries, relying on the variation of local temperatures from the average local temperature across the same day of the week of the same month. Although they added also covariates for special days of the year, like influenza peaks or holidays, they did not fully control for calendar date fixed effects and other daily climatic conditions, which may be correlated with temperatures and the risk of injury.

In this paper, we estimate the effect of temperatures on work-related accident rates in Italy in the period 2008-2021. Italy is an interesting case study for various reasons. First, it is vulnerable to climate change, and it is predicted to suffer greatly from increases in temperatures and from the modification of rainfall patterns. According to the 2019 Global Climate Risk Index (Eckstein et al., 2021), which summarizes fatalities and the losses in terms of GDP, Italy ranked 35th in the world, and 6th among the OECD countries. The forecasts in Spano et al. (2020) predicted that in Italy average temperatures will rise by 2°C in the period 2021-2050 and by 5°C by the end of the century, relatively to the period 1981-2010. Second, in terms of rates of both fatal and non-fatal accidents at work, Italy is characterized by a high incidence: in 2019 it was above the median among the EU-27 countries.[1] Third, since the Italian population is ageing quite rapidly, and the health of

[1]See the figures reported in the Eurostat Statistics Explained on Accidents at Work Statistics on

the elderly is more exposed to heat stress (Levi et al., 2018), the consequences in terms of public health and labor market issues are amplified because more workers in Italy are at greater risk of heat stress and potentially more severely affected than in other countries. Lastly, Italy is characterized by marked economic and social inequalities among regions. Prior research has found that the burden of rising temperatures will fall more on workers in sectors more exposed to heat and living in warmer regions (Connolly, 2018). Hence, this raises questions about the impact of climate change on inequalities that in Italy are particularly significant. Understanding how the climate change may affect occupational safety is important for obtaining a more complete picture of the health effects and costs of climate change.

One of the main problems in studying the effect of weather conditions on work-related accidents is obtaining granular data on both accidents and weather conditions, so as to relate the weather conditions experienced by workers on a particular day and in a given local area with the work-related accidents which occurred on that same day and in that same area (Dillender, 2021). We were able to resolve this problem by matching daily data on work-related accidents from the *Istituto Nazionale per l'Assicurazione contro gli Infortuni sul Lavoro* (INAIL), which is the Italian national workers compensation authority for work-related accidents, with daily meteorological data from Copernicus, the European Union's Earth Observation Programme. The former dataset contains information about the Italian province in which the work-related accident took place; the latter dataset reports the meteorological conditions with gridded fields at a spacing of $0.25° \times 0.25°$ in regular latitude/longitude coordinates (Cornes et al., 2018). We matched the meteorological data with provincial accident rates by using the latitude and longitude of the provincial capital. With the resulting matched dataset, we estimated the impact of local temperatures on local accident rates by means of fixed effects estimators. As in Dillender (2021), in our benchmark model we employed month-year-province fixed effects and calendar-date fixed effects, so that we relied on the plausible exogeneity of short-term variations in daily local temperatures.

Our results complement those set out in Dillender (2021), Park et al. (2021) and Marinaccio et al. (2019). Dillender (2021) and Park et al. (2021) limited their studies to two states of the USA – Texas and California, respectively. Therefore, their results cannot be easily generalized to a country with different labor market institutions, economy, climate, and demographic structure. With respect to Marinaccio et al. (2019), who studied

https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Accidents_at_work_statistics.

Italy in the period 2006-2010, we focused on more recent years and on a much longer time window. The past decade is interesting, because it was characterized by a surge in temperatures: the last seven years were globally the warmest on record.[2] Moreover, we tackled the issue of the identification of the causal effect of temperatures on work-related injuries more thoroughly: we used multiway high dimensional fixed effects, both at the level of calendar dates and for each interaction among local area, month, and year; and we added further controls for daily climate conditions. In addition, we also examined commuting accidents in order to isolate the importance of extreme weather conditions on the risk faced by workers while going to work. Finally, we delved into the issues of adaptation, acclimation, and changing inequalities. Adaptation, i.e. how people may adapt by modifying their behaviors or by investing to avoid negative consequences, and acclimation have not yet been investigated in Italy. Inequalities may be exacerbated by climate change, especially the North and South divide, for example if different geographical areas are differently affected by rising temperatures.

This article is organized as follows. Section 2 illustrates our data sources and provides summary statistics on the sample used in the empirical analysis. Section 3 presents the econometric model and the strategy used to identify the effect of temperatures on work-related accidents. Section 4 reports and discusses the main findings. Section 5 concludes and draws policy implications.

## 2 Data and sample

We conducted the empirical analysis by merging different data sources. We gathered meteorological data from Copernicus, the European Union's Earth Observation Programme. More specifically, we used the E-OBS, a daily gridded land-only observational dataset over Europe.[3] We downloaded meteorological data with a horizontal grid resolution of 0.25° on daily temperature (average, maximum and minimum),[4] precipitation amount, and wind speed from 1 January 2008 until 31 December 2021.

We obtained data on work-related accidents from INAIL,[5] to which the employers

[2] See https://climate.copernicus.eu/esotc/2021/globe-in-2021.

[3] For more details see https://cds.climate.copernicus.eu/cdsapp#!/dataset/insitu-gridded-observations-europe?tab=overview (last accessed on October 3rd, 2022).

[4] Daily mean, maximum, and minimum temperatures are dry bulb temperatures and measured 2 meters above ground level.

[5] (https://dati.inail.it/opendata/default/Daticadenzasemestrale/index.html, last accessed on October 3rd,

must report work-related accidents causing injuries which cannot be healed within three days. The INAIL dataset therefore contains all declared work-related injuries – both at the workplace and while commuting – that cause more than three days of absence from work.[6] After dropping accidents involving persons younger than 16, we collapsed the number of accidents by province and day over the observed time window and divided it by the number of people at work in that year derived from the National Institute of Statistics (Istat).[7] We therefore computed daily provincial accident rates per 100,000 workers. We also derived the same statistics by gender, sector, severity of the injury measured by the number of days of absence of the injured worker, and by whether the accident occurred at the workplace or while commuting.

We matched the meteorological data with provincial accident rates by using the latitude and longitude of the provincial capital. Hence, we used the meteorological conditions in the 0.25° $\times$ 0.25° latitude/longitude square where the provincial capital is located as an approximation of the conditions in the whole province.[8] After matching the two main data sources, we removed the days of national public holidays in Italy and those days in summer and during the Christmas period when workers are typically not at work.[9] The final sample was made up of 480,294 observations, coming from 106 provinces observed for a maximum of 4,624 days.

Descriptive statistics on work-related accident rates are set out in Figure A.1 and Table A.1, whereas Table A.2 reports the daily average temperature over the 24 hours after collapsing the data by province and date. On average, the daily provincial accident rate was about 5.6 per 100,000 workers. The fatal accident rate was 1.1 per million workers. These figures diminish to 4.8 and 0.8 if we only focus on workplace accidents. The workplace accident rate was higher for men: it was 5.8 per 100,000 workers for men compared to 3.4 for women. The gender difference was particularly large in terms of fatal workplace accident rates, with the male one (1.28 per million) being almost twelve

2022). Further information on the INAIL data is provided in the final Appendix.

[6]Although employers are not obliged to report work related injuries which can be healed within 3 days, in the administrative data some of these events are present. We excluded them, because they were likely to be a nonrandom sample of the underlying population of less severe injuries.

[7]Yearly provincial time series on employment by gender and sector are downloadable from http://dati.istat.it/ (last accessed on October 3rd, 2022).

[8]A 0.25° $\times$ 0.25° latitude/longitude square corresponds approximately to 27.8 square kilometres.

[9]We removed 25/04, 01/05, 02/06, 01/11, 08/12, and the time span from 23/12 to 06/01 and from 08/08 to 22/08. On those days, the accident rates decreased artificially because the number of people actually at work diminished. Furthermore, these periods are likely to have been affected by an important variation in the employment distribution, with workers mostly concentrated in sectors like tourism.

times higher than the female one (0.11 per million). About 1.5 workplace accidents per 100,000 workers induced an absence from work of more than 30 days. Finally, the highest workplace accident rates are registered in the manufacturing sector.

Like Dillender (2021), we used the deviation in daily temperature from the average temperature in the corresponding month-year-province, conditional on calendar-date fixed effects, to identify the causal effect of temperatures on accidents.[10] Hence our identification strategy ignored seasonal variation in work-related accidents and thus enabled us to avoid spurious correlation between temperatures and injuries. Indeed, over the seasons and across provinces, the kind of job activities performed may vary as the weather conditions change. For example, during the summer season the workforce may be more concentrated in a set of job activities connected to the tourist industry. Consequently, the work-related accident rate may change, and this may happen at the same time in which the temperatures rise, resulting in a spurious correlation. However, we did not identify responses to gradual and systemic changes in temperatures as predicted by the scientific literature on climate change, and our results may have low external validity for processes like global warming (Dell et al., 2014). Although imperfect, our results may be nonetheless useful to assess channels through which climate change may affect employment quality, sustainability of the social insurance system, and labor productivity.

## 3 Econometric model

In the last few years, there has been a rapid growth of the empirical literature that uses data from non-experimental settings to study how weather conditions affect economic outcomes (Dell et al., 2014). In this framework, the most convincing strategy with which to identify the causal effect is based on longitudinal high-frequency data and on short-term variation over time of the weather outcome within a given spatial entity. By exploiting this (plausibly) exogenous variation in weather variables, it is possible to identify the impact of temperatures on outcomes like work-related injuries.

Operationally, we estimated the following linear model

$$y_{it} = f(temp_{it}; \boldsymbol{\beta}) + \boldsymbol{\alpha}\mathbf{x}_{it} + \delta_t + \gamma_{im} + \varepsilon_{it}, \tag{1}$$

where $i = 1, \ldots, 106$ indexes the 106 provinces and $t = 1, \ldots, 4624$ refers to the differ-

[10] Figure A.2 graphically clarifies this identification source.

ent calendar dates in our observed time window; $y_{it}$ is the measure for the work-related accident rates; $\delta_t$ is the calendar-date fixed effects; $\gamma_{im}$ is the month-year-province fixed effects; $f(temp_{it}; \boldsymbol{\beta})$ is a step function of the daily average temperature and $\boldsymbol{\beta}$ is the parameter vector associated with the linear combination of indicators of temperature intervals; $\mathbf{x}_{it}$ is a $1 \times K$ vector of other weather characteristics which are likely to be correlated with both the daily temperature and to the risk of accident; finally, $\varepsilon_{it}$ is the idiosyncratic error term. We weighted each regression by the provincial employment during the year of the observation.

Calendar-date fixed effects $\delta_t$ control for daily shocks common at national level. They are therefore able to purge from estimates the fact that work-related accident rates may vary over particular days of the week, different months of the year, and different years. For example, they account for possible greater absenteeism on "bridging days" (Böheim and Leoni, 2020) or on Mondays and Fridays (Vahtera et al., 2001), which may be correlated to the weather and, at the same time, may affect the accident rate, because absenteeism artificially reduces it.

Month-year-province fixed effects $\gamma_{im}$ capture possible different patterns of labor market conditions and the business cycle across provinces. They enabled us to base the identification strategy on the exogeneity of daily temperature deviation from the month-year average temperature in the corresponding province.

In order not to impose too strict parametric restrictions on $f(temp_{it}; \boldsymbol{\beta})$, we opted for a step function to map the relation between daily average temperatures and work-related accident rates. More precisely, we divided the support of daily average temperatures among equally sized bins of two Celsius degrees, apart from a first bin for daily temperatures below 0°C, and a last one for those above 28°C. We chose the (10,12]°C bin as the reference point, and the corresponding indicator variable was excluded from the set of regressors entering Equation (1).

The vector $\mathbf{x}_{it}$ contained the constant term, a dummy for dry days (i.e. days with no precipitation), precipitation amount, wind speed, and their quadratic and cubic polynomials.

Finally, the idiosyncratic error term may be correlated within both calendar date $t$ and province $i$. The former correlation may be due to the fact that, when there are anomalous heat or cold waves on particular days, they often affect large areas, generating correlation across observations on those anomalous days. In regard to the latter correlation, each local area has its own features in terms of geography, climate, infrastructures, employment, and production structure. We therefore suspected that observations were not independent over time within a province. Hence, when estimating the variance-covariance matrix, we used the two-way cluster variance estimator proposed by Cameron et al. (2011). The number of clusters was sufficiently large in both dimensions, since in our sample we had 106 provinces and 4,624 calendar dates.

# 4 Estimation results

## 4.1 Main findings

Our main findings are reported in Figures 1–8, which display the estimated coefficients of each temperature bin, along with their 95% confidence intervals. The full set of estimation results are instead reported in the Appendix.

Panel a) of Figure 1 shows that the work-related injury rate increases with both cold and warm temperatures. A daily average temperature lower than 0°C (of 0-2°C) significantly increases the work-related accident rate by 0.727 (0.378) per 100,000 workers, relatively to a day with an average temperature of 10-12°C. With respect to the sample average work-related accident rate (5.63), this is an approximately 13% increase. The lowest work-related accident rate is registered when daily average temperatures are between 4 and 6°C. When they are above 16°C, we detect a significant and increasing positive impact of temperatures on the injury rate. When the daily average temperatures are above 28°C, the injury rate per 100,000 workers is 0.426 points higher than the reference (10-12°C). This effect is about 7.5% of the sample average. Panel b) of Figure 1 reports the impact of temperatures on the fatal accident rate. It shows that warmer temperatures result in higher fatal injury rates. With a daily average temperature above 28°C, the fatal injury rate per 100,000 workers is higher than that at the reference (10-12°C) by 0.004 points, which is about 38% of the sample average.

Several mechanisms may explain these findings. On the one hand, hotter temperatures create greater risks of physiological traumas like heat stroke, exhaustion, and respiratory failure. On the other hand, colder temperatures may cause low energy, muscle strains, and falls. More in general, the effect of extreme temperatures on occupational health may operate through different channels, such as workers' lower reaction capacities, cognitive performance, and concentration (Graff Zivin et al., 2018); compromised decision-making abilities (Heyes and Saberian, 2019); higher physical and mental stress (Heal and Park, 2016); perceived fatigue and energy outlays (Deschênes and Greenstone, 2011); increased costs of safety investments for both workers and firms (Park et al., 2021); or just because some jobs become more dangerous amid extreme weather conditions.

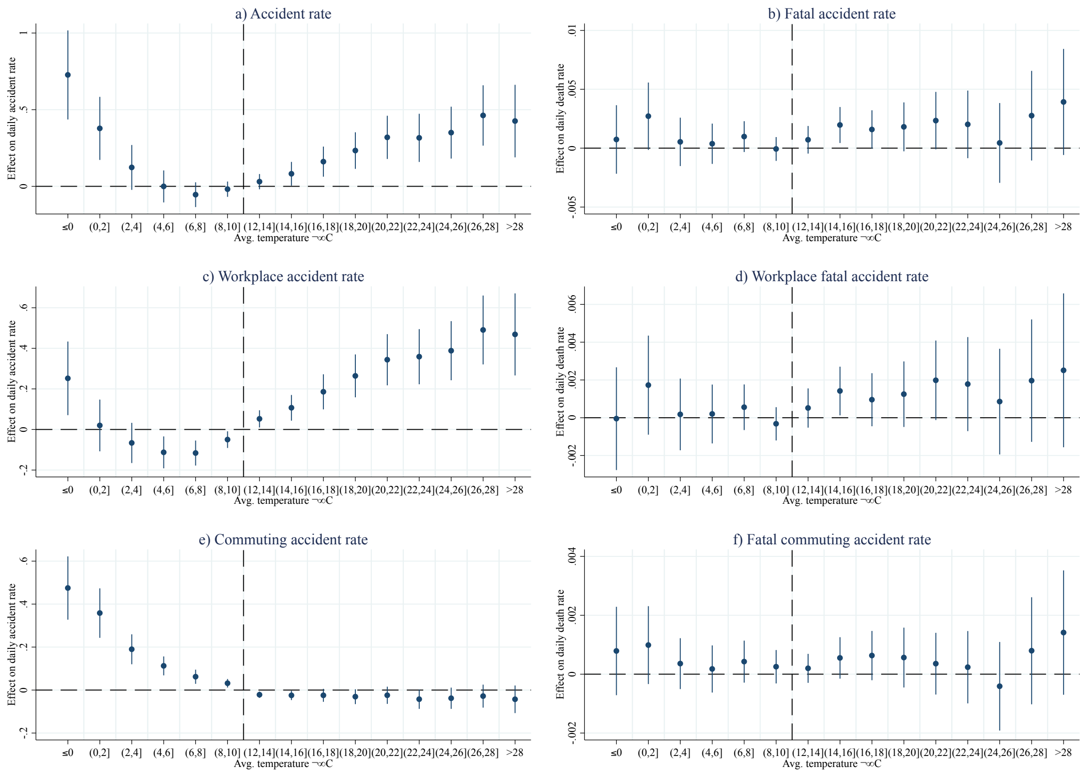
Panels (c) to (f) display estimates of the effects, distinguishing between workplace accidents and commuting injuries. Hot temperatures only impacted on workplace injuries, while cold temperatures are particularly significant for commuting accidents. The former effect may be due to a higher risk of injuries caused by exposure to heat, especially in outdoor workplaces like construction sites (Marinaccio et al., 2019), or in industries which do not provide adequate air-conditioning systems. Furthermore, not all jobs can benefit from climate control, and high temperatures may affect workers' decision-making and impair their cognitive capacities and performances even indoors (Park et al., 2020; Park, 2022). As regards the effect on commuting accidents, extremely low temperatures may strongly affect safety because of dangerous road conditions due, for example, to slipperiness caused by frost and/or rain.

To highlight these possible mechanisms, Figure 2 shows the estimation results after splitting the sample between dry days and days with precipitations. As in Dillender (2021), the temperature effect on the workplace accident rate is not influenced by rain, because the profile of the relation on dry days is very similar to the one on rainy days. The impact of extremely cold temperatures on commuting accidents becomes much more important on rainy days, probably due to the combined effect of frost and rain; when it is rainy and the temperatures are below 0°C, the commuting accident rate per 100,000 workers is 0.810 points higher than the rate on a rainy day with 10-12°C .

