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SUPERBONUS AND WORK INJURIES IN THE CONSTRUCTION SECTOR IN ITALY

by Andrea Benecchi*, Daniele Ruggeri** and Elisa Scarinzi**

Abstract

In response to the 2020 economic shutdown, the Italian government introduced the Superbonus, a substantial increase in existing incentives for residential building renovation aimed at supporting the construction sector. The measure triggered a sharp and sustained rise in sectoral output. Using sector-level data, we examine the policy's impact on workplace injuries, which have historically been frequent in construction. Contrary to previous evidence linking economic expansions to higher accident rates, we find that, following the introduction of the Superbonus, construction employment in Italy rose markedly relative to other sectors, while the injury rate declined slightly. Amid generally declining injury rates, driven by changes in legislation, the Superbonus reinforced this trend by increasing compliance incentives and the costs associated with regulatory infringements.

JEL Classification: H24, J28, L74, C21.

Keywords: workplace injuries, construction sector, Superbonus, synthetic difference-in-differences.

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1. Introduction¹

The construction sector is one of the most dangerous for workers worldwide: the International Labour Organization (2024) reports that it has the highest injury rate, that is, the number of accidents per worker, together with the agricultural sector. This is also true in Italy, as reported by the Italian Work Injury Institute (INAIL). In the United States and most European countries, the work injury rate has declined in recent years, according to data from the U.S. Bureau of Labor Statistics and Eurostat. Italy has experienced a similar pattern: Figure A1 in Appendix I shows a broad decline in the injury rate across the main Italian economic sectors compared with the early 2010s.

In Italy, the construction sector experienced a prolonged decline in employment and activity that began in 2011 and culminated during the Covid-19 crisis, before recovering substantially. In the second half of 2020, the Italian government strengthened the existing fiscal incentive for residential investment to support the construction industry. It raised the incentive rate from 65% to 110% and introduced the possibility of an invoice tax rebate, fuelling the demand for renovation among households; this new measure was branded the “Superbonus”. Accetturo et al. (2025) show that the new regime led to a 42% increase in real per capita investment in dwelling renovations relative to other European countries, where no similar policy had been introduced. Against this backdrop of rapidly expanding demand, Corsello and Ercolani (2024) estimate that the Superbonus contributed to the increase in construction costs, explaining around half of the cumulative rise observed between September 2021 and December 2023. Crucially, this demand shock coincided with a tightening of workplace safety enforcement: some provisions were embedded directly in the Superbonus framework, while others followed from a subsequent reform, Decree-Law No. 146/2021. As we argue below, this configuration created two opposing forces on construction injuries: a demand-driven upward pressure and an enforcement-driven downward pressure. Our empirical analysis suggests that the latter has prevailed.

The literature summarized by Gutiérrez-Falcón (2025) suggests a predominantly procyclical relationship between economic growth and occupational accidents, with increases in GDP or value added generally corresponding to higher injury rates. Their analysis highlights that the construction, manufacturing, and mining sectors are consistently identified

¹ We are thankful to Antonio Acconcia, Domenico Depalo, Edmondo Di Giuseppe, Tommaso Orlando, Achille Puggioni, Roberto Torrini, two anonymous referees, and all participants at Banca d’Italia’s seminar for their helpful comments to an early version of the paper. The views and opinions expressed in this paper are the authors’ and do not necessarily reflect those of Banca d’Italia.

The authors dedicate this work to those who lost their lives in workplace accidents, and to their families.

as the most sensitive to economic fluctuations, exhibiting clearly procyclical accident rates. In the Italian context, Farina et al. (2018) find that a 1-percentage-point rise in real GDP growth is associated with about a 1% increase in both total and serious injury rates between 1994 and 2012². A key mechanism linking demand shocks to workplace injuries is the pressure to accelerate production and meet rapidly rising demand: firms may hire less experienced workers, often under temporary contracts, and may increase work intensity and hours at the expense of routine safety procedures.

The literature identifies several determinants of injury rates beyond the business cycle, which can be clustered in four groups (Castaldo et al., 2024³): (i) workers' characteristics (age, gender, citizenship, experience); (ii) job characteristics (type of contract, environmental conditions); (iii) production-process characteristics (organization of activities, technology, firm size); and (iv) general economic characteristics (GDP, unemployment, labour and social insurance legislation, business cycles). The Italian case has been studied extensively along these lines. Fabiano et al. (2008), for 2000–2004, and Bena et al. (2012), for 1985–2004, find a positive correlation between temporary contracts and injury rates. Farina et al. (2013) show that two Italian laws enforcing construction safety, Legislative Decrees 494/96 and 528/99, reduced the sector's injury rate between 1994 and 2005. Castaldo et al. (2024) find that individual, job, and economic characteristics all matter for occupational injuries across European countries, Italy included. Farina et al. (2018) also document that the manufacturing injury rate fell faster after the 2008 crisis than before. Palma et al. (2025) show that air pollution, which induces inattention and fatigue, raises the probability of accidents, particularly for younger workers in manufacturing and construction⁴.

This body of work has generally studied how economic cycles or standalone safety regulations affect injury rates in isolation. The Superbonus offers a different setting: a large, demand-side fiscal stimulus bundled with safety-compliance requirements, allowing us to study how a demand shock and a deterrence shock interact. Under the Superbonus, the works supervisor (architect/engineer) was required to certify compliance with safety legislation (*asseverazione*), reinforcing earlier rules that made tax incentives conditional on compliance with safety regulations (Ministerial Decree 41/1998). At the same time, Decree 146/2021 strengthened the enforcement regime established by Legislative Decree 81/2008, making the

² They define an accident as serious if it was fatal or led to more than 30 days of absence from work (permanent disability included).

³ See also Cornelissen et al. (2017).

⁴ Similarly, Marinaccio et al. (2019) and Gariazzo et al. (2023) find that high temperatures raise work-related risks, particularly in construction.

suspension of a firm's activities mandatory rather than discretionary in case of safety violations, and eliminating the requirement for repeated offenses.

We argue that, while Decree 146/2021 applied economy-wide, the Superbonus raised the marginal cost of non-compliance more sharply in construction specifically. Because the incentive was repeatedly extended through legislative amendments with differentiated deadlines and eligibility conditions, it created strong deadline-driven incentives and front-loaded demand: a suspension would jeopardize eligibility, delay completion, and cut off access to subsidized demand, resulting in significant revenue losses. Firms may also have expected intensified monitoring given the unprecedented public financial commitment involved. Indeed, the Italian National Labour Inspectorate (INL) launched an extraordinary construction-site inspection campaign in the last quarter of 2021, extended throughout 2022⁵. Our identification strategy exploits this setting by constructing a synthetic counterfactual for construction from weighted combinations of other sectors, estimated via synthetic difference-in-differences (SDID). This lets us isolate the Superbonus-specific effect, over and above the economy-wide enforcement change from Decree 146/2021⁶, by comparing the construction's injury-rate trajectory to that of the synthetic control.

Our paper contributes to the literature on the macro-determinants of workplace injuries by studying a policy that combined a large demand stimulus with a parallel tightening of safety enforcement in construction. We develop a simple theoretical framework that links firms' compliance incentives to the cost of non-compliance, offering a lens to interpret the empirical patterns we document. Empirically, focusing on male workers⁷, we find that employment in construction rose by roughly 12% following the Superbonus, while the injury rate fell by around 7%. This pattern is at odds with the procyclical relationship between activity and injuries typically found in the literature. Consistent with our model, we find some evidence that the decline in injury rates was more pronounced in regions with greater exposure to Superbonus-related demand, supporting the interpretation that stronger compliance incentives, rather than an unrelated secular trend, drove the aggregate result. Taken together, these findings suggest that when the cost of non-compliance rises sharply for firms facing

⁵ See INL note N° 6023, published on the 27th of August 2021, and note N° 1231, published on the 23rd of February 2022.

⁶ Furthermore, inspection intensity may vary across sectors and over time, for example because of heightened attention to construction, and may therefore influence accident-rate dynamics. We address this issue in our robustness analysis.

⁷ Male workers represent close to 91% of the workforce in the construction sector, a much higher share than all other 1-digit sectors. Accordingly, virtually all work injuries of the sector (99%) refer to them.

high opportunity costs from sanctions and disruptions, stronger deterrence can offset the injury risk associated with rapid activity expansion.

Our paper is organized as follows: the next section briefly reviews the Italian legislation on dwelling renovations and the Superbonus; in Section 3 we introduce our data sources and explain how the dataset was built; Section 4 describes the empirical strategy; Sections 5 and 6 present the results, a theoretical model to interpret them, and robustness checks; Section 7 concludes.

2. The new “Superbonus” incentive and the institutional setting

In Italy the system of incentives supporting building renovation interventions dates back to 1998. The initial measure was a tax credit; over time, the percentage has changed significantly, ranging between 36% and 50%. Since 2007 these incentives have been strengthened: the deduction rate increased from 50% to 85% and primarily focused on energy-saving interventions for existing buildings and on the mitigation of seismic risk.

In 2020, at the onset of the pandemic crisis, the Italian government introduced the “Superbonus” through the Legislative Decree 34/2020 (so-called “decreto rilancio”, converted into Law 77/2020⁸). The new incentive was included in the existing framework of fiscal incentives, establishing a tax credit rate of 110% for outlays related to energy-efficiency interventions and seismic risk reduction. It was initially planned for interventions carried out between July 2020 and December 2021, but it was soon extended to December 2022 and then to December 2023. After 2022, the rate was gradually lowered to 90%, 70%, and 65%, before the measure was phased out entirely by the end of 2025. Unlike most tax incentives, which typically allow tax credits to be claimed over a ten-year period, the Superbonus allowed taxpayers to spread the credit over just four years. Taxpayers were also given the option to replace the credit with a transferable tax credit to third parties or an invoice rebate. Taken together, these features made the Superbonus much more attractive than any previous incentive.

The Superbonus became one of the largest fiscal stimuli ever implemented in Europe, amounting to about 3.7% of GDP in 2021–2022 (Accetturo et al., 2025). In Italy, dwelling investment had been declining since 2010 and plummeted during the Covid-19 crisis, but from 2021 onward it has grown strongly, surpassing pre-pandemic levels. Accordingly, in 2022

⁸ At the same time, an incentive called “*Bonus facciate*” introduced a 90% tax relief on expenditures for the renovation of the external facades of buildings. In 2022 its deduction rate was reduced to 60%.

employment in the construction sector increased by 16% and value added by 25% compared with 2019.

