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Health shocks, labour market outcomes and access to public transfer programs: evidence from Italian administrative data

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Preface

A relatively high consensus has been produced so far on the relationship between individuals' health and labour market activity; in particular, the existence of a detrimental effect of health shocks on labour and socioeconomic status has been extensively proved. Despite this, the potential - short and long-term - mechanisms through which this association arises, remain pretty unexplored. By taking different perspectives, the thesis explores the role played by acute health shocks such as cardiovascular diseases (CVDs), on a variety of labour market outcomes. The Italian institutional setting, traditionally placed among the highly regulated countries[1], provides an interesting panorama where studying (i) the role of sickness insurance system and the potential economic consequences of an extended period at home; (ii) the post-shock employment and earnings opportunities observed over a long period of time, and finally, (iii) the substitutability and the opportunities offered by the available social security programs (SS programs).

The choice of cardiovascular shocks has an outstanding social and policy relevance. More than others non-commutable diseases (NCDs), also defined as chronic conditions by the World Health Organization[2], cardiovascular diseases pose a serious threat to societies. Despite the decreasing rate of mortality observed over the last 30 years, they still represent one of the leading causes of death in developed countries: premature deaths[3] in Europe count for 29% of all deaths among people under 65, irrespectively of gender (EHN, 2017)[4]. Moreover, aided by the ageing process, their rate of incidence has steadily increased in many European countries. Italy for exam-

[1] https://www.oecd.org/employment/emp/oecdindicatorsofemploymentprotection.htm

[2] Non-commutable diseases (NCDs) are defined as long duration resulting from genetic, physiological, environmental and behaviours factors. (https://www.who.int/en/news-room/fact-sheets/detail/noncommunicable-diseases)

[3] Premature deaths are defined as preventable cases through reduced exposure to behavioural risk factors and timely treatments

[4] Similar values are found in Italy, where the rate of mortality associated to ischemic heart diseases is 33.6% for men aged between 55 and 64 years old, while cerebrovascular events lead to a mortality of 27.3% (Ministry of Health, 2010).

ple, shows a percentage increase of new CVD cases between 1990 and 2015 of about 22.5% among men, while reaching 23.6% among women[5]. Surviving a CVD shock poses an undeniable challenge for the policy-makers: physical and mental impairments can strongly limit an individual's daily-life activities and working-capabilities, leading as a consequence, to a remarkable economic burden. Of the total expenses of CVD in the EU - estimated as €210 billion per year overall - 53% is due to direct health care costs, 26% to productivity losses and 21% to the informal care[6] (EHN, 2017). Health care costs vary widely across EU countries; in Italy, the value registered in 2015 is 11%, 2 percentage points above the EU average, and much higher than 3% of Sweden.

Overall, the socio-economic impact of CVD shocks is of primary importance in the policy agendas since, on the one hand, individuals' poor health significantly increase the public expenditure on health care and medical treatments; while on the other, it drives people into unemployment, poverty, and social exclusion when the country-specific institutional setting does not accommodate their particular needs. Hence, institutional differences represent a precious source of identification when studying the role and effectiveness of particular policy instruments. Recent comparative evidence on European countries has shown that labour responses to the same health shock can vary substantially across heterogeneous labour market, social insurance and healthcare system settings. Both García-Gòmez (2011) and Trevisan and Zantomio (2016) found stronger employment contractions in Nordic countries, typically characterised by generous disability programs (both in terms of access rates and replacement income) and high job mobility. Instead, few analyses have been addressed on Southern European countries, generally featuring highly regulated labour markets w.r.t. the Nordic ones. Appropriate policy recommendations should be drawn from alternative - often heterogeneous - institutional settings.

The research takes advantage of a recently available Italian administrative dataset - called WHIP&Health - where three different sources of data have been linked together. The baseline population is characterised by a 7% random sample drawn from WHIP archives (*Work History Italian Panel*), an employer-employee dataset containing a rich set of individuals and firm-level characteristics between 1990 and 2012. The details of all individuals' hospitalisations, provided by the Italian Ministry

[5]In Europe, new CVD cases were 4,467,489 (5,013,645) among males (females) in 1990 compared with 5,441,564 (5,842,358) new cases in 2015, showing a percentage increase of 21% (16%).

[6]"Informal care costs are equivalent to the opportunity cost of unpaid care. This opportunity cost is a measure of the amount of money that carers forgo to provide unpaid care for their spouses, friends or relatives suffering CVD" (EHN, 2017)

of Health, are collected from the hospital discharge registers (*Schede di Dimissione Ospedaliera*, in Italian) between 2001 and 2014. Despite being unavailable, the full version of the dataset includes work injuries and professional diseases collected between 1994 and 2014 by the National Work Injuries Insurance Administration (INAIL). Aside from some epidemiological contributions, few economic research have been addressed with WHIP&Health; then making the following analyses even more valuable.

Based upon this, the thesis explores three different research questions. First of all, by assuming - in a sense - a short-term perspective I study the role played by the length of sick leave absence to the continuity of the labour contract that is in place at the time of the CVD shock. Although sick leave is an instrument designed by policy-makers to prevent potential income losses related to bad health, it is also a channel through which the employer can be negatively warned about workers' productivity (Hesselius, 2007; Markussen, 2012). Indeed, the employer trade-off between firing costs, the amount of past human capital investments and the potential expenditure of retraining unhealthy workers, is undoubtedly a critical factor in prolonging an individual's working life. Apart from this, the Italian employment protection legislation concerning unfair dismissals and various supports for job maintenance such as reallocation of tasks or changes in working-hours for example, matters. All considered, the sign of the relationship between the time spent at home, potentially quite extended when a CVD shock occurs, and the residual length of the labour contract cannot be established a priori. If individual preferences together with reduced career opportunities and lack of employer accommodations might shorten the time left on that job, the strictness of the Italian EPL can push the relationship the other way around. The occurrence of the shock and its severity allows relaxing the possible concerns related to individuals' opportunistic tendencies. Moreover, the details about the timing of the CVD shock, the number of weeks in sick leave and the ending date of the labour contract (if it occurs by the end of 2012), will make survival analysis as the most suitable for our purposes.

In the second chapter, co-authored with my supervisors - professors Francesca Zantomio and Michele Belloni - we measure the long-term effect of acute health shocks on multiple labour outcomes up to 9 years later. Contrary to the bulk of work, usually exploring one to three years after that episode, we aim to analyse alternative dynamics which can only appear over time. As pointed out by Charles (2003), the effects of recovery health capital or the development of different forms of disability-specific human capital can appear over a longer observational window. At the same time, the role and the peculiarities of the studied labour market cannot be neglected. Thanks to generous sources of data, most of the attention has so far been placed on Anglo-Saxon and Northern European countries, typically characterised by a high job-mobility and low in-job protection legislation. Therefore, the Italian institutional environment turns out to be interesting case of study: if, in some cases a high employment protection - especially for workers in open-ended contracts and medium/large companies - can be favourable; for others, its rigidity and low rate of turnover can make the return-to-work, even in the long-run, increasingly difficult. To this aim, a *selection on observables* approach have been adopted. In particular - following Jones et al. (2019) - the identification strategy is implemented through a combination of Coarsened Exact Matching and Entropy Balancing matching procedures, followed by parametric estimation to get the Average Treatment effect on the Treated (ATT) on a variety of labour outcomes. Differently from the previous chapter, the advantage of selecting acute CVD conditions for identification purposes relates to their time-specific onset (Braunwald et al., 2015), in contrast to other health condition whose onset is instead hardly referable to a specific point in time.

Finally, considering the findings which are made apparent in the previous chapter, the last part of the thesis is devoted to the analyse of how the experience of an acute health shock may drive individuals' choices in terms of Social Security Programs. So far lots of effort has been placed on assessing the role of early retirement and disability benefits following health deterioration, while little attention has been addressed to studying the potential substitutability offered by multiple SS programs. When generous disability benefits are available, unemployment support is of short duration, and the labour market offers few opportunities in terms of reallocation and job protection, the demand for DI will be relatively high. On the contrary, countries where labour opportunities are more tempting than health-related programs, the request of DI will be lower. The institutional setting together with additional factors such as personal health, and individuals' economic conditions and preferences undoubtedly enter the decision-making process. The analysis of a peculiar labour market such as the Italian one, traditionally characterised by a long history of reforms, offers a non-trivial panorama where studying individuals' responses of SS programs to health deterioration. Moreover, the focus on blue-collar workers - featuring by little employability opportunities - makes their response even more ambiguous. As in the previous chapter, despite adapted to the new framework, the identification strategy is based on the so-called Conditional Independence Assumption (CIA); according to which, once a full set of observed characteristics is controlled for, the probability to experience the treatment can be considered as good as random.

Overall, the three chapters shed new light on the short and long-term economic consequences - as well as the channels through which they appear - following an acute health shock. In the context of an ageing population, general economic difficulties and strong pressures on public finances, a better use of the residual resources of middle-age and older workers is considered essential. Therefore, all the following findings will be a useful insight to feed the public debate.

Chapter 1

The relationship between sick leave and job-interruption: evidence from severe health shocks

Irene Simonetti *

Abstract: Based on new administrative data the paper investigates the role played by the *length of sick leave* under severe health conditions on the subsequent risk of leaving the job. On the one hand, sick leave is an instrument designed by policy-makers to prevent the potential income losses related to bad health, but on the other hand, it is also a channel through which the employer can receive negative signals in terms of productivity. When studying the link between health deterioration and labour market activity many institutional factors come into play. Hence, the Italian institutional setting - traditionally characterised by high levels of employment protection legislation (EPL), especially for open-ended contracts - is a good framework for the analysis. Results point out a significant, and negative, relationship between sick leave duration and the likelihood of a job-interruption: an additional week at home increases the instantaneous risk of exit of about 1.6%. Surprisingly, age-related differences and firm dimension do not change the effect of extended sick leave. Overall, our findings question the effectiveness of the employment-support measures, especially when chronic conditions strongly discourage individuals' working activity.

Keywords: sick leave, job-interruption, duration analysis, administrative data
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1.1 Introduction

Increasing the economic activity of unhealthy workers is one of the most important challenges faced by policy makers. When studying the link between health deterioration and labour market activity many institutional factors come into play. In Italy, a country characterised by high levels of employment protection legislation[1] (EPL) (see OECD, 1999; Boeri and Jimeno, 2005), several national and European directives are in place to facilitate individuals with reduced working capabilities to retain their job: unfair dismissals[2] and workplace adjustments such as reallocation of tasks or changes of contractual working hours are among the possibilities. However, despite their availability, the effective application of these measures depends strongly on the employer's trade-off between firing costs and the expenditure to keep unhealthy people working.

With this in mind, the role played by an 'extended sick leave' and its relationship with the subsequent risk of closing a specific labour contract - especially if it is characterised by a high level of protection - is not straightforward. When people experience severe health shocks such as cardiovascular diseases (CVDs), the time needed to recover and return-to-work can be pretty long. At the same time, sickness absence is often considered a proxy of an individual's level of productivity and thus, a negative signal for employers. Depending on the country-specific sickness insurance regulation, notable costs for both employers and employees may arise. Beyond the direct losses people face when the replacement rate of sickness benefits is lower than the 100% of previous earnings, indirect effects can also occur: the reduction of future expected earnings deriving from lay-off or lack of promotions is often strongly related to the worker's history regarding sick leave (Hesselius (2007), Markussen (2012)). From the employers' perspective instead, the longer the time spent at home by the unhealthy worker, the higher the costs faced. Indeed, together with the sizeable productivity losses and additional expenses derived from sick workers' temporary replacement, employers usually pay - along with the Italian Social Security Institute (INPS, in Italian) - a percentage of earnings during illness periods (the so-called "sick pay").

This paper analyses the role of sick leave *duration*, under specific health conditions, in speeding up the exit from the specific job. On the one hand, the strictness of the Italian employment protection legislation and thus, employer's duties in terms of workplace adjustments, can lead to a positive - or even null - relationship between the two components. On the other hand, a variety of factors such as task difficulties, dismissal, reduced careers opportunities, and lack of employer accommodations would instead explain a shortening of the time left on that job. Although unable to disentangle the multiple channels through which such an early exit may occur, the resulting individuals' and social costs can be very high: discontinuous working careers, an increase of social

[1] According to the OECD Employment Protection Index, on a scale of 5 points (stringent EPL), the *Strictness of employment protection*(regular contracts) along the first decade of 2000, the value for Italy is equal to 2.76; while in the UK is stable to 1.26.

[2] A dismissal is unfair unless it is for a just cause (no notice required) or a justified motive (notice required) (see art. 1 and 3 Act 604/1966 and art. 2119 CC.)

security supports' recipients or early-exit from the labour market, are among the possibilities.

Evaluation of the link between sickness absence and a variety of labour market outcomes has often been impeded by one main challenge: the endogeneity of sick leave arising from many unknown factors, especially underlying health conditions. That is why the largest part of this literature has often focussed on assessing the role of hidden opportunistic behaviours rather than its actual effects on workers' careers. National reforms aiming to create a more efficient system of sickness benefits have often been exploited for this purpose (Johansson et al. (2002), Puhan et al. (2010), Ziebarth (2013)). By sampling workers hit by a severe form of CVD shock, a plausible relationship between the length of absence and people's underlying health conditions comes out. Moreover, retrospective information, covering almost fifteen years before the occurrence of the selected health event, have been extensively explored in order to partially take into account the prior health status as well as individual's labour market attachment. To the best of our knowledge, this is among the first papers exploring the survival rates in a specific labour contract and its relationship with a tricky instrument such as sick leave. Rather than looking at the probability of unemployment as an outcome variable, we claim that the "time until a job-interruption occurs" is better able to capture the effectiveness of the employment protection legislation, especially when open-ended contracts are considered. Finally, besides the need to ensure homogeneity among categories of workers receiving sickness benefits from the Italian Social Security Institute (INPS), the choice of blue-collar workers has also a notable policy interest. According to the European Labour Force Survey data (EU-LFS), the percentage of blue-collar men reporting "own illness or disability" as the main reason of leaving the last job is almost always double than that of white-collars (Figure A2 in Appendix): this is potentially related to the type of jobs, often demanding, carried out by the former group of people.

The research takes advantage of a newly available dataset, called WHIP&Health, that links the work histories of a 7% random Italian population from 1990 to 2012, together with individuals' hospitalisations sourced from the hospital discharge registers. In particular, a set of 1354 male and permanent blue-collar workers has been selected. In addition to being affected by a severe CVD shock in a year between 2003 and 2005, the sample selection also guarantees that they have not experienced similar health shocks in either of the two previous years, reassuring that the time spent at home cannot be the result of severe past illnesses (at least in the recent past). The precise information regarding the time of the CVD shock, the weeks in sick leave and the ending date of the labour contract (if it occurs by the end of the observational window) allows computing the distance between the time an individual return to work and the expiring date. Upon this framework, Cox's proportional hazard models are particularly suitable to describe the direction and the magnitude of the studied relationship. As previously stated, a variety of possible situations may occur, and thus, the direction is not straightforward. The first set of results, where the effect of sick leave is kept constant among different age groups, shows that a unitary increase in the number of weeks at home is associated with the significant growth of the instantaneous risk of exit from that job of about 1.6%. This finding suggests that, despite the legislative attempts to guarantee protection to unhealthy workers, the Italian labour market does not sufficiently help people with reduced working capabilities to continue working. The second part of the analysis takes advantage of the interactions between sick leave and different age groups to assess, if and how the role of a prolonged absence differs by age. Surprisingly, notable differences do not appear between the three younger age groups and the oldest one, i.e. those between 56 and 64 years old. Irrespectively of age, the experience of a CVD shock has undoubtedly negative consequences on individuals' labour market participation, raising questions about the appropriateness of the Italian EPL. Finally, although the effect of sick leave is found to be similar across firm size, this variable is instead relevant *per se* in shrinking the remaining duration of the labour contract. An easier reallocation of tasks together with different legislations in terms of dismissal costs, are some of the possible explanations.

The following section provides a brief overview of the past literature, while Section 1.3 defines the institutional background upon which the research idea is based. Section 1.4 extensively describes the dataset, the sample selection criteria, the available variables and some related issues. Section 1.5 illustrates the econometric approach and the baseline setup. The empirical results and some sensitivity checks are available in Section 1.6 and 1.7. Finally, the conclusions are in Section 1.8.

1.2 Literature Review

The relationship between sickness absence measured under severe health conditions, and the time until job-interruption occurs is a rather new field of research. Besides the huge literature exploring the moral hazard behaviours arising from different sickness insurance systems, a variety of additional fields are covered. Some studies focus on its link with the increase of unemployment risk/loss of earnings; some others instead, look at the strength to which employers' accommodations can help disabled people to keep on working as well as their fruitful (or not) implementation. To enrich the subsequent discussion, throughout this section the main findings of all these fields of research will be briefly covered.

In general, many direct and indirect costs can arise from sick leave absence. The formers depend on the replacement rates ensured by the country-specific legislation: the higher this rate is, the lower the income loss faced by ill workers. The indirect costs instead, arise from the losses in future expected earnings both in terms of increased layoff probability or missed careers opportunities. As shown in Schön (2015) by using the German Socioeconomic Panel (GSOEP), sick days are a strong predictor of unemployment. This is also confirmed for Italian workers by Scoppa et al. (2014). The idea is that more time spent at home increases the probability of being tagged as a less productive worker or a shirker (Hesselius (2007)). Thus, people who are less "absence-prone" are also more likely to remain employed in recession times. According to Markussen (2012), although sick leave should help unhealthy people to recover and go back to their job, it may often be a trap. Interestingly, by exploiting the number of certificates granted for sickness - proxy of the leniency of worker's physician - as an instrument for sick leave, he found that a one percent increase in sick leave is associated with a 1.2 percent reduction in earnings two years later, together with an increase of about 0.5 percentage points in the probability of being employed.

Complementary to these works, there is a wide literature concerning worker absenteeism and its moral hazard peculiarities, in relation to individual and labour characteristics. With respect to gender differences, Barmby et al. (2002) develop an interesting international comparison by using EU-LFS data, showing how women have higher absence rates than men in most of the countries; moreover, as expected, similarities are found among older individuals, who face increasing difficulties also due to the 'ageing process'. On a different perspective, Pfeifer (2013) explores the absenteeism phenomenon among private sector, public sector and self-employed workers. First of all, in line with the research exploiting the pro-cyclical trends of sick leave with the country-specific economic situation (Arai et al. (2005), Askilden et al. (2005), Schön (2015)), he confirms how regional unemployment rates are negatively correlated with the number of absent working days; and it is true for private, public and self-employed workers. Public sector employees, typically characterised by stronger job-protection rules, have the highest rates of absenteeism; they are followed by private-sector workers and finally by self-employed workers. Focusing on Italian public employees, De Paola et al. (2014) found that an Italian Law passed in June 2008, aiming to reduce sick leave compensation and increasing the monitoring of absences, has negatively affected workers' opportunistic behaviours, especially among those facing the highest-earning losses. Similarly, Puhani et al. (2010) evaluate the effects of a reduction in sick pay from 100% to 80% of the wage in Germany; while Johansson et al. (2002) explore Swedish blue-collar workers. Finally, heterogeneities in the type of contract have also been extensively studied by the literature (Leombruni (2011)): workers with temporary contracts take fewer absences than workers with permanent agreements.