## 4.2 Effect heterogeneity

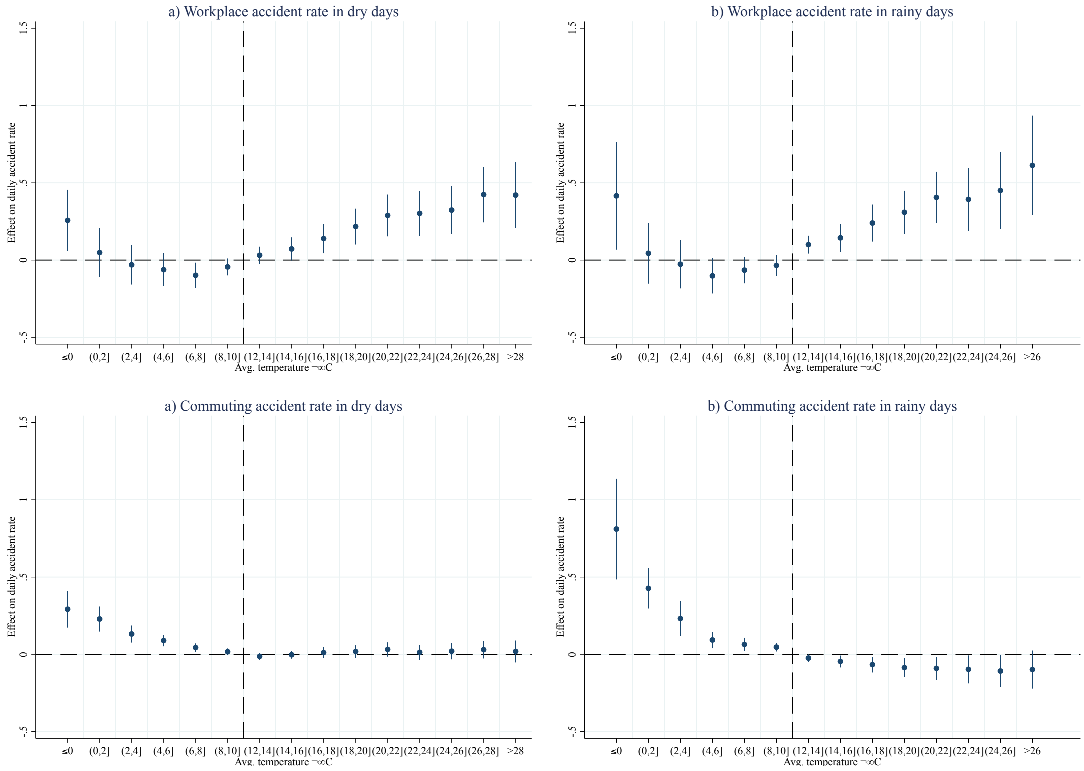
We now focus only on workplace accidents, and we delve further into the issue of effect heterogeneity by exploring whether the effect of extreme temperatures on workplace injuries differs between men and women, by sector, and by injury severity. Gender differences and segregation in occupations and industries are still important (Blau and Kahn, 2017), and they may imply that men and women are employed in workplaces which are differently affected by ambient temperatures. Similarly, since sectors are characterized by different production technologies, employees in them may be differently exposed to ambient temperatures, or they may work in environments which are differently equipped and equippable with systems for climate control. Finally, we checked whether the impact

**Figure 1:** Effect of today's average temperature on today's accident rates, disaggregated by workplace and commuting accidents




*Notes*: The vertical segments are 95% confidence intervals. The vertical dashed lines indicate the reference category (10, 12]°C, whose coefficient is normalized to zero. Each regression is weighted by the provincial employment during the year of the observation.

**Figure 2:** Effect of today's average temperature on today's accident rates, workplace and commuting accidents in dry and rainy days




*Notes*: The vertical segments are 95% confidence intervals. The vertical dashed lines indicate the reference category (10, 12]°C, whose coefficient is normalized to zero. Each regression is weighted by the provincial employment during the year of the observation.

of ambient temperatures is confined to mild workplace accidents or also involves more serious injuries. By doing so, we enriched the analysis reported in the previous subsection, which already provided evidence in terms of fatal injuries.

Figure 3 reports the effect of temperatures on both accident and fatal accident rates by gender. Like Marinaccio et al. (2019), we found that extremely cold temperatures (below 2°C) are especially important for women. By contrast, the male workplace accident rate is more sensitive to heat, and when the temperature is above 28°C, the injury rate per 100,000 workers is almost 0.700 points higher than at 10-12°C. These gender differences in our findings are in line with those reported by Park et al. (2021) and they may be due to the fact that men are more likely to be employed in outdoor jobs, like construction or transport, or physically demanding industrial jobs, which are more likely to cause trauma due to heat stress.

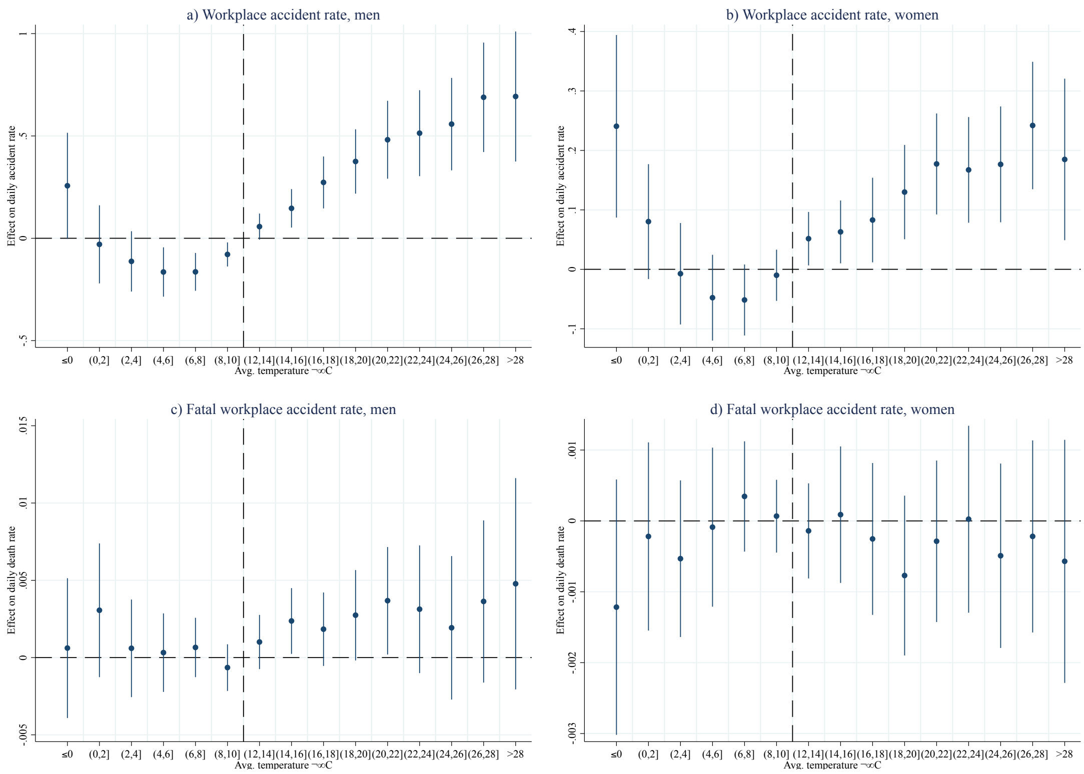
To understand if the type of industry in which workers are employed plays a significant role, we estimated Equation (1) separately for the primary, secondary, and tertiary sectors. Figure 4 displays the estimates for each sector. Extremely hot temperatures similarly affect the workplace accident rate in all sectors. The magnitude of this effect is however the largest in manufacturing, with an increase of about 0.664 accidents per 100,000 workers when the temperature is above 28°C, with respect to the reference temperature. Extremely cold temperatures are relevant only in the service sector. When the temperature is below 0°C, the injury rate per 100,000 workers is 0.303 higher than when the temperature is 10-12°C.

To check whether the severity of injuries is sensitive to cold and warm ambient temperatures, Figure 5 graphically presents the results by the severity of the injuries, measured by the number of days of absence from work caused by the workplace accident. In line with the evidence shown so far that fatal accident rates are marginally affected, we found that temperatures exert an effect on workplace accidents only through less severe injuries. This is true in the case of both cold and warm temperatures.

### 4.3 Quantification of the effect of rising temperatures

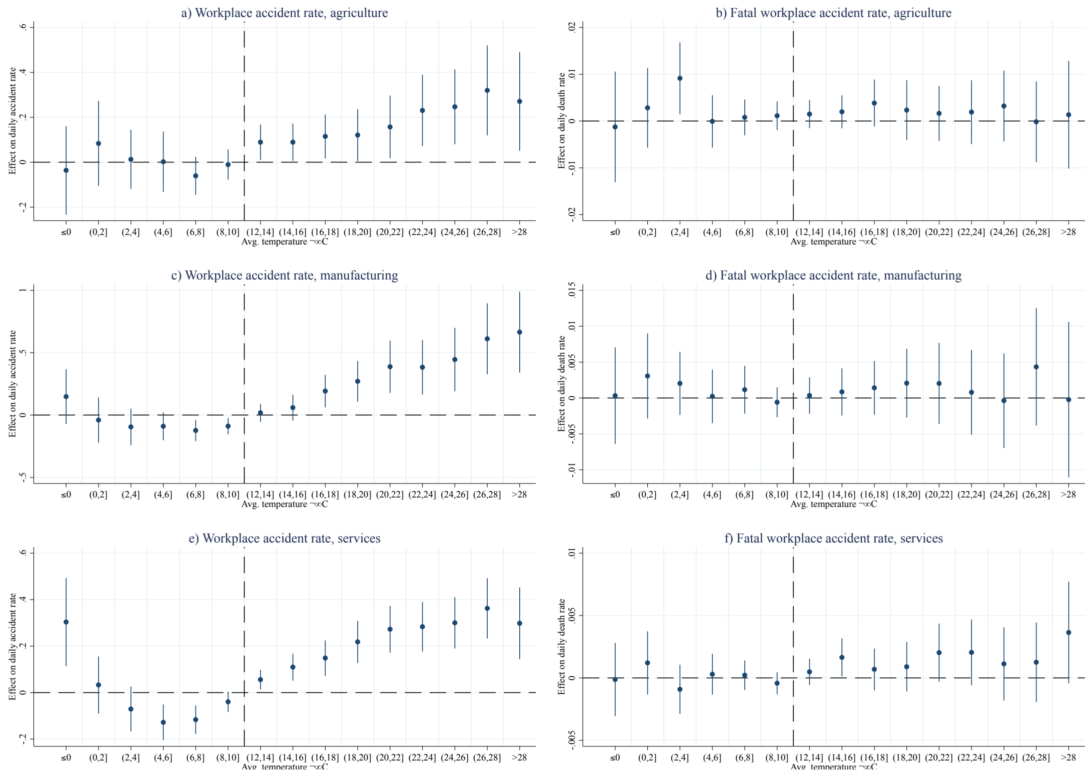
Our estimates suggest that the impact of temperatures on the accident rate is nonlinear, with both cold and warm temperatures creating a higher risk of injuries. Therefore, it is not straightforward to quantify what our findings imply in terms of the impact of rising temperatures on the number of injured workers. To gain a clearer idea about the effect

**Figure 3:** Effect of today's average temperature on today's accident rates, workplace accidents by gender



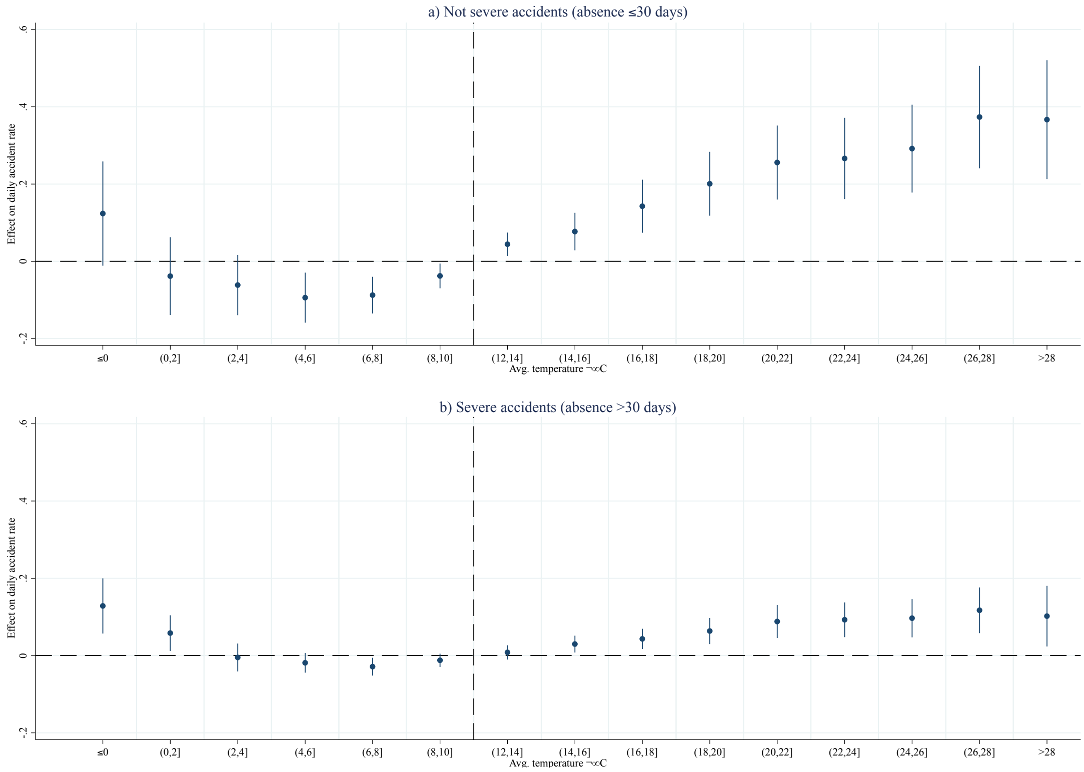

*Notes*: The vertical segments are 95% confidence intervals. The vertical dashed lines indicate the reference category (10, 12]°C, whose coefficient is normalized to zero. Each regression is weighted by the provincial employment by gender during the year of the observation.

**Figure 4:** Effect of today's average temperature on today's accident rates, workplace accidents by sector




*Notes*: The vertical segments are 95% confidence intervals. The vertical dashed lines indicate the reference category (10, 12]°C, whose coefficient is normalized to zero. Each regression is weighted by the provincial employment by sector during the year of the observation.

**Figure 5:** Effect of today's average temperature on today's accident rates, workplace accidents by severity




*Notes*: The vertical segments are 95% confidence intervals. The vertical dashed lines indicate the reference category (10, 12]°C, whose coefficient is normalized to zero. Each regression is weighted by the provincial employment during the year of the observation.

of rising temperatures on work-related accidents, we predicted the accident rates both using actual temperatures and after increasing them by two degrees Celsius, which is the expected increase in average temperatures in Italy for the period 2021–2050 (Spano et al., 2020).

Table 1 reports the predicted impact on the daily accident rate and the number of accidents per year at national level induced by an increase of two degrees Celsius when using 2014 as the reference year, which is the intermediate year of our time window. Moreover, hot temperatures are not only harmful for workers but also costly for firms because workplace accidents reduce labor productivity. In the last column of Table 1, we show the nationwide yearly impact on lost days.[11] An increase by 2°C in daily temperatures would translate, *ceteris paribus*, into a significant yearly increase of about 6,800 work-related accidents and almost 232,000 lost working days. Workplace and commuting accidents would be asymmetrically affected, with a decrease of about 2,000 commuting accidents and an increase of approximately 8,850 workplace accidents, which translate into 263,000 yearly lost days. Furthermore, the impact is markedly different in magnitude between genders, with an yearly increase of about 3,800 workplace accidents for women and of almost 13,000 workplace accidents for men, accounting for more than 450,000 days off work. Focusing on the number of yearly work-related accidents by sector, our estimates predict an increase of about 9,000 workplace injuries per year in manufacturing, while the predicted days lost in manufacturing industries will be more than twice as many as those in the other sectors.

## 4.4 Adaptation, accumulation, acclimation

The significance of the policy implications of our findings in light of climate change depends on whether firms and workers can adapt to changes in temperatures over time (Kahn, 2016; Park et al., 2021). The adaptation hypothesis suggests that the dangerous effect of warmer (colder) temperatures should be smaller in warmer (colder) climates. People who live in historically warmer regions should be more used to coping with extremely hot temperatures than people living in historically colder areas. Investigating whether an adaptive behavior is at work is closely relevant to assessing the importance that climate change and global warming may have in the long run (Kahn, 2016; Connolly,

[11] The full set of estimates of the effect of daily average temperatures on lost days rates per 100,000 workers is available from the authors upon request.

**Table 1:** Prediction of the effect of a 2°C increase in daily average temperatures with respect to 2014 temperatures

| Increase induced by +2°C in: | Daily accident rate | Yearly accidents nationwide | Daily fatal accident rate | Yearly deaths nationwide | Yearly lost days nationwide |
|---|---|---|---|---|---|
| Work related accidents | 0.03849*** | 6,812.191*** | 0.00015 | 26.437 | 232,187.300*** |
| | (0.01043) | (1,788.679) | (0.00019) | (33.093) | (65,799.010) |
| Workplace accidents | 0.05182*** | 8,852.090*** | 0.00014 | 23.894 | 263,224.700*** |
| | (0.00880) | (1,516.659) | (0.00017) | (29.249) | (58,698.570) |
| Commuting accidents | -0.01333*** | -2,039.899*** | 0.00000 | 2.543 | -28,562.15 |
| | (0.00357) | (592.567) | (0.00009) | (15.592) | (28,232.740) |
| Workplace accidents, men | 0.07532*** | 12,618.080*** | 0.00028 | 46.987 | 450,135.000*** |
| | (0.01394) | (2,344.214) | (0.00028) | (47.468) | (84,399.480) |
| Workplace accidents, women | 0.02238*** | 3,864.910*** | 0.00003 | -5.881 | 10,278.920 |
| | (0.00570) | (1,009.467) | (0.00007) | (12.734) | (55,916.520) |
| Workplace accidents, agriculture | 0.03067*** | 2,745.350*** | -0.00006 | 4.417 | 125,898.500** |
| | (0.00985) | (886.382) | (0.00047) | (43.550) | (55,600.900) |
| Workplace accidents, manufacturing | 0.06066*** | 8,829.452*** | 0.00002 | 3.902 | 322,118.200*** |
| | (0.01451) | (2,103.738) | (0.00040) | (58.347) | (97,690.760) |
| Workplace accidents, services | 0.04045*** | 7,300.289*** | 0.00017 | 29.213 | 181,158.900*** |
| | (0.00694) | (1,282.337) | (0.00017) | (30.693) | (56,994.900) |

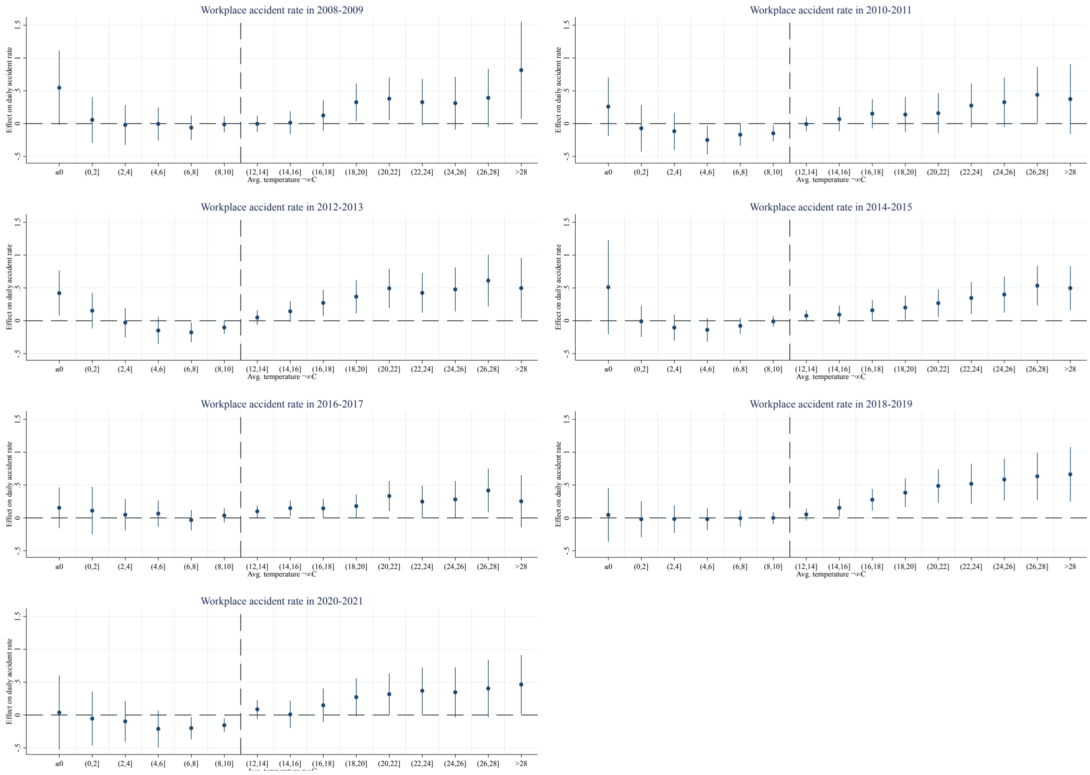
The figures reported in this table were estimated by: i) computing in each province the difference between the predicted accident rates using the actual 2014 temperatures and the predicted accident rates after adding 2°C to the daily average temperatures; ii) averaging over the 2014 sample. The nationwide yearly figures were obtained by multiplying the result of steps i) and ii) by the 2014 employment, the 107 provinces, and the 330 days of 2014. Standard errors are in parentheses and were estimated using the delta method.