According to the data published by ENEA⁹, Superbonus outlays were recorded from May 2021, approximately ten months after the law came into force. This indicates that the uptake of the incentive started in the early part of that year. The delay is reasonably due to the number of documents required to apply for the incentive, besides the time the government needed to enact the decrees required for the implementation of the law. In our empirical specification, we account for this by setting the start of the treatment period in the first quarter of 2021.

2.1 Fiscal incentives and the legislation on workers' safety in Italy

The right to health of workers is a fundamental principle in Italian law: the Constitution obliges firms to safeguard safety, personal freedom, and human dignity in the conduct of economic activities; article 2087 of the Civil Code requires entrepreneurs to adopt measures to protect workers' right of physical integrity. Yet, it is commonly held that more can be done to reduce the number of work-related accidents. Enhancing workplace safety is challenging, as such improvements often entail significant costs for firms. In the absence of immediate risks or incidents, employers may perceive non-compliance as economically advantageous.

Since the beginning, fiscal incentives in Italy were conditioned on compliance with safety regulations, excluding from tax benefits non-compliant firms (Ministerial Decree 41/1998). Legislative Decree 81/2008 tightened such a prescription, establishing the possibility of suspending entrepreneurial activity in case of a serious violation of safety laws. In 2021, Decree 146/2021 broadened the cases of business suspension, and the INL launched an extraordinary construction-site surveillance campaign. The Superbonus decree introduced two requirements for firms to qualify for the tax credit: (i) a compliance certificate confirming eligibility for the credit (*visto di conformità*); and (ii) a proof of compliance with national energy efficiency and occupational safety regulations, certified by the worksite manager (*asseverazione*)¹⁰.

⁹ ENEA is the Italian authority in charge of registering and publishing the data on Superbonus outlays.

¹⁰ Art.8, Minister Decree 06/08/2020. The worksite manager must submit the document to the authority in charge of managing Superbonus expenditures (ENEA).

3. Data and descriptive evidence

The construction sector – The Superbonus affected two segments of the construction industry: dwelling construction (code 41) and specialized construction works (code 43) under section F of the NACE Rev. 2 classification. In our analysis, “construction sector” refers exclusively to these two segments, while we exclude civil engineering (code 42). All data on injuries and employment are aggregated across these two segments.

Injuries – Data on work accidents are published by the Italian Work Injury Institute (INAIL). The dataset covers injuries reported by regularly employed workers, excluding certain categories¹¹, and includes details such as the date of the event, the worker’s economic sector, the number of days required for recovery, and the degree of impairment. The available period covers the years from 2018 to 2023.

The dataset records the number of indemnity claims filed by workers. Not all claims are recognized by INAIL as work-related injuries. A flag in the dataset indicates whether a claim has been approved, meaning the injury is eligible for indemnity. Moreover, a threshold applies to approved cases: injuries with a physical impairment degree below 6% are not indemnified, even if recognized as work accidents. Here we consider all approved cases¹².

Besides workplace injuries, the dataset collects commuting-related incidents, known as *in itinere* accidents. These are excluded from the analysis, as they are unrelated to the employee’s work activities and to the safety measures implemented by the firm. Injuries involving workers under the age of 15 are likewise excluded¹³. Furthermore, the analysis focuses on male workers, who account for 91% of employment and 99% of recorded work accidents in the construction sector. Henceforth, the term “work injuries” refers exclusively to workplace incidents, approved by INAIL, that involve male employees aged 15 and above.

Covid-19 infections – Covid-19 infections in the workplace are registered as work injuries and so are in our dataset. This is potentially misleading for our purposes, as these cases are not equivalent to a physical accident caused by work activity, nor do they depend on the worker’s ability, experience, and so on¹⁴. Unfortunately, Covid-19 cases cannot be

¹¹ The dataset covers about 80% of the Italian workforce. It does not collect injuries for workers in sectors with a specific insurance system: forced arms, firefighters and police workers, air transport, autonomous tradespeople, professional with VAT taxation (Marinaccio et al, 2019).

¹² Some accidents are marked as ‘under investigation’, indicating that no decision has yet been made. We exclude these cases.

¹³ Age of 15 is the minimum legal one for working. Employment under this age is permitted only in exceptional cases, e.g. school-to-work transition programs; as such, these instances are rare.

¹⁴ Covid-19 infections surged in March 2020. They cause a structural break in our work injuries data. Moreover, the probability of getting infected is different across work activities, see e.g. Barbieri et al. (2022).

identified in the dataset. To avoid their influence – and, more broadly, the repercussions of the economic shutdown during the pandemic’s peak – we exclude the year 2020 from the analysis. However, Covid-19 infections remained widespread in 2021. To exclude these cases, we retain only injuries that cause permanent impairments or lasting damage to workers’ psycho-physical integrity (in Italian “*menomazioni*”)¹⁵. This allows us to focus on more serious accidents, the socially most significant ones. In this way, we also reduce the influence of systematic under-reporting, which disproportionately affects less severe cases.

Employment – We obtained employment data using both the Italian Social Security Institute (INPS) and the Italian National Institute of Statistics (Istat) datasets published on the institutional websites.

The INPS dataset encompasses the private non-agricultural sector and provides monthly figures on the number of workers by gender, region, and sector. It also provides information on working hours compensated through the Italian social welfare program for private-sector employees, known as the *Cassa Integrazione Guadagni* (CIG). The CIG serves as a wage supplementation program for workers temporarily suspended from their jobs, who notably remain registered as active employees. Although we exclude data for 2020, the CIG continued to be extensively used in 2021 – and to a lesser extent in 2022 – in the sectors subject to activity restrictions. Specifically, in 2021, the hours covered by the CIG exceeded the 2018–2019 average by almost nine times, while in 2022 they remained approximately 34% above that value. CIG workers are officially counted as employed but are temporarily not exposed to workplace injury risks due to suspension from work. This creates a downward bias in injury rates, as the employee count overstates those actually at risk. To address this issue, we adjust our analysis by excluding employees under the CIG scheme from the total number of active workers¹⁶. From the resulting quarterly dataset, we computed the percentage of male employment for each region and sector.

The Istat dataset (Asia¹⁷) provides annual counts of workers by firm, region, and sector. We utilize this data to include both employed and self-employed individuals, consistent with the INAIL dataset on occupational injuries covering both groups. To estimate quarterly male employment by region and sector, we applied the quarterly share of male employment from INPS (excluding CIG recipients) to the annual Istat figures on total employment. Figures A2a–

¹⁵ About one in six reported injuries result in a measurable permanent impairment.

¹⁶ To compute the number of “equivalent” employees under the CIG, we applied the standard working time of private economy, reported by Istat, to the number of hours covered by the CIG.

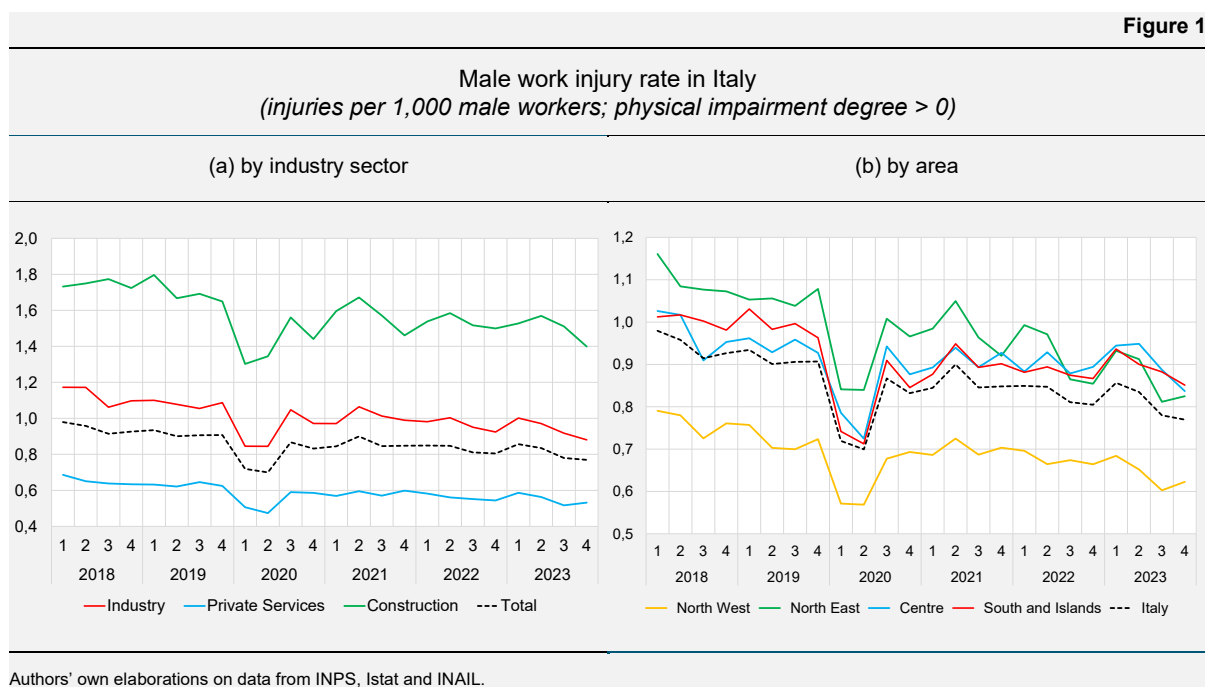
¹⁷ Asia is the Istat’s statistical registry of active firms, which contains information about employment headcount across all business units within each region.

A2b in Appendix I illustrate the effect of our CIG adjustment across economic sectors and regions, respectively¹⁸.

The final panel – In summary, our analysis employs a disaggregation of economic activities at the 1-digit level, corresponding to the letter codes in the NACE Rev. 2 classification, applied at the regional level with quarterly frequency. The resulting balanced panel spans from the first quarter of 2018 through the fourth quarter of 2023, excluding the year 2020. The intervention period is identified as beginning in the first quarter of 2021, coinciding with the initial uptake of the Superbonus.

3.1 Descriptive evidence: Severe work injuries in Italy

We now present descriptive evidence from the dataset we compiled. Severe injury rates for male workers have continued to decline across the Italian economy, extending the downward trend documented in the Introduction. Between 2018 and 2023, the quarterly injury rate fell from 1.0 to 0.8 per thousand. The decline is observable across all geographical areas and macro-sectors in the post-2020 period (Figure 1). These patterns are consistent with progressively tighter occupational health and safety enforcement, including the strengthening of the inspection regime introduced by Decree 146/2021.



Authors' own elaborations on data from INPS, Istat and INAIL.