A parallel and growing literature since the middle of 90s, focuses on the employers' provided accommodations and their role in improving the employment of people with disabilities. Burkhauser et al. (1995) are among the first exploring in detail that part of the "Americans with Disabilities Act" (1990) regarding the duties of employers to provide a reasonable placement for workers with disabilities. In particular, it is shown that workplace adjustments are as important as the individual's expectations with respect to the replacement rate of the Social Security Disability Insurance. In a similar vein, Burkhauser et al. (1999) test the importance of these two vectors on the timing of applications for disability benefits, showing how they act in opposite directions. Interestingly, Campolieti (2005) argues that only certain types of arrangements, like a flexible working schedule or modified workplaces, are associated with a significant increase of employment duration. By focussing on women treated for breast cancer pathologies, Neumark et al. (2015) brings additional evidence on how the type of workplace arrangements can also matter: some types of accommodations such as "assistance with rehabilitative services" bring positive spillovers to women labour supply, while some others like a shorter workday, schedule change etc. push instead negative effects. A recent paper by Hill et.al (2016) states two main points: first of all, there are personality traits such as assertiveness and open communication that are highly predictive of the likeliness to receive a new placement by employers, suggesting how employers can sometimes not even be aware of those needing some workplace arrangements. Moreover, they also find that if employer accommodation rates would have increased, disabled workers would be significantly more likely to delay labour force exit for up to two years. Finally, Anand et al. (2017), by using a sample of people with disabilities who applied for vocational rehabilitation services in three American states, first assess how one-third of reported difficulties (i.e. lack of transportation and an inaccessible workplace) could be potentially addressed by workplace accommodations. Even more interesting are the differences reported by demographic characteristics in perceived barriers. In particular, workplace accessibility is perceived as an employment barrier by those who have lower levels of educational attainment, in poor health and report a physical disability.

Upon the occurrence of an acute health shock, how a *prolonged absence* can affect individuals' working career? Is there sufficient protection against dismissal? Besides the administrative information about health shocks - a significant advantage compares to the previous analyses - the paper approaches a novel research question where many institutional (and not) factors come into play. Dismissal, loss of employability and/or working opportunities could increase the risk of exit from the labour contract, while appropriate on-the-job accommodations could help unhealthy workers to deal with the remaining working life. That is why the institutional setting is extremely important in this type of analysis and thus, throughout the following Section, few remarks on the Italian institutional context will be provided.

1.3 Institutional Framework

As outlined in the previous sections, Italy is undoubtedly among the countries with the strictest employment protection legislation (EPL) (Scoppa et al. (2014)). However, when asking the main reason for leaving the last job, Figure A2 in Appendix depicts notable differences in answers among blue and white-collar employees. This suggests how some types of workers - and jobs - are more vulnerable than others when health deterioration occurs. In this section, key features of the Italian system will be briefly revised: from the baseline regulation concerning sickness insurance to the employment guarantees offered to people with and without certified disabilities, up to the employer's costs of running "justified dismissals"[3].

[3]Under art. 2119 C.C., 'just cause', in broad terms, requires very grave conduct which, when evaluated both subjectively and objectively, constitutes a serious and irremediable reason that prevents the parties to continue the employment relationship even on an interim basis. Whether such a breach has occurred would normally have to be determined ultimately by a court, taking all relevant factors into account.

1.3.1 Sickness Insurance in Italy

A crucial aspect of the Italian sickness insurance system, which is similar to that of most European countries, is that both the public insurer and the private employer are key players: both of them, according to different percentages, must compensate a worker's earnings during his/her absence due to illness. This aspect is crucial within this context of analysis. During the first three days at home, the employer must pay the full wage to sick workers. From the 4th to the 20th days, conditional on a physician certificate (usually provided by the general practitioner (GP)), half of the usual[4] earnings are paid as sickness benefits by the Social Security Institute. From the 21st day up to a maximum of six months, the share rises to two thirds. The majority of the Italian Labour Collective Agreements entrust the employers to cover the remaining part of earnings through the so-called sickness pay [5]. In light of this, when full replacement of earnings is granted to employees, monitoring their real health conditions becomes an important tool. Home visits can be required by both the public insurer and the employer; the latter must pay about 60 euros per visit. As stressed by Biscardo et al. (2019) the employer has multiple reasons for administering home visits: first of all, he is personally involved in payments together with the social security institute; second, he is also encouraged by the increasing organisational costs, especially in cases of long-term absences. According to the baseline regulation, throughout the period of sick leave coverage - called "comporto" in Italian - the ill worker keeps the rights to his job. The Italian laws, together with each specific national collective agreement, defines the maximum period of coverage. Once the time is expired and the worker is still out of work, the employer can theoretically proceed with a lawful dismissal. In most cases, sick workers can extend the period of absence asking for the available vacations or unpaid "time-off work". Despite these guidelines, exceeding the comporto does not automatically lead to a lay-off as the existence of a justified reason must always be verified.

1.3.2 Illness and job retention rights

The Italian rules concerning the employment protection of people with long-lasting illness or reduced working capabilities, i.e. individuals unable to perform their previous job tasks, are rather unclear. Where legislative voids arise, erroneous or subjective implementations arise first, and then potential negative consequences not only for sick employees may occur: an unclear definition of the employers' duties regarding professional integration and reintegration of unhealthy workers may have damaging results on the whole system.

Even before the 90s, the awareness of discriminatory situations on the labour market deriving

[4]Sickness benefits are computed on the earnings received by the worker during the four past weeks prior to the onset of the disease

[5]As defined by a policy report of the European Commission (Spasova et al. (2016)) "sick pay is the continued, time-limited, payment of the worker's salary by the employer during a period of sickness", while "sickness benefits are provided by the social protection system and are paid as a fixed rate of previous earnings, or a flat-rate amount"

from health conditions and disabilities was widespread. According to the Article 15 of the Charter of Worker's Rights, any actions such as layoffs, discriminatory assignment of tasks and qualifications, transfers, disciplinary sanctions are null when driven by political, religious, language, sex or disability discriminations. The law 104/92 settled a comprehensive institutional framework to promote the assistance, social integration and rights of persons with disabilities. However, the first attempt to exclude "illnesses" among the reasons for a justified dismissal comes from the Law 68/1999: more precisely, Article 4 refers to disabled workers who become unable to perform their previous job tasks; in this case, they must be reallocated inside the firm without losing the previous economic power. If workplace adjustments are unavailable, they are driven toward different companies where their remaining working capabilities can be better used. Despite the initial purposes and all the refinements defined by subsequent laws (D.L. 216/2003 following the EU directive 2000/78/EC), their effectiveness is prevented by regional implementations. Each region, and often each province, independently manages how these directives must be performed and how to coordinate all related activities. The lack of a clear and univocal national guideline makes it difficult to run any functional employment support initiative.

As additional consideration, the distinction between people with and without certified disabilities is crucial for their application. While disabled individuals are strongly protected against an unlawful dismissal this is not the case for others, who are instead formally subjected to the same rules as the healthy workers. Thus, a more targeted legislation addressed to people with, for example, chronic conditions is still missing. Some exceptions are the following: cancer patients can request a switch from a full-time to a part-time contract (Art.46 D.L. 276/2003), or public-sector employees with cancers can also ask to work from home ("Circolare" 30 April 2009). A step forward in increasing the employment protection of people with reduced working capabilities is the legislative decree 81/2008. According to Article 41, "in case of an absence due to ill health lasting more than sixty consecutive days, it is necessary to check the sustainability of the worker to perform her/his task by a medical examination". Moreover, the next paragraph (the number 42) states the employer must assign the worker to a different, but equivalent, task; if this is not possible, the assignment to a lower duty is also allowed ensuring the previous level of income. In general, the dismissal of an employee with reduced capabilities resulting from a chronic disease is only possible when the employer is unable to find alternative job tasks which are suitable to worker's health conditions whilst always ensuring the good performances for the company. As it is often the case, when room is left for interpretation, a judge must decide how each unique situation must be dealt with. However, since such legal procedures are often costly, the employer's trade-off between the costs of workplace adaptation and the costs of dismissal is crucial and must always be well considered.

1.3.3 EPL and firm's costs

The baseline regulation on sickness insurance comes beside the employment protection legislation (EPL) concerning an "unlawful dismissal". The idea of just cause has been extensively defined by the Italian legislation starting from 1970; however, significant differences between small or large firms persist[6]. According to Article 18 Law 300/1970, part of Charter of Worker's Rights, job reintegration's rules are valid when a firm has more than fifteen employees, or six in the case of agricultural firms. In particular, when the dismissal is judged "unfair" the worker is allowed to receive the following payments: a) all the foregone earnings from the period between dismissal and judgement; b) the worker can also decide to either receive an extra financial compensation (corresponding to 15 monthly payments), or to be reinstated inside the firm (Scoppa et al. (2014)). On top of this, the employer must pay all the legal costs together with the penalty for the delayed payment of social security contributions. Thus, large firms face the risk of a costly trial with uncertain outcomes whenever firing a worker becomes necessary (Ichino and Riphahn, 2005). The Charter of Worker's Rights did not mention firms with less than fifteen employees. Despite a subsequent laws extended the criterion of "just cause" to all type of firms, irrespective of their dimension, different regimes of sanctioning are still in place: the employers of small firms may chose between the reintegration of the worker or the payment of a financial compensation ranging between 2.5 and 6 months. In light of this, the incentives for individuals and firms to behave differently according to the firm's dimension are relevant.

1.4 Data and Descriptive Statistics

1.4.1 Dataset and sample selection

The research is based on WHIP&Health, an Italian administrative dataset where both health and work histories are collected over time. The baseline population is characterised by a 7% random sample drawn from the *Work History Italian Panel* (WHIP) including a rich set of individual and firm-level characteristics between 1990 and 2012; neither the public nor the agricultural sectors are included. Gender, age, region of birth, area and region of work, the initial and final date of each employment spell, labour income and most importantly, all sickness episodes (paid and unpaid), are among the available information. In addition, information on retirement and other forms of social security benefits (invalidity, unemployment benefits etc.), are also observed. Individual's

[6]Legal safeguards have been reduced since 2011. The 'Fornero-Monti' reform of employment, which came into force in July 2012, rewrote in total article 18 of the Workers' Statute, providing different regulations for different types of dismissal. Its most relevant novelty concerns the possibility for a firm with more than 15 employees to dismiss workers for economic reasons. In this type of dismissal, the employee cannot claim his job back and has only right to an indemnity ranging from 12 to 24 months of salary, the sum being decided by a court. The Fornero-Monti reform thus lessened the restrictions to firing In Italy significantly.

health characteristics are linked with this "employer-employee" database: in particular, the details of all hospitalisations coming from the regional hospital discharge registers (Schede di Dimissione Ospedaliera, SDO) and provided by the Italian Ministry of Health, are collected between 2001 and 2014. The main variables are the primary diagnosis (defined according to the ICD-IX codes) and the length of reference hospitalisation. Despite unavailable, the full version of the dataset includes work injuries and professional diseases recorded between 1994 and 2010 by the National Work Injuries Insurance Administration (INAIL).

The target population is characterised by male workers aged between 18 and 64 years old, who were hospitalised for an acute form of cardiovascular shock - not resulting in death - in a year between 2003 and 2005. More precisely, myocardial infarction and other forms of coronary heart diseases and strokes have been selected (the details of ICD-IX codes is available in Appendix, Table A1). Although no additional restrictions are imposed from the reference hospitalisation onwards, according to the sample selection criteria it is the first hospital admission observed (for a CVD shock) since two years. These conditions become essential requirements for our identification strategy due to the possible endogeneity concerns arising from the main independent variable, i.e. the total number of weeks in sick leave at time $\bar{t}$ with a specific employer (the reference labour contract[7]). The analysis takes advantage of the severity of CVD shocks[8] to control - to some extent - the omitted information related to individuals' attitudes, preferences and unknown health that might be reflected on sick leave as well as on the outcome variable, and thus resulting in biased estimates. On this background, the experience of the first CVD shock since two years allows to better circumscribe an individual's health status and its link with sick leave in a specific point in time.

Furthermore, to reach a homogeneous group of people, both in terms of socio-economic characteristics and institutional framework[9], we only consider blue-collar workers at the time of the reference CVD hospitalisation. Finally, in order to increase both the internal and the external validity of our results, we explore blue-collar workers with *permanent contracts*[10]: besides the constraints in terms of sickness benefit's eligibility and period of coverage, possible findings among permanent employees would alert the policymaker about the adequacy of the employment protection legislation. Indeed, people with permanent contracts are (or, should be) more protected against firing: although specific laws have been implemented in Italy over time in order to prevent people with

[7]The reference labour contract is the working-spell at the time the selected CVD shock occurs. In the case of multiple and contemporary jobs, the longest is selected.

[8]CVD shocks are among the leading causes of death in developed countries, including Italy. For men in particular, CVDs represent the most common cause of death under 65 years old (31%) in Europe (compared to about 22% of deaths related to cancer). For women aged below 65 years old, they are the second largest cause of death (26%), after cancer (35%).

[9]Sick leave records are available in the Social Security archives for all blue-collar workers, but only to few categories of white-collars, i.e. those working in the sectors of "Wholesale and Retail Trade" and "Hotels and Restaurants".

[10]By doing this, only 6% of those in the original sample is excluded because they are fixed-term employees.

reduced working-capabilities from involuntary job losses, the limited incentives of the employers may pressure individual working careers in opposite directions.

The final sample is given by 1354 individuals[11]. Figure 1 helps to clarify both the overall structure of the dataset and the aforementioned sampling procedure: as is evident from the picture, the selected health-event (red cross) can occur in a month between January 2003 and December 2005; since then, the residual length of the reference job spell is measured. Job-interruption can either occur before the end of the observational window (December 2012) or after. In the latter case, they are called right-censored observations. The way in which the residual job-tenure is computed will be better explained in Section 1.5.2.

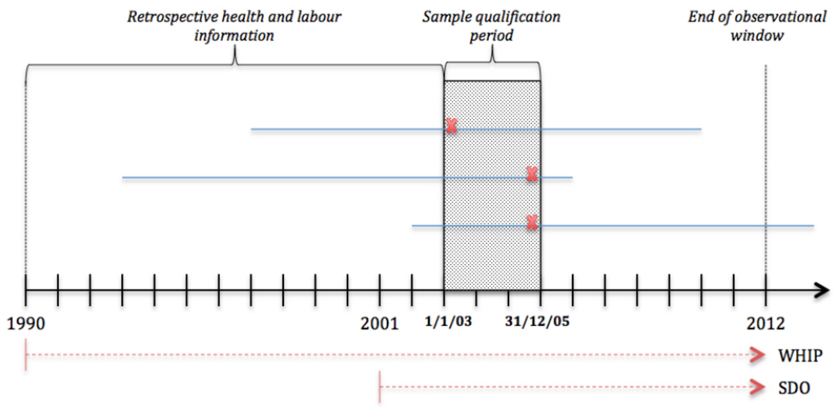

Figure 1: Dataset structure and sampling procedure
Notes: "SDO" refers to the Hospital Discharge Register (*Schede di Dimissione Ospedaliera*, in Italian)

1.4.2 Variables

The administrative nature of WHIP&Health limits the collection of many demographic characteristics such as the level of education, marital status, or other important information on individual risk behaviours, commonly available in survey data. However, in this case a strong effort has been placed to build a wide set of control variables. Many retrospectives information are available to describe both individuals' health and labour characteristics up to fifteen years prior to the shock (Table 1). The following paragraphs together with an extensive discussion on the potential endogeneity issues arising from sick leave (Section 4.3), aim to further motivate our identification approach.

Current Health Characteristics

Knowing the 'real' health status of people in sickness absence is one of the main challenges not

[11] In order to limit the misleading effect of extreme outliers, the 1st and the 99th percentiles are also dropped.

only for the employers but also for researchers aiming to describe the relationship between this measure and various of labour outcomes. Thanks to the sample selection applied - all workers were hit by an acute form of CVD shock in a given year - it is plausible to consider as severe their current health status. The length of the reference hospitalisation ($days\_cvd\_hosp$) is also available: this additional information - reasonably included in sickness absence and thus, redundant in the main model specification - will be subsequently exploited as an alternative, more objective, 'starting point' when defining the residual job-tenure (i.e. the outcome variable). Besides, when additional hospitalisations have been observed over the year $\bar{t}$, for both cardiovascular and other types of diseases, further covariates help to describe workers' current health conditions. In order to prevent the dimension of the dataset, these situations are taken into account by adding two main variables to the model: the total number of days in hospital for other types of diseases[12] ($days\_others\_\bar{t}$), and the total number of days in hospitals for additional (but subsequent) CVD shocks ($days\_cvd\_\bar{t}$).

Past Health Characteristics

Current health status possibly reflects heterogeneities in past health conditions. Despite the lack of information on risky behaviours, other covariates are useful to this purpose. As it is clear from Figure 1, hospital discharge records start to be collected from 2001 onwards, while labour archives go back to 1990. The structure of WHIP&Health together with the sample selection applied is important to understand the meaning of the following variables: all of them are 'cumulated' up to the year before the reference CVD shock. The variable "$days\_other\_cum$" represents the total number of days in hospitals for illnesses - other than CVD shocks - collected from 2001 up to $\bar{t} - 1$. Instead, by referring to the total number of days spent in hospitals for previous CVD shocks up to $\bar{t} - 1$ ($days\_cvd\_cum$), it counts all the events that happened two years before. Among the variables built from the labour archives, the total number of weeks in sick leave up to $\bar{t} - 1$($sick\_leave\_cum$) offers some insights about their past health conditions. As before, they are cumulated up to $\bar{t} - 1$ and consider all the previous jobs, not only to the reference one. Finally, conditional on having a certified level of disability (a reduction of working capabilities of at least 77% must be diagnosed), the Italian social security system allows individuals to receive an ordinary invalidity benefit (OIB) - different from the disability pension - while working. Therefore, aiming to further highlight past health conditions, the variable "$inv\_benefit\_cum$" is also included.

Current Job-related Characteristics

A broad variety of job-specific characteristics are available. Besides common information such

[12]The label "other" refers to aggregate information covering all the possible reasons why an individual might be admitted to the hospital: the inability of distinguishing among their severity is an issue of the dataset.

as labour income, the type of contract or the area of job etc., the dimension of the firm and the details of the starting and ending date of the reference working spell are relevant for our purposes. The variable on the firm's dimension ($firm\_015$) has been defined according to the number of employees. In particular, two reasons are behind the threshold of fifteen employees. On the one hand, bigger firms are often associated with higher levels of job-protection; thus, pushing them to increase unjustified sick leave. On the other hand, bigger firms can more easily adjust job-tasks in case of health-related limitations, allowing a longer labour market activity. The starting date of the reference labour contract together with the month the selected CVD shock, are useful to compute another piece of the story: the seniority of each blue-collar worker with that specific employer up to the time of the shock ($m\_seniority$). Even those who started the job one month before the shock are collected: individuals with a shorter experience, and in particular, with limited seniorities could be treated differently.

Past Labour Characteristics

By using the retrospective WHIP archives, it is possible to collect extensive information on past working histories. The idea is to capture that part of an individual's labour market attachment that makes their effect on heterogeneous working careers. Among them, the total number of years the person has been observed as either employee, a self-employed or atypical worker up to $\bar{t} - 1$. Together with the number of job-spells as employee ($nemployee\_cum$), we aim to describe how long and unstable the career of a person could have been. In a similar vein, we retrieve the variables representing how many times he received an unemployment benefit in the past (proxy of unemployment spells) and the cumulated number of weeks in "cassa integrazione guadagni"(CIG), a partial insurance against unemployment[13] ($nunempl\_cum$ and $ever\_cig$). Finally, additional covariates such as having experienced (or not) self-employed activities in the past or atypical jobs are also included ($ever\_selfempl$ and $ever\_atypical$).