2018).

To assess if the adaptation hypothesis is at work in Italy, we performed several empirical exercises. First, to check if Italian workers and firms have been able to adapt to changes in climate conditions over time, we estimated the effect by allowing it to be different over time, as in Park et al. (2021). We divided our sample into 7 groups, one for each two-year period. In the case of adaptation, the impact of temperatures on workplace accidents should decrease over time. The 7 graphs in Figure 6 do not reveal a clear time trend indicating a detrimental effect of hot temperatures. Higher temperatures are particularly harmful between 2010 and 2015 and again in 2018-2019. Such a non-monotonic trend in the heat-sensitivity of the injuries over time may reveal limits of adaptation. However, in the last two-year period the estimated coefficients are very close to zero. This suggests that an adaptation effect to warm temperatures has started in the very last years of our time window. Whether this is actually the case should be confirmed by future empirical investigations.

Second, we split the provinces of our sample between those in the Centre-North and those in the South. The North and the South of Italy are characterised by conspicuous

**Figure 6:** Effect of today's average temperature on today's workplace accident rates over time



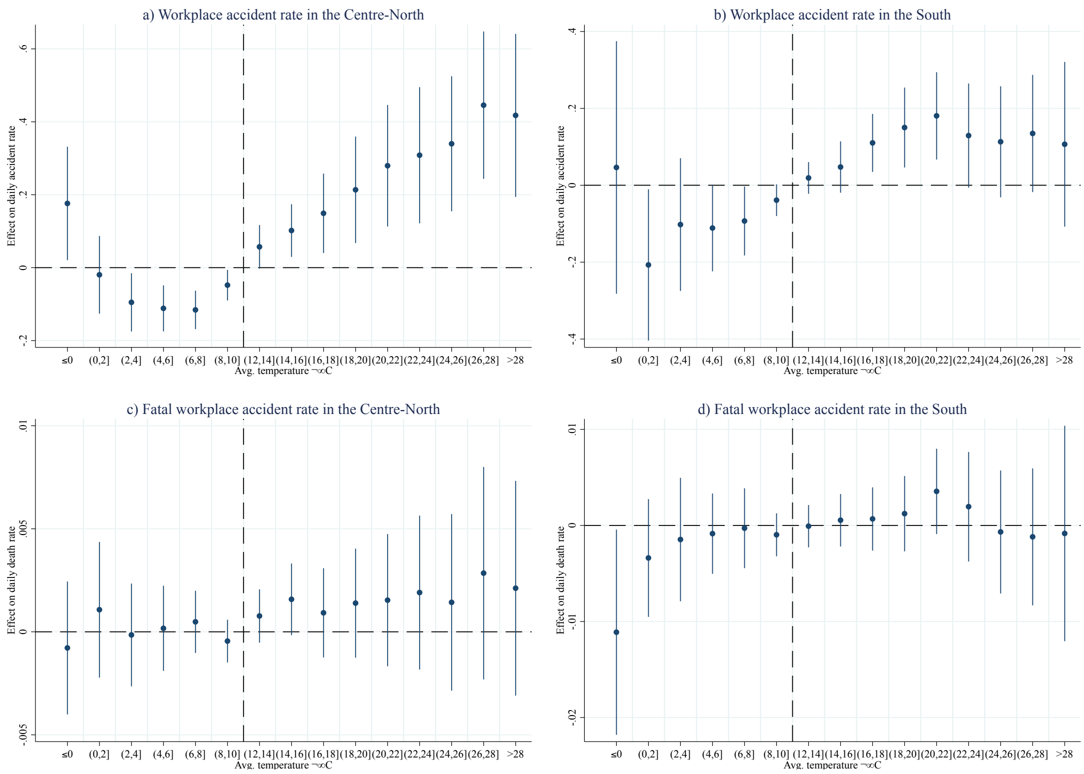

*Notes*: The vertical segments are 95% confidence intervals. The vertical dashed lines indicate the reference category (10, 12]°C, whose coefficient is normalized to zero. Each regression is weighted by the provincial employment during the year of the observation. The 2020-2021 estimates are obtained without using data during the Italian COVID-19 lockdown (March-May 2020).

differences in many socio-economic features and in climate. Questioning this dimension of heterogeneity may provide important evidence in terms of the capacity to adapt to extreme temperatures in different climates. Furthermore, it may be of help to understand if climate change may exacerbate geographical inequalities – for example, if extremely hot temperatures have a stronger effect in the South than in the rest of the country. Figure 7 shows the temperature effect on the workplace accident rate. Graphs (a) and (b) focus on all the workplace injuries in the Centre-North and in the South, respectively. Graphs (c) and (d) report the temperature effect on the fatal injury rate. On comparing graph (a) with graph (b), we realized that the U-shaped relationship between temperatures and workplace accident rates detected at national level is driven by the Centre-North and is almost non-existent in the South. In terms of the North-South economic divide, this finding suggests that climate change should not exacerbate the economic gap between the North and the South of the country when it comes to workplace injuries with their productivity, economic, and health costs. In terms of adaptation, if one considers the Centre-North as a climate area colder than the South, our findings contrast with those of Dillender (2021) for the USA, because we found that in Italy extremely warm temperatures more strongly impacted on the workplace injury rate in the supposedly colder climate provinces. However, our attribution of the colder/warmer climate label to the geographical Centre-North and South may be too rough an approximation of the real climatic features of the two macro regions and may conceal significant climatic heterogeneity within the two macro areas.

Third, to obtain a classification of provinces which was more consistent with their actual climate, we followed Fatima et al. (2021) and used the Köppen-Geiger climate classification (Beck et al., 2018). We distinguished Italian provinces into three different climatic zones: oceanic, humid subtropical, and hot Mediterranean. Figure 8 shows the temperature effect by climatic area. On the one hand, we found that extremely low temperatures increase the injury rate only in humid subtropical climates and reduce it in oceanic climates, supporting the adaptation hypothesis. On the other hand, we found statistically significant evidence that extremely hot temperatures play a role in the warmest and most humid climates, i.e. in hot Mediterranean and humid subtropical climates, a finding which does not confirm the adaptation hypothesis. As in Dillender (2021), we obtained evidence more in line with avoidance behavior where warmer temperatures are rarer, rather than acclimation as a mitigating factor of extreme temperatures.

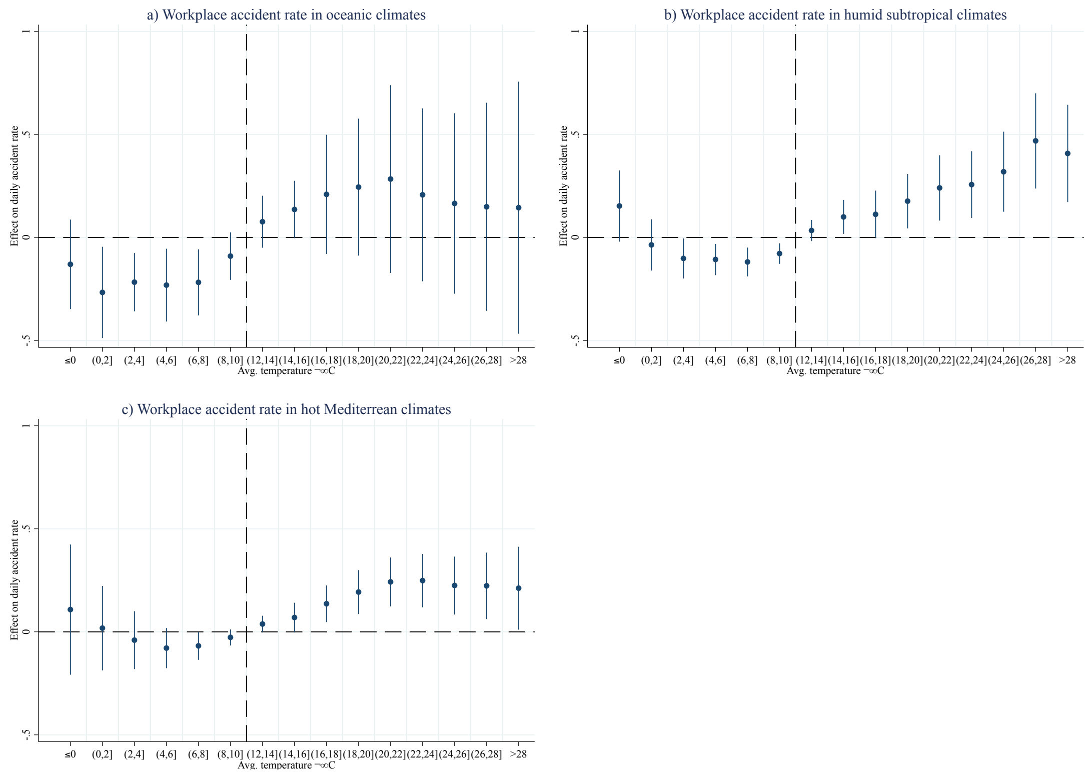
Fourth, to check if the relationship between temperatures and occupational health ac-

**Figure 7:** Effect of today's average temperature on today's accident rates, workplace accidents by geographical area




*Notes*: The vertical segments are 95% confidence intervals. The vertical dashed lines indicate the reference category (10, 12]°C, whose coefficient is normalized to zero. Each regression is weighted by the provincial employment during the year of the observation.

**Figure 8:** Effect of today's average temperature on today's accident rates, workplace accidents by climatic area




*Notes*: The vertical segments are 95% confidence intervals. The vertical dashed lines indicate the reference category (10, 12]°C, whose coefficient is normalized to zero. Each regression is weighted by the provincial employment during the year of the observation.

cumulates over time, as in Helo Sarmiento (2023), we allowed the effect of temperatures up to 3 days previously to affect workplace injury rates at time $t$. Like Helo Sarmiento (2023), we estimated the following equation

$$y_{it} = \sum_{l=0}^{3} f(temp_{it-l}; \boldsymbol{\beta}_l) + \boldsymbol{\alpha}\mathbf{x}_{it} + \delta_t + \gamma_{im} + \varepsilon_{it}, \tag{2}$$

where $\boldsymbol{\beta}_0$ is the effect of today's average temperature on today's accident rates, while the cumulative effect derives from summing all of the estimated coefficients of each temperature bin up to three days before today. Table B.2 in the Appendix displays the estimated parameters of the contemporaneous and lagged step functions, along with the cumulative effects, i.e. the effect of having 4 days in a row with a given temperature bin with respect to the reference temperature bin. The cumulative effect of hot days is significant: the impact of a series of days with warm temperatures on the workplace injury rate which is about one third bigger than that of the baseline model. For the workplace accident rate, the temperature on the previous day especially matters, whereas the lags of order 2 and 3 are not statistically significant.

Finally, to test for acclimation, we investigated the heat-sensitivity of workplace injuries to exposure to the temperature on previous days by interacting the binary indicators of the step function of the daily temperature at time $t$ with either the difference between the temperature at time $t$ and the average temperature in the preceding week or the number of days above 22°C in the previous week, similarly to what Sexton et al. (2022) did.[12] If there is an habituation effect at work, we would expect a positive sign of the interactions for the hottest bins: the warmer the previous week compared to the temperature today, i.e. the smaller the difference from the average temperature of the previous week, the lower the workplace injury rate. Table B.3 reports the estimated coefficients of the interaction terms. In all the models, they are jointly not significantly different from zero. When the dependent variable is the workplace accident rate, some of the bins for hot temperatures interacted with the difference between current temperature and the average temperature in the preceding week are statistically significant at the 5% level and negative. This means that we found some further evidence in favor of accumulation of the effect as in the previous empirical exercise, rather than evidence of acclimation.

[12] We also included among the regressors either the difference between the temperature at time $t$ and the average temperature in the preceding week or the number of days above 22°C in the previous week.

## 4.5 Sensitivity analysis

To assess the robustness of our findings, we performed several sensitivity checks. The corresponding estimation results are set out in the Online Appendix. First, we followed Dillender (2021) and controlled for weather conditions on the days surrounding the calendar date of observation. Thus, we included in the vector of covariates $\mathbf{x}_{it}$ the average temperature, precipitation amount, and wind speed on the previous three days and on the following three days. The results are shown in Table OA.8. They are very similar to the baseline estimates.

Second, we tested if using a different set of fixed effects, and therefore a different local variation of the daily temperatures as plausibly exogenous identifying information, might lead to different findings. We replaced fixed effects defined by the triple interaction among province, month, and year with fixed effects defined by the interaction between province and day of the year. Hence, in this sensitivity analysis we exploited the variation of the provincial temperature on a given day of the year from the 2008-2021 average temperature registered in the same province and on the same day of the year. Table OA.9 shows that the effects of hot temperatures on workplace accident rates are even larger than those from our baseline model.

Third, we replicated the empirical analysis using a different weather data source. Auffhammer et al. (2013) pointed out that, when relying on deviations from averages to identify the impact of weather variables on economic outcomes, one should conduct robustness analysis by using more than one data source. Many gridded weather datasets are constructed on the basis of observed weather conditions acquired from weather stations located with an irregular distribution and density in space. Then, through interpolation techniques, irregular distributed station data are converted into regular distributed (gridded) data. During this process, idiosyncratic measurement errors may arise, leading to attenuation biases (Fisher et al., 2012). We gathered further climatic data from the JRC MARS Meteorological database of the Agri4Cast project,[13] which contains meteorological observations on a daily basis from weather stations interpolated on a 25x25 km grid. The results shown in Table OA.10 are very similar to those obtained when using Copernicus data.

Fourth, we replaced temperature bins with equally sized bins for the Heat Index (HI)

[13]For more information on the JRC MARS Meteorological database, see https://-agri4cast.jrc.ec.europa.eu/dataportal/index.aspx (last accessed on November 7th, 2022).

calculated as in Blazejczyk et al. (2012), which combines air temperature and relative humidity in order to determine a measure of temperature perceived by the human body.[14] Table OA.11 reports these estimation results, which confirm previous findings from our benchmark specifications.

Fifth, to check whether our estimates were mixing seasonal differences with temperature shocks, for example because jobs may be heterogeneous over seasons, we replicated the main estimates using only the warmest months, i.e. from May until October. The results are reported in Table OA.12, and the effects of the warmest temperature bins are very similar to the baseline estimates.

Finally, we assessed the robustness of our findings by switching from the average daily temperature to the maximum daily temperature. The results are reported in Table OA.13, and they lead to the same conclusions as those obtained using average daily temperatures.

# 5 Conclusions

Although economists' interest in global warming has significantly increased in recent years, understanding the causal implications of climate change for health and economic outcomes is a major challenge (Connolly, 2018). Nevertheless, it is of utmost importance to highlight its impact in terms of occupational safety and economic costs, especially in light of a predicted continuous increase in temperatures.

In this article, we have contributed to this growing body of literature by estimating the causal effect of ambient temperatures on work-related accident rates in Italy during the period 2008-2021. For this purpose, we matched daily meteorological data with daily information on work-related injuries. Exploiting an identification strategy based on short-term variations of local daily temperatures, we obtained evidence that work-related accident rates increase with both cold and warm temperatures. On the one hand, hot temperatures are significantly harmful in terms of workplace injuries, in particular for men and for workers employed in the manufacturing and service sectors. On the other hand, extremely cold temperatures increase the commuting accident rate, especially during rainy days. We tried to quantify the economic significance of our results by predicting the variation in the number of injuries and lost work days induced by a 2°C increase in daily average temperatures. We found that a 2°C rise in daily average temperatures generates

[14] The HI corresponds to the daily temperature when the latter is below 20°C.

an increase in the number of lost work days especially for men and in the manufacturing sector (respectively +450,000 and +322,000 lost days per year at national level).

In addition, we investigated if workers and firms have been able to adapt to increasingly warmer temperatures and if increasing temperatures may exacerbate North-South economic inequalities in Italy. We did not find evidence for a decreasing trend over time in the heat-sensitivity of the injury rate. Moreover, when splitting provinces into climatic areas, we found that hotter temperatures play a role in warmer and more humid climates, a finding which does not support the hypothesis that acclimation has been a mitigating factor of extreme temperatures. When analyzing the presence of cumulative effects, we found that a series of hot days exacerbates the impact on workplace accident rates. The temperature effects are stronger in the Centre-North of Italy and almost absent in the South, suggesting that climate change should not exacerbate the economic gap between the North and the South of the country, at least in terms of workplace injuries and their associated productivity, economic, and health costs.

Our results highlight the importance of relevant firms and policy measures aimed at safeguarding workplace safety, occupational health, and labor productivity in case of rising temperatures. Different means may be employed to adapt to a changing climate. First, firms may allow a greater flexibility in working hours through mandatory pauses during the hottest hours, a reduction of working time, or greater turnover throughout the day. For example, shifting outdoor activities to cooler times of the day may be particularly helpful for outdoor workers, who are directly exposed to heat-related stress and have fewer options to adapt to extreme temperatures. Second, Park et al. (2021) pointed out that possible limits to adaptation may be not physical but endogenous to workers and firms' investments. Inefficient ventilation and temperature control in the workplace and the lack of mandatory safety regulations are likely to exacerbate the harmful impact of hot temperatures on workplace safety and labor productivity. Policy-makers should subsidize investments in technologies and mandate workplace safety standards to prevent work-related injuries being caused by exposure to extreme temperatures.

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# Appendix

## A. Data and summary statistics

INAIL is the Italian national agency monitoring work-related illness and injury and managing the mandatory insurance scheme against work-related accidents. The INAIL data do not include accidents involving some special categories of workers, like firemen, policemen, servicemen and journalists, because they are covered by other insurers. The INAIL data provide information like the day of the accident, the Italian province in which the accident took place, some information on the injured person (like gender and age), some administrative and health features of the injury and degree of impairment, some firm characteristics (like sector), and if the accident was at the workplace or while commuting. Thus, this dataset makes it possible to distinguish between accidents involving or not involving a means of transport. In this paper we have used the term 'workplace accident' to refer to those accidents which are strictly work related, i.e. which did not happen while the worker is commuting. Among the 'workplace accidents', therefore, we included both those involving a means of transport and those not involving one. About 95% of the workplace accidents did not involve a means of transport. After matching the meteorological data with provincial accident rates by using the latitude and longitude of the provincial capital, the final sample was made up of 480,294 observations, coming from 106 provinces observed for a maximum of 4,624 days.[15]

Table A.1 shows descriptive statistics of work-related accident rates after collapsing the data by province, and Figure A.1 depicts the variability of the accident rates and fatal accident rates across Italian provinces during the observed time-window. Table A.2 reports descriptive statistics about the daily average temperature over the 24 hours after the data have been collapsed by province and date.[16] The mean of the daily average temperature is about 14.5°C. After splitting its support among 16 (almost) equally spaced bins, the mode is the interval (12°C, 14°C], in which 9.3% of the observations lie. Fewer

[15]We could not use data for the province of Brindisi, because information about the wind speed was missing. Moreover, the meteorological data were not available on all the days of the observed time window for the following provinces: Matera, Catanzaro, Reggio di Calabria, Trapani, Palermo, Messina, Agrigento, Caltanisetta, Enna, Catania, Ragusa, Siracusa, and Vibo Valentia. They had between 3,913 and 4,623 daily observations instead of 4,624. Finally, the INAIL data for the province of Sud Sardegna are only available from 2013 (2,972 daily records).

[16]For 3,098 observations, the average daily temperature was either below the minimum temperature or above the maximum temperature. In these cases, we replaced the original value with the midpoint between the maximum and minimum daily temperature.

than 5% of the observations corresponds to a daily average temperature higher than 26°C.