¹⁸ The comparisons are based on total employment, the only series available in Asia, using index numbers. The figures show total employment per sector and per region in Italy. Our series and the Istat one have similar dynamics; our employment in 2021 is always lower than the original data thanks to the CIG correction.

In Appendix I, Tables A3 and A4 present the average male injury rates – limited to cases with a positive physical impairment degree – across regions and sectors grouped at the NACE Rev. 2 1-digit (letter) level, i.e. section. Table A3 reports data averaged over the years 2018–2019, while Table A4 presents averages for the years 2022–2023. Even at this disaggregated level it is possible to appreciate a widespread reduction in the rate. Table A5 shows the male employment in 2018 by region and section.

4. Empirical strategy

To estimate the effect of the Superbonus on construction work accidents, an appropriate counterfactual is needed. We accordingly use the construction sectors in each region as treated units and the other private sectors as the control group¹⁹. We use the synthetic difference-in-differences (SDID) estimator, a method for policy evaluation recently proposed by Arkhangelsky et al. (2021) as an evolution of the difference-in-differences and synthetic control²⁰.

Formally, the SDID estimates the treatment effect, $\hat{\tau}$, by solving the following weighted least squares problem:

$$(\hat{\tau}, \hat{\mu}, \hat{\alpha}, \hat{\beta}) = \arg \min_{\tau, \mu, \alpha, \beta} \left\{ \sum_{i=1}^N \sum_{t=1}^T (Y_{it} - \mu - \alpha_i - \beta_t - W_{it}\tau)^2 \hat{\omega}_i \hat{\theta}_t \right\}$$

where Y_{it} denotes the injury rate per 1,000 male workers for unit i (defined at the region-sector level) and quarter t ; W_{it} is a binary treatment indicator equal to 1 for treated region-sector combinations from the first quarter of 2021 onward, and 0 otherwise. The terms α_i and β_t denote unit and time fixed effects, respectively, while μ is the constant.

A key feature of the SDID estimator is the introduction of unit weights $\hat{\omega}_i$ and time weights $\hat{\theta}_t$. Unit weights are assigned to control units such that the pre-treatment outcome trajectories of treated and weighted control units are as similar as possible²¹. This addresses

¹⁹ The control group is constructed by excluding agriculture (section A), real estate (L), and the public sector, namely public administration, health, and education (sections O, P, and Q). We also exclude the remainder of the construction sector (F) to avoid potential spillovers or shared dynamics with the treated industries. Finally, we exclude administrative and support service activities (N), as this sector is closely linked to the expansion of construction employment: it includes the renting and leasing of construction machinery and equipment, as well as employment agencies involved in the recruitment and management of various categories of temporary workers.

²⁰ See a more detailed discussion of this estimation method in Appendix II.

²¹ In the difference-in-difference method $\hat{\omega}_i$ and $\hat{\theta}_t$ are equal for each i and t , whereas in the synthetic control formula weights $\hat{\theta}_t$ are all equal and there are not individual effects α_i . Thus, the SDID is the most complete model, which turns into a difference-in-differences or a synthetic control model when some restrictions are made.

potential differences in trends across region-sector combinations, particularly between those affected by the Superbonus policy and those that are not. Time weights serve a complementary role, emphasizing pre-treatment periods during which treated and control units exhibit the most comparable outcome dynamics. This temporal reweighting enhances the credibility of the parallel trends assumption by giving more importance to the periods that best approximate the shared pre-treatment trend.

4.1 Identification

To identify the parameter of interest, the SDID estimator relies on a set of assumptions that combine features of both difference-in-differences and synthetic control methods, namely: weighted parallel trends, absence of anticipation, and independence (or unconfoundedness) of the counterfactuals.

The standard difference-in-differences design requires a strong parallel-trend assumption: in the absence of treatment, the treated unit and each control unit would evolve similarly. In our context, this would mean that construction injury rates would have followed the same trajectory as all other sectors. SDID relaxes this assumption by using data-driven unit and time weights to construct a synthetic control group that closely matches the treated unit's pre-treatment trend. As a result, it is sufficient to assume that, conditional on these optimal weights, the difference between the treated unit and its synthetic counterpart would have remained approximately constant over time. This assumption is considerably less demanding and more credible than requiring untreated trends to coincide across all sectors.

Reliable SDID estimation also depends on having a sufficiently long pre-treatment period and a sufficiently large control group, so that time and unit weights can be identified. Using quarterly data for 1-digit NACE sector per region, we observe 20 treated units and 240 controls over twenty quarters, eight before and twelve after the treatment.

As with related methods, SDID assumes that treatment does not affect outcomes before its introduction. This assumption of no anticipation effects ensures that pre-treatment periods provide a valid basis for constructing the counterfactual. In the case of the Superbonus, a policy introduced during the Covid-19 pandemic, the assumption is plausible: given the extraordinary size and generosity of the subsidy, with no past examples in Italy or in the rest

of Europe, firms could not have anticipated this policy and the potential intensification of workplace safety inspections associated with it²².

Finally, SDID assumes that the treatment of one unit does not influence the outcomes of others, ruling out the possibility of interference or spillovers across control units (so-called stable unit treatment value assumption, or SUTVA). To address this, we perform placebo treatment tests on each of the counterfactual sectors to detect potential indirect effects of the Superbonus on male employment and injury rates.

In a further specification, we control for inspections by the public authority and for the share of young workers. The former variable captures possible indirect effects arising from changes in the distribution or frequency of inspections; the latter captures a recomposition toward younger, that is, less experienced, workers observed in both construction and the rest of the private-sector economy. We include this control because, as confirmed by INAIL data, young workers are more likely to be injured than the rest of the workforce. As discussed in the Introduction, environmental conditions such as air pollution and temperature can also influence work accidents, although we do not directly control for them. However, the inclusion of region-sector and time fixed effects already captures structural differences in these and other factors.

5. Results

We begin by testing whether the Superbonus increased labour input in the construction sector. Table 1 and Figure 2, panel (a), report the evolution of log male employment in the treated sector relative to the SDID counterfactual.

The estimated effect is positive and statistically significant at the 1% level, implying a 12% increase of male employment in the sector. The estimate indicates that employment in the construction sector rose sharply starting in the first quarter of 2021 relative to the selected private-sector control group. This finding is consistent with a substantial policy-induced expansion in construction activity²³.

²² We examined the data to confirm that no anticipatory effects are present prior to the treatment (see the robustness section for details).

²³ This result should be interpreted as the average effect of Superbonus on the regional construction sectors since we employed a panel dataset at the region-sector level. In the Appendix, we report the SDID estimates based on sectoral data aggregated at the national level. The results are qualitative similar (see Table A1 and Figures A3-A4). We present the regional analysis for consistency with our robustness checks, and specifically with the models of Section 6.3, which exploit regional differences in Superbonus uptake.

Panel (b) in Figure 2 reports the control-specific weights estimated via SDID, which are informative of the quality of our inference. In line with the SDID methodological framework, the weights are relatively evenly distributed across units: this indicates that the synthetic trend draws information from a broad range of comparison units rather than relying on a few heavily weighted observations. The overlap between the treated and control groups therefore seems good and ensures that the estimation result does not depend on choosing a limited number of observations.

Table 1

The effect of Superbonus on the construction sector – baseline results		
	Log of male workers	Male injury rate per thousand (physical impairment degree > 0)
Coefficient	0.120 ***	-0.114 **
t-statistic	(7.77)	(-2.18)
Obs. (year 2020 excluded)	5,200	5,200

Authors' own estimation. * p<0.10, ** p<0.05, *** p<0.01; t-statistic in parenthesis. All models control for fixed effects at the level of the cell (interaction between sector and region) as well as quarterly dummies (time fixed effects); errors are clustered at the level of the cell.

We then turn to workplace safety outcomes. Table 1 shows that the estimated effect of the Superbonus on the injury rate for accidents with physical impairment is -0.114 (p-value<0.05). Relative to the 2018–2019 average quarterly injury rate in construction (1.7 per thousand), this corresponds to a decline of roughly 7%. While the absolute number of injuries increased mechanically with the expansion of employment, the estimates indicate that the policy was associated with a reduction in injury incidence. This pattern is consistent with the mechanism discussed above: the Superbonus generated a strong increase in activity and employment (which would typically raise risk), but this force appears to have been more than offset by strengthened compliance incentives and enforcement. In Section 6.1 we provide the rationale behind this conclusion. Aggregating the estimated effects over the 2021–2023 period suggests that more than 1,700 injuries involving physical impairment were prevented²⁴.

The downward dynamics of the male injury rate can be seen in the trend of Figure 3, panel (a). After the treatment, the average gap between construction and the control sectors has narrowed compared to the period before²⁵. Figure 3, panel (b) shows that almost all

²⁴ The estimate is based on the average number of male workers between 2021 and 2023. This figure was multiplied by the injury rate decline and divided by 1,000. Since the injury rate is expressed quarterly, the result was then multiplied by 12 (the number of quarters over three years).

²⁵ This result, as well as the previous one on employment, hold for total labor force too, as shown in Table A2 and Figures A5-A6 in Appendix I.

observations are used and receive relatively homogeneous weights, implying a representative and well-distributed counterfactual.