[13]This is an integration or substitution of earnings when working activity has been reduced or suspended due to transitory (difficult) situations. It is thought for specific types of industries (typically manufacturing and construction)

Table 1: Variables name and definition

Variable	Definition
Demographic characteristics	
age	Age at the time of the reference CVD hospitalisation
abirth_north	Area of birth (north)
abirth_center	Area of birth (center)
abirth_south	Area of birth (south)
abirth_islands	Area of birth (islands)
abirth_abroad	Area of birth (abroad)
country_underdev	Equal to 1 if the person comes from an underdeveloped country
Health characteristics at the time of the reference CVD hospitalisation	
sick_leave	Number of weeks in sick leave at the time (year) of the reference CVD shock
sick_leave_paid	Number of paid weeks in sick leave at the time (year) of the reference CVD shock
sick_leave_unpaid	Number of unpaid weeks in sick leave at the time (year) of the reference CVD shock
hosp_cvd_$\bar{t}$	Number of hospitalisations for *other* CVD shocks
days_cvd_$\bar{t}$	Number of days spent in hospitals for *other* CVD shocks
hosp_other_$\bar{t}$	Number of days spent in hospitals for other type of diseases
days_other_$\bar{t}$	Number of days spent in hospitals for other type of diseases
days_cvd_hosp	Days of hospitalisation for the reference CVD hospitalisation
Past Health Characteristics	
hosp_cvd_cum	Equal to 1 if the person ever had a hospitalisation for cardiovascular diseases until $\bar{t}$-1
days_cvd_cum	Number of days spent in hospitals for a cardiovascular shock until $\bar{t}$-1
hosp_other_cum	Equal to 1 if the person ever had a hospitalisation for other diseases until $\bar{t}$-1
days_other_cum	Number of days spent in hospitals for other type of diseases until $\bar{t}$-1
inv_benefit_cum	Equal to 1 if the person ever received ordinary invalidity benefits until $\bar{t}$-1
sick_leave_cum	Number of weeks in sick leave until $\bar{t}$-1
sickleave_paid_cum	Number of paid weeks in sick leave until $\bar{t}$-1
sickleave_unpaid_cum	Number of unpaid weeks in sick leave until $\bar{t}$-1
Current Job Characteristics	
labour_income	Annual earnings
part_time	Equal to 1 if the person is a part-time employee
s_primary	Equal to 1 if the person works in the primary sector of activity
s_secondary	Equal to 1 if the person works in the secondary sector of activity
s_tertiary	Equal to 1 if the person works in the tertiary sector of activity
awork_north	Area of work (north)
awork_center	Area of work (center)
awork_south	Area of work (south and islands)
firm_015	Equal to 1 if the person works in a firm with less or equal than 15 employees
m_seniority	Months of seniority (with the same employer) up to the month of the reference CVD shock
Past Job Characteristics	
work_active_cum	Number of years the person is observed as employee, self-employed or atypical worker until $\bar{t}$-1
nemployee_cum	Number of contracts as employee until $\bar{t}$-1
ever_selfempl	Equal to 1 if the person ever worked as self-employed until $\bar{t}$-1
ever_atypical	Equal to 1 if the person ever worked as atypical worker until $\bar{t}$-1
nunempl_cum	Number of unemployment benefits received until $\bar{t}$-1
ever_cig	Equal to 1 if the person ever been in "cassa integrazione guadagni" until $\bar{t}$-1

1.4.3 Endogeneity of sick leave

The *possible* endogeneity of sickness absence is one of the main concerns often discussed by empirical researchers. Omitted information relating to both individual attitudes and underlying health conditions can lead to biased estimates. This section offers an extensive review of such an empirical issue, discussing the use of sample selection criteria and the full set of controls as a way of dealing with it in the following regression models.

A primary source of omitted information can arise from the *current* health condition, which is inherently latent. Hence, to what extent the number of weeks in sick leave is associated with the post-shock health status becomes essential in this context of analysis. The unknown health should be negatively correlated with the length of sickness absence and, at the same time, positively correlated with the residual stay in a labour contract. By focusing exclusively on those who have experienced an acute CVD shock in a specific point in time ($\bar{t}$), it is palusible that a sizeable part of the time spent on sick leave during that year strongly correlates with current health conditions. Different factors can support this argument: first of all, the information about sick leave is encoded by the Italian Social Security Institute as the number of entire weeks of absence due to illnesses, meaning that a few days at home taken by the workers (arguably correlated with own preferences) are not accounted for, and thus cannot confound the studied relationship. Here the use of an administrative source is an undeniable advantage with respect to the most common survey data where that measure is typically registered as the "number of days": a daily (and self-reported) evaluation potentially reflects diverse situations, some of them unrelated to the worsened health conditions. Secondly, according to the Italian regulation on sickness insurance, after three days at home, a GP's certificate is required, meaning that for longer time spans a professional doctor guarantees a worker's health conditions. Although some papers in the literature argue the subjective nature of judgements for certification practices among physicians (Askildsen et al. (2005), Markussen et al. (2011)), we claim this is less of an issue when CVD shocks occur. Moreover, the Italian legislation allows external medical visits, required by both the Social Security Institute (INPS) and by private employers, aiming to check the real workers' conditions and thus discourage absenteeism behaviours[14].

Another source of missing information possibly derives from past health conditions. Information on past health events and risky behaviours such as smoking habits, drug use, etc. are valuable when controlling for factors that correlate with, and possibly explain, the current health status. Although this information is often available in survey datasets, it is usually absent in administrative ones. However, WHIP&Health allows observation of more objective health episodes as they come from the national hospital discharge registers. As explained in the previous section, the paper extensively explores all possible information contained in both components of the dataset - WHIP and SDO archives - to enrich the set of control characteristics.

Eventually, a complete discussion of the possible endogeneity of sick leave cannot avoid mentioning the role of individual preferences and personal attitudes. For instance, low effort and low risk-averse workers may take advantage of generous sickness benefits schemes to extend the absence period beyond their real needs. This behaviour is the so-called absenteeism. On the contrary, as increasingly stressed in the literature, individuals at the left tail of the income distribution tend to shorten their sick leave periods at the expense of their health and of proper recovery as they fear losing their job and are also more vulnerable to income drops. This is commonly known as presenteeism behaviour, i.e. working while sick. Still, some considerations come in favour of our approach: again, the selection of CVD diseases enables us to focus on health shocks for which a

[14] After a home visit, the external doctor declares whether or not the employee is fit to return to work within three days.

doctor is asked to evaluate and recommend a proper recovery period. Additionally, behaviours like absenteeism or presenteeism, or factors such as individual discretionally (which mainly occur for less severe illness), are of minor importance. Furthermore, as mentioned before, institutional features such as "home visits" work as a strong disincentive against opportunistic behaviours. As proved by Biscardo et al. (2019), as long as the public insurer is not supported by specific algorithms[15], the private employer undoubtedly has an informative advantage when choosing which workers to visit, making home visits even more effective. As a final remark, personal attitudes and preferences will be further taken into account to the extent they correlate with observed characteristics. The Work History Italian Panel (WHIP) suits this task as it contains lots of information about their previous working history, which arguably correlates with and accounts for an employee's general attitude to the work. For instance, workers with stable and long career paths may be tempted to extend the period at home while sick and, on the contrary, young workers with unstable jobs could hurry up the recovery period and get back to work as soon as possible in order to show off their attitude to the employer. Variables such has the length of observed working career since 1990 ($work\_active\_cum$), the total number of unemployment spells ($nunempl\_cum$) or the number of different jobs as an employee up to $\bar{t}-1$ ($nemployee\_cum$), are only a few examples of useful predictors for these individual behaviours and attitudes, and will therefore be included in the following regression models.

[15]Since March 2011, the selection of workers' sick leave to minor is addressed by the public insurer by a "data mining software".

1.4.4 Descriptive Statistics

Before looking the distribution of the available covariates, a preliminary exploration of the studied event - the time until job-interruption occurs - is needed. Basic statistics on survival times show that for 24% of people we do not observe the expiring date of the reference labour contract; the first quartile of subjects survive in that job less than one year (8.86 months), while half of them less than 3 years (34.9 months). Figure 2 shows a non-parametric estimate, called Kaplan-Meier estimator[16], of the probability of survival past time t in the reference labour contract. The measure of sick leave in $\bar{t}$ has been divided in three different groups[17] according to its distribution: the blue line refers to those who spent between 1 and 6 weeks at home, the red line represents people who make between 7 and 18 weeks, while the green line characterises those with more than 19 weeks of absence. Unsurprisingly all the curves follow decreasing trends: month-after-month, the number of those who get out from that job increases, while those remaining decrease. Interestingly, clear differences appear in survival rates over the first six years after the return-to-work: individuals who did between 1 and 6 weeks in sick leave are more likely to survive in the reference contract beyond each point in time, as opposed to those with more than 19 weeks face a huge drop since the beginning. From the sixth year onwards, blue-collar workers in the middle and those in the lowest part of the distribution experience similar patterns. Besides the graphical evidence, it is possible to formally test the hypothesis for the equality of survivor functions across groups by using two different tests: the Log-rank[18] and Peto-Peto-Prentice[19] tests. Under the *null* hypothesis all survival curves are the same: in both cases, the equality of survival functions is rejected at 1% confidence level.

An extensive overview of the covariates' distribution is available in Table 2. In light of the type of health shock considered, the current number of weeks in sick leave is not surprising: on average, they take more than 12 weeks to recover (approximately 3 months); most of the time is paid by sickness benefits, while a smaller fraction is unpaid[20]. Similar reasons can be mentioned in order to justify the average age (50 years old) of the selected individuals; although the value is pretty

[16]The Kaplan-Meier estimator is defined as follows:

$$\hat{S}(t) = \prod_{j|t_j \leq t} (\frac{n_j - d_j}{n_j})$$

where n_j is the number of individuals at risk at time t_j and d_j is the number of observed failures at time t_j. The distance to the failure event (i.e. job-interruption) is computed in months, thus the estimator performs the evaluation month-after-months.

[17]People in the second and third quartile of the distribution have been grouped because showing similar trends in terms of survival times.

[18]The Log-Rank test is a large-sample chi-square test that uses as its test criterion a statistic that provides an overall comparison of the KM curves being compared (Kleinbaum et al.(2005)

[19]All the other types of tests are variations of the log-rank test statistic and are derived by applying different weights at the jth failure time. Peto test weights the jth failure time by the survival estimate calculated by considering all groups combined (Kleinbaum et al. (2005)

[20]This second option is allowed when the "comporto" is exceeded.

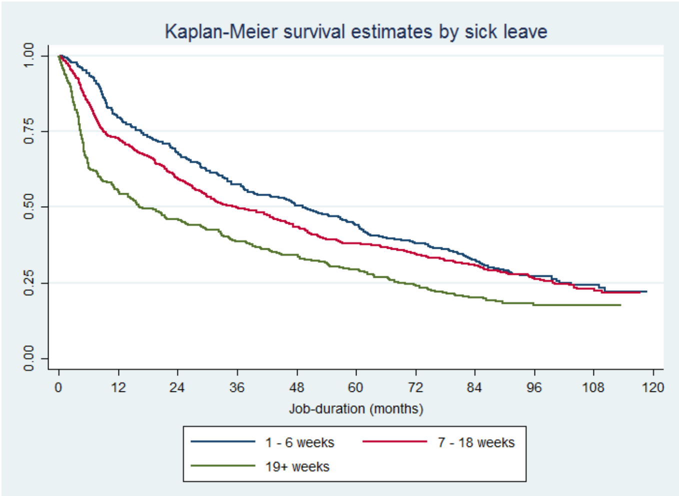

Figure 2: Kaplan-Meier survival estimates *by sick leave groups* in $\bar{t}$
Source: WHIP&Health. Notes: Log-rank and Peto-Peto-Prentice test of equality of survivor functions (χ^2(Prob)) have been performed: 26.22 (0.000) and 45.25 (0.000), respectively.

high, it is in line with the general national and international statistics[21] (as age increases, also their incidence grows). With respect to the reference hospitalisation, they spend approximately one week inside the hospital (7.4 days), rarely more than 9 days (75th percentile). This is reasonable considering that the most severe cases are followed by death or the patients are moved to specialised structures. Figure 3 depicts the distribution of sick leave and the number of days of hospitalisation, respectively. The statistics on the average number of additional events (and days spent in hospitals) for cardiovascular diseases are not exhaustive. Indeed, although the average number of hospitalisations is close to zero (0.4), a sizeable part of people (almost 30%) have at least one subsequent and very close new event[22]. Even "other types of health events" regularly occur, counting more than 30.1%. In this case, the number of days in hospitals is higher than CVD episodes, on average, 5.28 against 2.36. The reason of that can be found in the broad variety of diseases the label "other types of health events" covers: either a hip fracture or malign cancers can fall into this category.

Lagged health characteristics should be critically discussed thinking about our sample selection: as extensively stressed before, none of the selected subjects has any hospitalisation for CVD shocks during the two previous years. Thus, unsurprisingly, both the average of cumulated episodes and the days in hospitals are pretty low. Slightly different is the case of the other type of hospitalisations: driven by those in the last quartile having experienced more than one hospitalisation, the average number of days is 2.61. By comparing the values referring to $\bar{t}$ and $\bar{t}-1$, the latter is substantially lower than the former, suggesting how the general health conditions of these people

[21] http://www.salute.gov.it/imgs/C_17_navigazioneSecondariaRelazione_1_listaCapitoli_capitoli ItemName_1_scarica.pdf

[22] According to the sample selection, people are allowed to experience new CVD immediately after the reference one.

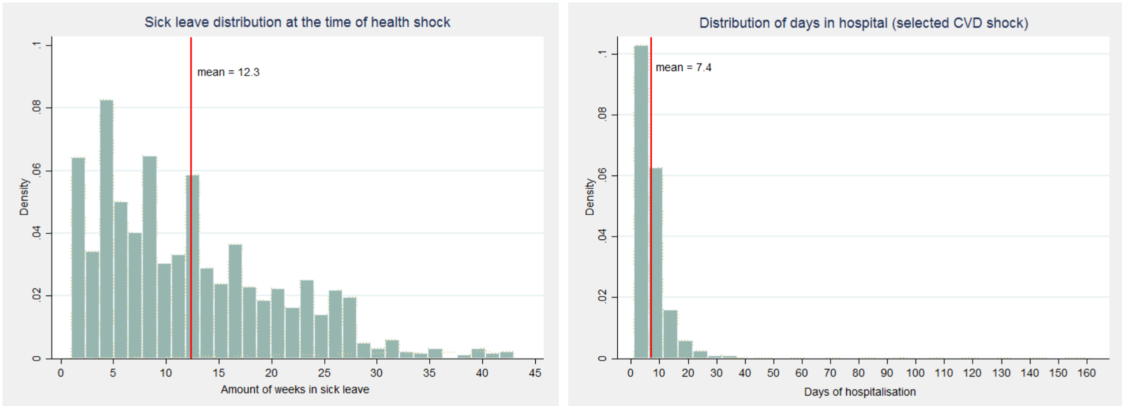

Figure 3: *Distribution of sick leave in $\bar{t}$ and length (days) of the reference hospitalisation*
Source: WHIP&Health. Notes: the vertical red line refers the average values

decreased significantly by the time of the reference shock. With respect to the number of past weeks in sick leave up until $(\bar{t} - 1)$, on average, 19 entire weeks in sick leave are counted, while the median individual reports 10 weeks. Reasonably many factors can be reflected in these values. For instance, a 35 years old blue-collar worker could have half of the weeks either because he is younger and healthier, or as a consequence of a shorter and more discontinuous working career characterised by lots of years of inactivity - especially as an employee - and unemployment spells.

With respect to the current job characteristics, the average seniority up to the time of the shock is 106 months, slightly less than 9 years. Most of them are full-time workers employed in Northern regions by secondary sector firms. Their gross labour income rarely exceeds 30.000 euros and more interestingly, 30% of them is employed by firms with less than fifteen employees. When looking at their past labour characteristics the first thing to stress is that, on average, they entered INPS archives more than 11 years before; since the 50th percentile they are already observed through 13 years. Only the 11% have had at least one period as self-employed in the past, and very few (2%) also ran atypical jobs. The number of past episodes in unemployment is rather limited, although 38% of them have experienced at least a period in "cassa integrazione guadagni".

Table 2: Descriptive Statistics

	Mean	SD	Min	Max	p50
Demographic characteristics					
age	50.47	7.45	22	64	52
abirth_north	0.271	0.45	0	1	0
abirth_centre	0.139	0.35	0	1	0
abirth_south	0.345	0.48	0	1	0
abirth_islands	0.143	0.35	0	1	0
abirth_abroad	0.102	0.30	0	1	0
country_underdev	0.094	0.29	0	1	0
Current Health Characteristics					
days_cvd_hosp*	7.400	7.56	1	162	6
sick_leave	12.30	8.41	1	43	10
sick_leave_paid	10.98	8.29	0	43	9
sick_leave_unpaid	1.205	3.68	0	38	0
hosp_cvd_$\bar{t}$	0.389	0.70	0	6	0
days_cvd_$\bar{t}$	2.362	6.25	0	96	0
hosp_other_$\bar{t}$	0.493	0.91	0	7	0
days_other_$\bar{t}$	5.275	17.6	0	212	0
Past health characteristics					
sick_leave_cum	19.32	25.7	0	272	10
sickleave_paid_cum	17.75	24.1	0	266	10
sickleave_unpaid_cum	1.567	5.86	0	103	0
inv_benefit_cum	0.067	0.25	0	1	0
hosp_other_cum	0.517	1.04	0	8	0
days_other_cum	2.612	7.05	0	82	0
hosp_cvd_cum	0.030	0.24	0	4	0
days_cvd_cum	0.162	1.35	0	18	0
Current Job Characteristics					
labour_income	23056	9377	695.4	137943	21934
part_time	0.058	0.23	0	1	0
m_seniority	106.4	86.9	0	254.6	73.1
s_primary	0.067	0.25	0	1	0
s_secondary	0.691	0.46	0	1	1
s_tertiary	0.242	0.43	0	1	0
awork_north	0.500	0.5	0	1	0.5
awork_centre	0.188	0.39	0	1	0
awork_south&islands	0.312	0.46	0	1	0
firm_015	0.309	0.46	0	1	0
Past Job Characteristics					
work_active_cum	11.82	3.62	1	15	13
nemployee_cum	12.32	4.49	1	27	14
ever_selfempl	0.106	0.31	0	1	0
ever_atypical	0.023	0.15	0	1	0
nunempl_cum	0.423	1.39	0	11	0
ever_cig	0.384	0.49	0	1	0

Source: WHIP&Health. **Notes**: the variable denoted with (*) is specific of the *reference* CVD hospitalisation.

1.5 Econometric modelling

1.5.1 Duration analysis and Cox Proportional Hazard Model

The aim of this paper is to study the relationship between the length of sickness absence under severe health conditions and the residual job-tenure. As extensively discussed in the previous sections, opposite mechanisms can differently influence this relationship, especially when permanent jobs are considered. Thanks to the detailed information available such as the starting and ending dates of the labour contract and the month of the CVD shock, duration models become a useful tool of analysis.