**Figure A.1:** Work related daily accident rates per 100,000 workers averaged over 2008–2021

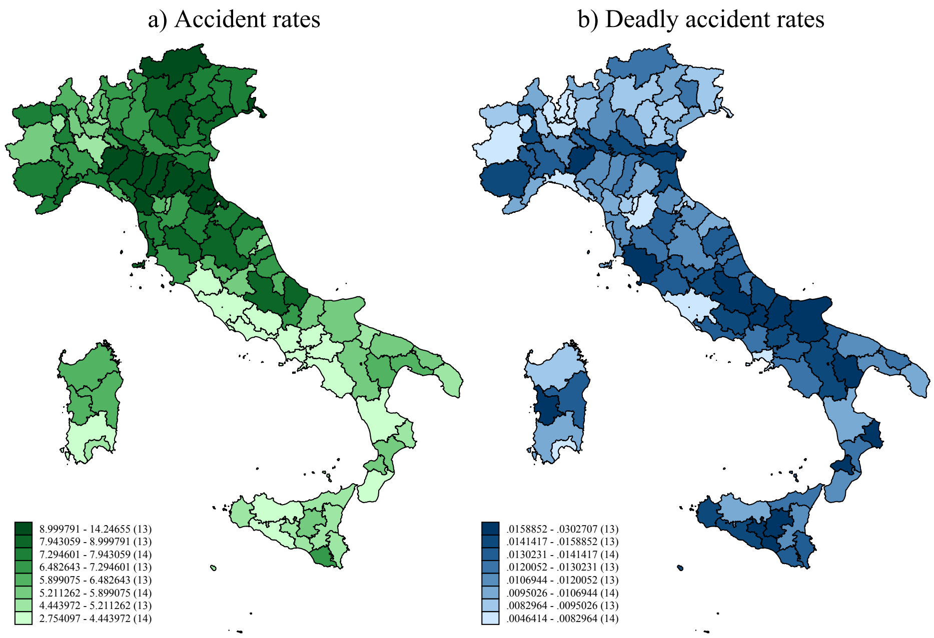



Figure A.2 graphically clarifies the identification source, focusing on both the whole sample (Figure A.2a) and four selected provinces, the most populated ones, in a particular month of our time window (Figure A.2b).

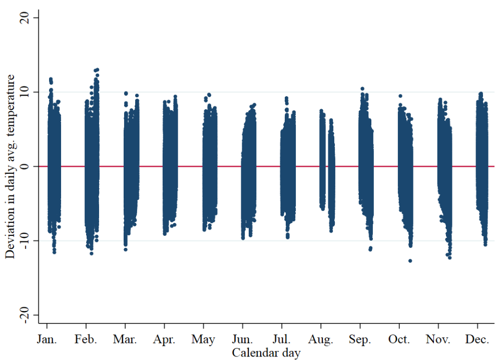
**Table A.1:** Summary statistics of the daily provincial accident rates (per 100,000 workers)

| Rates per 100,000 workers | Average | Std. Dev. | Min. | Max. |
|---|---|---|---|---|
| *a) Overall accident rates* | | | | |
| Accident rate | 5.6338 | 3.7273 | 0.0000 | 95.4481 |
| Deadly accident rate | 0.0106 | 0.0802 | 0.0000 | 9.5422 |
| *b) Accident rates at the workplace or in commuting* | | | | |
| Accident rate in commuting | 0.8449 | 0.9422 | 0.0000 | 65.8059 |
| Accident rate at the workplace | 4.7889 | 3.2322 | 0.0000 | 76.9326 |
| Deadly accident rate in commuting | 0.0027 | 0.0367 | 0.0000 | 6.6251 |
| Deadly accident rate at the workplace | 0.0079 | 0.0709 | 0.0000 | 9.5422 |
| *c) Workplace accident rates by gender* | | | | |
| Workplace accident rate for men | 5.8129 | 4.3557 | 0.0000 | 91.5783 |
| Workplace accident rate for women | 3.3524 | 2.8908 | 0.0000 | 107.2784 |
| Deadly workplace accident rate for men | 0.0128 | 0.1153 | 0.0000 | 9.1709 |
| Deadly workplace accident rate for women | 0.0011 | 0.0430 | 0.0000 | 13.1449 |
| *d) Workplace accident rates by seriousness of the consequences* | | | | |
| Severe workplace accident rate[(a)] | 1.4881 | 1.2339 | 0.0000 | 42.8736 |
| Not severe workplace accident rate | 3.3008 | 2.4355 | 0.0000 | 46.7318 |
| *e) Workplace accident rates by sector* | | | | |
| Workplace accident rate in agriculture | 1.0503 | 5.7589 | 0.0000 | 1,785.7140 |
| Workplace accident rate in manufacturing | 6.3672 | 5.6239 | 0.0000 | 115.3403 |
| Workplace accident rate in services | 4.3637 | 3.0382 | 0.0000 | 93.5793 |
| Deadly workplace accident rate in agriculture | 0.0033 | 0.3165 | 0.0000 | 934.5794 |
| Deadly workplace accident rate in manufacturing | 0.0120 | 0.1674 | 0.0000 | 45.7875 |
| Deadly workplace accident rate in services | 0.0063 | 0.0768 | 0.0000 | 13.7781 |
| # of observations | | | | 480,294 |
| # of days | | | | 4,624 |
| # of provinces | | | | 106 |

*Notes:* Summary statistics are weighed by the provincial employment.
[(a)] We defined as "severe" those accidents which caused a number of days of absence from work equal to or more than 30.

**Figure A.2:** Deviation in the daily temperature from the average temperature in the corresponding month-year-province

**(a)** All years and all provinces




**(b)** The 4 most populated provinces, July 2013

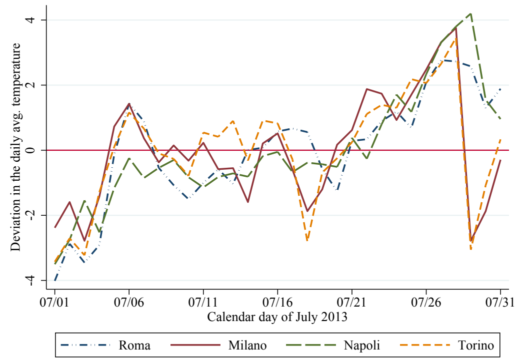


**Table A.2:** Summary statistics of daily average temperatures collapsed by province and day

| | Mean | Std. Dev | Min. | Max. |
|---|---|---|---|---|
| Daily average temperature | 14.5143 | 7.2898 | -18.9500 | 35.6200 |
| Fraction of days below 0°C | 0.0160 | 0.1255 | 0.0000 | 1.0000 |
| Fraction of days (0,2]°C | 0.0255 | 0.1578 | 0.0000 | 1.0000 |
| Fraction of days (2,4]°C | 0.0415 | 0.1995 | 0.0000 | 1.0000 |
| Fraction of days (4,6]°C | 0.0556 | 0.2292 | 0.0000 | 1.0000 |
| Fraction of days (6,8]°C | 0.0685 | 0.2525 | 0.0000 | 1.0000 |
| Fraction of days (8,10]°C | 0.0836 | 0.2768 | 0.0000 | 1.0000 |
| Fraction of days (10,12]°C | 0.0924 | 0.2896 | 0.0000 | 1.0000 |
| Fraction of days (12,14]°C | 0.0931 | 0.2906 | 0.0000 | 1.0000 |
| Fraction of days (14,16]°C | 0.0903 | 0.2867 | 0.0000 | 1.0000 |
| Fraction of days (16,18]°C | 0.0858 | 0.2801 | 0.0000 | 1.0000 |
| Fraction of days (18,20]°C | 0.0812 | 0.2732 | 0.0000 | 1.0000 |
| Fraction of days (20,22]°C | 0.0796 | 0.2707 | 0.0000 | 1.0000 |
| Fraction of days (22,24]°C | 0.0769 | 0.2665 | 0.0000 | 1.0000 |
| Fraction of days (24,26]°C | 0.0641 | 0.2449 | 0.0000 | 1.0000 |
| Fraction of days (26,28]°C | 0.0343 | 0.1819 | 0.0000 | 1.0000 |
| Fraction of days above 28°C | 0.0114 | 0.1061 | 0.0000 | 1.0000 |
| # of observations | | | | 480,294 |

# B. Further estimation results

**Table B.1:** Estimation results of the main model used to draw Figure 1

| | Accident rate (1) | Workplace accident rate (2) | Commuting accident rate (3) | Fatal accident rate (4) | Fatal workplace accident rate (5) | Fatal commuting accident rate (6) |
|---|---|---|---|---|---|---|
| *Temperature - Reference: (10,12]°C* | | | | | | |
| ≤0°C | 0.72679*** | 0.25208*** | 0.47471*** | 0.00074 | -0.00005 | 0.00079 |
| | (0.14650) | (0.09155) | (0.07425) | (0.00147) | (0.00137) | (0.00076) |
| (0, 2]°C | 0.37796*** | 0.01980 | 0.35817*** | 0.00271* | 0.00173 | 0.00099 |
| | (0.10372) | (0.06432) | (0.05803) | (0.00144) | (0.00132) | (0.00067) |
| (2, 4]°C | 0.12337* | -0.06640 | 0.18977*** | 0.00053 | 0.00018 | 0.00036 |
| | (0.07381) | (0.04995) | (0.03512) | (0.00104) | (0.00096) | (0.00044) |
| (4, 6]°C | -0.00042 | -0.11285*** | 0.11243*** | 0.00037 | 0.00020 | 0.00018 |
| | (0.05258) | (0.03961) | (0.02217) | (0.00086) | (0.00079) | (0.00040) |
| (6, 8]°C | -0.05428 | -0.11622*** | 0.06194*** | 0.00098 | 0.00056 | 0.00043 |
| | (0.04074) | (0.03107) | (0.01663) | (0.00066) | (0.00061) | (0.00036) |
| (8, 10]°C | -0.01841 | -0.05008** | 0.03167*** | -0.00007 | -0.00032 | 0.00025 |
| | (0.02520) | (0.02069) | (0.01006) | (0.00051) | (0.00044) | (0.00029) |
| (12, 14]°C | 0.03056 | 0.05234** | -0.02179*** | 0.00071 | 0.00051 | 0.00020 |
| | (0.02510) | (0.02133) | (0.00730) | (0.00059) | (0.00052) | (0.00025) |
| (14, 16]°C | 0.08198** | 0.10678*** | -0.02479** | 0.00197** | 0.00142** | 0.00055 |
| | (0.03910) | (0.03190) | (0.01096) | (0.00077) | (0.00065) | (0.00036) |
| (16, 18]°C | 0.16112*** | 0.18564*** | -0.02452 | 0.00158* | 0.00095 | 0.00063 |
| | (0.04951) | (0.04359) | (0.01515) | (0.00082) | (0.00071) | (0.00042) |
| (18, 20]°C | 0.23336*** | 0.26420*** | -0.03084* | 0.00181* | 0.00125 | 0.00056 |
| | (0.06017) | (0.05330) | (0.01738) | (0.00105) | (0.00087) | (0.00051) |
| (20, 22]°C | 0.31957*** | 0.34385*** | -0.02428 | 0.00234* | 0.00198* | 0.00036 |
| | (0.07106) | (0.06363) | (0.02011) | (0.00123) | (0.00106) | (0.00053) |
| (22, 24]°C | 0.31633*** | 0.35887*** | -0.04253* | 0.00202 | 0.00178 | 0.00024 |
| | (0.07922) | (0.06852) | (0.02267) | (0.00145) | (0.00126) | (0.00062) |
| (24, 26]°C | 0.35030*** | 0.38837*** | -0.03806 | 0.00044 | 0.00085 | -0.00041 |
| | (0.08535) | (0.07348) | (0.02494) | (0.00171) | (0.00141) | (0.00076) |
| (26, 28]°C | 0.46235*** | 0.49059*** | -0.02824 | 0.00276 | 0.00196 | 0.00080 |
| | (0.09929) | (0.08558) | (0.02693) | (0.00192) | (0.00163) | (0.00092) |
| >28°C | 0.42580*** | 0.46872*** | -0.04291 | 0.00392* | 0.00251 | 0.00141 |
| | (0.11926) | (0.10197) | (0.03237) | (0.00227) | (0.00205) | (0.00106) |
| Dry day | -0.00068 | 0.01835 | -0.01903** | -0.00001 | -0.00002 | 0.00001 |
| | (0.01839) | (0.01348) | (0.00849) | (0.00049) | (0.00040) | (0.00025) |
| Precipitation (mm) | 0.00797*** | -0.00199 | 0.00996*** | -0.00006 | -0.00002 | -0.00004 |
| | (0.00288) | (0.00224) | (0.00134) | (0.00009) | (0.00006) | (0.00006) |
| Precipitation$^2$ | -0.00842 | 0.00366 | -0.01207*** | 0.00029 | 0.00016 | 0.00013 |
| | (0.00675) | (0.00595) | (0.00309) | (0.00028) | (0.00017) | (0.00019) |
| Precipitation$^3$ | -0.00084 | -0.00576** | 0.00493** | 0.00001 | -0.00007 | 0.00008 |
| | (0.00311) | (0.00283) | (0.00213) | (0.00016) | (0.00009) | (0.00012) |
| Wind speed (m/s) | -0.00497 | -0.02863 | 0.02365 | 0.00038 | -0.00041 | 0.00079* |
| | (0.03159) | (0.02827) | (0.01709) | (0.00106) | (0.00085) | (0.00043) |
| Wind speed$^2$ | 0.22210 | 0.72560 | -0.50351 | -0.01305 | 0.00628 | -0.01933* |
| | (0.77962) | (0.76802) | (0.38325) | (0.02562) | (0.02032) | (0.01027) |
| Wind speed$^3$ | -0.38188 | -3.57537 | 3.1935 | 0.02917 | -0.06725 | 0.09642 |
| | (5.38715) | (5.64600) | (2.56967) | (0.16249) | (0.13953) | (0.05816) |
| # of observations | 480,294 | 480,294 | 480,294 | 480,294 | 480,294 | 480,294 |
| # of calendar dates | 4,624 | 4,624 | 4,624 | 4,624 | 4,624 | 4,624 |
| # of provinces | 106 | 106 | 106 | 106 | 106 | 106 |
| Adj. E-Square | 0.72087 | 0.7071 | 0.37854 | 0.007666 | 0.0065491 | 0.005707 |

* $p$-value$<$0.10, ** $p$-value$<$0.05, *** $p$-value$<$0.01. Two-way clustered standard errors are in parenthesis; clusters are at the level of calendar dates and of provinces. All the models contain calendar date fixed effects and month-year-province fixed effects. Each regression is weighted by the provincial employment during the year of the observation.

**Table B.2:** Lagged effects and cumulative effect of temperature on workplace accident rate

| | Workplace accident rate | | | | | Fatal workplace accident rate | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Current $\beta_0$ | Lag 1 $\beta_1$ | Lag 2 $\beta_2$ | Lag 3 $\beta_3$ | Cumulative $\sum_{l=0}^{3}\beta_l$ | Current $\beta_0$ | Lag 1 $\beta_1$ | Lag 2 $\beta_2$ | Lag 3 $\beta_3$ | Cumulative $\sum_{l=0}^{3}\beta_l$ |
| *Temperature - Reference: (10,12]°C* | | | | | | | | | | |
| ≤0°C | 0.14119* | 0.13130 | 0.04218 | 0.15901* | 0.47368*** | -0.00044 | 0.00241 | -0.00313 | 0.00025 | -0.00092 |
| | (0.08451) | (0.09268) | (0.08555) | (0.08887) | (0.14785) | (0.00154) | (0.002) | (0.00205) | (0.00183) | (0.00195) |
| (0,2]°C | -0.01481 | 0.03241 | 0.00416 | -0.01128 | 0.01049 | 0.00111 | 0.00201 | -0.00135 | 0.00029 | 0.00206 |
| | (0.06604) | (0.06959) | (0.06798) | (0.06381) | (0.09304) | (0.00144) | (0.00151) | (0.00143) | (0.00132) | (0.00166) |
| (2,4]°C | -0.06699 | -0.01659 | -0.00950 | -0.00633 | -0.09941 | -0.00038 | 0.00128 | 0.0002 | -0.00044 | 0.00066 |
| | (0.0531) | (0.05793) | (0.05139) | (0.05377) | (0.07436) | (0.00107) | (0.00129) | (0.00131) | (0.00098) | (0.00141) |
| (4,6]°C | -0.10851** | 0.01286 | -0.01123 | -0.03061 | -0.13749** | -0.00024 | 0.00117 | -0.00014 | -0.00114 | -0.00035 |
| | (0.04302) | (0.04653) | (0.04094) | (0.0419) | (0.06117) | (0.00087) | (0.00091) | (0.00105) | (0.00085) | (0.00125) |
| (6,8]°C | -0.10876*** | -0.00258 | -0.00521 | 0.00099 | -0.11556** | 0.0004 | 0.00036 | 0.00019 | -0.0006 | 0.00035 |
| | (0.03319) | (0.03388) | (0.03024) | (0.0344) | (0.05450) | (0.00067) | (0.00075) | (0.00086) | (0.00072) | (0.00105) |
| (8,10]°C | -0.04174* | -0.00935 | -0.00868 | 0.02928 | -0.03049 | -0.00031 | 0.00012 | -0.00046 | -0.00036 | -0.00102 |
| | (0.02155) | (0.02169) | (0.01935) | (0.02319) | (0.03376) | (0.00044) | (0.00055) | (0.00054) | (0.00058) | (0.00085) |
| (12,14]°C | 0.03742* | 0.04430** | 0.01195 | -0.03699* | 0.05667 | 0.00039 | 0.00058 | -0.00026 | -0.0004 | 0.00031 |
| | (0.02151) | (0.02108) | (0.0202) | (0.02223) | (0.03510) | (0.00053) | (0.00047) | (0.00061) | (0.00065) | (0.00104) |
| (14,16]°C | 0.07909** | 0.07640** | 0.01305 | -0.06886* | 0.09968** | 0.00132* | 0.00075 | -0.00087 | -0.00127 | -0.00008 |
| | (0.03361) | (0.03119) | (0.02974) | (0.03576) | (0.04898) | (0.0007) | (0.00067) | (0.00074) | (0.00077) | (0.00107) |
| (16,18]°C | 0.15338*** | 0.08211** | 0.01862 | -0.07214* | 0.18198*** | 0.00101 | 0.00051 | -0.0004 | -0.00166* | -0.00054 |
| | (0.04569) | (0.03885) | (0.03775) | (0.0386) | (0.06134) | (0.00078) | (0.00099) | (0.00096) | (0.00092) | (0.00132) |
| (18,20]°C | 0.22287*** | 0.11091** | 0.00978 | -0.05776 | 0.28580*** | 0.00144 | -0.00004 | 0.0005 | -0.00219* | -0.00029 |
| | (0.05691) | (0.04676) | (0.04396) | (0.04733) | (0.06852) | (0.00099) | (0.00117) | (0.00107) | (0.00113) | (0.00163) |
| (20,22]°C | 0.29274*** | 0.11659** | 0.01772 | -0.04677 | 0.38029*** | 0.00228** | -0.00049 | 0.00065 | -0.00272** | -0.00027 |
| | (0.0691) | (0.05295) | (0.04924) | (0.05295) | (0.07799) | (0.00115) | (0.00133) | (0.00129) | (0.0013) | (0.00186) |
| (22,24]°C | 0.29474*** | 0.12893** | 0.04261 | -0.05942 | 0.40686*** | 0.00202 | -0.00043 | 0.00133 | -0.00333** | -0.00041 |
| | (0.07519) | (0.05788) | (0.0563) | (0.05834) | (0.08453) | (0.00144) | (0.00139) | (0.00135) | (0.00139) | (0.00192) |
| (24,26]°C | 0.30133*** | 0.18288*** | 0.06839 | -0.06858 | 0.48402*** | 0.00083 | 0.00011 | 0.00081 | -0.00309** | -0.00134 |
| | (0.07784) | (0.06445) | (0.06367) | (0.063) | (0.09660) | (0.0016) | (0.00157) | (0.00154) | (0.00149) | (0.00218) |
| (26,28]°C | 0.39275*** | 0.19427*** | 0.06795 | -0.06807 | 0.58690*** | 0.00174 | 0.00012 | 0.00062 | -0.00232 | 0.00015 |
| | (0.08671) | (0.07247) | (0.07619) | (0.07157) | (0.11719) | (0.00181) | (0.00184) | (0.00178) | (0.00154) | (0.00236) |
| >28°C | 0.38700*** | 0.18980** | 0.01860 | -0.05207 | 0.54334*** | 0.00107 | 0.00297 | 0.00173 | -0.00367* | 0.00210 |
| | (0.11333) | (0.09176) | (0.09082) | (0.08488) | (0.12548) | (0.00222) | (0.00244) | (0.00251) | (0.00205) | (0.00345) |
| Joint significance test $\beta_1 = \beta_2 = \beta_3 = 0$, $p$-value | | | 0.0998 | | | | | 0.0204 | | |
| Joint significance test $\beta_2 = \beta_3 = 0$, $p$-value | | | 0.4958 | | | | | 0.0990 | | |
| Joint significance test $\beta_1 = 0$, $p$-value | | | 0.0747 | | | | | 0.7286 | | |
| # of observations | | | 480,294 | | | | | 480,294 | | |
| # of calendar dates | | | 4,624 | | | | | 4,624 | | |
| # of provinces | | | 106 | | | | | 106 | | |
| Adj. R-Square | | | 0.7072 | | | | | 0.0065 | | |

* $p$-value$<$0.10, ** $p$-value$<$0.05, *** $p$-value$<$0.01. Two-way clustered standard errors are in parenthesis; clusters are at the level of calendar dates and of provinces. The model contain calendar date fixed effects, month-year-province fixed effects, a dummy for dry days, precipitation amount, wind speed, and their quadratic and cubic polynomials. The full set of estimation results are available from the authors upon request. Each regression is weighted by the provincial employment during the year of the observation. The standard errors of the cumulative effects in the last column are estimated by the delta method.