Figure 2

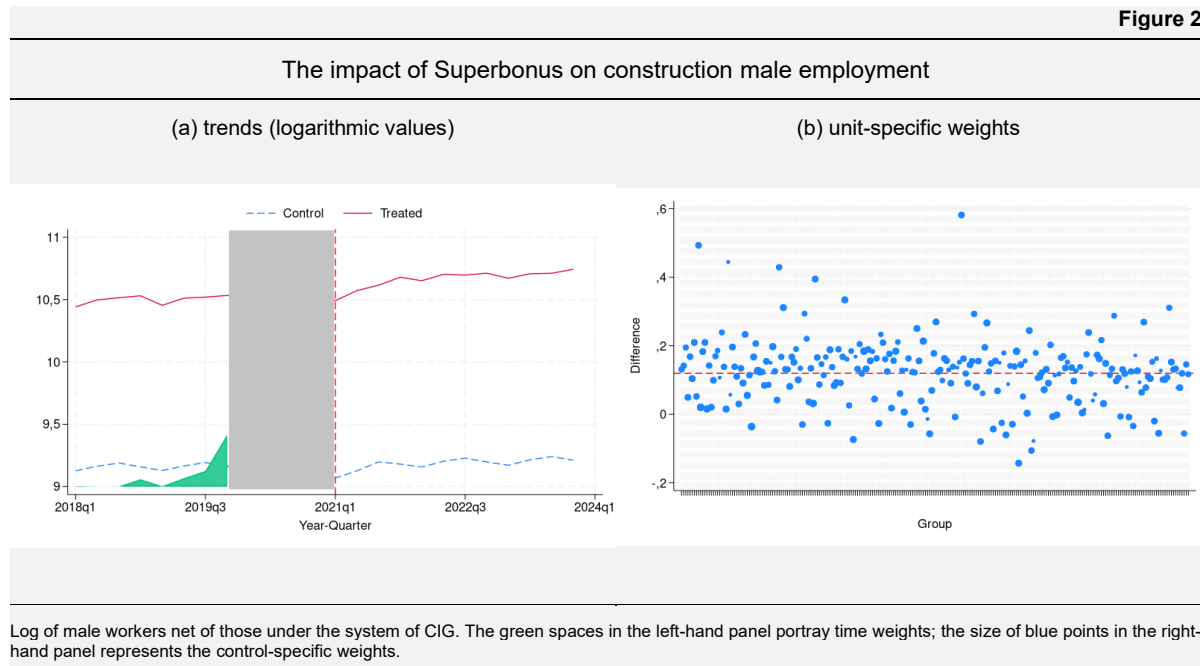
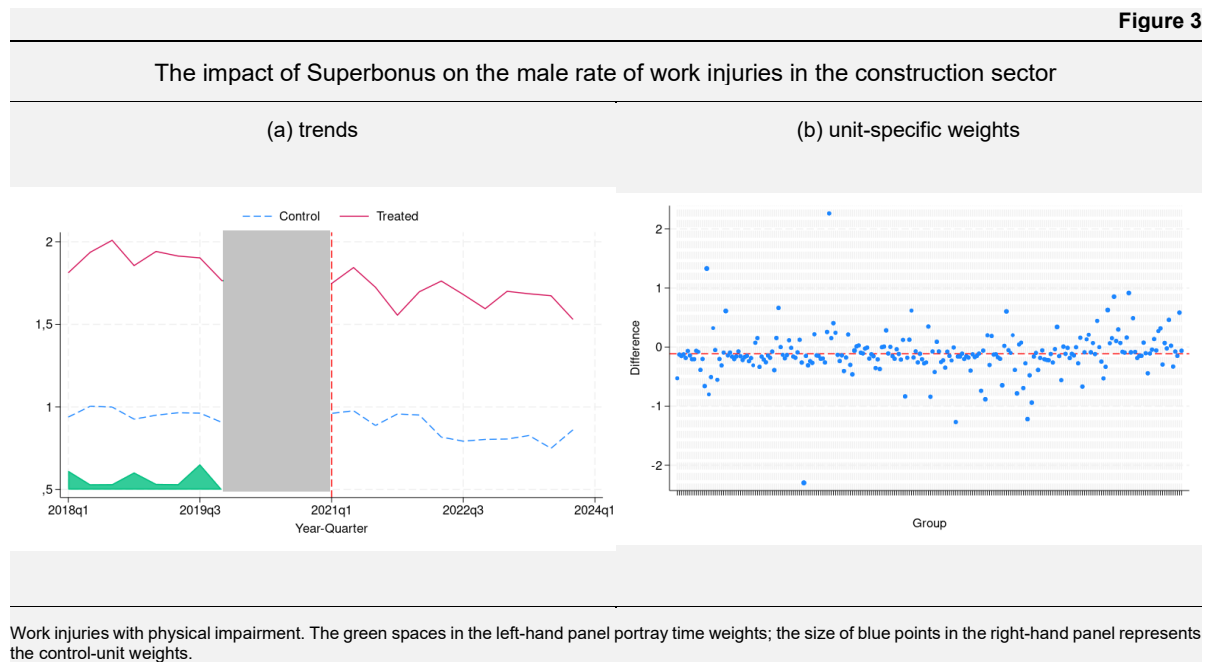


Figure 3



6. Discussion of the results

6.1 Mechanism

Our results indicate that, after the introduction of the Superbonus, the injury rate among male construction workers declined. We interpret this pattern as evidence of a Superbonus-

specific strengthening of compliance with safety rules in construction relative to other sectors. The key intuition is that in a high-demand, subsidized environment, violations that trigger sanctions or work stoppages become more costly. The subsidy, indeed, increased the marginal cost of non-compliance for construction firms as it increased the availability and profitability of construction contracts, thereby raising the opportunity cost of any interruption in activity (usually firms would be idle between one project and the next, but this was much less likely during the Superbonus period). This, in turn, makes a suspension of activities due to work accidents or safety-law infringements particularly costly.

This interpretation is non-trivial because construction activity and employment expanded sharply after the first quarter of 2021. In standard procyclical accounts, rapid expansions tend to increase injury risk as work intensity rises, and new or less-experienced workers enter the workforce. The fact that injury incidence nonetheless declined suggests that an offsetting compliance channel dominated.

Decree 146/2021 tightened enforcement economy-wide, but the Superbonus plausibly amplified deterrence specifically in the construction sector. It created a temporary period of high-margin opportunities and abundant demand, making any potential exclusion from the scheme due to safety violations exceptionally costly in a sector experiencing a policy-induced demand surge.

6.2 *The theoretical model*

To formalize this intuition, we rely on the canonical expected-penalty model of regulatory compliance, in which firms trade off compliance costs against the expected costs of enforcement (Becker, 1968; Polinsky and Shavell, 2000). The model predicts an increase in compliance as benefits (profits) increase.

In each period, a representative firm chooses a compliance intensity $e \in [0,1]$. The firm earns a per-period benefit $B > 0$ from operating (profits/rents from ongoing activity) and incurs a convex compliance cost $c(e)$, with $c'(e) > 0$ and $c''(e) > 0$. Non-compliance is summarized by a violation index $v(e) \geq 0$, with $v'(e) < 0$ (greater compliance reduces violations). Enforcement is probabilistic: with probability $p \in [0,1]$ the firm is inspected, and violations are detected.

If detected, the firm faces an expected sanction $F(B)$, assumed strictly increasing in the benefit of market participation: $F(B) > 0$, $F'(B) > 0$; this modelling choice captures that, when market rents are larger, the effective consequences of being sanctioned (e.g., work

stoppages, loss of eligibility, reputational losses, contract termination) are more costly in expectation. Expected profit is thus:

$$\Pi(e) = B - c(e) - p \times F(B) \times v(e).$$

The optimal compliance choice e^* solves $\max_{e \in [0,1]} \Pi(e)$ and, for an interior solution, satisfies: $c'(e^*) = -p \times F(B) \times v'(e^*)$. Because $v'(e^*) < 0$, the marginal incentive to comply increases in both the detection probability p and the sanction term $F(B)$, reflecting the standard deterrence logic of expected enforcement.

The Superbonus can be considered as a policy shock that (i) raises the benefit of operating in the construction market ($B \uparrow$) by expanding demand and rents, and (ii) may increase construction firms' perceived inspection intensity ($p \uparrow$) if the policy environment induces expectations of heightened enforcement. Under $F'(B) > 0$, the increase in B mechanically raises the expected sanction $F(B)$ and thus the expected cost of violations, while $p \uparrow$ raises the likelihood of detection; both channels shift construction firms' optimal choice toward higher compliance e^* , leading to a reduction in injury rates.

This mechanism helps explain the paper's central empirical pattern. Because injury rates were already declining economy-wide in Italy, the relevant comparison is not simply a fall versus no fall, but a relative improvement: the construction trend improves compared with a counterfactual built from other private sectors, consistent with the Superbonus strengthening deterrence and altering the behaviour of construction firms within an overall downward trajectory.

6.3 Heterogeneity

To verify that the observed decline in injury rates is attributable to the overall restrictive effect brought about by the Superbonus decree, this sub-section leverages the regional heterogeneity in the policy's adoption.

We exploit the regional and temporal heterogeneity in the diffusion of Superbonus-related works using the number of *asseverazioni* as a proxy for the local incidence of projects subject to the policy. These projects reflect the exposure to the policy than to overall economic activity: where they are more prevalent, larger effects are expected. By relying on this variation, we assess whether injury rates fall more in areas more exposed to Superbonus interventions. This provides further evidence that the observed decline reflects the mechanism activated by the policy rather than cyclical fluctuations in construction activity.

Table 2

The effect of Superbonus on the construction sector – geographical heterogeneity		
	Log of male workers	Male injury rate per thousand (physical impairment degree > 0)
Top regions	0.150 *** (6.80)	-0.133 ** (-2.33)
Bottom regions	0.095 *** (4.31)	-0.117 (-1.33)
Obs. (year 2020 excluded)	2,600	2,600

Authors' own estimation. * p<0.10, ** p<0.05, *** p<0.01; t-statistic in parenthesis. All models control for fixed effects at the level of the cell (interaction between sector and region) as well as quarterly dummies (time fixed effects); errors are clustered at the level of the cell.

Top (bottom) Superbonus regions are the regions with higher (lower) number of *asseverazioni* under the regime. Top regions are Lombardia, Veneto, Emilia-Romagna, Lazio, Toscana, Piemonte, Sicilia, Campania, Puglia and Sardegna; bottom regions are Abruzzo, Calabria, Umbria, Basilicata, Molise, Liguria, Valle D'Aosta, Marche, Friuli-Venezia Giulia, and Trentino-Alto Adige.

We therefore divided Italy's 20 regions into two groups based on Superbonus activity (measured by the number of *asseverazioni*) and estimated two separate SDID models: one for the ten highest-activity regions (top group), and one for the ten lowest-activity regions (bottom group). The results, reported in Table 2, indicate that in the most active regions there was a greater increase in male employment compared to the least active regions (15% and 9.5%, respectively). Regarding accidents, in the top group of regions the Superbonus is associated with a decline in the injury rate of 0.133 per thousand male workers (an 8.3% decrease relative to the 2018–2019 average) while in the bottom group the parameter results smaller and statistically insignificant.

Table 3

The effect of Superbonus on the construction sector – continuous treatment		
	Log of male workers	Male injury rate per thousand (physical impairment degree > 0)
Coefficient	0.142 ***	-0.102 *
t-statistic	(3.75)	(-1.96)
Obs. (year 2020 excluded)	5,200	5,200

Authors' own estimation. * p<0.10, ** p<0.05, *** p<0.01; t-statistic in parenthesis. This model controls for fixed effects at the level of the cell (interaction between sector and region) as well as quarterly dummies (time fixed effects); errors are clustered at the level of the cell.