Duration models are based on two complementary elements: the *survivor function* ($S(t)$) is the probability of surviving beyond time t (where t is the elapsed time since the first entry into the risky set)[23]; while the *hazard function* ($h(t)$), also known as the conditional failure rate, gives the instantaneous potential for failing at time t per unit of time, given the survival up to time t[24]. Rather than a probability, the hazard function is a rate, and thus it is constrained to range between zero and infinity. According to the Cox PH regression model (Cox (1972)), a semi-parametric approach, the hazard rate can be defined as:

$$h(t, \mathbf{X}) = h_0(t) e^{\sum_{i=1}^{p} \beta_i X_i} \qquad (1)$$

where $h_0(t)$ is the baseline hazard function and X_i is a vector of time-independent covariates, either continuous or dummies, measuring individuals' health and labour status (i) at the time of the shock ($\bar{t}$) and (ii) up to the year before (i.e. $\bar{t} - 1$). Our main interest is the predictor "sick_leave", i.e. a continuous variable capturing the total number of weeks in sick leave during the year of the reference CVD shock. As it is clear from the equation (1), while the baseline hazard function depends on the time component, the covariates do not. An alternative version of Cox PH model, the so-called extended Cox model, allows to consider time-dependent covariates. Despite the potential advantages, we consider this approach not suitable in our context: moving the covariates over time instead of keeping them fixed at $\bar{t}$, would have further increased the risk of including the confounding effect of individual attitudes and preferences.

In general, the knowledge of how the risk of the studied event moves over time - in this case, the time until job-interruption occurs - guides the choice between parametric or semi-parametric approaches. When the underlying functional form of $h_0(t)$ is known (exponential, Weibull, lognormal etc.), parametric estimates are preferred. Otherwise, to avoid misspecification problems, semi-parametric

[23] S(t) = 1 - F(t) = Pr(T>t) where F(t) is the cumulative distribution function

[24]
$$h(t) = \lim_{\Delta t \to 0} \frac{Pr(t + \Delta t > T > t | T > t)}{\Delta t} = \frac{f(t)}{S(t)}$$

where f(t) is the density function. In few steps we could easily demonstrate the relationship between the survivor and hazard functions.

methods are the best choice when the functional form is unknown: it has been shown how these methods closely approximate the results of the *correct* parametrization. Indeed, this paper takes advantage of the flexibility of Cox proportional hazard models to estimate the relationship between the hazard function and a set of explanatory variables without "making assumptions about the shape of the baseline hazard over time" (Cleves et al. (2010)). In other words, the baseline hazard function is simply left non-estimated thanks to an alternative method proposed by Cox (1972) - hence the name of the approach - where a Partial Likelihood (PL) function substitutes the common Maximum Likelihood estimator (ML). The PL estimator essentially orders *events*, not persons, and thus, instead of considering the probabilities of all units, it takes into account only the probabilities retained from those who are observed to fail (Jenkins (2005)) [25]. Parametric estimates will be run in section 1.7 as an additional robustness check of the baseline results.

In general, whatever it is the shape of $h_0(t)$, the baseline hazard is assumed to be same for every unit. Thus, the hazard ratio (HR) between two different individuals, whose characteristics are represented by the vectors of covariates $\mathbf{X}^*$ and $\mathbf{X}$ respectively, can be written as:

$$\hat{HR} = \frac{\hat{h}(t, \mathbf{X}^*)}{\hat{h}(t, \mathbf{X})} \qquad (2)$$

By substituting the equation (1), we get an additional expression which only depends on the vectors of covariates $\mathbf{X}^*$ and $\mathbf{X}$, while the baseline hazard cancel out:

$$= \frac{\hat{h}_0(t)exp[\sum \hat{\beta}_i X_i^*]}{\hat{h}_0(t)exp[\sum \hat{\beta}_i X_i]}$$

$$= exp[\sum_{i=1}^{p} \hat{\beta}_i (X_i^* - X_i)] \qquad (3)$$

The proportional hazard assumption (PH) requires that the an individual's hazard is proportional to the hazard of another individual, and the ratio does not depend on time. In Section 1.7 the validity of the PH assumption will be tested by running appropriate checks; moreover, as additional sensitivity analysis, a stratified Cox PH model will be also performed. Rather than assuming that everyone face the same baseline hazard, this alternative specification allows $h_0(t)$ to differ among different groups according to the predictors not satisfying the PH assumption. As consequence, the hazard function can be slightly modified:

$$h_s(t, \mathbf{X}) = h_{0s}(t) e^{\sum_{i=1}^{p} \beta_i X_i} \quad s = 1, ..., S$$

where S is the total number of strata.

[25] We remind to Jenkins (2005) for an extensive explanation about the approach and survival analysis in general.

1.5.2 Basic setup: event, risk period and censoring definition

The main feature of duration analysis is to model the instantaneous probability of a transition from one state to another one: the occurrence of a specific event sets that transition. The event, or *failure*, is now defined as the job-interruption (the exit from the reference labour contract), while the time since the individual can potentially fail is the *risk period* (residual job-tenure). Hence, each point in time (monthly defined) will be characterised by people who exit from the labour contract and subjects for whom the event has not yet occurred.

Upon this setting, a clear definition of the residual job-tenure turns out to be crucial: while the ending point is straightforward, less clear what the starting point is. Although the available data do not allow a precise link of each hospitalisation with the number of subsequent days/weeks at home, thanks to the type of shock considered we are pretty confident that most of the weeks in sick leave during that year are associated to the reference hospitalisation. Therefore, knowing the month in which the reference CVD shock occurs, we place the return-to-work "n-weeks after that point in time", i.e. the number of weeks in sick leave observed in $\bar{t}$. Accordingly, the residual-job

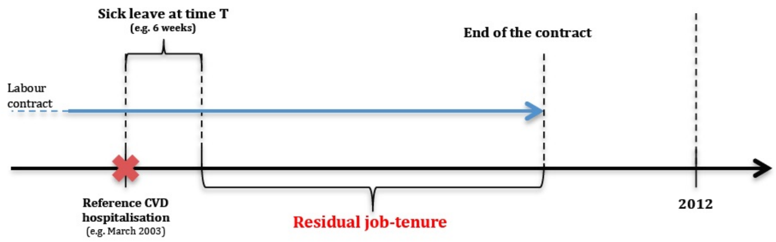

Figure 4: Graphical representation of the general setup

tenure is computed as the distance (in months) between the return-to-work, after the occurrence of the reference CVD shock, and the end of the reference contract. Figure 4 offers a graphical representation of this measure. When the failure event (job-interruption) has not yet occurred by the end of the observational window, right-censored subjects appear. In this study, WHIP archives collect information on the individual working careers up to 2012, in particular December 2012. Among our observations, 329 individuals (24.26% of the total) are still under the same employer. Dealing with censored data is one of the main advantages of using survival analysis; an extension (mainly on the right) of the sample qualification window would have further increased the number of these situations.

As a final remark, it is worth mentioning that when multiple hospitalisations are observed in $\bar{t}$, either for "other types of diseases" or additional (subsequent) CVD shocks, a misleading association between the number of sick leave and the reference hospitalisation may arise. In order to preserve the frequencies, the following Cox PH models will take these situations into account by including specific variables such as the total number of days in hospitals in $\bar{t}$ for CVD shocks or other illnesses; later on, various sensitivity analyses will be also run to test measurement concerns.

1.6 Empirical Results

The popularity of Cox models relies on a key factor: differing from the parametric approaches, the functional form of the baseline hazard is unknown and thus, left unspecified. Accordingly, the estimated hazard ratios can be interpreted as the instantaneous relative risk of exit from the labour contract - conditional of being survived up to t - given a unitary change in a specific covariate (all the others kept constant[26]). Table 3, where four different specifications of Cox PH models are presented, aims to investigate the role of potential confounders in studying the relationship between the length of sick leave and the survival in a permanent job. Subsequently, some heterogeneities in the effect of extended absences will be also considered in Table 4.

Besides all the available covariates, the main independent variable is the number of weeks in sick leave during the year of the reference CVD hospitalisation. On the one hand, thanks to the selection applied, the length of sick leave can plausibly reflect an individual's time needed to recover. On the other hand, an extended absence (a negative signal in terms of productivity), drives many possible situations: for instance, the employer can either make an effort to find a new accommodation inside the firm or conversely, make additional pressure for an early job-interruption. In light of this, the strictness and the effectiveness of legislative constraints matter. Irrespectively to the model specification, all the values in Table 3 show a negative relationship between the two measures: as the absence increases, so does the instantaneous risk of exit from that contract (about 1.6% for each additional week at home). It is worth noticing how the hazard ratios estimated in Table 3 are all strongly robust across alternative specifications. In other words, they seem insensitive to controls, suggesting how the 'time needed to return-to-work' does not reflect the confounding effect of hidden factors. This evidence, even though incomplete, points in favour of the baseline idea that, thanks to the specific sample selection it is reasonable to consider the number of weeks spent at home the result of a doctor's judgement based on the severity of the shock occurred. For instance, if the relationship between sick leave and the subsequent risk of closing a job is spurious because of workers' presenteeism or absenteeism behaviours, then we would arguably observe a positive correlation between the current and the past-cumulative days spent on sick leave. In that case, controlling for 'past health characteristics' in the model should absorb part of this effect and would attenuate the magnitude and the significance of the main coefficient. Another possibility is when the relationship is spurious because of heterogeneities in employment careers: recently hired employees may have the incentive to reduce absences relative to more senior workers. Even in this case, part of this effect would be captured by variables such as working experience and the seniority within the firm, and the coefficient would be lower when switching from specification 1 to 4.

[26]When X_1 is a dichotomous variable for example, HR is the difference in instantaneous risk among those who have a specific characteristic and those who have not, keeping constant all the others

Table 3: Effect of sick leave duration on job-interruption - *baseline*

	Model 1	Model 2	Model 3	Model 4
sick_leave	1.017***	1.018***	1.015***	1.016***
	(0.004)	(0.004)	(0.005)	(0.005)
Past Health Characteristics	NO	YES	YES	YES
Current Job Characteristics	NO	NO	YES	YES
Past Job Characteristics	NO	NO	NO	YES
N.Obs.	1354	1354	1354	1354
Log pseudolikelihood	-6722.4	-6722.1	-6683.8	-6668.8
Wald chi2	283.0	286.3	369.3	395.2

Source: WHIP&Health. **Notes**: The table reports the *hazard ratios* of four different specifications of Cox PH models. The variable "sick_leave" refers to the whole number of weeks in sick leave at the time (year) of the reference CVD hospitalisation. Robust standard errors have been considered. * p<0.1, ** p<0.05, ***p<0.01

In detail, the first model includes few essential covariates regarding an individual's health status at the time of the reference CVD shock ($\bar{t}$) and his demographic characteristics. The second specification takes into account the confounding effect of past health conditions; while the third one also includes firm and job's characteristics. The last model instead, considers all the covariates mentioned above plus a set of controls describing individuals' past working life and their labour market attachment: unknown attitudes and preferences for working activity may potentially affect the amount of sick leave as well as the residual job tenure. The full estimates are available in the Appendix (Table A2). Unlike the initial expectations, past health conditions appear slightly powerful - per se - in predicting the risk of exit from that labour contract. On the contrary, some interesting results come out from the current job characteristics: working less hours is reasonably one of the first post-shock workplace adjustments; thus, when switching to part-time is not allowed, job-interruption is the only alternative. Indeed, part-time workers show a lower instantaneous risk of ceasing the reference labour contract than those employed full-time. Moreover, as remarked by Scoppa et al. (2014), notable differences appear among people working in small rather than bigger firms. Individuals employed in large companies, here firms with more than fifteen employees, are doubly advantaged against job-interruption: first of all, firms would face higher costs in case of an unlawful dismissal; secondly, they allow an easier reallocation of tasks when working capabilities reduce. The *Likelihood Ratio* statistic[27] - typically used with ML estimates - is useful to test the significance of the covariates added along the four different specifications. In particular, while no significant improvements have been found between the first two models, past job characteristics together with the current ones, significantly increase the fit of the model. From now on, the last one will be used as the reference one.

Table 4 takes into account potential heterogeneities hidden behind our main independent variable [28]. Due to dimensionality concerns, the use of interaction terms turns out to be particularly

[27] The LS test has been performed on the two models without the option of robust standard errors

[28] The extended version of the regression models are available in Appendix (Table A3)

suitable in our setting. By including interactions, we allow the effect of our main variable *sick leave* to increase or diminish with the level of an another factor: in particular, if the interaction is greater than 1, a positive relationship between the two variables arises; if it is lower than 1, a negative relationship turns out; a value equal to 1 suggests a constant effect. The first type of interaction aims to investigate whether the effect of an equal amount of sick leave differently affect the instantaneous risk of job-interruption among younger and older groups of people [29]. On the one hand, younger individuals are likely to better recover after a CVD shock, keeping their levels of pre and post-shock productivity constant. On the other hand, preferences for leisure and expectations about future working lives can strongly differ among the two groups: while younger blue-collar workers retrain themselves encouraged by a longer remaining working-life, the elderly can easily exit from the labour market through early retirement. Besides, the role played by employers is non-negligible. Some of them can find retraining the youngest more convenient if it brings higher profits in the future. On the contrary, some others might consider the reallocation of the elderly less costly due to past investments. Column 2 of Table 4 shows our findings: surprisingly, no significant differences appear in the effect of sick leave among age groups. Despite negligible, the only exception appears in the second interaction ($sickleave\_age4751$): at a confidence level of 10%, the effect of one more week in sick leave among people aged between 47 and 51 years old, is 2 percentage points lower than the risk of the elderly (the baseline group). Although the available data do not allow to disentangle the potential adjustment channels, it is clear that all individuals experience increasing difficulties in their post-shock working activity. Irrespectively of age, the occurrence of an acute CVD shock has undoubtedly negative consequences on individuals' labour market participation. Whatever it is the underlying reason (from a discriminatory work environment to a missing reallocation of tasks or incentives to retrain), being in a permanent contract does not prevent blue-collars against the economic deprivations followed by a severe health shock.

With the second interaction instead, we aim to partially address the question of whether or not the employers behave differently according to firm dimension. As previously mentioned, companies with a number of employees above or under fifteen units face very different costs when unfair dismissal are stated. As a consequence, the effect of an additional week at home on the instantaneous risk of ceasing the reference job can potentially be higher in smaller than bigger firms[30]. Even in this case the interaction term turns out insignificant and equal to 1, thus the effect does not differ for dimensionality reasons. Despite this, the overall effect of firm dimension is relevant *per se*: working in a small company increases the instantaneous risk of job-interruption of about 43%. Such a huge difference might be the result of many reasons: from the easiest reallocation of the

[29] Age group dummies have been defined according to the age distribution. The median value is equal to 52 years old.

[30] Not surprisingly, among the companies with less than 20 employees permanent contracts were 68% of all the type of contracts stipulated in 1998, reaching 77% in 2001; bigger firms register values of 35% and 20%, respectively. (Contini, 2018)

unhealthy workers in big firms to the higher costs of unlawful dismissals. Similar outcomes had already appeared throughout the baseline estimates.

Table 4: Effect of sick leave duration on job-interruption - *Interactions*

	No Interactions (Model 4)	Interaction 1	Interaction 2
sick_leave	1.016***	1.021**	1.016***
	(0.004)	(0.01)	(0.005)
age1846	0.331***	0.368***	0.331***
	(0.03)	(0.06)	(0.03)
age4751	0.390***	0.500***	0.390***
	(0.04)	(0.08)	(0.04)
age5255	0.690***	0.667**	0.690***
	(0.06)	(0.10)	(0.06)
sickleave_age1846	-	0.991	-
	-	(0.01)	-
sickleave_age4751	-	0.980*	-
	-	(0.01)	-
sickleave_age5255	-	1.002	-
	-	(0.01)	-
firm_015	1.431***	1.431***	1.429***
	(0.11)	(0.112)	(0.177)
sickleave_firm015	-	-	1.000
	-	-	(0.01)
Past Health Characteristics	YES	YES	YES
Current Job Characteristics	YES	YES	YES
Past Job Characteristics	YES	YES	YES
N.Obs.	1354	1354	1354
Log pseudolikelihood	-6668.8	-6666.4	-6668.8
Wald chi2	395.15	399.7	395.8

Source: WHIP&Health. Notes: The table compares the *hazard ratios* of the last model in Table 3 (Model 4) with two additional specifications of Cox PH model: "interaction 1" includes some interaction terms between sick leave and different age groups (people aged between 56 and 64 are the baseline); "interaction 2" includes an interaction between sick leave and the dummy variable for firm dimension (above or under fifteen employees). Robust standard errors have been considered. * p<0.1, ** p<0.05, ***p<0.01

1.7 Sensitivity Analysis

As extensively explained in the previous sections, the residual job-tenure and thus, the empirical analysis, has been performed by assuming that the number of weeks in sick leave observed in $\bar{t}$ is linked to the reference CVD hospitalisation. Despite the confidence of a strong linkage among them, the first set of sensitivity analysis is primarily employed to loosen possible measurement issues. The second part of this section instead, is devoted to relax the PH assumption, while the last set of analyses offers an overview of the alternative ways in which duration models can be performed.

The association between the reference CVD hospitalisation and sick leave can be imprecise, especially when people experience additional - but subsequent - acute CVD hospitalisations during the same year ($\bar{t}$). Although the awareness that such measurement issue cannot be completely solved due to the existence of bad-health episodes that are not associated with a hospitalisation, we aim to reinforce the validity of our previous findings by first excluding those who had additional hospitalisations for CVD diseases in the same year as the referenced health episode[31]. The results available in column 2 of Table 5 (*sensitivity 1*) are strongly encouraging: the instantaneous risk of ceasing that job is still significant at 1% confidence level and the magnitude is equal to the main result in the previous section (model 4). Despite dimensionality concerns, we further exclude those who had other types of health shocks in $\bar{t}$ besides CVD shocks: the HR turns out insignificant but the negative relationship persists (see Table A4 in Appendix).

Table 5: Effect of sick leave duration on job-interruption - *Sensitivity Checks*

	Baseline (Model 4)	Sensitivity 1	Sensitivity 2
sick_leave	1.016***	1.016***	1.005
	(0.004)	(0.005)	(0.004)
Past Health Characteristics	YES	YES	YES
Current Job Characteristics	YES	YES	YES
Past Job Characteristics	YES	YES	YES
N.Obs.	1354	954	1354
Log pseudolikelihood	-6668.8	-4408.9	-6683.6
Wald chi2	395.15	342.4	398.8

Source: WHIP&Health. Notes: The table compares the *hazard ratios* of the last model in Table 3 (Model 4) with two additional specifications of Cox PH model: "sensitivity 1" excludes those who experienced additional hospitalisations for CVD diseases in the same year as the referenced CVD hospitalisation. "sensitivity 2" performs a Cox PH model considering a residual job-tenure which starts the day after the discharge from the reference CVD hospitalisation. Robust standard errors have been considered. * p<0.1, ** p<0.05, ***p<0.01

As explained before, one of the main elements of duration analysis is 'the time until an event occurs'. Hence, how the distance to this event is computed becomes important. The way how the residual job-tenure has been previously defined, i.e. placing the whole number of weeks in sick leave after the reference CVD shock, kept us safe from an inappropriate measure of the distance: without considering the length of sick leave in $\bar{t}$ the duration model would not be able to disentangle the effect of longer or shorter absences. Accordingly, as explained in Section 1.5.2, the return-to-work had been placed n-weeks after the occurrence of the reference CVD shock. However, the concern of a wrong association between our main independent variable "sick leave" and the reference hospitalisation, remains. Besides the initial approach, we can alternatively test the baseline results by setting a different starting point, and thus a different distance: taking advantage of the number of days of hospitalisation, information which is only available for the reference CVD shock, we place the return-to-work just after the discharge. Therefore, the residual job-tenure is computed as the distance from this new point in time and the job-interruption; the results are available in Table 5 (*sensitivity 2*). Unsurprisingly, our main independent variable turns out insignificant at a confidence level of 5% and 10%. This result confirms what has been stated before; despite its objectiveness, such a distance is unable to adequately capture the role played by an extended

[31] In the case of new CVD shocks, the sample selection ensures they occur strictly after our reference CVD hospitalisation.

period at home on the subsequent risk of leaving the job. Therefore, we claim the baseline results are still rather robust.