**Table B.3:** Interactions among temperature bins and either the difference from the average temperature of the previous week or the number of days above 22°C in the previous week

| | Interaction with the difference from the average temperature of the previous week | | Interaction with the number of days above 22°C in the previous week | |
|---|---|---|---|---|
| | Workplace accident rate (1) | Fatal workplace accident rate (2) | Workplace accident rate (3) | Fatal workplace accident rate (4) |
| *Temperature - Reference: (10,12]°C* | | | | |
| ≤0°C | 0.00999 | -0.00066* | -0.04987 | -0.00134 |
| | (0.02593) | (0.00037) | (0.05215) | (0.00111) |
| (0,2]°C | 0.01545 | -0.00034 | -0.01505 | -0.00132 |
| | (0.01852) | (0.00036) | (0.03141) | (0.00079) |
| (2,4]°C | 0.01199 | -0.00007 | -0.04350* | -0.00134* |
| | (0.01501) | (0.00031) | (0.02315) | (0.00071) |
| (4,6]°C | 0.00472 | 0.00002 | -0.03001 | -0.00110 |
| | (0.01275) | (0.00028) | (0.02354) | (0.00075) |
| (6,8]°C | 0.00936 | 0.00007 | -0.01526 | -0.00048 |
| | (0.01141) | (0.00021) | (0.02119) | (0.00076) |
| (8,10]°C | -0.00341 | -0.00029 | -0.01016 | -0.00043 |
| | (0.00753) | (0.00020) | (0.01856) | (0.00080) |
| (12,14]°C | -0.00401 | 0.00007 | -0.00399 | -0.00098 |
| | (0.00797) | (0.00022) | (0.02326) | (0.00078) |
| (14,16]°C | -0.01489 | 0.00017 | 0.02178 | -0.00141* |
| | (0.01148) | (0.00026) | (0.03413) | (0.00072) |
| (16,18]°C | -0.01322 | 0.00014 | 0.04650 | -0.00084 |
| | (0.01218) | (0.00024) | (0.03536) | (0.00076) |
| (18,20]°C | -0.02179* | -0.00022 | 0.04193 | -0.00045 |
| | (0.01270) | (0.00029) | (0.03634) | (0.00076) |
| (20,22]°C | -0.03236** | -0.00016 | 0.04437 | -0.00050 |
| | (0.01449) | (0.00033) | (0.03673) | (0.00072) |
| (22,24]°C | -0.03641** | 0.00031 | 0.04482 | -0.00093 |
| | (0.01526) | (0.00033) | (0.03709) | (0.00072) |
| (24,26]°C | -0.04154** | -0.00003 | 0.04159 | -0.00054 |
| | (0.01728) | (0.00039) | (0.03828) | (0.00077) |
| (26,28]°C | -0.01942 | -0.00030 | 0.00943 | -0.00055 |
| | (0.01950) | (0.00055) | (0.04146) | (0.00100) |
| >28°C | -0.04244 | 0.00201 | 0.06549 | -0.00109 |
| | (0.02897) | (0.00141) | (0.06335) | (0.00202) |
| Difference from average temperature of previous week | 0.00917 | 0.00012 | | |
| | (0.01043) | (0.00019) | | |
| Number of days above 22°C previous week | | | -0.02250 | 0.00070 |
| | | | (0.03611) | (0.00075) |
| Joint significance test of interactions, $p$-value | 0.3971 | 0.1938 | 0.4363 | 0.0899 |
| # of observations | 411,755 | 411,755 | 480,294 | 480,294 |
| # of calendar dates | 3,966 | 3,966 | 4,624 | 4,624 |
| # of provinces | 106 | 106 | 106 | 106 |
| Adj. R-Square | 0.70719 | 0.0068362 | 0.70712 | 0.0065433 |

* $p$-value$<$0.10, ** $p$-value$<$0.05, *** $p$-value$<$0.01. Two-way clustered standard errors are in parenthesis; clusters are at the level of calendar dates and of provinces. All the models contain temperature bins, calendar date fixed effects, month-year-province fixed effects, a dummy for dry days, precipitation amount, wind speed, and their quadratic and cubic polynomials. The full set of estimation results are available from the authors upon request. Each regression is weighted by the provincial employment during the year of the observation.

# Online Appendix

## OA.1 Heterogeneity analysis

**Table OA.1:** Estimation results used to draw Figure 2

| | Workplace accident rate in dry days (1) | Workplace accident rate in rainy days (2) | Commuting accident rate in dry days (3) | Commuting accident rate in rainy days (4) |
|---|---|---|---|---|
| *Temperature - Reference: (10,12]°C* | | | | |
| ≤0°C | 0.25675** | 0.41560** | 0.29173*** | 0.81048*** |
| | (0.10007) | (0.17561) | (0.05992) | (0.16435) |
| (0, 2]°C | 0.04851 | 0.04384 | 0.22844*** | 0.42675*** |
| | (0.07965) | (0.09897) | (0.04094) | (0.06567) |
| (2, 4]°C | -0.03082 | -0.02678 | 0.13143*** | 0.23129*** |
| | (0.06422) | (0.07889) | (0.02790) | (0.05701) |
| (4, 6]°C | -0.06217 | -0.10210* | 0.08902*** | 0.09256*** |
| | (0.05362) | (0.05751) | (0.01871) | (0.02689) |
| (6, 8]°C | -0.09863** | -0.06507 | 0.04351*** | 0.06371*** |
| | (0.04144) | (0.04300) | (0.01375) | (0.02202) |
| (8, 10]°C | -0.04431 | -0.03493 | 0.01685 | 0.04637*** |
| | (0.02765) | (0.03363) | (0.01083) | (0.01409) |
| (12, 14]°C | 0.03095 | 0.10006*** | -0.01357 | -0.02457** |
| | (0.02819) | (0.02913) | (0.01130) | (0.01233) |
| (14, 16]°C | 0.07209* | 0.14384*** | -0.00292 | -0.04637** |
| | (0.03788) | (0.04604) | (0.01275) | (0.01946) |
| (16, 18]°C | 0.13909*** | 0.23969*** | 0.01109 | -0.06674** |
| | (0.04790) | (0.06051) | (0.01769) | (0.02558) |
| (18, 20]°C | 0.21689*** | 0.30915*** | 0.01786 | -0.08608*** |
| | (0.05857) | (0.07038) | (0.02044) | (0.03121) |
| (20, 22]°C | 0.28881*** | 0.40544*** | 0.03135 | -0.09102** |
| | (0.06830) | (0.08380) | (0.02339) | (0.03757) |
| (22, 24]°C | 0.30204*** | 0.39262*** | 0.01256 | -0.09749** |
| | (0.07370) | (0.10293) | (0.02413) | (0.04572) |
| (24, 26]°C | 0.32327*** | 0.45016*** | 0.01999 | -0.10819** |
| | (0.07828) | (0.12570) | (0.02650) | (0.05272) |
| (26, 28]°C (>26°C for rainy days) | 0.42378*** | 0.61246*** | 0.03005 | -0.09853 |
| | (0.09062) | (0.16265) | (0.02867) | (0.06220) |
| >28°C | 0.42043*** | | 0.01851 | |
| | (0.10719) | | (0.03577) | |
| Precipitation (mm) | | -0.00071 | | 0.01218*** |
| | | (0.00215) | | (0.00166) |
| Precipitation$^2$ | | 0.00408 | | -0.01696*** |
| | | (0.00611) | | (0.00355) |
| Precipitation$^3$ | | -0.00646** | | 0.00682*** |
| | | (0.00302) | | (0.00231) |
| Wind speed (m/s) | -0.02558 | -0.05843 | 0.00909 | 0.01842 |
| | (0.03125) | (0.04511) | (0.01384) | (0.03271) |
| Wind speed$^2$ | 0.70956 | 1.35151 | -0.35037 | -0.33436 |
| | (0.77792) | (1.10328) | (0.33705) | (0.68176) |
| Wind speed$^3$ | -5.28449 | -5.45894 | 3.88600 | 1.67367 |
| | (6.01909) | (7.25098) | (2.49909) | (3.95388) |
| # of observations | 333,578 | 145,861 | 333,578 | 145,861 |
| # of calendar dates | 4,587 | 3,841 | 4,587 | 3,841 |
| # of provinces | 106 | 106 | 106 | 106 |
| Adj. R-Square | 0.70960 | 0.71362 | 0.41109 | 0.37583 |

* $p$-value$<$0.10, ** $p$-value$<$0.05, *** $p$-value$<$0.01. Two-way clustered standard errors are in parenthesis; clusters are at the level of calendar dates and of provinces. All the models contain calendar date fixed effects and month-year-province fixed effects. Each regression is weighted by the provincial employment during the year of the observation.

**Table OA.2:** Estimation results by gender used to draw Figure 3

| | Workplace accident rate (Men) (1) | Fatal workplace accident rate (Men) (2) | Workplace accident rate (Women) (3) | Fatal workplace accident rate (Women) (4) |
|---|---|---|---|---|
| *Temperature - Reference: (10,12]°C* | | | | |
| ≤0°C | 0.25655* | 0.00061 | 0.24059*** | -0.00122 |
| | (0.13057) | (0.00228) | (0.07743) | (0.00091) |
| (0,2]°C | -0.02969 | 0.00306 | 0.08023 | -0.00022 |
| | (0.09619) | (0.00218) | (0.04873) | (0.00067) |
| (2,4]°C | -0.11294 | 0.00060 | -0.00741 | -0.00053 |
| | (0.07433) | (0.00159) | (0.04300) | (0.00056) |
| (4,6]°C | -0.16487*** | 0.00032 | -0.04774 | -0.00009 |
| | (0.06077) | (0.00128) | (0.03639) | (0.00057) |
| (6,8]°C | -0.16419*** | 0.00065 | -0.05157* | 0.00034 |
| | (0.04654) | (0.00097) | (0.03011) | (0.00039) |
| (8,10]°C | -0.07900*** | -0.00065 | -0.01004 | 0.00007 |
| | (0.02969) | (0.00076) | (0.02171) | (0.00026) |
| (12,14]°C | 0.05699* | 0.00101 | 0.05154** | -0.00014 |
| | (0.03210) | (0.00088) | (0.02269) | (0.00034) |
| (14,16]°C | 0.14629*** | 0.00237** | 0.06294** | 0.00009 |
| | (0.04736) | (0.00107) | (0.02665) | (0.00049) |
| (16,18]°C | 0.27294*** | 0.00183 | 0.08289** | -0.00025 |
| | (0.06396) | (0.00120) | (0.03587) | (0.00054) |
| (18,20]°C | 0.37525*** | 0.00274* | 0.12990*** | -0.00077 |
| | (0.07927) | (0.00147) | (0.04000) | (0.00057) |
| (20,22]°C | 0.48139*** | 0.00368** | 0.17723*** | -0.00029 |
| | (0.09594) | (0.00175) | (0.04282) | (0.00057) |
| (22,24]°C | 0.51359*** | 0.00313 | 0.16719*** | 0.00002 |
| | (0.10596) | (0.00208) | (0.04482) | (0.00067) |
| (24,26]°C | 0.55794*** | 0.00193 | 0.17654*** | -0.00049 |
| | (0.11388) | (0.00234) | (0.04915) | (0.00066) |
| (26,28]°C | 0.68883*** | 0.00363 | 0.24188*** | -0.00022 |
| | (0.13489) | (0.00265) | (0.05403) | (0.00068) |
| >28°C | 0.69285*** | 0.00478 | 0.18481*** | -0.00057 |
| | (0.16019) | (0.00345) | (0.06850) | (0.00086) |
| Dry days | 0.03246 | -0.00016 | 0.00088 | 0.00020 |
| | (0.02019) | (0.00067) | (0.01439) | (0.00019) |
| Precipitation (mm) | -0.00973*** | -0.00006 | 0.00857*** | 0.00002 |
| | (0.00304) | (0.00009) | (0.00230) | (0.00004) |
| Precipitation$^2$ | 0.01340* | 0.00031 | -0.00994 | -0.00004 |
| | (0.00766) | (0.00027) | (0.00692) | (0.00010) |
| Precipitation$^2$ | -0.00977** | -0.00014 | 0.00003 | 0.00002 |
| | (0.00383) | (0.00014) | (0.00280) | (0.00005) |
| Wind speed (m/s) | -0.02807 | -0.00094 | -0.02771 | 0.00042 |
| | (0.04094) | (0.00143) | (0.02760) | (0.00039) |
| Wind speed$^2$ | 0.71663 | 0.01805 | 0.7218 | -0.01278 |
| | (1.04073) | (0.03482) | (0.67585) | (0.00892) |
| Wind speed$^3$ | -3.29516 | -0.14991 | -3.82372 | 0.07175 |
| | (7.30713) | (0.23904) | (4.94226) | (0.05395) |
| # of observations | 480,294 | 480,294 | 480,294 | 480,294 |
| # of calendar dates | 4,624 | 4,624 | 4,624 | 4,624 |
| # of provinces | 106 | 106 | 106 | 106 |
| Adj. R-Square | 0.67228 | 0.00537 | 0.45707 | 6.90E-06 |

* $p$-value<0.10, ** $p$-value<0.05, *** $p$-value<0.01. Two-way clustered standard errors are in parenthesis; clusters are at the level of calendar dates and of provinces. All the models contain calendar date fixed effects and month-year-province fixed effects. Each regression is weighted by the provincial employment by gender during the year of the observation.

**Table OA.3:** Estimation results by sector to draw Figure 4

| | Workplace accident rate in agriculture (1) | Fatal workplace accident rate in agriculture (2) | Workplace accident rate in manufacturing (3) | Fatal workplace accident rate in manufacturing (4) | Workplace accident rate in services (5) | Fatal workplace accident rate in services (6) |
|---|---|---|---|---|---|---|
| *Temperature - Reference: (10,12]°C* | | | | | | |
| ≤0°C | -0.03629 | -0.00126 | 0.14753 | 0.00032 | 0.30343*** | -0.00013 |
| | (0.09930) | (0.00596) | (0.11052) | (0.00339) | (0.09558) | (0.00148) |
| (0,2]°C | 0.08347 | 0.00282 | -0.04054 | 0.00307 | 0.03293 | 0.00120 |
| | (0.09541) | (0.00429) | (0.09158) | (0.00298) | (0.06197) | (0.00127) |
| (2,4]°C | 0.01267 | 0.00914** | -0.09505 | 0.00203 | -0.07069 | -0.00092 |
| | (0.06638) | (0.00387) | (0.07386) | (0.00222) | (0.04885) | (0.00099) |
| (4,6]°C | 0.00216 | -0.00008 | -0.08998 | 0.00022 | -0.12782*** | 0.00029 |
| | (0.06776) | (0.00282) | (0.05664) | (0.00188) | (0.03887) | (0.00082) |
| (6,8]°C | -0.06074 | 0.00078 | -0.12384*** | 0.00115 | -0.11633*** | 0.00021 |
| | (0.04268) | (0.00192) | (0.04323) | (0.00168) | (0.03091) | (0.00060) |
| (8,10]°C | -0.01072 | 0.00113 | -0.08912*** | -0.00060 | -0.03958* | -0.00043 |
| | (0.03386) | (0.00154) | (0.03280) | (0.00105) | (0.02219) | (0.00045) |
| (12,14]°C | 0.08928** | 0.00148 | 0.01806 | 0.00034 | 0.05580** | 0.00048 |
| | (0.03983) | (0.00151) | (0.03610) | (0.00128) | (0.02140) | (0.00053) |
| (14,16]°C | 0.08927** | 0.00197 | 0.05925 | 0.00084 | 0.10964*** | 0.00164** |
| | (0.04163) | (0.00178) | (0.05217) | (0.00166) | (0.02935) | (0.00077) |
| (16,18]°C | 0.11491** | 0.00384 | 0.19170*** | 0.00141 | 0.14860*** | 0.00068 |
| | (0.04938) | (0.00253) | (0.06564) | (0.00188) | (0.03857) | (0.00084) |
| (18,20]°C | 0.12095** | 0.00233 | 0.27026*** | 0.00206 | 0.21807*** | 0.00089 |
| | (0.05826) | (0.00324) | (0.08223) | (0.00241) | (0.04568) | (0.00100) |
| (20,22]°C | 0.15696** | 0.00163 | 0.38746*** | 0.00202 | 0.27257*** | 0.00202* |
| | (0.07056) | (0.00296) | (0.10566) | (0.00284) | (0.05070) | (0.00117) |
| (22,24]°C | 0.23037*** | 0.00191 | 0.38321*** | 0.00079 | 0.28321*** | 0.00204 |
| | (0.07997) | (0.00345) | (0.10992) | (0.00298) | (0.05405) | (0.00133) |
| (24,26]°C | 0.24672*** | 0.00320 | 0.44502*** | -0.00038 | 0.30016*** | 0.00112 |
| | (0.08396) | (0.00383) | (0.12819) | (0.00332) | (0.05568) | (0.00148) |
| (26,28]°C | 0.31976*** | -0.00017 | 0.61104*** | 0.00433 | 0.36235*** | 0.00125 |
| | (0.10093) | (0.00436) | (0.14354) | (0.00412) | (0.06536) | (0.00161) |
| >28°C | 0.27080** | 0.00134 | 0.66437*** | -0.00024 | 0.29812*** | 0.00364* |
| | (0.11084) | (0.00581) | (0.16358) | (0.00546) | (0.07774) | (0.00206) |
| Dry day | 0.00661 | 0.00009 | -0.02003 | -0.00074 | 0.02127 | 0.00018 |
| | (0.02357) | (0.00103) | (0.02770) | (0.00098) | (0.01447) | (0.00037) |
| Precipitation (mm) | -0.00364 | -0.00009 | -0.01400*** | -0.00016 | 0.00346 | 0.00003 |
| | (0.00320) | (0.00013) | (0.00359) | (0.00014) | (0.00231) | (0.00005) |
| Precipitation$^2$ | 0.01210 | 0.00040 | 0.02445** | 0.00056 | -0.00511 | 0.00001 |
| | (0.00966) | (0.00049) | (0.01020) | (0.00040) | (0.00679) | (0.00016) |
| Precipitation$^3$ | -0.00619 | -0.00024 | -0.01892*** | -0.00017 | -0.00142 | -0.00002 |
| | (0.00464) | (0.00026) | (0.00583) | (0.00028) | (0.00284) | (0.00008) |
| Wind speed (m/s) | 0.00848 | -0.00023 | -0.03506 | 0.00061 | -0.03031 | -0.00083 |
| | (0.03253) | (0.00223) | (0.04397) | (0.00202) | (0.02812) | (0.00080) |
| Wind speed$^2$ | -0.17797 | -0.01118 | 0.81863 | -0.02250 | 0.75255 | 0.01772 |
| | (0.88970) | (0.04432) | (1.20420) | (0.05589) | (0.76329) | (0.01697) |
| Wind speed$^3$ | 0.52481 | 0.05404 | -3.00029 | 0.10286 | -4.05948 | -0.13574 |
| | (5.47765) | (0.25018) | (9.75095) | (0.46011) | (5.58541) | (0.10208) |
| # of observations | 478,310 | 478,310 | 480,294 | 480,294 | 480,294 | 480,294 |
| # of calendar dates | 4,624 | 4,624 | 4,624 | 4,624 | 4,624 | 4,624 |
| # of provinces | 106 | 106 | 106 | 106 | 106 | 106 |
| Adj. R-Square | 0.22079 | -0.006007 | 0.61660 | 0.0009625 | 0.58559 | 0.0059564 |

* $p$-value$<$0.10, ** $p$-value$<$0.05, *** $p$-value$<$0.01. Two-way clustered standard errors are in parenthesis; clusters are at the level of calendar dates and of provinces. All the models contain calendar date fixed effects and month-year-province fixed effects. Each regression is weighted by the provincial employment by sector during the year of the observation.