To further validate these findings, we investigate the correlation between the use of Superbonus and the decline in the injury rate. We estimate a two-stage difference-in-differences model with the quarterly value of the number of interventions approved by ENEA at the regional level. The model includes region-sector and quarter fixed effects, with standard errors clustered at the region-sector level. The estimate indicates that each 1,000 additional interventions are associated with an increase in construction male employment and a reduction in the injury rate of 0.102 per thousand workers (Table 3). The magnitude and the 10%

statistical significance of this estimate, together with the heterogeneity described above, provide favourable evidence that the Superbonus policy’s implications led to a measurable reduction in construction workplace injuries.

To assess the credibility of the parallel trends assumption underlying the continuous-treatment estimator in Table 3, we estimate an event-study specification using the same two-stage difference-in-differences framework. Since the treatment variable (the number of *asseverazioni*) is zero for all units prior to the first quarter of 2021 by construction, we cannot directly use it as a time-varying dose in the pre-treatment period. We therefore interact a time-invariant regional exposure measure, defined as the average quarterly number of *asseverazioni* over the post-treatment period, with quarterly dummies, restricting this interaction to the construction sector. The resulting coefficients trace out the pre-treatment dose-response relationship: under the null hypothesis of parallel trends, they should be jointly indistinguishable from zero. Figure A7 in the Appendix plots the estimated coefficients for the pre-treatment quarters available in the sample. The pre-treatment coefficients are small, centered around zero, and statistically insignificant throughout. A joint Wald test fails to reject the null of no pre-existing differential trend ($\chi^2(7) = 5.48, p\text{-value} = 0.60$), supporting the identifying assumption of the continuous-treatment model.

6.4 Falsification test

The effects documented for construction could stem from factors common to all private sectors rather than from the Superbonus itself. We therefore conduct a series of falsification exercises: for every control sector, we re-estimate the SDID model assigning a fictitious treatment to that sector while retaining the remaining sectors as controls (including the construction sector). Under the null hypothesis that the policy did not affect the placebo-treated sector, the estimated coefficient should be statistically indistinguishable from zero.

Table 4 provides reassuring evidence in support of our main estimates. For the injury-rate outcome, which is the variable of primary interest, most placebo coefficients are statistically indistinguishable from zero. A few exceptions emerge in sectors G (wholesale and retail trade), J (information and communication), and K (financial and insurance activities), but these estimates are positive rather than negative and do not appear to map onto any plausible transmission channel of the Superbonus. Their sign pattern is therefore inconsistent with the compliance-deterrence mechanism discussed above, suggesting that these effects are more likely spurious than evidence of a genuine policy spillover. For employment, only a small number of sectors show significant positive estimates, notably J and M (professional

activities). These effects are not associated with a decline in injury rates and are more plausibly interpreted as reflecting post-Covid dynamics rather than a Superbonus-induced effect.

Table 4

The non-effect of Superbonus on other sectors		
	Log of male workers	Male injury rate per thousand (physical impairment degree > 0)
B - Mining and quarrying	-0.060 * (-1.82)	-0.023 (-0.09)
C - Manufacturing	-0.013 (-1.48)	-0.034 (-0.72)
D - Electricity, gas	-0.036 ** (-2.10)	-0.067 (-0.63)
E - Water supply, sewerage	0.032 (1.20)	-0.116 (-1.37)
G - Wholesale and retail trade	-0.047 *** (-5.19)	0.072 * (1.93)
H - Transportation and storage	-0.022 (-1.34)	-0.110 (-1.60)
I – Accommodation and food service activities	-0.067 *** (-3.30)	0.014 (0.45)
J – Information and communication	0.055 *** (2.84)	0.102 ** (2.12)
K – Financial and insurance activities	-0.046 (-1.61)	0.073 * (1.75)
M – Professional, scientific and technical activities	0.154 *** (14.02)	0.020 (0.58)
R – Arts, entertainment and recreation	-0.020 (-0.64)	0.083 (0.59)
S – Other service activities	-0.048 *** (-4.45)	-0.051 (-0.73)
Obs. (year 2020 excluded)	5,200	5,200

Authors' own estimation. * p<0.10, ** p<0.05, *** p<0.01; t-statistic in parenthesis. All models control for fixed effects at the level of the cell (interaction between sector and region) as well as quarterly dummies (time fixed effects); errors are clustered at the level of the cell. Construction is included in the control sectors.

Taken together, the placebo exercises do not suggest that the decline in the construction injury rate reflects an economy-wide trend or a mechanical artifact of the estimation procedure. Instead, the fact that the falsification tests overwhelmingly fail to detect significant negative effects on injury rates, while the few significant positive effects in employment have a natural alternative explanation, strengthens the internal validity of the SDID design and is consistent with the maintained SUTVA assumption throughout the analysis.

6.5 Other robustness checks

The validity of our findings is further assessed by complementary tests addressing alternative treatment timings and possible omitted variables. Specifically, we examine: (i) the impact of shifting the treatment period to the time when the law was enacted and to a pre-policy period; and (ii) the inclusion of workplace inspections and of the share of young workers as covariates.

Enactment of the law and anticipation effects – In the main analysis, we placed the treatment in the first quarter of 2021, coinciding with the start of the Superbonus expenditures. However, it is also useful to consider the introduction of the law in the third quarter of 2020, in order to assess whether similar patterns in work injuries emerge. Construction firms may indeed have perceived an urgency to comply from that time. For this estimation, the treatment is set in the second half of 2020, while the first semester is again excluded. All baseline parameters are confirmed, with minor differences (Table 5).

We also test for the absence of anticipation effects. It is unlikely that the Superbonus was anticipated by economic agents: the policy was suddenly introduced in response to the pandemic shock of March 2020 and could not have been foreseen by firms or households. We conduct a placebo test by anticipating treatment to 2019 and estimating its effects during that year, excluding observations from 2020 onward. The results are reported in Table 5. They indicate a 1.7% increase in employment, a magnitude well below the 12% estimate obtained in the main specification, and they do not show a corresponding decline in the injury rate. In particular, the absence of a negative injury-rate effect in the placebo period is consistent with the view that the main results are not driven by pre-existing trends or anticipation, but rather by the post-2021 policy environment under the Superbonus.

Table 5

The effect of Superbonus on the construction sector – alternative treatment periods		
	Log of male workers	Male injury rate per thousand (physical impairment degree > 0)
Treatment in 2020-Q3	0.113 ***	-0.122 ***
t-statistic	(8.15)	(-2.52)
Obs. (first semester of 2020 excluded)	5,720	5,720
Treatment in 2019-Q1	0.017 *	0.016
t-statistic	(1.77)	(0.21)
Obs. (from 2020 on excluded)	2,080	2,080

Authors' own estimation. * p<0.10, ** p<0.05, *** p<0.01; t-statistic in parenthesis. All models control for fixed effects at the level of the cell (interaction between sector and region) as well as quarterly dummies (time fixed effects); errors are clustered at the level of the cell.

Inspections and younger workers – As mentioned in the Introduction, changes in workplace inspection activity and in the share of low-experience workers can affect injury rates.

In Italy, the National Labour Inspectorate (INL) has primary responsibility for enforcing occupational safety regulations. Unfortunately, its data are incomplete for the period under analysis. Given the cooperative role of the Guardia di Finanza (GdF) with the INL in recent years, we use GdF data as a proxy for the intensity of safety surveillance²⁶. We construct a measure of the number of GdF inspections up to 2022, the last available year. These inspections cover a wide range of phenomena, for example criminal activities related to organized crime and irregularities in public spending, including workplace-safety compliance. We therefore capture the extent to which specific sector-region cells are exposed to public authority scrutiny on an annual basis²⁷.

While our data do not allow us to observe workers' previous labour-market experience, unemployment spells, or contract type at the required level, we can examine age composition using the share of young workers (under 35) per sector, quarter, and region. After the pandemic, the composition of the workforce has changed, with an increase in the share of younger workers. In the construction sector, this share rose from 26.1% on average in 2018–2019 to 26.5% in 2021–2023, while in the rest of the economy it increased from 27.3% to 28.1%.

Table 6

The effect of Superbonus on the construction sector – inspections and younger workers as covariates		
	Log of male workers	Male injury rate per thousand (physical impairment degree > 0)
Coefficient	0.111 ***	-0.125 **
t-statistic	(7.63)	(-2.02)
Obs. (year 2020 excluded)	4,160	4,160

Authors' own estimation. * p<0.10, ** p<0.05, *** p<0.01; t-statistic in parenthesis. All models control for fixed effects at the level of the cell (interaction between sector and region) as well as quarterly dummies (time fixed effects); errors are clustered at the level of the cell.
The sample period ends in 2022 as inspections data are not available for 2023. The younger workers regressor is the share of 15-34-year-old male workers.

²⁶ The data are made available through an information-exchange agreement between Banca d'Italia and the GdF; see Albanese et al. (forthcoming).

²⁷ The number of inspections in construction increased by almost 18% from 2018–2019 to 2021–2022, compared with 2% in the rest of the economy. While this suggests a stronger increase in inspection intensity in construction, the pattern is heterogeneous across sectors: some, such as wholesale and retail trade and professional, scientific and technical activities, increased even more, while others, such as manufacturing, declined.

Including these two variables as controls alters only marginally the estimated effect of the Superbonus (Table 6). The injury rate impact (-0.125 per thousand) is even slightly larger than the baseline estimate (-0.114). This suggests that the reduction in injuries in construction is not explained by regulatory oversight or by changes in the age composition of employment.

A further possible mechanism is that the Superbonus may have increased firms' investments in safety-related inputs. Since part of the cost of renovation works could be shifted to the public budget through the subsidy, firms may have had greater financial scope to adopt safer technologies, purchase safer equipment, or improve safety-related organizational practices. We do not have sufficiently detailed data on firm-level safety investments to test this channel directly. Nevertheless, this mechanism would operate in the same direction as the compliance channel discussed above: both would imply an improvement in workplace safety during the Superbonus period. Therefore, our estimates could be interpreted as capturing the overall policy effect, combining stronger incentives to comply with safety regulations and possible increases in safety-related investments, rather than isolating the compliance channel alone.

7. Conclusions

The introduction of the Superbonus generated a sharp expansion in construction-sector activity in Italy, with male employment increasing by 12% between 2021 and 2023. Despite the procyclical pattern of occupational injuries documented in the literature, the construction accident rate declined by 0.114 per thousand workers (-7% from the 2018–2019 average) relative to the counterfactual.

This pattern is consistent with a compliance channel activated by the Superbonus, complementing the economy-wide one introduced by Decree 146/2021. The Superbonus may have made compliance more valuable for construction firms: access to time-limited tax credits required documented adherence, and violations could trigger suspension or ineligibility. These features increased the payoff to safety and offset the injury risks due to the rapid increase in construction activity.