Thanks to the previous analyses, the measurement issues arising from the structure and the drawbacks of the dataset can be substantially decreased. We are now going to relax one of the main assumptions of the Cox proportional hazard model, i.e. the hypothesis that everyone faces the same shape of baseline hazard. With this in mind, we claim the individual's age is the variable creating the most doubts: the underlying preferences of individuals, reliably dissimilar among age groups, may strongly determine the speed of ceasing the labour contract, and thus the shape of the baseline hazard function. As mentioned in Section 1.5.1, the stratification approach add more flexibility by allowing people to experience different baseline hazards instead of being one the multiplicative version of the other[32]. Various post-estimation diagnoses have been initially performed on the baseline model 4 to inspect our concern. According to the PH assumption, the effects of covariates "do not change with time except in ways that you have already parameterized" (Cleves et al. (2010)). Therefore, by including time-dependent covariates in the model, i.e. the interactions between each predictor and a time component, we can easily verify whether or not interactions are different from zero. When significant predictors appear, a violation of the proportional assumption for that specific covariate arises. Among our age dummies, defined in Model 4 according to age-distribution, only the interaction between the first group (individuals aged 18 to 45) and time is found to be significant at 5% confidence level. An alternative way of testing the PH assumption is through the Schoenfeld and scaled Schoenfeld residuals: basically, when the PH assumption for a specific covariates holds, the Schoenfeld residual must not be related to survival times[33]. Both the proportionality test of predictors (p-values greater than 0.05) and the graphical check (Figure A3 in Appendix shows almost perfect horizontal lines) reject the violation of the PH assumption. Based upon these tests, unable to provide a clear and univocal answer to our concern, we get the conclusions by comparing the baseline Cox PH model with its stratified version. Table 6 compares the results with and without the stratification approach. As it is clear from column 2, there are virtually no differences when the hazards are constrained to be multiplicative replicas of each other (baseline esteems) or they are allowed to change freely among different age groups.

Similar concerns on the equality of baseline hazards also arise with respect to the type of cardiovascular shock occurred: the level of impairments derived from cerebrovascular diseases, namely strokes, can be potentially stronger and more severe than cardiovascular ones. According to this, the way how the two groups of blue-collar workers behave and thus, the speed of exit from that labour contract, can be very different. Table 6 column 3 shows the stratification approach applied on the type of CVD shock. As additional check, column 4 reports the results when both age

[32] The baseline Cox PH model allows people to differ in their covariates' values.

[33] The test proceeds as follows: the first step is to retrieve the residuals from the baseline estimation, and then, by fitting a smoothed function of time to them, the test will check whether a significant relationship turns out.

and disease groups are considered. No changes appear, thus increasing the internal validity of the baseline results.

Table 6: Effect of sick leave duration on job-interruption - *Stratification*

	Stratification			
	baseline	*by age-groups*	*by CVD type*	*by age-group and CVD type*
sick_leave	1.016***	1.016***	1.016***	1.016***
	(0.004)	(0.004)	(0.004)	(0.004)
Past Health Characteristics	YES	YES	YES	YES
Current Job Characteristics	YES	YES	YES	YES
Past Job Characteristics	YES	YES	YES	YES
N.Obs.	1354	1354	1354	1354
Log pseudolikelihood	-6668.8	-5279.4	-6096.6	-4715.9
Wald chi2	395.2	182.3	393.52	169.24

Source: WHIP&Health. Notes: The table compares the *hazard ratios* of the last model in Table 3 (Model 4) with its stratified version: the stratification has been performed according to the age distribution of people (18-46/ 47-51/ 52-55 /56+). Robust standard errors have been considered. * p<0.1, ** p<0.05, ***p<0.01

We end this section by offering an overview of both the advantages and disadvantages of parametric duration models. As briefly mentioned before, while the Cox model can be performed without making any assumption about the shape of the baseline hazard function ($h_0(t)$), when the functional form is known, an efficiency gain can be obtained by its parameterization. Table A5 in Appendix makes clear how the differences between parametric and semi-parametric estimates are not remarkable *per se*: the magnitudes are similar. However, as an undeniable advantage, the former group of models permits to consider a random component - the frailty component (α_i) - allowing people in the population to differ due to unobserved factors[34]. In particular, when $\alpha_i < 1$ the hazard decreases, i.e. that individual is less risky than others; on the contrary, if $\alpha_i > 1$ he/she is characterised by a higher risk to frail. The frailty component, not exploited by Cox models[35], has a multiplicative effect on hazard and it is assumed to follow a specific distribution with mean equal to 1 and variance θ. Table 7 compares two types of distributions, the gamma and the inverse-Gaussian: the choice implies a different interpretation of how the relative hazard changes with time. Rather than the magnitude and significance associated with sick leave, two main values are extremely important here. The first one is the measure of θ, i.e. the estimated variance of the frailty component, and the second is the p-value of the Likelihood Ratio Test. Under the null hypothesis of the LR test, the variance is equal to zero and the frailty component does not contribute to the model. According to it, if we are willing to accept that the individual's

[34]Shortly, the frailty model can be represented as follows:

$$h(t_i|\mathbf{X}_i, \alpha_i) = \alpha_i h(t_i|\mathbf{X}_i)$$

where α_i is the unobserved individual-specific effect.

[35]The shared frailty is the only option of Cox models. With shared frailty models clusters of subjects are assumed to share the same frailty. For example, subjects from the same family may be similar with respect to some unobserved genetic. (Kleinbaum et al. (2005)

hazard moves as a Weibull distribution, then there is evidence pointing toward a heterogeneous population. The estimated coefficient for sick leave cannot be directly compared with the previous results. Although they are still hazard ratios, their interpretation when frailty is included is slightly different: 1.027 (or 2.7%) is the estimated hazard of a unitary increase of sick leave between two individuals sharing the same frailty.

Table 7: Effect of sick leave duration on job-interruption - *Parametric models with frailty*

	Model 4 (Weibull)	
	Gamma	*Inverse-Gaussian*
sick_leave	1.027***	1.028***
	(0.006)	(0.007)
N.Obs.	1354	1354
p	1.117	1.247
θ	0.724	2.884
LR test	0.000	0.000

Source: WHIP&Health. Notes: The table compares the *hazard ratios* of two types of parametric models with frailty component: column 1 considers a gamma frailty distribution while column 2 an inverse-Gaussian distribution. Under the null of the Likelihood Ratio test $\theta = 0$. No robust standard errors. * p<0.1, ** p<0.05, ***p<0.01

Overall, the choice between a parametric model with heterogeneity control and a semi-parametric model is not an obvious one (Hesselius (2007)): the former assumes independence between individual heterogeneity and covariates, likely to be violated. Instead, the latter has been shown by Lancaster (1990) to yield a bias toward zero when the unobserved heterogeneity is neglected by partial likelihood estimates. As stressed in the previous sections, Cox models are the safest choice especially when the modelled risky process - in this analysis, the time until job-interruption occurs - follows an ambiguous dynamic over time and thus, the shape of the hazard cannot be safely parametrized.

1.8 Conclusion

This paper analyses the role played by sick leave duration, under severe health conditions, on the risk of exit from a specific (and permanent) job. Although sick leave is an instrument designed by policymaker to prevent the potential income losses related to bad health, it is also a channel through which the employer can be negatively warned. 'The previous absence behaviour of workers can be seen as a signal for the employer or future employers of worker's health status and/or shirking tendency' (Hesselius (2007)). Thus, as extensively proved by the literature, as sick leave increases, the future risk of unemployment also increases. By assuming a slightly different perspective, the research looks at the labour contract which in place at the time of the reference CVD hospitalisation. As permanent employees, their working activity should be highly supported, both in terms of dismissal and intra-firm reallocation of tasks when health status prevent suitable performances. Upon this background, the effectiveness of the employment protection legislation

(EPL), rather heterogeneous by firm dimension, is extremely relevant, especially when blue-collar workers are considered. From a broad analysis of EU-LFS data is evident how the type of job can influence the post-shock return-to-work (Figure A1 and A2 in Appendix). Overall, the way in which sick leave may affect the residual job-tenure is not clearly determined; opposite forces can play a role when permanent workers are studied.

Thanks to a novel administrative dataset, the aim of this paper has been addressed by focussing on male blue-collar workers hit by a severe form of cardiovascular disease between 2003 and 2005. Through the specific sample selection, a sizeable part of the endogeneity issues arising from sick leave can be relaxed. Moreover, detailed information about the date of the reference CVD hospitalisation and the closing date of the labour contract make the continuous-time duration models as the most suitable in this context. In particular, the original version of the Cox proportional hazard model with time-invariant covariates (Cox, 1972), has been performed. The baseline results show a negative relationship between sick leave duration and the subsequent job-interruption: an additional week of absence increases the instantaneous risk of exit from the labour contract of about 1.6%. It is worth mentioning that both the magnitude and significance are insensitive to controls (models 1 to 4), suggesting how the 'the time needed to return-to-work' does not reflect additional confounding factors. Besides, we further investigate our baseline findings by including two main interaction terms. Heterogeneities among different age groups and different dismissal incentives according to the firm dimension may potentially affect the role of extended periods at home. Surprisingly, the effect of an extended period at home after the experience of an acute CVD shock has similar (negative) consequences along with all age groups and the firm's dimension. Regardless of the number of weeks at home, bigger firms offer greater opportunities to continue a regular working activity: being employed in small companies increases the instantaneous risk of job-interruption of about 43%. A variety of sensitivity checks and alternative survival approaches increase the confidence of our findings.

Overall, the paper offers a worrisome picture of the limited working opportunities unhealthy blue-collars face after an acute health shock. Surprisingly, being permanently employed is not enough to cope with these growing difficulties: in other words, the guarantees offered by the employment protection legislation (EPL) seem insufficient to allow blue-collar workers a safe continuation of their jobs. In a context where the rate of incidence of CVD diseases is increasing while the rate of mortality is decreasing (EHN, 2017), those labour markets unable to facilitate these types of workers will be strongly under pressure. Therefore, more targeted policies aimed to help specific categories of workers, together with a specific attention on the type of disease, should also be implemented. Our findings are in line with that part of the literature pointing the lack of workplace arrangements as one of the leading cause of job-interruption (Hill et al. (2016), Anand et al. (2017)). The employer's trade-off between the costs of workplace adaptation, legal constraints and the potential costs of dismissal, undoubtedly determine the likelihood as well as the speed of a job-interruption.

Bibliography

[1] Anand, P., Sevak, P. (2017). *The role of workplace accommodations in the employment of people with disabilities.* IZA Journal of Labor Policy, 6.

[2] Arai M., Thoursie P.S. (2005) *Incentives and selection in cyclical absenteeism.* Labour Economics 12(2), 269-280

[3] Askildsen J.E., Bratberg E., Nilsen I.A. (2005) *Unemployment, labor force composition and sickness absence: a panel study.* Health Economics, 14 (2005), pp. 1087-1101

[4] Barmby T., Marco A., Ercolani G., Treble J.G. (2002) *ickness absence: an international comparison.* Economic Journal, 112 (480) (2002), pp. F315-F331

[5] Biscardo C.A., Bucciol A., Pertile P. (2019) *Job sick leave: Detecting opportunistic behavior.* Health Economics; 28(3):373-386.

[6] Boeri T.Jimeno J. (2005) *The effects of employment protection: learning from variable enforcement.* European Economic Review , 49, 2057-77

[7] Burkhauser R.V., Butler J.S., Kim Y.W. (1995). *The importance of job accommodation on the job duration of workers with disabilities: a hazard model approach.* Labour Economics, 2 (1995), pp. 109-130

[8] Burkhauser, R. V., Butler, J. S., Kim, Y. W., Weathers, R. R. (1999). *The importance of accommodation on the timing of disability insurance applications: Results from the survey of disability and work and the health and retirement study.* Journal of Human Resources, 589-611.

[9] Campolieti, M. (2005). *How accommodations affect the duration of post?injury employment spells.* Journal of Labor Research, 26, 485-499.

[10] Cleves M., Gutierrez R.G., Gould W., Marchenko Y. V. (2010) *An introduction to survival analysis using stata* Stata Press book, third edition

[11] Contini, B. (2019), Dai "lavori usa e getta" al Jobs Act. Aracne editrice, Roma.

[12] Cox D.R. (1972) *Regression models and life-tables* J. R. Stat. Soc. Series B (Methodological), 34 (2) (1972), pp. 187-220

[13] De Paola M. , Pupo V. , Scoppa V. (2014) *Absenteeism in the Italian public sector: the effects of changes in sick leave policy.* Journal of Labor Economics

[14] Hesselius P (2007) *Does sickness absence increase the risk of unemployment?*. Journal of Socio-Economics 36: 288-310.

[15] Hill, M., Maestas, N., Mullen, K. J. (2016). *Employer accommodation and labor supply of disabled workers*. Labour Economics, 41, 291-303.

[16] Ichino A., Riphahn R.T. (2005) *The effect of employment protection on worker effort. A comparison of absenteeism during and after probation*. Journal of European Economic Association, 3 (1) (2005), pp. 120-143

[17] Jenkins S. P. (2005) *Survival Analysis* Available: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.176.7572&rep=rep1&type=pdf

[18] Johansson P., Palme M. (2002) *Assessing the effect of public policy on worker absenteeism*. Journal of Human Resources, 37 (2) (2002), pp. 381-409

[19] Kleinbaum D. G., Klein M. (2005). *Survival Analysis. A self-Learning Text*. Springer Book, second edition

[20] Lancaster T. (1990) *The econometric analysis of transition data* Cambridge University Press, Cambridge

[21] Leombruni, R., (2011). *Livello di protezione del contratto e assenteismo* Atti del Convegno Absenteeism in the Italian Public and Private Sector: The Effects of Changes in Sick Leave Compensation, 159-168.

[22] Markussen S., Roed K., Rogeberg O., Gaure S. (2011) *The anatomy of absenteeism*. Journal of Health Economics, 30 (2) (2011), pp. 277-292

[23] Markussen S. (2012) *The individual cost of sick leave*. J. Popul. Econ., 25 (4) (2012), pp. 1287-1306

[24] Neumark D, Bradley CJ, Henry M, Dahman B. (2015). *Work continuation while treated for breast cancer: The role of workplace accommodations*. ILR Review, 68, 916- 954.

[25] OECD (1999). *The Employment Outlook*, Chapter 5

[26] Pfeifer C. (2013) *Cyclical absenteeism among private sector, public sector and self-employed workers*. Health Economics, 22 (3) (2013), pp. 366-370

[27] Puhani P.A., Sonderhof K. (2010) *The effects of a sick pay reform on absence and on health-related outcomes*. Journal of Health Economics, 29 (2) (2010), pp. 285-302

[28] Schön, M. (2015) *Unemployment, sick leave and health*.

[29] Scoppa V., Vuri D. (2014) *Absenteeism, unemployment and employment protection legislation: Evidence from Italy*. IZA J Labor Econ (2014) 3: 3. https://doi.org/10.1186/2193-8997-3-3

[30] Spasova S., Bouget D. and Vanhercke B. (2016). *Sick pay and sickness benefit schemes in the European Union.* Background report for the Social Protection Committee?s In-depth Review on sickness benefits (17 October 2016), European Social Policy Network (ESPN), Brussels, European Commission.

[31] Wilkins E, Wilson L, Wickramasinghe K, Bhatnagar P, Leal J, Luengo-Fernandez R, Burns R, Rayner M, Townsend N (2017). *European Cardiovascular Disease Statistics 2017* European Heart Network, Brussels.

[32] Ziebarth, N. R. (2013) *Long-term Absenteeism and Moral Hazard: Evidence from a Natural Experiment.* Labour Economics 24: 277-292.

Appendices

Table A1: Frequencies by diagnoses

ICD 9-CM diagnostic category	**Num.**	**%**
Ischemic Heart Disease	**(1029)**	**(76.00%)**
Acute myocardial infarction (410)	533	39.36
Other acute and subacute forms of ischemic heart disease (411)	202	14.92
Old myocardial infarction (412)	10	0.74
Angina pectoris (413)	149	11.00
Other forms of chronic ischemic heart disease (414)	135	9.97
Cerebrovascular Disease	**(325)**	**(24.00%)**
Subarachnoid hemorrhage (430)	24	1.77
Intracerebral hemorrhage (431)	29	2.14
Other and unspecified intracranial hemorrhage (432)	8	0.59
Occlusion and stenosis of precerebral arteries (433)	34	2.51
Transient cerebral ischemia (434)	114	8.42
Other and ill-defined, cerebrovascular disease (436)	39	2.88
Late effects of cerebrovascular disease (437)	77	5.69
Total number of admissions	1354	100.00

Source:WHIP&Health

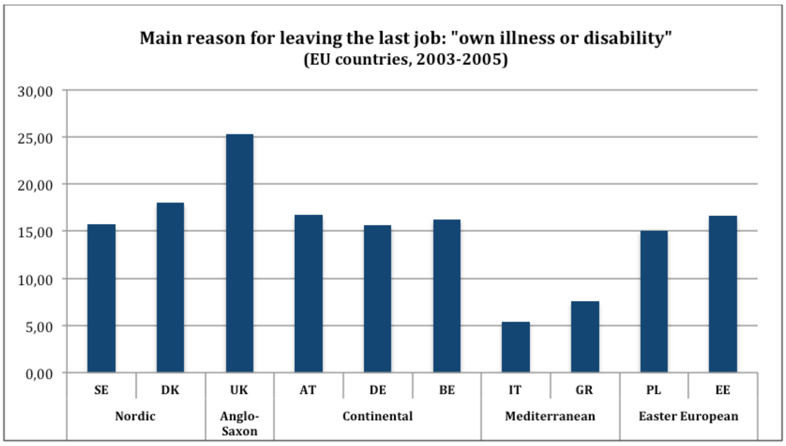

Figure A1: EU comparison of male blue-collar workers reporting "own illness or disability"
Source: EU-LFS. Notes: Percentages of male blue-collar workers reporting "own illness or disability" as the main reason for leaving the last job. EU countries are grouped according to their homogeneity in cultural attitudes, social security environment, labour and welfare institutions

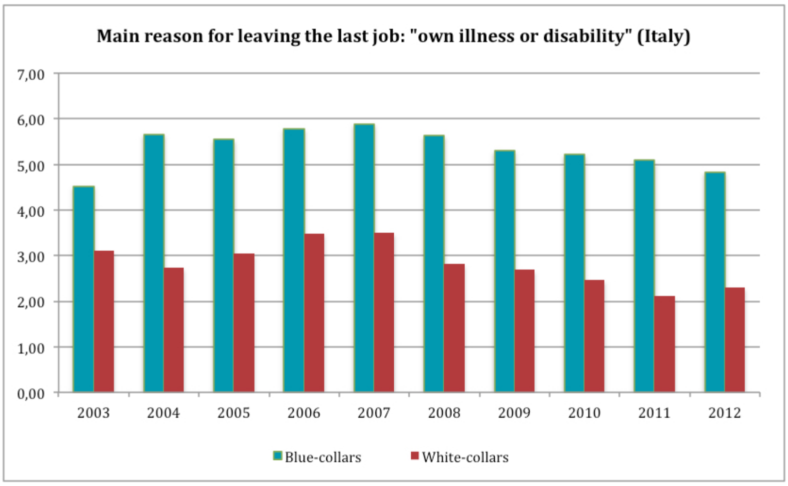

Figure A2: Differences among those answering "own illness or disability" over time and type of worker
Source: EU-LFS. Notes: Differences in the percentage of male blue and white collar workers reporting "own illness or disability" as the main reason for leaving the last job. EU countries are grouped according to their homogeneity in cultural attitudes, social security environment, labour and welfare institutions