**Table OA.4:** Estimation results by injury severity used to draw Figure 5

| | Workplace accident rate absence < 30 days (1) | Workplace accident rate absence $\geq$ 30 days (2) |
|---|---|---|
| *Temperature - Reference: (10,12]°C* | | |
| $\leq$0°C | 0.12364* | 0.12845*** |
| | (0.06810) | (0.03602) |
| (0,2]°C | -0.03831 | 0.05811** |
| | (0.05083) | (0.02328) |
| (2,4]°C | -0.06149 | -0.00491 |
| | (0.03926) | (0.01819) |
| (4,6]°C | -0.09402*** | -0.01882 |
| | (0.03266) | (0.01280) |
| (6,8]°C | -0.08749*** | -0.02873** |
| | (0.02392) | (0.01159) |
| (8,10]°C | -0.03776** | -0.01232 |
| | (0.01611) | (0.00867) |
| (12,14]°C | 0.04422*** | 0.00813 |
| | (0.01526) | (0.00930) |
| (14,16]°C | 0.07706*** | 0.02972*** |
| | (0.02444) | (0.01095) |
| (16,18]°C | 0.14256*** | 0.04308*** |
| | (0.03464) | (0.01324) |
| (18,20]°C | 0.20069*** | 0.06351*** |
| | (0.04167) | (0.01703) |
| (20,22]°C | 0.25577*** | 0.08808*** |
| | (0.04830) | (0.02154) |
| (22,24]°C | 0.26621*** | 0.09265*** |
| | (0.05302) | (0.02266) |
| (24,26]°C | 0.29166*** | 0.09671*** |
| | (0.05728) | (0.02493) |
| (26,28]°C | 0.37341*** | 0.11717*** |
| | (0.06682) | (0.02981) |
| >28°C | 0.36672*** | 0.10200** |
| | (0.07761) | (0.03953) |
| Dry day | 0.01955* | -0.00121 |
| | (0.01070) | (0.00544) |
| Precipitation (mm) | 0.00032 | -0.00230*** |
| | (0.00181) | (0.00087) |
| Precipitation$^2$ | -0.00191 | 0.00556** |
| | (0.00474) | (0.00244) |
| Precipitation$^3$ | -0.00153 | -0.00423*** |
| | (0.00216) | (0.00133) |
| Wind speed (m/s) | -0.03028 | 0.00166 |
| | (0.02146) | (0.01397) |
| Wind speed$^2$ | 0.73722 | -0.01162 |
| | (0.52876) | (0.37713) |
| Wind speed$^3$ | -3.68159 | 0.10622 |
| | (3.57389) | (3.02566) |
| # of observations | 480,294 | 480,294 |
| # of calendar dates | 4,624 | 4,624 |
| # of provinces | 106 | 106 |
| Adj. R-Square | 0.66956 | 0.43932 |

* $p$-value<0.10, ** $p$-value<0.05, *** $p$-value<0.01. Two-way clustered standard errors are in parenthesis; clusters are at the level of calendar dates and of provinces. All the models contain calendar date fixed effects and month-year-province fixed effects. Each regression is weighted by the provincial employment during the year of the observation.

## OA.2 Adaptation, accumulation, acclimation

**Table OA.5:** Estimation results by two-year periods used to draw Figure 6

| | Workplace accident rate (2008-2009) (1) | Workplace accident rate (2010-2011) (2) | Workplace accident rate (2012-2013) (3) | Workplace accident rate (2014-2015) (4) | Workplace accident rate (2016-2017) (5) | Workplace accident rate (2018-2019) (6) | Workplace accident rate (2020-2021) (7) |
|---|---|---|---|---|---|---|---|
| *Temperature - Reference: (10,12]°C* | | | | | | | |
| ≤0°C | 0.54648* | 0.25920 | 0.42130** | 0.51076 | 0.15349 | 0.04430 | 0.03707 |
| | (0.28449) | (0.22376) | (0.17384) | (0.36117) | (0.15662) | (0.20672) | (0.28483) |
| (0,2]°C | 0.05702 | -0.07124 | 0.15351 | -0.00904 | 0.10995 | -0.02050 | -0.05498 |
| | (0.17552) | (0.17992) | (0.13628) | (0.12049) | (0.18196) | (0.13881) | (0.20743) |
| (2,4]°C | -0.01986 | -0.11564 | -0.02923 | -0.10453 | 0.04780 | -0.01764 | -0.09706 |
| | (0.15375) | (0.14329) | (0.11302) | (0.10021) | (0.120779) | (0.10577) | (0.15674) |
| (4,6]°C | -0.00424 | -0.24956** | -0.14797 | -0.13881 | 0.06507 | -0.01930 | -0.21170 |
| | (0.12663) | (0.11105) | (0.10440) | (0.09026) | (0.10144) | (0.08553) | (0.14011) |
| (6,8]°C | -0.06122 | -0.16862* | -0.17702** | -0.07748 | -0.03406 | -0.00508 | -0.19971** |
| | (0.09386) | (0.08656) | (0.07606) | (0.06135) | (0.07812) | (0.06376) | (0.08562) |
| (8,10]°C | -0.01163 | -0.14736** | -0.10230** | -0.01001 | 0.03590 | -0.00101 | -0.15565*** |
| | (0.06106) | (0.06149) | (0.04961) | (0.04141) | (0.05558) | (0.04512) | (0.05315) |
| (12,14]°C | -0.00332 | -0.00667 | 0.04962 | 0.07686* | 0.09948** | 0.05154 | 0.08666 |
| | (0.06220) | (0.05448) | (0.05639) | (0.04256) | (0.04685) | (0.04612) | (0.07244) |
| (14,16]°C | 0.01409 | 0.06880 | 0.14343* | 0.09351 | 0.14781** | 0.15295** | 0.00863 |
| | (0.08835) | (0.09329) | (0.07933) | (0.07054) | (0.05956) | (0.06902) | (0.10536) |
| (16,18]°C | 0.12404 | 0.15152 | 0.27221*** | 0.15928** | 0.14442** | 0.27584*** | 0.14817 |
| | (0.11712) | (0.11194) | (0.10095) | (0.07868) | (0.07227) | (0.08349) | (0.12937) |
| (18,20]°C | 0.32539** | 0.13778 | 0.36688*** | 0.20069** | 0.17857** | 0.38342*** | 0.27178* |
| | (0.14530) | (0.13439) | (0.12811) | (0.09187) | (0.08903) | (0.11017) | (0.14651) |
| (20,22]°C | 0.38012** | 0.15905 | 0.49347*** | 0.26871** | 0.33236*** | 0.48645*** | 0.31653* |
| | (0.16465) | (0.15478) | (0.15205) | (0.10720) | (0.11576) | (0.12996) | (0.16017) |
| (22,24]°C | 0.32739* | 0.27543 | 0.42458*** | 0.34754*** | 0.24777** | 0.51841*** | 0.36910** |
| | (0.17888) | (0.16910) | (0.15251) | (0.12280) | (0.12333) | (0.15435) | (0.17918) |
| (24,26]°C | 0.31152 | 0.32656* | 0.47779*** | 0.39957*** | 0.28074** | 0.58392*** | 0.34590* |
| | (0.20216) | (0.19008) | (0.16941) | (0.13883) | (0.14117) | (0.16199) | (0.19260) |
| (26,28]°C | 0.39246* | 0.43842** | 0.61164*** | 0.53518*** | 0.41667** | 0.63187*** | 0.40383* |
| | (0.22269) | (0.21403) | (0.19794) | (0.15172) | (0.16795) | (0.18272) | (0.21957) |
| >28°C | 0.81384** | 0.37382 | 0.49730** | 0.49725*** | 0.25248 | 0.66239*** | 0.46431** |
| | (0.37220) | (0.26911) | (0.23254) | (0.16981) | (0.20080) | (0.21046) | (0.22642) |
| Dry day | 0.02175 | 0.06884* | 0.01148 | 0.00790 | 0.01285 | 0.01258 | 0.01160 |
| | (0.04414) | (0.03955) | (0.03729) | (0.02881) | (0.03161) | (0.03065) | (0.04591) |
| Precipitation (mm) | 0.00000 | 0.00551 | -0.00940 | -0.00090 | -0.00925* | 0.00063 | 0.00107 |
| | (0.00684) | (0.00588) | (0.00620) | (0.00397) | (0.00534) | (0.00489) | (0.01125) |
| Precipitation$^2$ | -0.00580 | -0.01986 | 0.02808 | 0.00458 | 0.02019 | -0.00597 | 0.00594 |
| | (0.01785) | (0.01776) | (0.02017) | (0.01089) | (0.01409) | (0.01670) | (0.03987) |
| Precipitation$^3$ | -0.00081 | 0.01208 | -0.01859 | -0.00704 | -0.01080** | 0.00194 | -0.01931 |
| | (0.01087) | (0.01177) | (0.01555) | (0.00551) | (0.00528) | (0.01139) | (0.02663) |
| Wind speed (m/s) | 0.02878 | -0.00531 | -0.01624 | -0.00235 | -0.11004 | 0.07828 | -0.00738 |
| | (0.08394) | (0.09966) | (0.07905) | (0.06263) | (0.06922) | (0.05414) | (0.10360) |
| Wind speed$^2$ | -0.81453 | -0.02680 | -1.68590 | 0.58334 | 3.30785 | -1.32201 | 0.77403 |
| | (2.02746) | (2.73051) | (2.45201) | (1.59110) | (2.05345) | (1.08666) | (2.11402) |
| Wind speed$^3$ | 10.86849 | 3.57282 | 26.86002 | -6.40230 | -26.3542 | 5.99964 | -4.47128 |
| | (15.40036) | (21.77845) | (20.10221) | (12.8083) | (18.08926) | (6.37553) | (11.52715) |
| # of observations | 67,412 | 69,300 | 69,731 | 69,512 | 67,749 | 69,948 | 57,102 |
| # of calendar dates | 661 | 660 | 661 | 660 | 661 | 660 | 571 |
| # of provinces | 102 | 105 | 106 | 106 | 106 | 106 | 106 |
| Adj. R-Square | 0.73558 | 0.70400 | 0.66150 | 0.64862 | 0.64277 | 0.64166 | 0.67686 |

* $p$-value<0.10, ** $p$-value<0.05, *** $p$-value<0.01. Two-way clustered standard errors are in parenthesis; clusters are at the level of calendar dates and of provinces. All the models contain calendar date fixed effects and month-year-province fixed effects. Each regression is weighted by the provincial employment during the year of the observation. The 2020-2021 estimates are obtained without data during the Italian COVID-19 lockdown (March-May 2020).

**Table OA.6:** Estimation results by geographical area used to draw Figure 7

| | Workplace accident rate (Centre-North) (1) | Fatal workplace accident rate (Centre-North) (2) | Workplace accident rate (South) (3) | Fatal workplace accident rate (South) (4) |
|---|---|---|---|---|
| *Temperature - Reference: (10,12]°C* | | | | |
| ≤0°C | 0.17610** | -0.00078 | 0.04632 | -0.01112** |
| | (0.07797) | (0.00162) | (0.16202) | (0.00527) |
| (0,2]°C | -0.01962 | 0.00107 | -0.20719** | -0.00339 |
| | (0.05334) | (0.00165) | (0.09710) | (0.00302) |
| (2,4]°C | -0.09513** | -0.00015 | -0.10228 | -0.00147 |
| | (0.04004) | (0.00125) | (0.08514) | (0.00317) |
| (4,6]°C | -0.11161*** | 0.00017 | -0.11133* | -0.00086 |
| | (0.03161) | (0.00103) | (0.05547) | (0.00206) |
| (6,8]°C | -0.11577*** | 0.00048 | -0.09296** | -0.00029 |
| | (0.02636) | (0.00076) | (0.04419) | (0.00205) |
| (8,10]°C | -0.04799** | -0.00045 | -0.03878* | -0.00098 |
| | (0.02101) | (0.00052) | (0.02032) | (0.00110) |
| (12,14]°C | 0.05713* | 0.00077 | 0.01902 | -0.00008 |
| | (0.02991) | (0.00065) | (0.02033) | (0.00109) |
| (14,16]°C | 0.10181*** | 0.00158* | 0.04744 | 0.00054 |
| | (0.03619) | (0.00087) | (0.03295) | (0.00135) |
| (16,18]°C | 0.14899*** | 0.00092 | 0.11021*** | 0.00067 |
| | (0.05457) | (0.00109) | (0.03718) | (0.00162) |
| (18,20]°C | 0.21349*** | 0.00139 | 0.15016*** | 0.00122 |
| | (0.07316) | (0.00133) | (0.05126) | (0.00193) |
| (20,22]°C | 0.27945*** | 0.00154 | 0.18054*** | 0.00354 |
| | (0.08347) | (0.00161) | (0.05605) | (0.00219) |
| (22,24]°C | 0.30834*** | 0.00190 | 0.12917* | 0.00195 |
| | (0.09357) | (0.00187) | (0.06679) | (0.00281) |
| (24,26]°C | 0.33974*** | 0.00143 | 0.11310 | -0.00068 |
| | (0.09280) | (0.00215) | (0.07123) | (0.00316) |
| (26,28]°C | 0.44550*** | 0.00285 | 0.13471* | -0.00119 |
| | (0.10129) | (0.00258) | (0.07518) | (0.00352) |
| >28°C | 0.41757*** | 0.00211 | 0.10661 | -0.00084 |
| | (0.11204) | (0.00261) | (0.10567) | (0.00553) |
| Dry day | 0.00568 | -0.00025 | -0.00828 | 0.00137 |
| | (0.01566) | (0.00041) | (0.01939) | (0.00122) |
| Precipitation (mm) | 0.00128 | -0.00006 | -0.00404 | 0.00014 |
| | (0.00215) | (0.00006) | (0.00271) | (0.00023) |
| Precipitation$^2$ | -0.00070 | 0.00010 | 0.00892 | 0.00028 |
| | (0.00640) | (0.00016) | (0.00862) | (0.00066) |
| Precipitation$^3$ | -0.00413 | -0.00001 | -0.00719 | -0.00025 |
| | (0.00306) | (0.00011) | (0.00428) | (0.00032) |
| Wind speed (m/s) | -0.06876 | -0.00111 | 0.01267 | 0.00262 |
| | (0.04284) | (0.00088) | (0.03301) | (0.00209) |
| Wind speed$^2$ | 1.83282 | 0.02294 | -0.45880 | -0.04595 |
| | (1.39524) | (0.02104) | (0.58913) | (0.04749) |
| Wind speed$^3$ | -12.51523 | -0.16935 | 4.20085 | 0.17618 |
| | (11.39335) | (0.16676) | (2.99601) | (0.28900) |
| # of observations | 317,686 | 317,686 | 162,608 | 162,608 |
| # of calendar dates | 4,624 | 4,624 | 4,624 | 4,624 |
| # of provinces | 69 | 69 | 37 | 37 |
| Adj. R-Square | 0.73648 | 0.0080984 | 0.58408 | 0.0004912 |

* $p$-value$<$0.10, ** $p$-value$<$0.05, *** $p$-value$<$0.01. Two-way clustered standard errors are in parenthesis; clusters are at the level of calendar dates and of provinces. All the models contain calendar date fixed effects and month-year-province fixed effects. Each regression is weighted by the provincial employment during the year of the observation.

**Table OA.7:** Estimation results by climate area used to draw Figure 8

| | Workplace accident rate (Oceanic climates) (1) | Workplace accident rate (Humid subtropical climates) (2) | Workplace accident rate (Hot mediterranean climates) (3) |
|---|---|---|---|
| *Temperature - Reference: (10,12]°C* | | | |
| ≤0°C | -0.12983 | 0.15323* | 0.10774 |
| | (0.09868) | (0.08605) | (0.15707) |
| (0,2]°C | -0.26623** | -0.03561 | 0.01770 |
| | (0.10061) | (0.06184) | (0.10173) |
| (2,4]°C | -0.21642*** | -0.10119** | -0.04052 |
| | (0.06416) | (0.04841) | (0.06982) |
| (4,6]°C | -0.23082** | -0.10660*** | -0.07908 |
| | (0.08016) | (0.03762) | (0.04840) |
| (6,8]°C | -0.21734** | -0.11834*** | -0.06827** |
| | (0.07278) | (0.03474) | (0.03379) |
| (8,10]°C | -0.09002 | -0.07772*** | -0.02721 |
| | (0.05248) | (0.02483) | (0.01933) |
| (12,14]°C | 0.07677 | 0.03420 | 0.03776* |
| | (0.05729) | (0.02548) | (0.01987) |
| (14,16]°C | 0.13617* | 0.10009** | 0.06916* |
| | (0.06317) | (0.04103) | (0.03564) |
| (16,18]°C | 0.20949 | 0.11262* | 0.13612*** |
| | (0.13148) | (0.05734) | (0.04422) |
| (18,20]°C | 0.24489 | 0.17669*** | 0.19276*** |
| | (0.15098) | (0.06556) | (0.05302) |
| (20,22]°C | 0.28400 | 0.24102*** | 0.24213*** |
| | (0.20711) | (0.07884) | (0.05904) |
| (22,24]°C | 0.20737 | 0.25692*** | 0.24838*** |
| | (0.19061) | (0.08064) | (0.06426) |
| (24,26]°C | 0.16540 | 0.31944*** | 0.22471*** |
| | (0.19900) | (0.09663) | (0.06985) |
| (26,28]°C | 0.14940 | 0.46919*** | 0.22307*** |
| | (0.22949) | (0.11490) | (0.08022) |
| >28°C | 0.14508 | 0.40821*** | 0.21160** |
| | (0.27795) | (0.11731) | (0.09994) |
| Dry day | 0.04039 | -0.01371 | 0.02266 |
| | (0.02384) | (0.01788) | (0.01651) |
| Precipitation (mm) | 0.00558 | -0.00111 | -0.00302 |
| | (0.00512) | (0.00371) | (0.00254) |
| Precipitation$^2$ | -0.00708 | 0.00550 | 0.00715 |
| | (0.01294) | (0.01386) | (0.00718) |
| Precipitation$^3$ | -0.00251 | -0.01085 | -0.00678 |
| | (0.00508) | (0.01114) | (0.00405) |
| Wind speed (m/s) | 0.04569 | -0.04983 | -0.01297 |
| | (0.06395) | (0.04439) | (0.03000) |
| Wind speed$^2$ | -1.90697 | 0.54837 | 0.48533 |
| | (1.47433) | (1.26539) | (0.72808) |
| Wind speed$^3$ | 12.40508 | -0.34562 | -2.14379 |
| | (11.97092) | (11.21945) | (4.69456) |
| # of observations | 50,712 | 219,967 | 209,509 |
| # of calendar dates | 4,624 | 4,624 | 4,624 |
| # of provinces | 12 | 48 | 48 |
| Adj. R-Square | 0.70055 | 0.74746 | 0.62844 |

* $p$-value$<$0.10, ** $p$-value$<$0.05, *** $p$-value$<$0.01. Two-way clustered standard errors are in parenthesis; clusters are at the level of calendar dates and of provinces. All the models contain calendar date fixed effects and month-year-province fixed effects. Each regression is weighted by the provincial employment during the year of the observation.