From a policy perspective, these findings demonstrate that conditioning economic stimulus on safety compliance can potentially deliver dual benefits: supporting investment while improving worker safety. Future policies in high-risk industries such as construction may therefore benefit from pairing verifiable safety requirements with credible, proportionate sanctions, so that worker protection advances alongside economic growth.

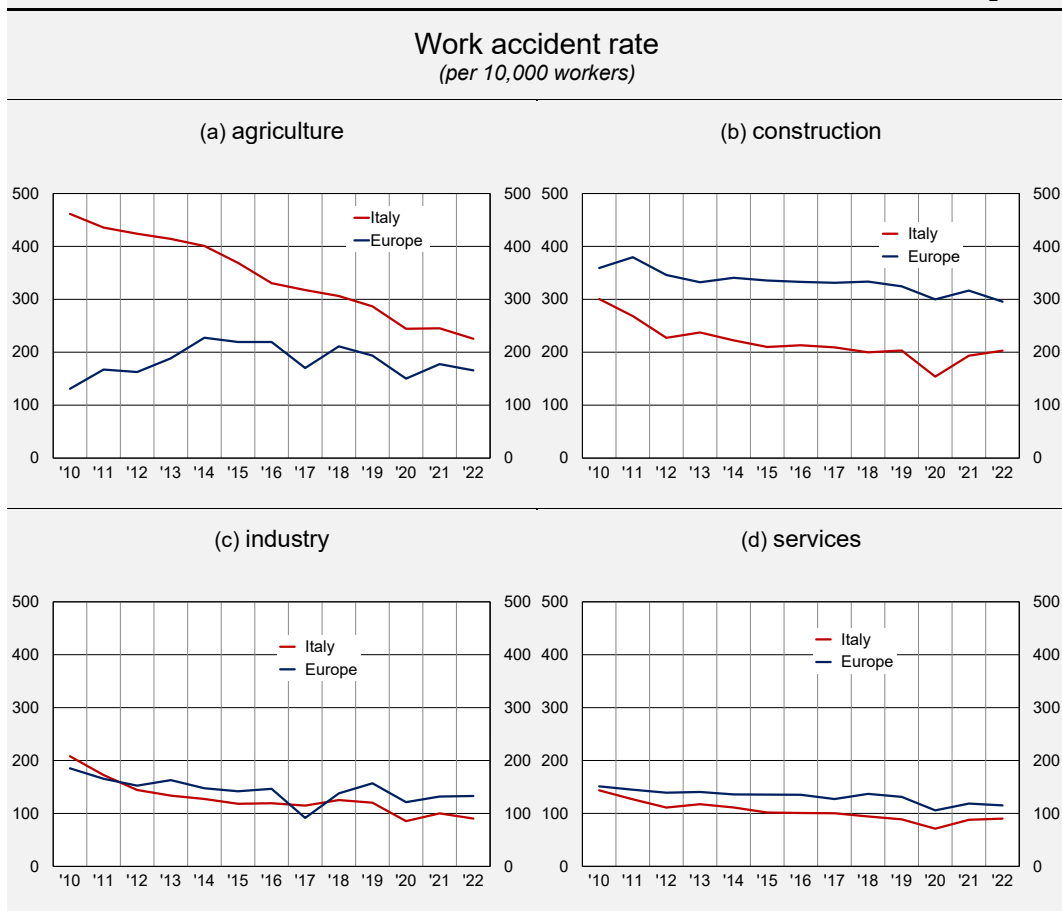
References

- Abadie A. (2021). “*Using Synthetic Controls: Feasibility, Data Requirements, and Methodological Aspects*”, *Journal of Economic Literature*, vol. 59(2), 391-425
- Accetturo A., Olivieri E., and Renzi F. (2025). “*Incentives for Dwellings Renovations: Evidence from a Large Fiscal Program*”, *Fiscal Studies*, vol. 47, 69–87
- Albanese G., David F., Giacomelli S., Linarello A., Mocetti S., Orlando T., and Scarinzi E. (forthcoming). “*L’economia irregolare in Italia: nuove evidenze dai dati granulari*”
- Arkhangelsky D., Athey S., Hirshberg D. A., Imbens G. W., and Wager S. (2021). “*Synthetic Difference-In-Differences*”, *American Economic Review*, vol. 111(12), 4088-4118
- Athey S., Clarke D., Imbens G., and Pailaňir D. (2023). “*On Synthetic Difference-In-Differences and Related Estimation Methods in Stata*”, *The Stata Journal*
- Barbieri T., Basso G., and Scicchitano S. (2022). “*Italian Workers at Risk During the COVID-19 Epidemic*”, *Italian Economic Journal*, vol. 8, 175-195
- Becker G. S. (1968). “*Crime and punishment: An economic approach*”, *Journal of Political Economy*, 76(2), 169–217
- Bena A., Leombruni R., Giraudo M., and Costa G. (2012). “*A new Italian surveillance system for occupational injuries: Characteristics and initial results*”, *American Journal of Industrial Medicine*, vol. 55(7), 584-592
- Castaldo A., Germani A. R., Marrocco A., Forti M., and Salustri A. (2024). “*Drivers and frictions of workplace accidents: an empirical investigation of cross-country European heterogeneity*”, *Applied Economics*, vol. 56(24), 2931-2946
- Cornelissen P. A., Van Hoof J. J., and De Jong M. D. T. (2017). “*Determinants of safety outcomes and performance: A systematic literature review of research in four high-risk industries*”, *Journal of Safety Research*, vol. 62, 127-141
- Corsello F., and Ercolani V. (2024). “*The role of the Superbonus in the growth of Italian construction costs*”, *Banca d’Italia, Questioni di Economia e Finanza*, 903
- Palma A., Depalo D., and Curci G. (2025). “*Air pollution and workplace accidents: Evidence and implications*”, *Journal of Public Economics*, vol. 252

- Fabiano B., Currò F., Reverberi A. P., and Pastorino R. (2008). “*A Statistical Study on Temporary Work and Occupation Accidents: Specific Risk Factors and Risk Management Strategies*”, Safety Science, vol. 46(3), 535-544
- Farina E., Bena A., Pasqualini O., and Costa G. (2013). “*Are regulations effective in reducing construction injuries? An analysis of the Italian context*”, Occupational and Environmental Medicine, vol. 70, 611-616
- Farina E., Giraudo M., Costa G., and Bena A. (2018). “*Injury rates and economic cycles in the Italian manufacturing sector*”, Occupational Medicine, vol. 68, 459-463
- Gariazzo C., Taiano L., Bonafede M., Leva A., Morabito M., de’ Donato F., and Marinaccio A. (2023). “*Association between extreme temperature exposure and occupational injuries among construction workers in Italy: An analysis of risk factors*”, Environmental International, vol. 171
- Gutiérrez-Falcón P. C. (2025). “*A systematic review of the relationship between economic growth and occupational accidents*”, South African Journal of Economic and Management Sciences, vol. 28(1), a6144
- International Labour Organization (2024). “*A call for safer and healthier working environments*”, Report N. 903140
- Marinaccio A. et al. (2019). “*Nationwide epidemiological study for estimating the effect of extreme outdoor temperature on occupational injuries in Italy*”, Environmental International, vol. 133
- Polinsky A. M., & Shavell S. (2000). “*The economic theory of public enforcement of law*”, Journal of Economic Literature, 38(1), 45–76

Appendix I: Additional tables and results

Figure A1



Source: Eurostat.

The rate is computed as the number of work injuries (including both commuting and workplace accidents) over the total number of regular workers. All workers are included in the denominator, including those temporarily inactive due to participation in work-supplementation schemes.

Figure A2a

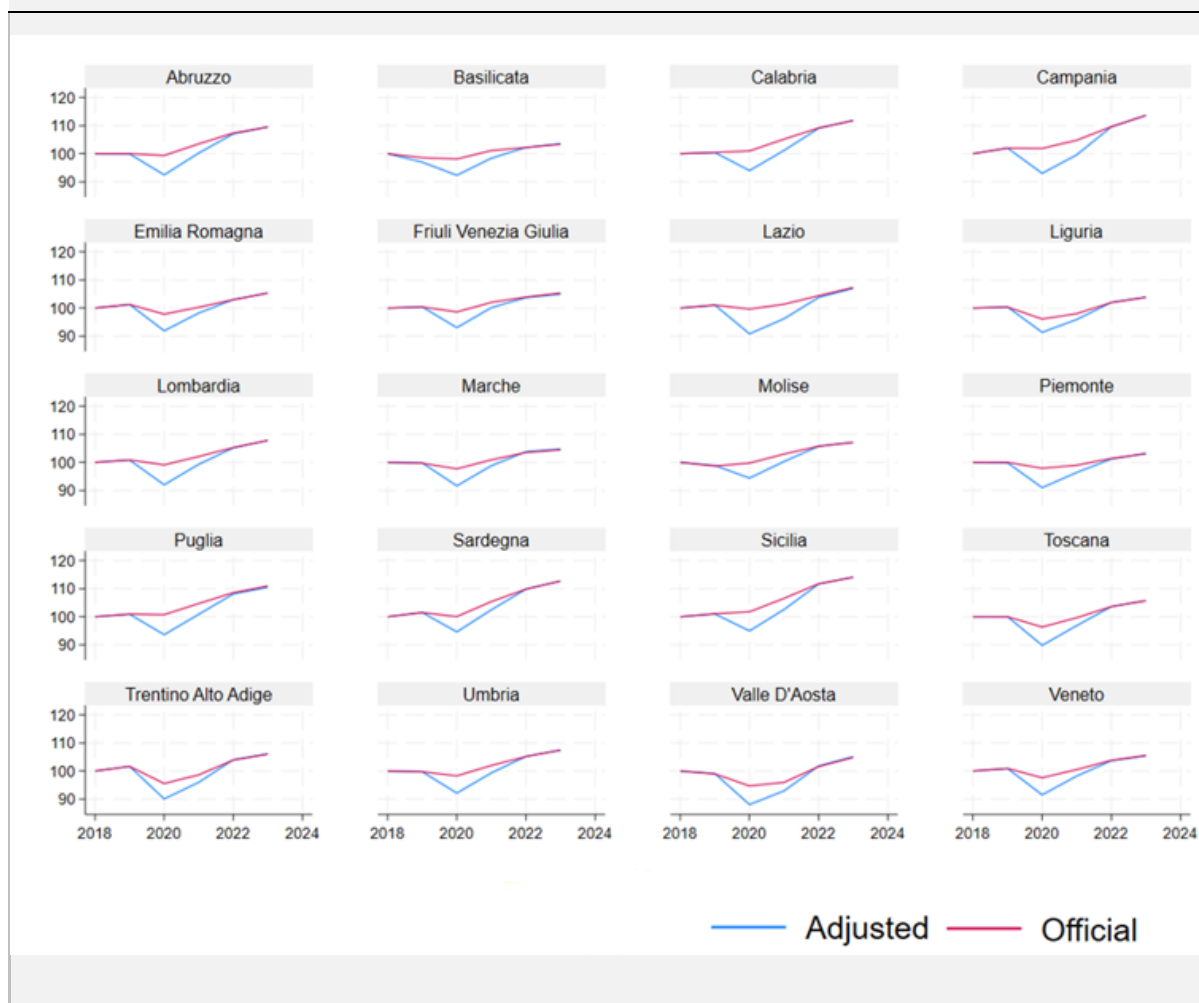
Total employment by sector
(index numbers: 2018=100)



Adjusted total employment comes from our elaborations, while official total employment comes from Istat data (Asia).