Table A2: Cox proportional hazard model - *baseline*

	Model 1	Model 2	Model 3	Model 4
sick_leave	1.017***	1.018***	1.015***	1.016***
	(0.004)	(0.004)	(0.004)	(0.004)
age1846	0.336***	0.337***	0.335***	0.331***
	(0.033)	(0.033)	(0.033)	(0.033)
age4751	0.368***	0.369***	0.389***	0.390***
	(0.035)	(0.035)	(0.037)	(0.038)
age5255	0.664***	0.665***	0.674***	0.670***
	(0.054)	(0.054)	(0.058)	(0.060)
abirth_centre	1.000	0.997	0.964	0.976
	(0.102)	(0.102)	(0.158)	(0.160)
abirth_south	1.074	1.070	1.081	1.081
	(0.085)	(0.085)	(0.117)	(0.121)
abirth_islands	1.368**	1.364**	1.325**	1.281**
	(0.138)	(0.138)	(0.158)	(0.152)
abirth_abroad	0.883	0.876	0.715	0.703
	(0.344)	(0.343)	(0.322)	(0.306)
country_underdev	1.212	1.215	1.321	1.281
	(0.488)	(0.490)	(0.604)	(0.563)
days_other_$\bar{t}$	1.010***	1.010***	1.010***	1.010***
	(0.002)	(0.001)	(0.002)	(0.002)
days_cvd_$\bar{t}$	0.996	0.996	0.998	0.997
	(0.007)	(0.007)	(0.007)	(0.007)
sick_leave_cum		0.999	1.001	1.000
		(0.001)	(0.001)	(0.001)
inv_benefit_cum		1.004	1.003	1.002
		(0.017)	(0.016)	(0.016)
days_other_cum		1.002	1.004	1.003
		(0.005)	(0.004)	(0.005)
days_cvd_cum		1.004	0.997	0.991
		(0.02)	(0.021)	(0.023)
lab_income(*log*)			0.746**	0.758**
			(0.079)	(0.083)
m_seniority			0.999***	0.999
			(0.0004)	(0.001)
part_time			0.586***	0.663**
			(0.099)	(0.116)
s_secondary			0.869	0.847
			(0.115)	(0.111)
s_tertiary			0.863	0.892
			(0.124)	(0.127)
arwork_centre			1.002	0.975
			(0.137)	(0.135)
arwork_south			0.975	1.012
			(0.098)	(0.103)
firm_015			1.439***	1.431***
			(0.112)	(0.112)
work_active_cum				0.927***
				(0.024)
nemployee_cum				1.056**
				(0.021)
ever_selfempl				1.149**
				(0.178)
ever_atypical				1.354
				(0.280)
nunempl_cum				0.929***
				(0.027)
ever_cig				1.213**
				(0.089)
N.Obs.	1354	1354	1354	1354
Log pseudolikelihood	-6722.4	-6722.1	-6683.8	-6668.8
Wald chi2	283.0	286.3	369.3	395.2

Source: WHIP&Health. Note: Extended version of Table 3: comparison of the *hazard ratios* of four Cox PH models where different covariates have been included. The variable "age_5664" is the reference age group; "abirth_north" is the reference group for area of birth; "s_primary" is the reference sector of activity; "awork_north" is the reference area of work. Robust standard errors have been considered. * p<0.1, ** p<0.05, ***p<0.01

Table A3: Cox proportional hazard model - *Interactions*

	No interactions (Model 4)	Interaction1	Interaction 2
sick_leave	1.016***	1.021**	1.016***
	(0.004)	(0.008)	(0.005)
age1846	0.331***	0.368***	0.331***
	(0.033)	(0.060)	(0.033)
age4751	0.390***	0.500***	0.390***
	(0.038)	(0.079)	(0.038)
age5255	0.670***	0.667**	0.690***
	(0.060)	(0.102)	(0.060)
sickleave_1846	-	0.991	-
	-	(0.012)	-
sickleave_4751	-	0.980*	-
	-	(0.012)	-
sickleave_5255	-	1.002	-
	-	(0.011)	-
firm_015	1.431***	1.431***	1.429***
	(0.112)	(0.112)	(0.177)
sickleave_firm015	-	-	1.000
	-	-	(0.009)
abirth_centre	0.976	0.987	0.975
	(0.160)	(0.161)	(0.160)
abirth_south	1.081	1.080	1.081
	(0.121)	(0.122)	(0.121)
abirth_islands	1.281**	1.130**	1.280**
	(0.152)	(0.154)	(0.152)
abirth_abroad	0.703	0.743	0.703
	(0.306)	(0.325)	(0.307)
country_underdev	1.281	1.212	1.281
	(0.563)	(0.537)	(0.565)
days_other_$\bar{t}$	1.010***	1.010***	1.010***
	(0.002)	(0.002)	(0.002)
days_cvd_$\bar{t}$	0.997	0.997	0.997
	(0.007)	(0.007)	(0.007)
sick_leave_cum	1.000	1.000	1.000
	(0.001)	(0.001)	(0.001)
inv_benefit_cum	1.002	1.003	1.002
	(0.016)	(0.017)	(0.016)
days_other_cum	1.003	1.003	1.003
	(0.005)	(0.005)	(0.005)
days_cvd_cum	0.991	0.990	0.992
	(0.023)	(0.022)	(0.023)
lab_income(*log*)	0.758**	0.754**	0.758**
	(0.083)	(0.083)	(0.083)
m_seniority	0.999	0.999	0.999*
	(0.001)	(0.001)	(0.001)
part_time	0.663**	0.660**	0.663**
	(0.116)	(0.117)	(0.115)
s_secondary	0.847	0.850	0.847
	(0.111)	(0.111)	(0.127)
s_tertiary	0.892	0.904	0.892
	(0.127)	(0.128)	(0.127)
arwork_centre	0.975	0.965	0.975
	(0.135)	(0.133)	(0.135)
arwork_south	1.012	1.007	1.012
	(0.103)	(0.103)	(1.103)
work_active_cum	0.927***	0.928***	0.927***
	(0.024)	(0.024)	(0.024)
nemployee_cum	1.056**	1.056**	1.056**
	(0.021)	(0.021)	(0.021)
ever_selfempl	1.149**	1.137	1.149
	(0.178)	(0.177)	(0.177)
ever_atypical	1.354	1.322	1.354
	(0.280)	(0.277)	(0.280)
nunempl_cum	0.929***	0.930**	0.929**
	(0.027)	(0.027)	(0.027)
ever_cig	1.213**	1.214**	1.213**
	(0.089)	(0.090)	(0.089)
N.Obs.	1354	1354	1354
Log pseudolikelihood	-6668.8	-6666.4	-6668.8
Wald chi2	395.2	399.7	395.8

Source: WHIP&Health. Note: Extended version of Table 4: comparison of the *hazard ratios* of the baseline Cox PH model and two alternative specifications where interaction terms are included. The variable "age_5664" is the reference age group; "abirth_north" is the reference group for area of birth; "s_primary" is the reference sector of activity; "awork_north" is the reference area of work. Robust standard errors have been considered. * p<0.1, ** p<0.05, ***p<0.01

Table A4: Effect of sick leave duration on job-interruption - *Sensitivity Check*

	Baseline (Model 4)	No hospitalisations at time T
sick_leave	1.016***	1.010
	(0.004)	(0.007)
Past Health Characteristics	YES	YES
Current Job Characteristics	YES	YES
Past Job Characteristics	YES	YES
N.Obs.	1354	677
Log pseudolikelihood	-6668.8	-2884.34
Wald chi2	395.15	241.21

Source: WHIP&Health. Notes: The table compares the *hazard ratios* of the last model in Table 3 (Model 4) with an additional specification of Cox PH model: we exclude those who experienced additional hospitalisations for CVD shock and other types of diseases in the same year as the referenced CVD hospitalisation. Robust standard errors have been considered. * p<0.1, ** p<0.05, ***p<0.01

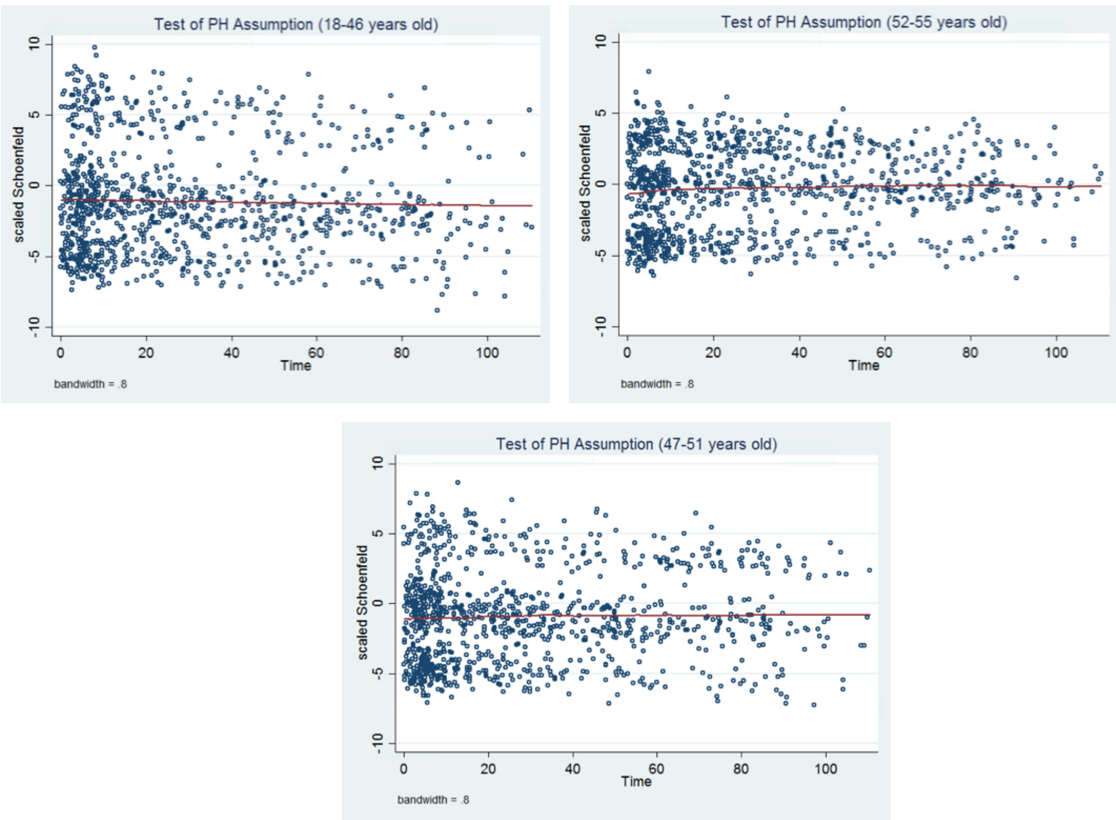

Figure A3: Test of PH assumption by age groups - Schoenfeld residuals
Source: WHIP&Health. **Notes:** The idea of this test is to retrieve the residuals, fit a smooth function of time to them, and then test whether there is a relationship (Cleves et al. 2010). Model 4 in Table 3 is our reference estimation. The baseline age group are those between 56 and 64 years old.

Table A5: *Parametric Estimates - no frailty*

	Baseline *Cox Model*	Exponential	Weibull	Gompertz
sick_leave	1.016***	1.016***	1.015***	1.015***
	(0.004)	(0.004)	(0.004)	(0.004)
Past Health Characteristics	YES	YES	YES	YES
Current Job Characteristics	YES	YES	YES	YES
Past Job Characteristics	YES	YES	YES	YES
N.Obs.	1354	1354	1354	1354
Log pseudolikelihood	-6668,8	-2158.1	-2141.2	-2140.7
LR(chi2)	381.22	477.56	398.28	396.64

Source: WHIP&Health. Note: The table compares the *hazard ratios* of our baseline semi-parametric duration model, i.e. the Cox Model (Model 4, Table 3), with its parametric version. Survival times have been modelled according to three different distributions: *exponential*, *Weibull* and *Gompertz*. According to the distributions, the hazard function assumes the following forms respectively: $h(t) = \lambda$, $h(t) = \lambda p t^{p-1}$ and $h(t) = exp(\gamma t)$. * p<0.1, ** p<0.05, ***p<0.01

Chapter 2

Long-run effects of health shocks in a highly regulated labour market

Michele Belloni * Irene Simonetti † Francesca Zantomio ‡

Abstract: Based on administrative data covering employment, social security and hospital record histories, we investigate the effect of acute cardiovascular health shocks resulting in unplanned hospitalisation, on blue collars' long-term labour outcomes in Italy. The Italian institutional setting, characterised by a highly regulated labour market and high job protection, is different from that of countries - mainly Nordic and Anglo-Saxon - covered in previous studies. We apply matching and parametric regression techniques to remove possible bias arising from observable and time-invariant unobservable confounders. Results point at sizeable and persistent reductions in employment and labour income, while hours and wage adjustments appear limited. Whereas a relatively generous social insurance system might compensate the earnings loss, our findings question the appropriateness of existing labour inclusion policies.

Keywords: health shocks, employment, labour market institutions, administrative data
JEL codes: I10, J22, J24, J31, C14

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2.1 Introduction

Fostering the labour market inclusion of older and unhealthy workers is indeed a daunting task among those appearing in the economic policy agenda of many countries. While social security sustainability calls for extending working lives as a policy priority, this comes at the cost of an increased chance for older workers to experience health deteriorations. Policy makers are thus compelled to face complex choices, trading-off the provision of incentives to remain active, and the protection that motivates social insurance institutions.

In such scenario, empirical evidence on how workers' labour market performance is affected after a health deterioration experienced in a particular institutional setting, is crucial for shaping the policy agenda. Insights on the issues at stake represent a primary step for identifying the kind of policy interventions that could be recommended. Indeed, existing evidence has produced so far a relative consensus on the existence of a detrimental effect (Currie and Madrian, 1999) of health shocks on labour and other socioeconomic outcomes: first and foremost, labour market participation (Jones et al, 2019; Au et al, 2005; García Gòmez et al., 2010; Bradley et al, 2013), but also hours worked (Moran et al, 2011; Cai et al, 2014), labour income (Flores et al., 2019; García Gòmez and Lopez Nicolas, 2006; Halla and Zweimüller, 2013; Moller Dano, 2005), and even wealth, due to increased health expenditures (Dobkin et al., 2018; Wu, 2003).

However, a recurrent limitation of this literature, and to its potential for informing policy design, is that results are typically confined to a short time horizon. Except for a few cases providing evidence for up to 6 years (García Gòmez et al. 2013; Moller Dano, 2005 and Moran 2011), the bulk of works covers about one to three years after the health shock occurrence, due to reasons involving a combination of data availability and identification strategy credibility[1]. In this way though, the picture remains pretty partial. On the one hand, a thorough assessment of the adverse socioeconomic consequences of health deteriorations should account for possibly cumulative detrimental effects arising over time. For example, a labour market exit observed in the short term, and intended to be temporary because meant to foster health recovery, could become permanent in the longer run, particularly in rigid labour market settings offering more limited opportunities of re-entry to older 'outsiders'. On the other hand, a return to employment or a recovery in earnings could emerge only in the medium to long run, through health improvements or the development of different forms of disability-specific human capital. For example Charles (2003) finds, in the US, the immediate reduction in earnings to be then followed by a recovery, evident since the first two post-onset years.

No less important than the timeframe, for policy design purposes, comes devoting attention to the peculiarity of the institutional setting (Arpaia and Mourre, 2012; Holmlund, 2014) where the

[1] Credible identification strategies generally rely on observing information on previous labour and health histories, which then results in a reduced observational window for analysing the post-shock outcomes dynamic.

empirical evidence is drawn. Recent comparative evidence from European countries has shown that labour responses to the same health shock can vary substantially across heterogeneous labour market, social insurance and healthcare system settings. Both García Gòmez (2011) and Trevisan and Zantomio (2016) found, in the short term, stronger employment contractions (following a health shock) in Nordic countries[2], characterised by more generous disability benefits (both in terms of access rates and replacement income) and high job mobility, in comparison to other European countries.

Actually, institutional differences represent a precious source of identification for the role played by particular policy instruments or institutional features. In this respect, the bulk of existing works have been produced on Anglo-Saxon countries (e.g. Jones et al, 2019; Dobkin et al, 2018; Moran et al, 2011; Au et al., 2005; Coile, 2004; García Goḿez et al., 2010; Zucchelli et al., 2010), Nordic countries, (e.g. Datta Gupta et al 2011; Lundborg et al., 2015; Moller Dano, 2005; Heinesen et al, 2013; Maczulskij and Bockerman, 2019), and the Netherlands (García Goḿez et al., 2013). Such pattern reflects these countries' more generous availability of appropriate data sources, which have sometimes allowed exploring subgroups responses (by gender, or education, see e.g. Moller Dano, 2005; Lundborg et al., 2015; Heinesen et al, 2013), also useful to draw policy inference. However, in comparative terms (OECD, 2014; OECD, 2016; EC, 1999; EC, 2009), these countries generally feature high job mobility[3] and a more limited role for job protection legislation (such as obligations for firms to employ a mandatory quota of disabled workers). This partial view casts doubts on the obtained results' robustness to different institutional environments, such as Southern European countries, generally[4] featuring highly regulated labour markets, typically resulting in comparatively low labour flow indicators (EC, 2009; OECD, 2016); and therefore questions the appropriateness of possibly extending the potential policy recommendations drawn there, to these other settings.

This work offers a contribution towards these limitations of an otherwise undoubtedly developed stream of literature, by measuring the effect of health shocks on labour outcomes until up to 9 years later, in Italy, a country characterised by a highly regulated labour market and high job protection by European standards, as explained in Section 2.2. In more detail, we study the outcomes of blue-collar male workers, aged 18 to 64 years old, hit by acute forms of cardiovascular diseases (CVD) between 2003 and 2005, namely myocardial infarction (ischemic heart disease) and stroke (a cerebrovascular disease), which typically result in an unplanned hospitalisation (Braunwald et

[2]Followed by the UK, in Trevisan and Zantomio (2016) (while UK is not covered in García Gòmez 2011) a country featuring less generous disability benefits than Nordic countries but a tight labour market, in comparative terms.

[3]With the notable exception of the Netherlands, featuring comparatively low hiring rates: in 2006 the hiring rate for older workers (ages 55-64: measured as the number of employees with job tenure of less than one year as a percentage of total employees) was 1.7 (against an OECD average of 9.2).

[4]One exception though is Spain, featuring high hiring rates (in 2006 the hiring rate for older workers was 7.7, while the same indicator was 4.0 for Italy- against an OECD average of 9.2). For evidence on the consequences of health shocks in Spain, see García Goḿez and Lopez Nicolas (2006).

al., 2015).