## OA.3 Sensitivity analysis

**Table OA.8:** Estimation results by including the average temperature, precipitation, wind speed in the previous three days and in the following three days

| | Accident rate (1) | Workplace accident rate (2) | Commuting accident rate (3) | Fatal accident rate (4) | Fatal workplace accident rate (5) | Fatal commuting accident rate (6) |
|---|---|---|---|---|---|---|
| *Temperature - Reference: (10,12]°C* | | | | | | |
| ≤0°C | 0.75404*** | 0.28518*** | 0.46887*** | 0.00019 | -0.00038 | 0.00057 |
| | (0.14453) | (0.08888) | (0.07405) | (0.00158) | (0.00146) | (0.00080) |
| (0, 2]°C | 0.40079*** | 0.04683 | 0.35396*** | 0.0023 | 0.00147 | 0.00083 |
| | (0.11155) | (0.06446) | (0.06622) | (0.00154) | (0.00139) | (0.00069) |
| (2, 4]°C | 0.14390* | -0.04261 | 0.18651*** | 0.0002 | -0.00004 | 0.00024 |
| | (0.07679) | (0.05002) | (0.03949) | (0.00111) | (0.00101) | (0.00045) |
| (4, 6]°C | 0.01536 | -0.09423** | 0.10959*** | 0.00012 | 0.00003 | 0.00009 |
| | (0.05737) | (0.04063) | (0.02705) | (0.00093) | (0.00085) | (0.00041) |
| (6, 8]°C | -0.04423 | -0.10393*** | 0.05970*** | 0.00081 | 0.00044 | 0.00037 |
| | (0.04306) | (0.03155) | (0.01925) | (0.00067) | (0.00063) | (0.00036) |
| (8, 10]°C | -0.01302 | -0.04360** | 0.03058*** | -0.00015 | -0.00038 | 0.00023 |
| | (0.02640) | (0.02106) | (0.01088) | (0.00053) | (0.00046) | (0.00028) |
| (12, 14]°C | 0.02518 | 0.04570** | -0.02052** | 0.00079 | 0.00058 | 0.00021 |
| | (0.02613) | (0.02197) | (0.00824) | (0.00059) | (0.00053) | (0.00024) |
| (14, 16]°C | 0.07142* | 0.09381*** | -0.02239* | 0.00212*** | 0.00154** | 0.00058 |
| | (0.04274) | (0.03429) | (0.01284) | (0.00075) | (0.00064) | (0.00036) |
| (16, 18]°C | 0.14495** | 0.16608*** | -0.02114 | 0.00182** | 0.00115 | 0.00067 |
| | (0.05555) | (0.04799) | (0.01721) | (0.00083) | (0.00072) | (0.00042) |
| (18, 20]°C | 0.21095*** | 0.23792*** | -0.02697 | 0.00213** | 0.00151* | 0.00062 |
| | (0.06751) | (0.05842) | (0.02110) | (0.00106) | (0.0009) | (0.00051) |
| (20, 22]°C | 0.29124*** | 0.31041*** | -0.01917 | 0.00276** | 0.00233** | 0.00043 |
| | (0.08097) | (0.07073) | (0.02427) | (0.00123) | (0.00106) | (0.00052) |
| (22, 24]°C | 0.28255*** | 0.31876*** | -0.0362 | 0.00253* | 0.00221* | 0.00033 |
| | (0.09072) | (0.07679) | (0.02836) | (0.00146) | (0.00127) | (0.00059) |
| (24, 26]°C | 0.31203*** | 0.34277*** | -0.03074 | 0.00105 | 0.00135 | -0.0003 |
| | (0.09934) | (0.08331) | (0.03205) | (0.00178) | (0.00146) | (0.00074) |
| (26, 28]°C | 0.42009*** | 0.44024*** | -0.02015 | 0.00345* | 0.00252 | 0.00092 |
| | (0.11670) | (0.09741) | (0.03499) | (0.00201) | (0.00170) | (0.00089) |
| >28°C | 0.37992*** | 0.41412*** | -0.03420 | 0.00469* | 0.00313 | 0.00156 |
| | (0.13841) | (0.11489) | (0.04254) | (0.00242) | (0.00213) | (0.00110) |
| Dry day | -0.00069 | 0.01775 | -0.01844** | -0.00001 | -0.00001 | -0.00001 |
| | (0.01823) | (0.01335) | (0.00849) | (0.00049) | (0.00040) | (0.00025) |
| Precipitation (mm) | 0.00797*** | -0.00204 | 0.01001*** | -0.00006 | -0.00002 | -0.00004 |
| | (0.00292) | (0.00225) | (0.00136) | (0.00009) | (0.00006) | (0.00006) |
| Precipitation$^2$ | -0.00849 | 0.00368 | -0.01217*** | 0.00028 | 0.00016 | 0.00012 |
| | (0.00674) | (0.00594) | (0.00310) | (0.00028) | (0.00017) | (0.00019) |
| Precipitation$^3$ | -0.00073 | -0.00571** | 0.00499** | 0.00001 | -0.00007 | 0.00008 |
| | (0.00311) | (0.00282) | (0.00213) | (0.00016) | (0.00009) | (0.00012) |
| Wind speed (m/s) | -0.00466 | -0.02882 | 0.02416 | 0.00035 | -0.00043 | 0.00077* |
| | (0.03162) | (0.02828) | (0.01712) | (0.00107) | (0.00085) | (0.00043) |
| Wind speed$^2$ | 0.18972 | 0.70876 | -0.51904 | -0.01267 | 0.00651 | -0.01918* |
| | (0.78221) | (0.76815) | (0.38564) | (0.02563) | (0.02028) | (0.01034) |
| Wind speed$^3$ | -0.17474 | -3.42211 | 3.24737 | 0.02624 | -0.06928 | 0.09552 |
| | (5.41522) | (5.6406) | (2.60298) | (0.16229) | (0.13908) | (0.05847) |
| Avg. lag. temp.[(a)] | -0.00105 | 0.00339 | -0.00445 | -0.00009 | -0.00006 | -0.00003 |
| | (0.00776) | (0.00579) | (0.00306) | (0.00012) | (0.00011) | (0.00006) |
| Avg. for. temp.[(b)] | 0.00643 | 0.00487 | 0.00156 | -0.00004 | -0.00003 | -0.00001 |
| | (0.00882) | (0.00601) | (0.00399) | (0.00011) | (0.00010) | (0.00005) |
| Avg. lag. wind[(a)] | 0.00865 | 0.00632 | 0.00233 | 0.00034* | 0.00023 | 0.00011 |
| | (0.00960) | (0.00850) | (0.00318) | (0.000189) | (0.00017) | (0.00008) |
| Avg. for. wind[(b)] | 0.00078 | -0.00278 | 0.00356 | -0.00004 | -0.00006 | 0.00001 |
| | (0.00788) | (0.00644) | (0.00315) | (0.00024) | (0.00021) | (0.00009) |
| Avg. lag. prec.[(a)] | -0.00410** | -0.00374** | -0.00036 | 0.00002 | 0.00003 | -0.00001 |
| | (0.00173) | (0.00153) | (0.00073) | (0.00004) | (0.00004) | (0.00002) |
| Avg. for. prec.[(b)] | 0.00420** | 0.00191 | 0.00229** | -0.00001 | 0.00000 | -0.00002 |
| | (0.00203) | (0.00151) | (0.00092) | (0.00004) | (0.00003) | (0.00002) |
| # of observations | 480,294 | 480,294 | 480,294 | 480,294 | 480,294 | 480,294 |
| # of calendar dates | 4,624 | 4,624 | 4,624 | 4,624 | 4,624 | 4,624 |
| # of provinces | 106 | 106 | 106 | 106 | 106 | 106 |
| Adj. R-Square | .72089 | .70712 | .37861 | .0076606 | .0065423 | .0056991 |

* $p$-value<0.10, ** $p$-value<0.05, *** $p$-value<0.01. Two-way clustered standard errors are in parenthesis; clusters are at the level of calendar dates and of provinces. All the models contain calendar date fixed effects and month-year-province fixed effects. Each regression is weighted by the provincial employment during the year of the observation.

[(a)] Avg. lag. temp./wind/prec. stands for the average of the daily temperature/wind/precipitation in the previous 3 days.

[(b)] Avg. for. temp./wind/prec. stands for the average of the daily temperature/wind/precipitation in the next 3 days.

**Table OA.9:** Estimation results by exploiting the deviation in the daily temperature from the average temperature in the same day of the year-province

| | Accident rate (1) | Workplace accident rate (2) | Commuting accident rate (3) | Fatal accident rate (4) | Fatal workplace accident rate (5) | Fatal commuting accident rate (6) |
|---|---|---|---|---|---|---|
| *Temperature - Reference: (10,12]°C* | | | | | | |
| ≤0°C | 0.80801*** | 0.27734** | 0.53068*** | -0.00104 | -0.00103 | -0.00001 |
| | (0.16300) | (0.10971) | (0.07842) | (0.00137) | (0.00128) | (0.00069) |
| (0,2]°C | 0.41423*** | 0.02903 | 0.38520*** | 0.00127 | 0.00099 | 0.00028 |
| | (0.11173) | (0.07356) | (0.05914) | (0.00128) | (0.00126) | (0.00061) |
| (2,4]°C | 0.12333* | -0.06019 | 0.18352*** | -0.00028 | -0.00029 | 0.00001 |
| | (0.07301) | (0.05761) | (0.03038) | (0.00102) | (0.00097) | (0.00045) |
| (4,6]°C | 0.00661 | -0.09483* | 0.10144*** | 0.00036 | 0.00016 | 0.00020 |
| | (0.05723) | (0.04826) | (0.01887) | (0.00089) | (0.00083) | (0.00041) |
| (6,8]°C | -0.07242 | -0.11684*** | 0.04442*** | 0.00062 | 0.00023 | 0.00039 |
| | (0.04596) | (0.03935) | (0.01522) | (0.00070) | (0.00063) | (0.00037) |
| (8,10]°C | -0.05544* | -0.07433*** | 0.01889** | -0.00014 | -0.00047 | 0.00033 |
| | (0.02883) | (0.02505) | (0.00897) | (0.00056) | (0.00048) | (0.00028) |
| (12,14]°C | 0.07116** | 0.07393*** | -0.00277 | 0.00078 | 0.00054 | 0.00024 |
| | (0.03064) | (0.02716) | (0.00792) | (0.00059) | (0.00054) | (0.00027) |
| (14,16]°C | 0.17591*** | 0.16643*** | 0.00947 | 0.00178** | 0.00134** | 0.00044 |
| | (0.04707) | (0.04064) | (0.01292) | (0.00077) | (0.00066) | (0.00037) |
| (16,18]°C | 0.28952*** | 0.25986*** | 0.02966* | 0.00139* | 0.00082 | 0.00057 |
| | (0.06551) | (0.05920) | (0.01655) | (0.00080) | (0.00073) | (0.00042) |
| (18,20]°C | 0.41900*** | 0.37517*** | 0.04383** | 0.00164* | 0.00111 | 0.00053 |
| | (0.08270) | (0.07267) | (0.02046) | (0.00099) | (0.00089) | (0.00056) |
| (20,22]°C | 0.56351*** | 0.49403*** | 0.06948*** | 0.00242** | 0.00192* | 0.00050 |
| | (0.10357) | (0.09199) | (0.02392) | (0.00117) | (0.00110) | (0.00055) |
| (22,24]°C | 0.60072*** | 0.53130*** | 0.06943** | 0.00229* | 0.00188 | 0.00041 |
| | (0.11905) | (0.10292) | (0.02900) | (0.00136) | (0.00124) | (0.00063) |
| (24,26]°C | 0.68616*** | 0.59674*** | 0.08942*** | 0.00102 | 0.00129 | -0.00027 |
| | (0.14140) | (0.12346) | (0.03082) | (0.00158) | (0.00137) | (0.00071) |
| (26,28]°C | 0.80778*** | 0.69443*** | 0.11335*** | 0.00317* | 0.00209 | 0.00108 |
| | (0.16733) | (0.14915) | (0.03449) | (0.00177) | (0.00156) | (0.00075) |
| >28°C | 0.81366*** | 0.70184*** | 0.11182*** | 0.00495** | 0.00338* | 0.00158 |
| | (0.19328) | (0.16675) | (0.04218) | (0.00226) | (0.00196) | (0.00112) |
| Dry day | -0.00111 | 0.02044 | -0.02155** | 0.00007 | 0.00012 | -0.00005 |
| | (0.02129) | (0.01720) | (0.00899) | (0.00052) | (0.00041) | (0.00025) |
| Precipitation (mm) | 0.00827*** | -0.00158 | 0.00985*** | -0.00005 | -0.00001 | -0.00004 |
| | (0.00292) | (0.00231) | (0.00134) | (0.00009) | (0.00006) | (0.00006) |
| Precipitation$^2$ | -0.00875 | 0.00327 | -0.01202*** | 0.00024 | 0.00012 | 0.00012 |
| | (0.00685) | (0.00554) | (0.00352) | (0.00028) | (0.00017) | (0.00020) |
| Precipitation$^3$ | 0.00044 | -0.00458* | 0.00502** | 0.00002 | -0.00007 | 0.00008 |
| | (0.00371) | (0.00265) | (0.00244) | (0.00015) | (0.00009) | (0.00012) |
| Wind speed (m/s) | -0.03187 | -0.05026 | 0.01839 | -0.00066 | -0.00081 | 0.00015 |
| | (0.06232) | (0.06489) | (0.02277) | (0.00089) | (0.00076) | (0.00041) |
| Wind speed$^2$ | 1.46189 | 1.85294 | -0.39106 | 0.01665 | 0.02164 | -0.00500 |
| | (1.28208) | (1.39760) | (0.50748) | (0.02117) | (0.01728) | (0.01021) |
| Wind speed$^3$ | -10.02001 | -12.9737 | 2.95369 | -0.17871 | -0.18752* | 0.00881 |
| | (7.85629) | (9.09527) | (3.39917) | (0.13528) | (0.11049) | (0.06251) |
| # of observations | 480,294 | 480,294 | 480,294 | 480,294 | 480,294 | 480,294 |
| # of calendar dates | 4,624 | 4,624 | 4,624 | 4,624 | 4,624 | 4,624 |
| # of provinces | 106 | 106 | 106 | 106 | 106 | 106 |
| Adj. R-Square | 0.68921 | 0.67066 | 0.36075 | 0.0042775 | 0.0031408 | 0.000159 |

* $p$-value$<$0.10, ** $p$-value$<$0.05, *** $p$-value$<$0.01. Two-way clustered standard errors are in parenthesis; clusters are at the level of calendar dates and of provinces. All the models contain calendar date fixed effects and month-year-province fixed effects. Each regression is weighted by the provincial employment during the year of the observation.

**Table OA.10:** Estimation results of the main model exploiting Agri4Cast data

| | Accident rate (1) | Workplace accident rate (2) | Commuting accident rate (3) | Fatal accident rate (4) | Fatal workplace accident rate (5) | Fatal commuting accident rate (6) |
|---|---|---|---|---|---|---|
| *Temperature - Reference: (10,12]°C* | | | | | | |
| ≤0°C | 0.98791*** | 0.38329*** | 0.60461*** | 0.00037 | -0.00044 | 0.00081 |
| | (0.18720) | (0.09615) | (0.11093) | (0.00176) | (0.00156) | (0.00082) |
| (0,2]°C | 0.46635*** | 0.06322 | 0.40313*** | -0.00012 | -0.00042 | 0.00030 |
| | (0.11179) | (0.06471) | (0.06529) | (0.00138) | (0.00126) | (0.00061) |
| (2,4]°C | 0.20833*** | -0.02221 | 0.23055*** | -0.00022 | -0.00055 | 0.00033 |
| | (0.07343) | (0.04692) | (0.04000) | (0.00086) | (0.00075) | (0.00047) |
| (4,6]°C | 0.07561 | -0.06051 | 0.13613*** | 0.00033 | 0.00012 | 0.00021 |
| | (0.05381) | (0.03783) | (0.02590) | (0.00086) | (0.00076) | (0.00040) |
| (6,8]°C | 0.00705 | -0.06759** | 0.07464*** | -0.00020 | -0.00071 | 0.00051* |
| | (0.03839) | (0.02875) | (0.01739) | (0.00057) | (0.00053) | (0.00030) |
| (8,10]°C | -0.02502 | -0.04800** | 0.02298** | -0.00015 | -0.00044 | 0.00029 |
| | (0.02313) | (0.01996) | (0.00938) | (0.00058) | (0.00048) | (0.00028) |
| (12,14]°C | 0.02713 | 0.04990** | -0.02277*** | 0.00022 | -0.00004 | 0.00026 |
| | (0.02305) | (0.02045) | (0.00641) | (0.00056) | (0.00049) | (0.00026) |
| (14,16]°C | 0.05260 | 0.08952*** | -0.03692*** | 0.00067 | 0.00049 | 0.00018 |
| | (0.03557) | (0.03108) | (0.00969) | (0.00083) | (0.00070) | (0.00034) |
| (16,18]°C | 0.09789** | 0.15482*** | -0.05694*** | 0.00262*** | 0.00218*** | 0.00044 |
| | (0.04264) | (0.03775) | (0.01244) | (0.00079) | (0.00068) | (0.00042) |
| (18,20]°C | 0.15344*** | 0.22442*** | -0.07098*** | 0.00151 | 0.00113 | 0.00037 |
| | (0.05312) | (0.04795) | (0.01632) | (0.00103) | (0.00084) | (0.00056) |
| (20,22]°C | 0.18978*** | 0.27330*** | -0.08352*** | 0.00117 | 0.00123 | -0.00007 |
| | (0.05887) | (0.05195) | (0.01813) | (0.00102) | (0.00090) | (0.00058) |
| (22,24]°C | 0.23238*** | 0.32509*** | -0.09271*** | 0.00117 | 0.00128 | -0.00011 |
| | (0.06733) | (0.05822) | (0.02034) | (0.00119) | (0.00103) | (0.00067) |
| (24,26]°C | 0.26733*** | 0.35942*** | -0.09209*** | -0.00020 | 0.00005 | -0.00025 |
| | (0.07500) | (0.06506) | (0.02110) | (0.00132) | (0.00116) | (0.00070) |
| (26,28]°C | 0.34449*** | 0.44674*** | -0.10225*** | 0.00057 | 0.00047 | 0.00010 |
| | (0.08744) | (0.07748) | (0.02426) | (0.00148) | (0.00134) | (0.00078) |
| >28°C | 0.34513*** | 0.44815*** | -0.10302*** | -0.00091 | 0.00017 | -0.00108 |
| | (0.10257) | (0.08910) | (0.02594) | (0.00215) | (0.00179) | (0.00125) |
| dry day | 0.00250 | 0.01246 | -0.00996 | 0.00051* | 0.00039 | 0.00012 |
| | (0.01375) | (0.01072) | (0.00601) | (0.00030) | (0.00028) | (0.00014) |
| Precipitation (mm) | 0.00786** | -0.00519** | 0.01305*** | 0.00001 | 0.00004 | -0.00003 |
| | (0.00317) | (0.00241) | (0.00138) | (0.00008) | (0.00006) | (0.00005) |
| Precipitation$^2$ | -0.00359 | 0.01562** | -0.01921*** | 0.00013 | -0.00002 | 0.00016 |
| | (0.00872) | (0.00761) | (0.00313) | (0.00025) | (0.00016) | (0.00019) |
| Precipitation$^3$ | -0.00108 | -0.00899** | 0.00792*** | 0.00000 | 0.00000 | 0.00000 |
| | (0.00445) | (0.00396) | (0.00163) | (0.00012) | (0.00008) | (0.00009) |
| Wind speed (m/s) | 0.04095 | 0.01338 | 0.02757* | 0.00001 | -0.00030 | 0.00032 |
| | (0.02784) | (0.01654) | (0.01563) | (0.00053) | (0.00050) | (0.00023) |
| Wind speed$^2$ | -0.65655 | -0.12644 | -0.53011* | -0.00719 | -0.00058 | -0.00662 |
| | (0.55002) | (0.33124) | (0.31004) | (0.01303) | (0.01224) | (0.00426) |
| Wind speed$^3$ | 3.71055 | 0.87890 | 2.83165* | 0.05108 | 0.02940 | 0.02168 |
| | (2.83142) | (1.67800) | (1.61984) | (0.09285) | (0.08822) | (0.02121) |
| # of observations | 473,289 | 473,289 | 473,289 | 473,289 | 473,289 | 473,289 |
| # of calendar dates | 4,456 | 4,456 | 4,456 | 4,456 | 4,456 | 4,456 |
| # of provinces | 107 | 107 | 107 | 107 | 107 | 107 |
| Adj. R-Square | 0.71960 | 0.70591 | 0.37866 | 0.0066768 | 0.0056259 | 0.0046404 |

* $p$-value$<$0.10, ** $p$-value$<$0.05, *** $p$-value$<$0.01. Two-way clustered standard errors are in parenthesis; clusters are at the level of calendar dates and of provinces. All the models contain calendar date fixed effects and month-year-province fixed effects. Each regression is weighted by the provincial employment during the year of the observation.