Figure A2b

Total employment by region
(index numbers: 2018=100)



Adjusted total employment comes from our elaborations, while official total employment comes from Istat data (Asia).

Table A1

The effect of Superbonus on the construction sector at national level

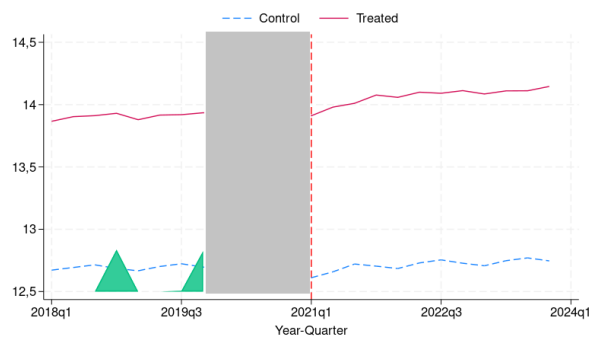
	Log of male workers	Male injury rate per thousand (physical impairment degree > 0)
Coefficient	0.111 *	-0.167 ***
t-statistic	(1.73)	(-3.70)
Obs. (year 2020 excluded)	260	260

Authors' own estimation. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; t-statistic in parenthesis. All models control for fixed effects at the level of the sector as well as quarterly dummies (time fixed effects); errors are clustered at the level of the sector.

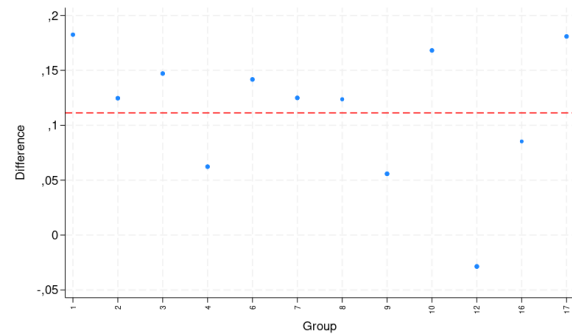
Figure A3

The impact of Superbonus on construction male employment at national level

(a) trends (logarithmic values)



(b) unit-specific weights

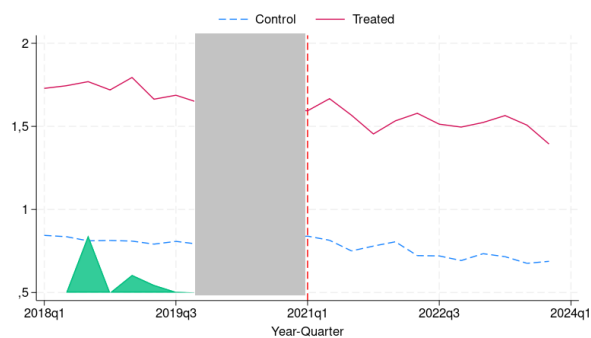


Log of male workers net of those under the system of CIG. The green spaces in the left-hand panel portray time weights; the blue points in the right-hand panel portray control-specific weights.

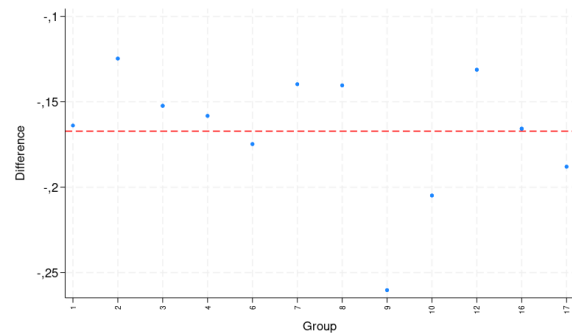
Figure A4

The impact of Superbonus on the male rate of work injuries in the construction sector at national level

(a) trends



(b) unit-specific weights



Work injuries with physical impairment. The green spaces in the left panel portray time weights; the right panel portrays control-specific weights.

Table A2

The effect of Superbonus on the construction sector – total employment

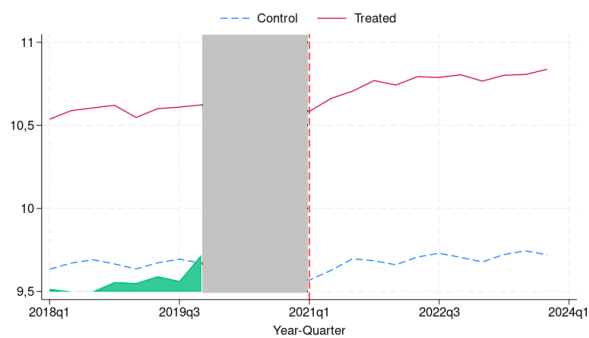
	Log of total workers	Total work injuries rate per thousand (physical impairment degree > 0)
Coefficient	0.130 ***	-0.112 ***
t-statistic	(9.16)	(-2.46)
Obs. (year 2020 excluded)	5,200	5,200

Authors' own estimation. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; t-statistic in parenthesis. All models control for fixed effects at the level of the cell (interaction between sector and region) as well as quarterly dummies (time fixed effects); errors are clustered at the level of the cell.

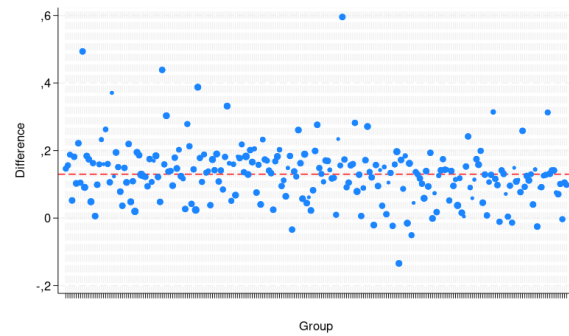
Figure A5

The impact of Superbonus on construction total employment

(a) trends (logarithmic values)



(b) unit-specific weights

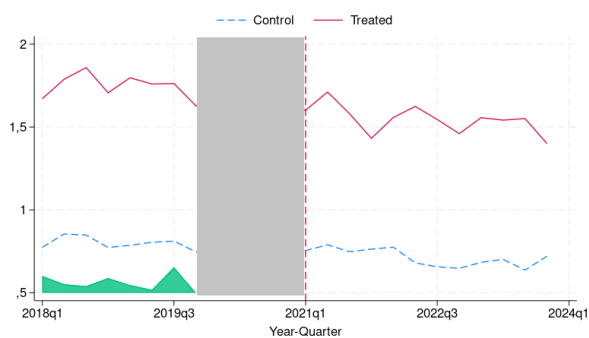


Log of total workers net of those under the system of CIG. The green spaces in the left-hand panel portray time weights; the blue points in the right-hand panel portray control-specific weights.

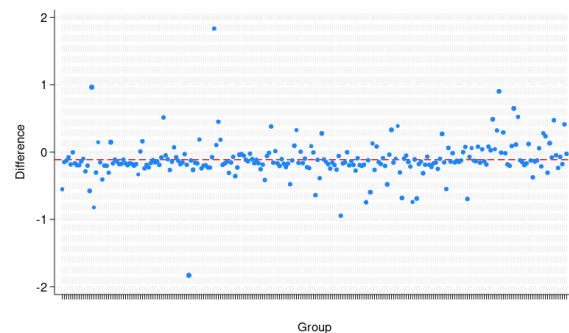
Figure A6

The impact of Superbonus on the rate of work injuries in the construction sector

(a) trends



(b) unit-specific weights



Work injuries with physical impairment. The green spaces in the left panel portray time weights; the right panel portrays control-specific weights.

Figure A7

Parallel trends test with continuous treatment

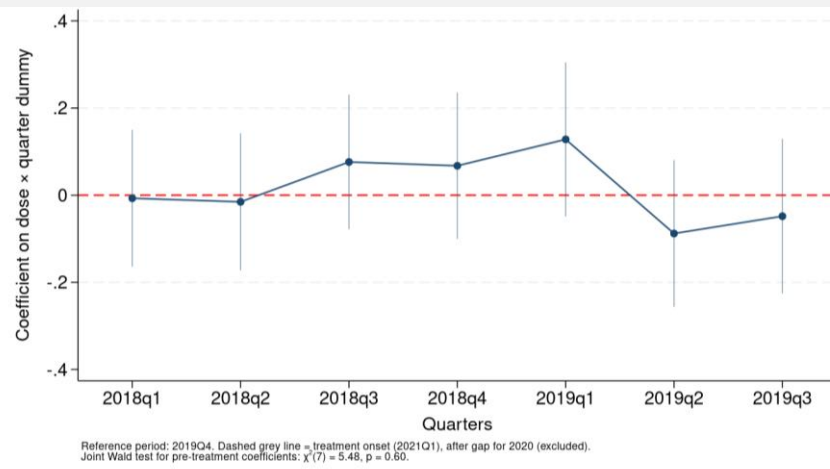


Table A3

Rate of work-related injuries among men, 2018-2019 averages by region and sector
(per thousand male workers)