Multiple reasons underpin the choice of focussing on these CVD shocks. On the one hand, there is policy interest. CVDs represent a source of major human and economic cost in developed countries (Wilkins et.al., 2017)[5]. Over the past 25 years, the incidence of CVD cases has increased in most European countries, including Italy[6]. In 2015, the incidence of myocardial infarction was 2,968,582 among males and 2,784,341 among females; while new cases of stroke were 675,872 among males and 879,493 among females. Data on the crude prevalence for the same year depict an impressive situation: more than 85 million people across Europe were living with CVDs[7], myocardial infarction representing one of the most prevalent conditions, with corresponding costs estimated in about €59 billion a year. The cost of stroke was estimated in €45 billion per year. While CVDs are among the leading causes of death in developed countries, survival rates have remarkably improved over the past decades[8]. Upon survival, these types of health deteriorations often lead to serious physical and mental impairments limiting most daily-life activities and also work-capabilities.

Besides policy interest, the choice of focussing on CVD shocks relates to the endogeneity challenge that plagues empirical research on the relationship between health and labour (Haan and Myck, 2009; Cai, 2010). Grossman (1972) seminal contribution, based on Becker (1964), introduced a model of health production where people are endowed with a depreciable stock of health capital, restorable with additional investment. While additional economic resources may increase health through such investment, the health stock enhances socioeconomic outcomes through extended working times and higher earnings. At the empirical level, the main resulting implication is that health must be treated as endogenous, with respect to labour (Currie and Mandrian (1999)), or in other words, identification of health effects is to be based on exogenous sources of variation in health[9]. As pointed out by Smith (1999), particular forms of major health shocks might represent a source of unexpected variation in health: indeed, although people may anticipate to some extent the onset of a certain illness, or their underlying risk, the actual realisation and its timing come as unexpected. Previous authors (Smith, 1999, 2005; Coile, 2004; Datta Gupta et al., 2011; Trevisan et al., 2016; Jones et al., 2019; Bradley et al., 2013) have studied the consequences of selected

[5]Both direct health costs, productivity loss and informal care costs are considered in the total estimated cost.

[6]In Europe, new CVD cases were 4,467,489 (5,013,645) among males (females) in 1990 compared with 5,441,564 (5,842,358) new cases in 2015, showing a percentage increase of 21% (16%). In Italy there were 293,767 (300,865) new cases among males (females) in 1990 compared to 359,888 (371,869) cases in 2015.

[7]The more than 30 million of CVD cases among males (34 million for females) in 1990 have increased to more than 41 million cases (44 million for females) in 2015. Age-standardised prevalence rates show instead a decline over the 25 years period in Europe, for both genders.

[8]For men in particular, CVD diseases represent the most common cause of death under 65 years old (31%) in Europe (compared to about 22% of deaths related to cancer). For women aged below 65 years old, CVD shocks are the second largest cause of death (26%), after cancer (35%).

[9]For example, Moller-Dano(2005) and Halla et al. (2013) consider respectively accidents occurred on the way to and from work, road accidents in general; García Goḿez et al. (2013) and Lindeboom et al. (2016) consider unplanned hospitalisations.

subgroups of major health shocks, which typically included CVD shocks, cancer and lung diseases. The advantage of selecting only acute CVD conditions, such as myocardial infarction and stroke for identification purposes, relates to their local time-specific onset (Braunwald et al., 2015), in contrast to other health condition, whose onset is hardly referable to a specific point in time.

Studying the labour outcomes consequences of CVD shocks in the Italian institutional context is possible thanks to a unique opportunity in the national panorama, the availability of a new administrative dataset, WHIP&Health, described in more detail in Section 3.2. WHIP&Health covers the work and social security histories of a 7% random sample drawn from the Italian Social Security (INPS) archives from 1990 to 2012, which are linked to individuals' hospital discharge records from all private and public hospitals, between 2001 and 2012. The availability of administrative data on acute CVD shock hospitalisations allows overcoming several measurement error challenges typically encountered when approaching the subject using survey data, spanning from recall and justification biases, to pure filling errors (Jackle and Himmler, 2010; Benitez-Silva et al., 2004; Baker et al., 2004).

While the topic areas covered by WHIP&Health, as generally by other administrative data, remain limited in scope with respect to survey data, the wide time window covered gives the opportunity to exploit a very long record of labour market and social insurance information, up to 15 years before the health shock occurrence. Conditioning on such a long history of health, labour and social insurance variables, we assume the conditional probability for a worker to experience a CVD health shock or not, at a particular point in time, to be as good as random. Also, by conditioning on lagged outcomes, we remove the bias stemming from time invariant unobservables, on top of time varying observables. Following Jones et al. (2019), the identification strategy detailed in Section 2.3.1 is implemented through a combination of Coarsened Exact Matching and Entropy Balancing matching procedures, followed by parametric estimation of the Average Treatment effect on the Treated (ATT) for employment, labour activity (including also self-employment and atypical work), the probability of working full, rather than part-time, annual labour income and hourly wage.

Results, presented in Section 2.4, reveal that, in the current Italian institutional setting, acute CVD shocks cause a significant and sizeable reduction in employment. The probability of exiting employment one year after the shock is increased of one third, with respect to its baseline value. The dynamic pattern over the nine years past the shock shows an employment reduction that peaks three years past the shock, and displays only a minor recovery thereafter. After nine years, the drop in employment reaches a value that, in terms of relative size, is four times larger than the effect observed in the first year. Moreover, loss of employment is not compensated by increased chances of transition to other forms of work, i.e. self-employment or atypical work. The shock-induced loss of employment entails a substantial income loss, also persisting up to nine years after, and amounting to more than 10% of the counterfactual value since the first year past the shock. For those who maintain employment, no significant adjustment in terms of working hours emerges in the short run. The probability of working full- versus part-time registers a slight reduction between two and five years after the health event, driven by individuals hit by stroke, but the effect substantially fades for workers remaining active after then, up to nine years past the shock. Wage dynamics after the shock reveal a small negative effect of health shocks, arising from lower wage growth, with respect to the counterfactual. Interestingly, a systematic gradient in the size of the effect by firm size emerges, consistent with the higher employment protection legally granted to workers in large firms. Overall, results suggest that, in a highly regulated institutional setting like the Italian labour market, there appears to be limited scope for workers to flexibly adjust working times on the one side, and for employers to adjust the wage of lower productivity workers, on the other. This might force some workers, who would have preferred to remain active under a reduced working time and/or under adjusted wages, to withdraw from the labour force; and at the same time, might favor the dismissal of less healthy workers: in both cases with remarkable labour income losses to be borne. Such evidence questions the appropriateness of existing labour inclusion policies for unhealthy workers, besides their income opportunities.

2.2 Institutional background

When looking at comparative labour market institutions indicators over the period covered by our study (1990-2012), the Italian labor market emerges as highly regulated one. The value of the *Strictness of Employment Protection*[10] OECD indicator (ranging 0 to 5) for Italy scores 2.76 (in the period 1990-end 2011, decreasing to 2.68 in 2012), a value close to other Southern European countries (e.g. Greece, 2.8) but much higher than for Anglo-Saxon countries (e.g. UK, 1.1) and for OECD countries as a whole (2.08, in 2012).

In Italy, employment protection has historically been particularly high for workers on open-ended contracts in medium and large companies (i.e. firms with more than 15 employees). Their dismissal was in facts not allowed[11] during most of the time period we study. Legal safeguards[12] have been

[10] Referring to individual dismissals in regular contracts.

[11] Reinstatement of the worker was the sanction the employer was subject to in case of unlawful dismissal.

[12] Based on Article 18 of the Workers' Statute (Law No. 300 of May 20, 1970). In 2011, an attempt to circumvent article 18 was introduced by the Berlusconi government (Law 148, September 2011, art. 8). This law allowed for collective agreements at the plant or local level ("proximity agreements") to derogate from national collective agreements and the law in various matters, including the possibility to permit compensation in lieu of reinstatement in case of unlawful dismissal in larger firms' apparently even if acting against the guidelines issued by peak-level unions (Berton et.al., 2012). The application of article 8 Law 148 was limited due to the fear of a massive number of lawsuits triggered by the unions. The Fornero-Monti reform of employment law, which came into force in July 2012, rewrote in total article 18 of the Workers' Statute, providing different regulations for different types of dismissal. Its most relevant novelty concerns the possibility for a firm with more than 15 employees to dismiss workers for economic reasons. In this type of dismissal, the employee cannot claim his job back and has only right to an indemnity ranging from 12 to 24 months of salary, the sum being decided by a court. The Fornero-Monti reform thus

later reduced, since 2011; in more detail, the 2012 'Monti-Fornero' reform introduced the possibility of dismissal for economic reasons, significantly lowering firing restrictions previously applying to medium and large companies. Employees in small firms (i.e. up to 15 employees, a widespread case in the Italian productive panorama, also in comparison with all the other OECD countries)[13] or under fixed term-contracts (which remain relatively marginal in comparative terms, particularly for older workers, more exposed to health shocks)[14] have historically, and throughout the period we consider, relied on remarkably lower levels of employment protection.

High regulation, in comparative terms, emerges also from the OECD *Trade unions and Collective Bargaining* indicators. The *Collective bargaining coverage* rate is 80 percent for Italy (years 1998-2016), similarly to Spain, Portugal and Greece before the crisis, against an OECD average of 33 percent. Although a legal minimum wage does not exist in the country, it is de facto otherwise set through collective bargaining agreements on a sector-by-sector basis. In comparative terms, the compensation structure emerges as particularly rigid: in facts, Italy stands out as having a completely different profile for lifecycle trajectories of hourly wages than other countries (Contini, 2009). Strikingly, for many years, Italy has been the only European country where remuneration was not declining at older ages[15] because, as long as open-ended contracts were prevailing, particularly in large firms, wages were linked to seniority until retirement[16]. This type of wage adjustment contributes to shaping a highly regulated market, where firms can hardly adjust working hours, require overtime work, make workers redundant, and no firm level negotiations generally occur (Contini, 2019). More in detail, Devicienti et al. (2007) provide evidence of a sizeable amount of downward wage rigidity in Italy, with a prevalence of real over nominal rigidity.

High downward wage rigidity might result in frictions that increase labor mobility and workers reallocations (see Devicienti et.al., 2007, using WHIP data for the period 1985-1999). Indeed, although highly regulated, the Italian labor market has been characterised by hiring rate and labor turnover indicators that during the 1980s and the 1990s were middle-way between central European and Anglo-Saxon countries (OECD 1994, Contini, 2019). More recently, in the years 2002-2007 (covered by European Commission (2009)), Italy is found among the bottom positions in terms of hiring, separations and turnover (European Commission,2009). More disaggregated statistics on

lessened the restrictions to firing In Italy significantly.

[13]Italy is the second leading OECD country by number of micro-businesses (319k firms with 0 to 9 persons employed) preceded only by Turkey, while is third by number of small size business (40k firms with 10-19 persons employed) preceded only by the US (OECD, 2017). Micro-businesses represented 95% of all Italian firms in 2015 (all sectors), while firms with 10-49 employees an additional 4.1% (ISTAT, 2017).

[14]According to OECD (2016), the incidence of temporary work for those aged 55-64 was 6.4 per cent in 2006, decreasing to 5.8 in 2016, against corresponding OECD figures amounting to 8.9 and 7.9 respectively.

[15]Whereas in Nordic countries and the UK wages peak at around 45 years old, and then start decreasing, in Italy wages continue to increase until 60 years old.

[16]After 1991, Italy experienced a trend of declining union power and increasing role of local wage setting. Nevertheless, the influence of local wage bargaining has always been modest. Devicienti et.al. (2007) report a wage drift of about 1 percent.

labor mobility in the country can be found in Contini (2019), based on Italian administrative data for the period 1991-2012[17]. Interestingly, the hiring rate in small firms is about 50 percent, declining to a value of 25 percent for firms with more than 200 employees, where stricter employment protection legislation applies.

The incidence of part-time contracts has been increasing at a fast pace during the last two decades; this increase has led Italy to register, in 2018, a higher incidence of part time (18.8%) than the average OECD countries[18]. However, the majority of part time in the country is involuntary: in 2018, the share of voluntary part-timers as a % of total employment was 6.9% (the residual 11.9% being involuntary). Moreover, the share of voluntary part time is even lower if one focuses on males (1.5%), slightly increasing for older males (aged 55 to 64: 3.1%). These are astonishing figures if compared with the corresponding OECD values, where the share of voluntary part-timers in total employment is equal to 13.4% (all ages, both genders), 7.5% (males, all ages), and 7.1% (older males) (OECD, 2019). Also, evidence from Eurostat (2019) revels that prevalence of part-time contracts, among male workers aged 45 or older and suffering health-related limitations, is only 12%, a figure that places Italy in penultimate position among EU28 countries.

In case of sickness, blue collar workers are entitled to paid sickness leave, which is granted for a maximum of 180 days (about six months) per calendar year. Combining the public benefit rate with further compensations obtained through collective bargaining agreements results in a full replacement rate[19]. After 180 days, if work is not resumed, the employer may rescind the contract.

Still, further protection against health-related income risk is offered though two types of welfare schemes targeted at disabled workers. The first is a temporary disability benefit (*assegno ordinario di invaliditá*) in case of certified mental or physical impairment leading to a reduction in working capacity by at least two-thirds. The entitlement lasts three years, and, upon medical screening, can be renewed for up to three times, until it becomes permanent. Noticeably, the temporary disability benefit is compatible with working activity; and while being earnings-tested, the earnings-related reduction applies to high income levels[20]. The second disability-related benefit is a very generous permanent disability pension (*pensione di inabilitá*) paid to claimants who, after medical screening,

[17]Based on WHIP data (note that the frequency of WHIP is monthly: therefore, indicators of labor mobility cannot be compared with the European Commission ones, based on EU-LFS, which is quarterly). Open-ended contracts appear characterised by separation rates regularly greater than association rates; for these contracts, the value of labor turnover has been constant over time around a value of 25 percent, implying a surprisingly low average length of open-ended contracts of 4 years.

[18]In Italy, the incidence of part-time on the total employment was 11.7 percent in 2000, to reach a value of 18.8 percent in 2018. The corresponding values for the OECD are 13.9% and 16.5%.

[19]By law, the benefit is equal to 50% of the average daily earnings for the first 20 days and to 66.66% of it for the following days. The first three days ('periodo di carenza') are not paid. Generally, however, collective bargaining agreements provide a more generous coverage, with benefits raised up to 100 percent of the remuneration and extended to the first three days of sickness.

[20]The benefit is reduced by 25% (50%) when labour income is greater than four (five) times the minimum pension (i.e. €26676,52 or €33.345,65 in 2019).

result in permanent and total impossibility of performing any kind of work activity[21]. This payment is incompatible with any type of paid work.

2.3 Empirical Approach

2.3.1 Identification strategy

Ideally, the causal effect of health deterioration on labour would be measured as the difference in individual labour outcome $Y_{i,t}$ observed for individual i at time t, simultaneously in two states of the world. In the first, the CVD shock event T occurs for individual i at time $\bar{t}$ ($T_{i,\bar{t}} = 1$), yielding outcome $Y^1_{i,t}$; in the other, for the same individual, it does not ($T_{i,\bar{t}} = 0$), yielding outcome $Y^0_{i,t}$. In that case, we could estimate the average treatment effects on the treated (i.e. on individuals' hit by the CVD shock) $ATT_{\bar{t}+\nu}$ at time $\bar{t}+\nu$, i.e. ν years after the CVD shock, as:

$$E[Y^1_{i,\bar{t}+\nu} - Y^0_{i,\bar{t}+\nu}|T_{i,\bar{t}} = 1] = E[Y^1_{i,\bar{t}+\nu}|T_{i,\bar{t}} = 1] - E[Y^0_{i,\bar{t}+\nu}|T_{i,\bar{t}} = 1]$$

In practice though, an individual will only experience - and be observed - in one state, implying that the two potential health states ($T_{i,\bar{t}} = 1$,$T_{i,\bar{t}} = 0$), and the corresponding labour outcomes ($Y^0_{i,t}$, $Y^1_{i,t}$) are never simultaneously observed. The potential outcome approach tackles the evaluation problem modelling the counterfactual unobserved outcome under the assumption of unconfoundedness, or conditional independence (Rosembaum and Rubin, 1983). In our context, the assumption can be formulated as:

$$(Y^0_{i,t}, Y^1_{i,t}) \perp T_{i,\bar{t}}|(W_i, X_{i,\bar{t}-s}) \qquad s = 1...S$$

where W_i represents the individual time invariant characteristics, and $X_{i,\bar{t}-s}$ the time varying ones, including labour, social insurance and health histories, observed s years before the shock, up to past time S. Under unconfoundedness, conditioning on the observables W_i and $X_{i,\bar{t}-s}$ makes both potential outcomes independent w.r.t the treatment status, and the conditional probability of experiencing an acute CVD shock in $\bar{t}$, as good as random. The assumption would be violated if unobservables systematically differed between individuals experiencing the $T_{i,\bar{t}} = 0$ and those experiencing the $T_{i,\bar{t}} = 1$ states. Therefore, while untestable, its credibility crucially relies on the scope of the available data, a point to which we come back in the following section, after presenting our data in more detail. A second assumption for identification requires some overlap in the distribution of observables W_i and $X_{i,\bar{t}-s}$ between individuals experiencing, and not experiencing, the health shock, so that for both, the conditional treatment probability is:

$$0 < pr(T_{i,\bar{t}} = 1|W_i = w, X_{i,\bar{t}-s=x} < 1$$

[21] Additional requirements to claim these benefits are five years of enrolment to Social Security and at least three years of contributions in the previous five.

Under both assumptions, i.e. under strong ignorability (Rosenbaum and Rubin, 1983), the $ATT_{\bar{t}+\nu}$ at time $\bar{t}+\nu$, i.e. ν years after the CVD shock, denoted by $\tau_{\bar{t}+\nu}$, is identified as:

$$\tau_{\bar{t}+\nu} \equiv E[Y^1_{i,\bar{t}+\nu} - Y^0_{i,\bar{t}+\nu} | W_i = w, X_{i,\bar{t}-s} = x]$$

$$\equiv E[Y^1_{i,\bar{t}+\nu} | W_i = w, X_{i,\bar{t}-s} = x] - E[Y^0_{i,\bar{t}+\nu} | W_i = w, X_{i,\bar{t}-s} = x]$$

2.3.2 Data, sample selection and research design implementation

WHIP&Health is an administrative dataset that combines the work and social insurance histories with the health histories of a 7% random sample of workers covered by the Italian Social Security System (INPS) i.e. all private sector workers, excluding agriculture.

The first component, i.e. the Work Histories Italian Panel (WHIP), spanning from 1990 to 2012[22], is a rich employer-employee database collecting detailed information for each employment contract (e.g. qualification, sector of activity, firm, firm dimension, labour income). Further information available includes other types of working spells (i.e. self-employment or atypical work), and non-working spells, such as unemployment. Information on a variety of social security programmes is also available. Information on death is generally not available (except for deaths occurring during hospitalisation, captured in the health component).

The health component is drawn from the hospital discharge records (or SDO i.e. *Schede di dimissione ospedaliera*) registry maintained by the Italian Ministry of Health and collects information on all types of hospitalisations occurred between 2001 and 2014. Variables include the main and the secondary diagnoses, accordingly to the ICD codes (ICD-IX), the year and month of hospitalisation and the type of dismissal (which allows identifying death occurred in the hospital). We identify unplanned hospitalisations related to an acute CVD shock onset (ischemic, codes: ICD-IX 410-414; or cerebrovascular, codes: ICD-IX 430-434 and 436-437) which does not result in death, before reaching or while staying at the hospital. Figure 1 clarifies the time window covered respectively by the labour and social insurance (WHIP), and health (SDO) components of WHIP&Health, and how these are exploited to implement the research design.