**Table OA.11:** Estimation results of the main model with the HI

| | Accident rate (1) | Workplace accident rate (2) | Commuting accident rate (3) | Fatal accident rate (4) | Fatal workplace accident rate (5) | Fatal commuting accident rate (6) |
|---|---|---|---|---|---|---|
| *Temperature - Reference: (10,12]°C* | | | | | | |
| ≤0°C | 0.67205*** | 0.23204** | 0.44001*** | -0.00001 | -0.00095 | 0.00094 |
| | (0.14341) | (0.08866) | (0.07456) | (0.00159) | (0.00142) | (0.00085) |
| (0,2]°C | 0.35928*** | 0.00793 | 0.35136*** | 0.00210 | 0.00081 | 0.00129* |
| | (0.10435) | (0.06295) | (0.06066) | (0.00153) | (0.00137) | (0.00076) |
| (2,4]°C | 0.11907 | -0.06773 | 0.18679*** | -0.00005 | -0.00050 | 0.00045 |
| | (0.07434) | (0.04957) | (0.03680) | (0.00109) | (0.00099) | (0.00048) |
| (4,6]°C | 0.00517 | -0.10833*** | 0.11350*** | 0.00026 | -0.00004 | 0.00029 |
| | (0.05138) | (0.03850) | (0.02308) | (0.00091) | (0.00081) | (0.00044) |
| (6,8]°C | -0.05468 | -0.11609*** | 0.06141*** | 0.00088 | 0.00025 | 0.00063* |
| | (0.04075) | (0.03102) | (0.01745) | (0.00069) | (0.00063) | (0.00038) |
| (8,10]°C | -0.01704 | -0.04620** | 0.02916*** | 0.00002 | -0.00038 | 0.00040 |
| | (0.02557) | (0.02093) | (0.01023) | (0.00054) | (0.00047) | (0.00029) |
| (12,14]°C | 0.04292* | 0.06151*** | -0.01859** | 0.00075 | 0.00068 | 0.00007 |
| | (0.02519) | (0.02180) | (0.00733) | (0.00060) | (0.00055) | (0.00026) |
| (14,16]°C | 0.09136** | 0.11365*** | -0.02229** | 0.00229*** | 0.00180*** | 0.00050 |
| | (0.03978) | (0.03251) | (0.01108) | (0.00082) | (0.00068) | (0.00038) |
| (16,18]°C | 0.16614*** | 0.18812*** | -0.02198 | 0.00182** | 0.00137* | 0.00045 |
| | (0.05079) | (0.04576) | (0.01559) | (0.00090) | (0.00078) | (0.00048) |
| (18,20]°C | 0.22909*** | 0.26040*** | -0.03131* | 0.00219* | 0.00172* | 0.00047 |
| | (0.062079 | (0.05655) | (0.01778) | (0.00118) | (0.00097) | (0.00059) |
| (20,22]°C | 0.29463*** | 0.33102*** | -0.03639 | 0.00045 | 0.00102 | -0.00057 |
| | (0.07949) | (0.07351) | (0.02278) | (0.00161) | (0.00143) | (0.00066) |
| (22,24]°C | 0.28348*** | 0.31751*** | -0.03403* | 0.00295** | 0.00250** | 0.00045 |
| | (0.07294) | (0.06758) | (0.02043) | (0.00135) | (0.00115) | (0.00060) |
| (24,26]°C | 0.34350*** | 0.36494*** | -0.02145 | 0.00234 | 0.00196 | 0.00038 |
| | (0.07879) | (0.07076) | (0.02184) | (0.00143) | (0.00121) | (0.00065) |
| (26,28]°C | 0.39263*** | 0.41497*** | -0.02235 | 0.00340** | 0.00284** | 0.00056 |
| | (0.08391) | (0.07558) | (0.02340) | (0.00170) | (0.00141) | (0.00081) |
| >28°C | 0.43829*** | 0.46258*** | -0.02429 | 0.00561*** | 0.00460*** | 0.00101 |
| | (0.09781) | (0.08879) | (0.02615) | (0.00191) | (0.00175) | (0.00088) |
| Dry day | -0.00014 | 0.01631 | -0.01645* | -0.00036 | -0.00030 | -0.00006 |
| | (0.01880) | (0.01362) | (0.00914) | (0.00051) | (0.00039) | (0.00028) |
| Precipitation (mm) | 0.00791*** | -0.00210 | 0.01001*** | -0.00009 | -0.00005 | -0.00004 |
| | (0.00299) | (0.00234) | (0.00141) | (0.00009) | (0.00006) | (0.00006) |
| Precipitation$^2$ | -0.00714 | 0.00456 | -0.01170*** | 0.00033 | 0.00020 | 0.00013 |
| | (0.00681) | (0.00619) | (0.00311) | (0.00030) | (0.00017) | (0.00022) |
| Precipitation$^3$ | -0.00185 | -0.00638** | 0.00453** | 0.00000 | -0.00009 | 0.00008 |
| | (0.00307) | (0.00302) | (0.00205) | (0.00017) | (0.00009) | (0.00013) |
| Wind speed (m/s) | -0.00814 | -0.02856 | 0.02042 | 0.00017 | -0.00054 | 0.00071 |
| | (0.03102) | (0.02894) | (0.01750) | (0.00112) | (0.00089) | (0.00045) |
| Wind speed$^2$ | 0.31862 | 0.75767 | -0.43905 | -0.01027 | 0.00779 | -0.01806 |
| | (0.77963) | (0.81207) | (0.39218) | (0.02718) | (0.02123) | (0.01092) |
| Wind speed$^3$ | -1.41196 | -4.19127 | 2.77931 | 0.01821 | -0.07070 | 0.08892 |
| | (5.34078) | (5.90885) | (2.61739) | (0.16964) | (0.14402) | (0.06163) |
| # of observations | 427,156 | 427,156 | 427,156 | 427,156 | 427,156 | 427,156 |
| # of calendar dates | 4,624 | 4,624 | 4,624 | 4,624 | 4,624 | 4,624 |
| # of provinces | 95 | 95 | 95 | 95 | 95 | 95 |
| Adj. R-Square | 0.72885 | 0.71585 | 0.38719 | 0.00829 | 0.00685 | 0.00600 |

* $p$-value$<0.10$, ** $p$-value$<0.05$, *** $p$-value$<0.01$. Two-way clustered standard errors are in parenthesis; clusters are at the level of calendar dates and of provinces. All the models contain calendar date fixed effects and month-year-province fixed effects. Each regression is weighted by the provincial employment during the year of the observation. The number of observations and the number of provinces is lower than in the benchmark estimates because humidity, which is used to calculate the HI, is not available in 12 Italian provinces.

**Table OA.12:** Results of the main model using only days from May until October

| | Accident rate (1) | Workplace accident rate (2) | Commuting accident rate (3) | Fatal accident rate (4) | Fatal workplace accident rate (5) | Fatal commuting accident rate (6) |
|---|---|---|---|---|---|---|
| *Temperature - Reference:* $\leq$*12°C* | | | | | | |
| (12,14]°C | 0.04602 | 0.07046* | -0.02444 | 0.00138 | 0.00089 | 0.00049 |
| | (0.04888) | (0.04014) | (0.01630) | (0.00118) | (0.00107) | (0.00051) |
| (14,16]°C | 0.09298 | 0.11200** | -0.01902 | 0.00202 | 0.00104 | 0.00098 |
| | (0.06662) | (0.05417) | (0.02063) | (0.00136) | (0.00126) | (0.00062) |
| (16,18]°C | 0.15777** | 0.18675*** | -0.02898 | 0.00160 | 0.00070 | 0.00091 |
| | (0.07861) | (0.06488) | (0.02326) | (0.00145) | (0.00134) | (0.00071) |
| (18,20]°C | 0.22806** | 0.26376*** | -0.03570 | 0.00179 | 0.00106 | 0.00072 |
| | (0.09094) | (0.07505) | (0.02568) | (0.00173) | (0.00154) | (0.00078) |
| (20,22]°C | 0.31791*** | 0.34442*** | -0.02651 | 0.00238 | 0.00186 | 0.00052 |
| | (0.09944) | (0.08311) | (0.02747) | (0.00190) | (0.00170) | (0.00082) |
| (22,24]°C | 0.31910*** | 0.36416*** | -0.04506 | 0.00195 | 0.00163 | 0.00032 |
| | (0.10792) | (0.08875) | (0.02942) | (0.00215) | (0.00190) | (0.00090) |
| (24,26]°C | 0.35585*** | 0.39690*** | -0.04105 | 0.00032 | 0.00073 | -0.00040 |
| | (0.10977) | (0.09079) | (0.03018) | (0.00242) | (0.00206) | (0.00104) |
| (26,28]°C | 0.46990*** | 0.50170*** | -0.03179 | 0.00263 | 0.00187 | 0.00076 |
| | (0.11811) | (0.09791) | (0.03274) | (0.00261) | (0.00226) | (0.00116) |
| >28°C | 0.43504*** | 0.48205*** | -0.04700 | 0.00377 | 0.00244 | 0.00134 |
| | (0.13668) | (0.11483) | (0.03581) | (0.00280) | (0.00256) | (0.00133) |
| Dry day | 0.00102 | 0.00631 | -0.00528 | -0.00068 | -0.00084 | 0.00016 |
| | (0.02491) | (0.02066) | (0.00691) | (0.00071) | (0.00058) | (0.00033) |
| Precipitation (mm) | 0.01219*** | 0.00120 | 0.01099*** | -0.00021* | -0.00014 | -0.00007 |
| | (0.00436) | (0.00375) | (0.00143) | (0.00011) | (0.00009) | (0.00005) |
| Precipitation$^2$ | -0.01726 | -0.00244 | -0.01482*** | 0.00071** | 0.00051* | 0.00020 |
| | (0.01256) | (0.01133) | (0.00357) | (0.00035) | (0.00030) | (0.00015) |
| Precipitation$^3$ | 0.00245 | -0.00414 | 0.00659*** | -0.00032 | -0.00021 | -0.00011 |
| | (0.00618) | (0.00550) | (0.00197) | (0.00021) | (0.00019) | (0.00008) |
| Wind speed (m/s) | 0.00764 | -0.04755 | 0.05519** | 0.00231 | 0.00086 | 0.00145* |
| | (0.05796) | (0.05206) | (0.02505) | (0.00189) | (0.00153) | (0.00077) |
| Wind speed$^2$ | 0.12722 | 1.48424 | -1.35701** | -0.06237 | -0.02886 | -0.03350 |
| | (1.53633) | (1.42782) | (0.68126) | (0.04747) | (0.03776) | (0.02019) |
| Wind speed$^3$ | -4.41221 | -13.53286 | 9.12065 | 0.28845 | 0.15643 | 0.13203 |
| | (12.37372) | (11.39861) | (5.77129) | (0.31753) | (0.27288) | (0.13684) |
| # of observations | 243,085 | 243,085 | 243,085 | 243,085 | 243,085 | 243,085 |
| # of calendar dates | 2,338 | 2,338 | 2,338 | 2,338 | 2,338 | 2,338 |
| # of provinces | 106 | 106 | 106 | 106 | 106 | 106 |
| Adj. R-Square | 0.73395 | 0.71118 | 0.39831 | 0.00669 | 0.00413 | 0.00922 |

* $p$-value<0.10, ** $p$-value<0.05, *** $p$-value<0.01. Two-way clustered standard errors are in parenthesis; clusters are at the level of calendar dates and of provinces. All the models contain calendar date fixed effects and month-year-province fixed effects. Each regression is weighted by the provincial employment during the year of the observation.

**Table OA.13:** Results of the main model using maximum daily temperatures rather than average daily temperature

| | Accident rate (1) | Workplace accident rate (2) | Commuting accident rate (3) | Fatal accident rate (4) | Fatal workplace accident rate (5) | Fatal commuting accident rate (6) |
|---|---|---|---|---|---|---|
| *Temperature - Reference: (14,16]°C* | | | | | | |
| ≤4°C | 0.27284*** | -0.05082 | 0.32366*** | 0.00107 | 0.00057 | 0.00050 |
| | (0.10110) | (0.06472) | (0.05521) | (0.00139) | (0.00130) | (0.00056) |
| (2, 6]°C | 0.11554 | -0.10475** | 0.22029*** | 0.00095 | 0.00025 | 0.00070 |
| | (0.08303) | (0.04807) | (0.05032) | (0.00109) | (0.00089) | (0.00059) |
| (6, 8]°C | -0.04841 | -0.14764*** | 0.09923*** | -0.00023 | -0.00050 | 0.00027 |
| | (0.05899) | (0.04021) | (0.02866) | (0.00086) | (0.00084) | (0.00040) |
| (8, 10]°C | -0.10323** | -0.15523*** | 0.05200*** | 0.00012 | -0.00013 | 0.00025 |
| | (0.04243) | (0.03477) | (0.01731) | (0.00077) | (0.00071) | (0.00032) |
| (10, 12]°C | -0.08082*** | -0.11681*** | 0.03599*** | -0.00081 | -0.00086 | 0.00005 |
| | (0.02942) | (0.02340) | (0.01173) | (0.00075) | (0.00063) | (0.00032) |
| (12, 14]°C | -0.08348*** | -0.08788*** | 0.00439 | -0.00093 | -0.00072 | -0.00021 |
| | (0.02087) | (0.01771) | (0.00695) | (0.00057) | (0.00045) | (0.00026) |
| (16, 18]°C | 0.02745 | 0.04023** | -0.01278* | -0.00106** | -0.00115** | 0.00009 |
| | (0.02305) | (0.01932) | (0.00707) | (0.00052) | (0.00046) | (0.00026) |
| (18, 20]°C | 0.05995* | 0.07325** | -0.01330 | -0.00001 | 0.00027 | -0.00028 |
| | (0.03368) | (0.02821) | (0.01090) | (0.00075) | (0.00064) | (0.00030) |
| (20, 22]°C | 0.07669* | 0.09835** | -0.02166* | 0.00106 | 0.00062 | 0.00044 |
| | (0.04446) | (0.03770) | (0.01272) | (0.00088) | (0.00075) | (0.00038) |
| (22, 24]°C | 0.14065*** | 0.16306*** | -0.02241 | 0.00056 | 0.00044 | 0.00012 |
| | (0.05214) | (0.04420) | (0.01675) | (0.00089) | (0.00077) | (0.00039) |
| (24, 26]°C | 0.19516*** | 0.20378*** | -0.00862 | 0.00021 | -0.00001 | 0.00022 |
| | (0.05738) | (0.04808) | (0.01858) | (0.00108) | (0.00084) | (0.00047) |
| (26, 28]°C | 0.22301*** | 0.22454*** | -0.00153 | 0.00144 | 0.00126 | 0.00018 |
| | (0.06436) | (0.05523) | (0.01959) | (0.00126) | (0.00105) | (0.00050) |
| (28, 30]°C | 0.24471*** | 0.25239*** | -0.00768 | 0.00158 | 0.00104 | 0.00053 |
| | (0.07393) | (0.06155) | (0.02254) | (0.00148) | (0.00120) | (0.00062) |
| (30, 32]°C | 0.29153*** | 0.28965*** | 0.00187 | 0.00135 | 0.00112 | 0.00024 |
| | (0.08143) | (0.06770) | (0.02465) | (0.00154) | (0.00126) | (0.00068) |
| >32°C | 0.35082*** | 0.33655*** | 0.01427 | 0.00320* | 0.00235 | 0.00086 |
| | (0.09187) | (0.07585) | (0.02667) | (0.00173) | (0.00145) | (0.00077) |
| Dry day | -0.00055 | 0.01380 | -0.01435* | -0.00007 | -0.00007 | -0.00000 |
| | (0.01887) | (0.01380) | (0.00856) | (0.00050) | (0.00041) | (0.00025) |
| Precipitation (mm) | 0.00814*** | -0.00162 | 0.00976*** | -0.00006 | -0.00002 | -0.00004 |
| | (0.00293) | (0.00226) | (0.00136) | (0.00009) | (0.00006) | (0.00006) |
| Precipitation$^2$ | -0.00845 | 0.00334 | -0.01179*** | 0.00028 | 0.00016 | 0.00012 |
| | (0.00682) | (0.00600) | (0.00310) | (0.00028) | (0.00017) | (0.00019) |
| Precipitation$^3$ | -0.00096 | -0.00574** | 0.00478** | 0.00001 | -0.00007 | 0.00008 |
| | (0.00313) | (0.00285) | (0.00212) | (0.00016) | (0.00009) | (0.00012) |
| Wind speed (m/s) | -0.01110 | -0.03363 | 0.02253 | 0.00043 | -0.00037 | 0.00080* |
| | (0.03154) | (0.02868) | (0.01722) | (0.00106) | (0.00086) | (0.00043) |
| Wind speed$^2$ | 0.40639 | 0.92330 | -0.51691 | -0.01359 | 0.00581 | -0.01940* |
| | (0.78713) | (0.78751) | (0.38732) | (0.02593) | (0.02049) | (0.01034) |
| Wind speed$^3$ | -1.51524 | -4.82007 | 3.30484 | 0.03201 | -0.06485 | 0.09686* |
| | (5.44151) | (5.77775) | (2.59413) | (0.16473) | (0.14098) | (0.05832) |
| # of observations | 480,294 | 480,294 | 480,294 | 480,294 | 480,294 | 480,294 |
| # of calendar dates | 4,624 | 4,624 | 4,624 | 4,624 | 4,624 | 4,624 |
| # of provinces | 106 | 106 | 106 | 106 | 106 | 106 |
| Adj. R-Square | 0.72071 | 0.70701 | 0.37822 | 0.00765 | 0.00656 | 0.00569 |

* $p$-value<0.10, ** $p$-value<0.05, *** $p$-value<0.01. Two-way clustered standard errors are in parenthesis; clusters are at the level of calendar dates and of provinces. All the models contain calendar date fixed effects and month-year-province fixed effects. Each regression is weighted by the provincial employment during the year of the observation.