	B	C	D	E	F(42)	G	H	I	J	K	M	N	R	S	F(41,43)
Abruzzo	1,0	1,3	0,3	2,7	2,4	0,8	2,1	0,8	0,4	0,2	0,2	0,7	1,4	1,0	2,4
Basilicata	0,4	1,2	0,6	2,0	1,8	0,8	2,1	0,7	0,8	0,3	0,2	0,8	1,9	0,4	2,0
Calabria	3,4	2,0	1,1	4,0	4,2	0,9	2,2	0,9	0,6	0,1	0,5	1,5	3,2	0,9	2,2
Campania	1,2	0,9	0,4	2,1	1,5	0,4	1,2	0,4	0,4	0,1	0,2	0,7	0,9	0,5	1,1
Emilia-Romagna	1,1	1,2	0,3	1,6	1,6	0,7	2,1	0,6	0,2	0,1	0,3	0,9	1,6	0,6	2,4
Friuli-Venezia Giulia	1,2	1,0	0,2	1,4	3,3	0,5	1,5	0,5	0,2	0,1	0,2	0,7	1,9	0,4	1,8
Lazio	0,7	0,7	0,3	2,5	1,4	0,5	1,1	0,4	0,2	0,1	0,2	0,5	0,6	0,4	1,2
Liguria	6,1	1,9	1,1	3,1	3,2	0,8	1,4	0,6	0,2	0,2	0,6	1,7	1,3	0,8	2,7
Lombardia	0,4	0,8	0,3	1,4	1,6	0,4	1,1	0,3	0,1	0,1	0,1	0,4	0,9	0,3	1,2
Marche	1,3	1,1	0,4	2,7	4,1	0,7	1,8	0,5	0,2	0,2	0,2	0,8	2,5	1,1	2,5
Molise	2,4	0,9	0,7	4,1	2,9	0,5	1,3	0,6	0,6	0,2	0,1	1,0	0,6	0,8	1,4
Piemonte	0,5	0,8	0,3	1,6	2,3	0,4	1,4	0,3	0,1	0,1	0,2	0,6	1,4	0,3	1,4
Puglia	2,8	1,2	0,2	2,7	2,8	0,6	1,6	0,4	0,4	0,1	0,3	0,9	1,5	0,7	1,8
Sardegna	2,2	1,6	0,2	2,6	3,7	0,7	1,9	0,7	0,3	0,1	0,3	1,0	1,9	0,7	1,8
Sicilia	1,4	1,2	0,5	2,7	2,4	0,5	1,7	0,4	0,3	0,1	0,3	0,9	1,2	0,6	1,8
Toscana	3,2	1,2	0,5	3,1	4,4	0,8	2,3	0,6	0,3	0,2	0,3	1,3	1,9	1,0	2,2
Trentino-Alto Adige	2,0	1,0	0,7	1,1	3,3	0,4	1,3	0,4	0,2	0,1	0,2	0,6	1,7	0,5	2,0
Umbria	0,6	1,4	0,5	2,3	4,7	0,8	1,9	0,7	0,3	0,1	0,1	1,1	2,7	0,9	2,2
Valle D'Aosta	-	0,8	1,6	0,8	2,3	0,3	2,6	0,3	0,2	-	-	0,8	0,3	0,7	1,7
Veneto	2,7	1,2	0,4	1,8	2,8	0,6	1,8	0,5	0,2	0,1	0,2	0,6	1,5	0,5	1,9

Source: Authors' own elaborations on INPS, Istat and INAIL data.

Table A4

Rate of work-related injuries among men, 2022-2023 averages by region and sector
(per thousand male workers)

	B	C	D	E	F(42)	G	H	I	J	K	M	N	R	S	F(41,43)
Abruzzo	1,5	1,1	0,8	2,6	2,7	0,9	1,8	0,6	0,4	0,0	0,2	0,6	1,2	0,9	2,1
Basilicata	0,8	1,0	0,5	1,7	1,7	0,7	1,8	0,6	0,5	-	0,1	0,8	1,4	0,7	1,8
Calabria	2,4	1,6	0,6	3,0	2,9	0,7	1,8	0,7	0,3	0,1	0,2	0,8	1,6	0,9	1,8
Campania	2,2	0,8	0,2	2,1	1,8	0,4	1,0	0,3	0,3	0,1	0,1	0,7	0,8	0,3	1,1
Emilia-Romagna	0,9	1,0	0,2	1,5	2,2	0,6	1,9	0,4	0,2	0,1	0,2	0,7	1,4	0,5	1,9
Friuli-Venezia Giulia	2,5	0,9	0,2	1,7	2,1	0,5	1,3	0,4	0,2	0,1	0,1	0,7	1,1	0,1	1,5
Lazio	1,7	0,7	0,2	2,6	1,4	0,5	1,1	0,3	0,3	0,1	0,1	0,5	0,5	0,4	1,2
Liguria	0,6	1,4	0,4	2,5	4,2	0,8	1,3	0,5	0,3	0,1	0,2	1,3	1,4	0,9	2,3
Lombardia	0,4	0,7	0,3	1,5	1,3	0,3	1,0	0,2	0,1	0,0	0,1	0,4	0,8	0,3	1,1
Marche	1,9	1,0	0,2	2,1	3,7	0,6	2,0	0,6	0,3	0,0	0,2	0,6	2,0	1,0	2,4
Molise	3,1	0,8	0,4	4,5	2,5	0,6	1,9	0,3	0,3	0,7	0,1	0,5	1,2	0,6	1,6
Piemonte	0,4	0,7	0,2	1,6	2,1	0,4	1,3	0,3	0,2	0,0	0,1	0,5	1,3	0,4	1,3
Puglia	2,1	1,1	0,6	2,4	2,2	0,5	1,5	0,4	0,3	0,1	0,1	0,9	1,3	0,5	1,6
Sardegna	1,8	1,0	0,4	2,2	1,8	0,5	1,2	0,4	0,4	0,0	0,2	0,5	1,2	0,6	1,2
Sicilia	0,8	1,1	0,3	2,8	2,7	0,5	1,4	0,4	0,6	0,1	0,1	0,6	0,8	0,5	1,6
Toscana	4,7	1,0	0,5	2,7	3,5	0,7	2,1	0,5	0,3	0,1	0,2	0,9	1,8	0,8	2,1
Trentino-Alto Adige	1,7	0,7	0,2	0,9	2,2	0,4	1,2	0,4	0,1	0,0	0,1	0,4	1,7	0,3	1,6
Umbria	0,9	1,3	0,3	1,7	2,7	0,7	1,8	0,5	0,2	0,1	0,3	0,9	1,8	0,6	2,1
Valle D'Aosta	-	0,9	-	1,5	1,8	0,6	1,7	0,3	0,4	-	-	0,4	0,2	-	1,3
Veneto	0,9	0,9	0,3	1,6	2,6	0,5	1,5	0,4	0,1	0,1	0,1	0,6	1,0	0,5	1,5

Source: Authors' own elaborations on INPS, Istat and INAIL data.

Table A5

Number of male workers in 2018 by region and sector (1)
(thousands)

	B	C	D	E	F(42)	G	H	I	J	K	M	N	R	S	F(41,43)	Total
Abruzzo	1	60	1	4	2	33	14	14	4	4	9	15	2	5	28	196
Basilicata	1	21	1	4	1	14	6	5	1	1	3	5	1	1	11	77
Calabria	0	21	2	5	2	47	18	17	4	4	11	11	2	4	23	170
Campania	0	141	4	17	6	162	82	62	19	14	35	51	9	16	78	696
Emilia-Romagna	1	313	4	11	7	141	75	57	25	23	39	63	10	17	87	874
Friuli-Venezia Giulia	0	78	1	4	1	29	16	13	5	6	8	14	2	4	22	203
Lazio	1	105	7	16	9	161	114	86	65	33	59	99	14	19	93	882
Liguria	0	45	2	6	3	42	52	24	6	7	10	14	4	5	31	253
Lombardia	4	634	12	24	13	345	171	122	94	74	119	180	17	36	211	2.057
Marche	0	101	1	5	1	44	16	16	6	6	11	14	3	5	29	260
Molise	0	9	0	1	1	6	3	2	1	1	2	2	0	1	6	35
Piemonte	1	249	5	11	6	120	56	39	31	24	33	51	5	14	84	731
Puglia	1	107	4	12	4	117	42	43	10	12	23	34	5	12	65	492
Sardegna	1	25	3	6	2	40	18	23	5	4	9	12	2	4	28	182
Sicilia	1	70	4	15	4	127	45	49	10	13	25	33	7	11	58	470
Toscana	1	197	4	11	4	118	47	56	17	18	29	37	8	13	76	636
Trentino-Alto Adige	0	53	3	2	2	38	16	28	8	6	9	11	2	3	32	215
Umbria	0	40	1	3	1	26	11	8	3	3	6	7	1	3	18	133
Valle D'Aosta	0	4	1	0	0	3	2	3	1	0	1	1	1	0	4	21
Veneto	1	368	4	13	7	162	76	67	25	23	37	57	9	16	105	971
Italia	18	2.643	66	169	77	1.776	881	735	338	279	477	712	104	191	1.089	9.554

Source: Authors' own elaborations on INPS and Istat data.

(1) Net of estimated CIG-impacted workers.

Appendix II: a review of the Synthetic difference-in-differences estimator (SDID)

Arkhangelsky et al. (2021) proposed the synthetic difference-in-differences estimator (SDID). Their method builds from both the difference-in-differences and synthetic control method (DID and SC), and, according to the authors, outperforms both.

The DID was the first method proposed in the literature; the SC was introduced later to overcome a main restriction of DID, that is the condition of parallel pre-treatment trends between treated and non-treated units. When this condition is not met, the DID estimate biases the treatment effect as the post-treatment difference between treated and controls cannot be compared to the pre-treatment one.

The SC implements a set of weights to construct a synthetic, counterfactual trend in the pre-treatment period that mimics the observed trend of treated units and makes it possible to estimate the treatment effect (see e.g. Abadie, 2021, for a deeper discussion). These weights account for how much each control differs from treated units at any time before the treatment

period. Thus, SC cannot include unit-specific effects, which are allowed in the DID regression²⁸.

The SDID exploits weighting to a greater extent than DID and SC do. The DID uses equal weights on control units and times, the SC puts unequal weights on controls but equal weights on times; the SDID uses different weights on both dimensions. Moreover, the SC uses only a few units as controls, giving them very large weights; SDID uses almost all observations (assigning positive and more uniform weights), thereby exploiting the heterogeneity across units to a larger extent.

The SDID closely resembles the SC model since a synthetic control trend is set up, but with time weights as a methodological advancement. Time weights are chosen by comparing the trend of each control unit before and after the treatment. The more the post-treatment trend of a unit is useful to explain its pre-treatment dynamics, the larger its importance and weight. Moreover, unlike the SC, SDID accepts unit-specific effects. These dummies account for unobserved heterogeneity between units and so remove a further degree of estimation bias.

For these reasons, Arkhangelsky et al. (2021) argue that SDID is preferable to SC. Moreover, the authors maintain that SDID should be preferred to DID even when the parallel trends condition is met, as the estimation of the treatment effect is improved by the addition of time-period weights²⁹.

²⁸ Time-specific effects can be included both in DID and in SC.

²⁹ For SDID implementation in Stata, see. Athey et al. (2023).