For the unconfoundedness assumption to be credible, one needs to observe as much previous labour and health history information as possible: therefore, the identification strategy requires a sizeable time widow for observing pre-shock characteristics. On the other hand though, the research question is centred around the chance of evaluating the effect of a health shock in the longer term. Trading-off the two, we place the treatment time window of CVD shocks occurrence in the years 2003-2005. This allows observing up to s=15 years of previous labour and social insurance history

[22]Previous years would also be available, from 1985, but useless for our purposes due to lower coverage and high frequency of missing information.

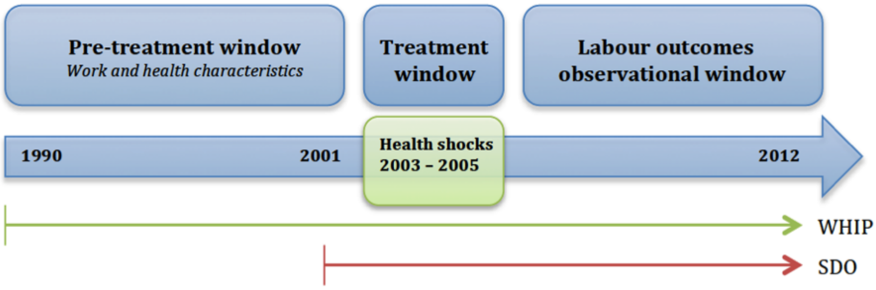

Figure 1: Dataset time coverage and related identification strategy

(i.e. for individuals experiencing the CVD shock in 2005, with WHIP available variables dating back to 1990), and up to ν=9 years of labour outcomes past the health shock onset year (i.e. for individuals experiencing the CVD shock in 2003, with WHIP available variables dating back to 1990).

The sample for analysis includes male individuals who, in any year between 2003 and 2005, were observed in employment as blue-collars, and aged 18-64 years old. The first two restrictions reflect limitations of the underlying WHIP data with respect our identification strategy needs. In more detail, for women, besides lack of reliable information on fertility, the scope of available information on history would be significantly reduced due to their more discontinuous employment patterns, and lack of corresponding information in WHIP (which captures only job or social security spells). The exclusion of white-collar workers is motivated by lack of information on their sickness leave, which is not captured in WHIP (while it is, in the case of blue collars)[23]. Sickness leave represents a crucial confounder that allows capturing health-related information for up to 15 previous years, with the SDO time frame being limited to up to 4 years prior the CVD shock occurrence. Because of unobserved heterogeneity concerns, we further restrict the sample to those who had not experienced an acute CVD shock in 2001 and 2002 i.e. the two years before the treatment observational window, and to individuals who could claim four previous years of employment since 1990. We further drop cases with missing or inconsistent information on relevant variables.

The resulting working sample consists of 326,337 individuals: among them, 1,629 experience an acute CVD shock between 2003 and 2005 (i.e. 506 in 2003, 556 in 2004 and 567 in 2005) and represent the 'treated' subsample. While they might potentially experience recurrent CVD events within the treatment window, we consider the first shock observed within the 2003-2005 window as the reference shock. In line with the national and international trends[24], most cases involve an myocardial infarctions (76,98%), and about one in four (23,02%) are cerebrovascular diseases. The subsample of those who do not experience any acute CVD shock between 2003 and 2005, i.e.

[23]More precisely, while the majority of blue-collars receive sickness benefits from the Italian Social Security Institute (INPS), only few white-collars categories do that (tertiary sector only).

[24]Wilkins E, Wilson L, Wickramasinghe K, Bhatnagar P, Leal J, Luengo-Fernandez R, Burns R, Rayner M, Townsend N (2017). European Cardiovascular Disease Statistics 2017. European Heart Network, Brussels.

our 'control' subsample, amounts to 324,708 individuals. Overall considering our sample selection criteria, the only difference among the two groups of people is the experience of an acute form of CVD shock during the treatment window.
Table 1 describes the full set of variables that we exploit to credibly implement the identification strategy outlined in section 2.3.1: besides basic demographics and health history variables, they include a strikingly rich battery of retrospective labour and social security history information, reconstructing the workers' past for up to 15 previous years. We derive multiple summary indicator of labour market trajectories, as well as time-and job-specific characteristics for previous employments, aiming at substantially reducing the potential influence of time-varying unobservables, captured to the extent they are correlated with observed confounders. Notably, we also include time-specific lagged outcomes, which allow removing any bias that would stem from time-invariant unobservables (O'Neill et al., 2016). Indeed unobserved heterogeneity concerns might arise, for example, from lack of available information on genetic or behavioural risk factors (e.g. smoking, eating habits, physical activity) correlated with labour market outcomes. However our results would not be invalidated, if, besides genetic invariance over time, the above mentioned behaviours are deemed as pretty stable over time (in which case their effect would be purged via lagged outcomes inclusion). Full descriptive statistics for our working sample are reported in Appendix, Table A1.

Table 1: Variables description

Variable Name	Description
Time and demographic characteristics	
Year	Year (of CVD shock, for the treated)
Age	Age (when the CVD shock occurs, for the treated)
Abirth_north	Area of birth (north)
Abirth_center	Area of birth (center)
Abirth_south&Isl.	Area of birth (south or islands)
Abirth_abroad	Area of birth (abroad)
Country_underdev	Equal to 1 if the person comes from an underdeveloped country
Health History	
Hosp_cvd_cum	Equal to 1 if the person ever had a hospitalisation for cardiovascular diseases until ($\bar{t}$-1)
Days_cvd_cum	Number of days spent in hospitals for a cardiovascular shock until ($\bar{t}$-1)
Hosp_other_cum	Equal to 1 if the person ever had a hospitalisation for other diseases until ($\bar{t}$-1)
Days_other_cum	Number of days spent in hospitals for other type of diseases until ($\bar{t}$-1)
Hosp_other_($\bar{t}$-1)	Number of hospitalisations for other types of diseases in ($\bar{t}$-1)
Days_other_($\bar{t}$-1)	Number of days spent in hospitals for other types of diseases in ($\bar{t}$-1)
Inv_benefit_cum	Equal to 1 if the person ever received ordinary invalidity benefits until ($\bar{t}$-1)
Sick_leave_cum	Number of weeks in sick leave until ($\bar{t}$-1)
Labour History	
Work_active_cum	Number of years the person is observed as employee, self-employed or atypical worker, until ($\bar{t}$-1)
Nemployee_cum	Number of contracts as employee until ($\bar{t}$-1)
Rate_employee_cum	Percentage of years as an employee over the total observed as a worker, until ($\bar{t}$-1)
Jobloss_cum	Number of involuntary job losses experienced until ($\bar{t}$-1)
New_firm_cum	Number of firms changed until ($\bar{t}$-1)
Nblue_collar_cum	Number of contracts as blue-collar until ($\bar{t}$-1)
Nwhite_collar_cum	Number of contracts as white-collar until ($\bar{t}$-1)
Nmanager_cum	Number of contracts as manager until ($\bar{t}$-1)
Rate_perm_cum	Percentage of permanent contracts on the total as an employee until ($\bar{t}$-1)
Rate_fullt_cum	Percentage of full-time contracts and the total as an employee until ($\bar{t}$-1)
Ever_CIG	Equal to 1 if the person ever been in "cassa integrazione guadagni" until ($\bar{t}$-1)
Nunempl_cum	Number of unemployment benefits received until ($\bar{t}$-1)
Unempl_($\bar{t}$-1)	Equal to 1 if the person received unemployment benefits in ($\bar{t}$-1)
Rate_selfempl_cum	Percentage of years as self-employed over the total observed as a worker until ($\bar{t}$-1)
Days_self_cum	Total number of days as self-employed until ($\bar{t}$-1)
Rate_atypical_cum	Percentage of years as atypical worker over the total observed as a worker until ($\bar{t}$-1)
N_atypical_cum	Total number of contracts as atypical worker until ($\bar{t}$-1)
Characteristics of the last (pre-shock) job as employee	
Dist_last1_employee	Distance between the treatment year and the last job as employee as if ($\bar{t}$-1)
Dist_last2_employee	Distance between the treatment year and the second previous job as employee as if ($\bar{t}$-1)
Dist_last3_employee	Distance between the treatment year and the third previous job as employee as if ($\bar{t}$-1)
Dist_last4_employee	Distance between the treatment year and the fourth previous job as employee as if ($\bar{t}$-1)
Last_sick_leave	Number of weeks in sick leave corresponding to the last job as employee as if ($\bar{t}$-1)
Last_weeks_paid	Number of paid weeks corresponding to the last job as employee as if ($\bar{t}$-1)
Last_fix_term	Equal to 1 if the person is in a permanent contract during the last job as employee as if ($\bar{t}$-1)
Last_jtenure	Number of years under the same employer up until the last job as employee as if ($\bar{t}$-1)
Last_awork_north	Area of work (north) of the last job as employee as if ($\bar{t}$-1)
Last_awork_center	Area of work (center) of the last job as employee as if ($\bar{t}$-1)
Last_awork_south&Isl.	Area of work (south or islands) of the last job as employee as if ($\bar{t}$-1)
Last_awork_abroad	Area of work (abroad) of the last job as employee as if ($\bar{t}$-1)
Last_apprentice	Job qualification (apprentice) of the last job as employee as if ($\bar{t}$-1)
Last_bluecollar	Job qualification (blue-collar) of the last job as employee as if ($\bar{t}$-1)
Last_whitecollar	Job qualification (white-collar) of the last job as employee as if ($\bar{t}$-1)
Last_manager	Job qualification (manager) of the last job as employee as if ($\bar{t}$-1)
Last_director	Job qualification (director) of the last job as employee as if ($\bar{t}$-1)
Last_firm_015	Firm dimension (between 0 and 15 employees) corresponding to the last job as employee as if ($\bar{t}$-1)
Last_firm_16250	Firm dimension (between 16 and 250 employees) corresponding to the last job as employee as if ($\bar{t}$-1)
Last_firm_250	Firm dimension (more than 250 employees) corresponding to the last job as employee as if ($\bar{t}$-1)
Last_sec_agriculture	Sector of activity (agriculture) corresponding to the last job as employee as if ($\bar{t}$-1)
Last_sec_manufac	Sector of activity (manufacturing) corresponding to the last job as employee as if ($\bar{t}$-1)
Last_sec_construc	Sector of activity (construction) corresponding to the last job as employee as if ($\bar{t}$-1)
Last_sec_extraction	Sector of activity (mineral extraction) corresponding to the last job as employee as if ($\bar{t}$-1)
Last_sec_energy	Sector of activity (energy) corresponding to the last job as employee as if ($\bar{t}$-1)
Last_sec_trade	Sector of activity (trade) corresponding to the last job as employee as if ($\bar{t}$-1)
Last_sec_foodservices	Sector of activity (food and hotel services) corresponding to the last job as employee as if ($\bar{t}$-1)
Last_sec_transports	Sector of activity (transports) corresponding to the last job as employee as if ($\bar{t}$-1)
Last_sec_finance	Sector of activity (finance services) corresponding to the last job as employee as if ($\bar{t}$-1)
Last_sec_realestate	Sector of activity (real estate services) corresponding to the last job as employee as if ($\bar{t}$-1)
Last_public	Sector of activity (public services) corresponding to the last job as employee as if ($\bar{t}$-1)

(continue)

Variable Name	Description
Lagged outcomes	
Last1_lab_income	Annual earnings of the last job as employee as if ($\bar{t}$-1)
Last2_lab_income	Annual earnings of the second previous job as employee as if ($\bar{t}$-2)
Last3_lab_income	Annual earnings of the third previous job as employee as if ($\bar{t}$-3)
Last4_lab_income	Annual earnings of the fourth previous job as employee as if ($\bar{t}$-4)
Last1_hwage	Hourly wage of the last job as employee as if ($\bar{t}$-1)
Last2_hwage	Hourly wage of the second previous job as employee as if ($\bar{t}$-2)
Last3_hwage	Hourly wage of the third previous job as employee as if ($\bar{t}$-3)
Last4_hwage	Hourly wage of the fourth previous job as employee as if ($\bar{t}$-4)
Last1_fulltime	Equal to 1 if the person is full-time employed in the last job as employee as if ($\bar{t}$-1)
Last2_fulltime	Equal to 1 if the person is full-time employed in the second previous job as employee as if ($\bar{t}$-2)
Last3_fulltime	Equal to 1 if the person is full-time employed in the third previous job as employee as if ($\bar{t}$-3)
Last4_fulltime	Equal to 1 if the person is full-time employed in the fourth previous job as employee as if ($\bar{t}$-4)
Last1_LMP	Equal to 1 if the person is an employee, self-employed or an atypical worker in $\bar{t}$-1
Last2_LMP	Equal to 1 if the person is an employee, self-employed or an atypical worker in $\bar{t}$-2
Last3_LMP	Equal to 1 if the person is an employee, self-employed or an atypical worker in $\bar{t}$-3
Last4_LMP	Equal to 1 if the person is an employee, self-employed or an atypical worker in $\bar{t}$-4

2.3.3 Implementation

Before any compositional adjustment, the distribution of characteristics varies remarkably between treated and control individuals (visible in Table 2, first and second columns), revealing selection in experiencing CVD shocks. Individuals who experience an acute CVD shock are on average older, with poorer previous health outcomes (e.g. more frequent previous hospitalisations and for longer periods, higher receipt of invalidity benefits and sickness leave take-up etc.) and significant differences in labour market outcomes, possibly related to their different age distribution, with respect to control individuals. In the spirit of Ho et al. (2007), we compute ATTs combining preprocessing procedures, aimed at balancing the distribution of covariates between treated and control individuals over a common support, with parametric estimation on the preprocessed samples (via OLS and Probit for continuous and binary outcomes respectively), thus obtaining ATTs that are robust to model misspecification[25].

Following Jones et al. (2019), the distributional adjustments are implemented in two steps: coarsened exact matching (CEM) (Iacus et al., 2011) along a set of basic confounders[26], and entropy balancing matching (EB)(Hainmueller, 2012; Hainmueller and Xu, 2013) on the full set of observed potential confounders. CEM performs an exact matching between treated and control individuals based on coarsened variables values. The advantage, with respect to other matching procedures, is that CEM reduces the imbalance in selected variables, while implementing common support on these, without affecting the balancing in other variables (as other procedures, such as propensity

[25]This two-step approach is regarded as doubly robust as consistency only requires that either the parametric or the nonparametric component is consistently estimated (Ho et al., 2007).

[26]Age, year, distance (in years) from the previous time the individual was observed as employee, whether the individual had a past experience of acute CVD shock, whether working in a part-time or full-time contract as of $\bar{t}-1$, whether under a fixed-term or open-ended contract as of $\bar{t}-1$, firm size (coarsened: 0-15/16-250/250+) as of $\bar{t}-1$, region of work (coarsened to north-east, north-west,centre,south) as of $\bar{t}-1$

score matching, might instead entail, trading-off the balance obtainable for different variables), while also accounting for variables' interactions and nonlinearities. In practice, the CEM algorithm stratifies the sample by subsets of coarsened variables values (or exact variable values, in the case of dichotomous variables, or if no coarsening is applied) of selected variables. Individuals falling in strata lacking at least one treated and one control are dropped, while retained individuals are attributed a weight accounting for the different number of treated and control individuals retained in each matched stratum. The greater the number of variables involved, and the finer the coarsening applied to non-dichotomous variables, the higher the loss of cases for which no exact matching is found.

Table 2: Pre and post matching covariates balance

	Pre-matching				Post-matching			
	Mean				Mean			
	Treated (1629)	Controls (769174 obs.)	%bias	p-value	Treated (1596)	Controls (294862 obs.)	%bias	p-value
Year	2004	2004	1.7	0.503	2004	2004	0.0	1.000
Age	50.73	39.77	127.9	0.000	50.68	50.68	0.0	0.998
Abirth_north	0.271	0.359	23.4	0.000	0.273	0.273	0.0	1.000
Abirth_center	0.142	0.133	2.6	0.284	0.142	0.142	0.0	1.000
Abirth_south&Isl.	0.508	0.354	31.3	0.000	0.507	0.507	0.0	1.000
Abirth_abroad	0.079	0.154	-23.4	0.000	0.078	0.078	0.0	1.000
Country_underdev	0.073	0.139	-21.5	0.000	0.072	0.072	0.0	1.000
Hosp_cvd_cum	0.037	0.001	26.6	0.000	0.024	0.024	0.0	1.000
Days_cvd_cum	0.409	0.012	19.3	0.000	0.282	0.282	0.0	1.000
Hosp_other_cum	0.311	0.190	28.2	0.000	0.308	0.308	0.0	1.000
Days_other_cum	2.814	1.303	22.3	0.000	2.766	2.766	0.0	1.000
Hosp_other_($\bar{t}$-1)	0.207	0.096	21.6	0.000	0.204	0.204	0.0	1.000
Days_other_($\bar{t}$-1)	0.993	0.440	14.7	0.000	0.979	0.979	0.0	1.000
Inv_benefit_cum	0.077	0.007	35.5	0.000	0.068	0.068	0.0	1.000
Sick_leave_cum	19.28	10.70	38.9	0.000	19.10	19.10	0.0	0.999
Work_active_cum	12.37	10.99	43.0	0.000	12.41	12.41	0.0	0.998
Nemployee_cum	14.23	13.2	25.2	0.000	14.27	14.27	0.0	0.999
Rate_employee_cum	97.01	97.90	-8.9	0.000	96.98	96.98	0.0	1.000
Jobloss_cum	0.312	0.324	-1.8	0.476	0.315	0.315	0.0	1.000
New_firm_cum	2.843	2.937	-3.7	0.120	2.847	2.847	0.0	1.000
Nblue_collar_cum	12.78	10.84	43.8	0.000	12.82	12.82	0.0	0.998
Nwhite_collar_cum	0.281	0.261	1.5	0.523	0.271	0.271	0.0	0.999
Nmanager_cum	0.001	0.002	-1.0	0.753	0.001	0.001	0.0	0.992
Rate_perm_cum	94.88	89.86	28.1	0.000	95.11	95.11	0.0	0.998
Rate_fullt_cum	96.39	96.55	-1.1	0.636	96.64	96.64	0.0	1.000
Ever_CIG	0.384	0.335	10.2	0.000	0.385	0.385	0.0	0.999
Nunempl_cum	0.393	0.381	1.1	0.646	0.384	0.384	0.0	1.000
Unempl_($\bar{t}$-1)	0.039	0.059	-9.5	0.000	0.039	0.039	0.0	0.999
Rate_selfempl_cum	3.699	2.596	9.1	0.000	3.749	3.748	0.0	1.000
Days_self_cum	165.5	130.6	5.9	0.013	168.4	168.4	0.0	1.000
Rate_atypical_cum	0.403	0.632	-6.1	0.030	0.374	0.374	0.0	1.000
N_atypical_cum	0.050	0.062	-2.6	0.307	0.046	0.046	0.0	1.000
Dist_last1_employee	1.044	1.056	-3.3	0.205	1.036	1.036	0.0	1.000
Dist_last2_employee	2.141	2.153	-1.4	0.580	2.130	2.130	0.0	1.000
Dist_last3_employee	3.261	3.267	-0.6	0.816	3.249	3.249	0.0	1.000
Dist_last4_employee	4.391	4.413	-1.6	0.536	4.375	4.375	0.0	1.000
Last_sick_leave	2.202	1.156	23.4	0.000	2.167	2.167	0.0	1.000
Last_weeks_paid	47.57	45.95	14.5	0.000	47.65	47.65	0.0	0.999
Last_fix_term	0.041	0.081	-16.9	0.000	0.036	0.036	0.0	0.997
Last_jtenure	8.911	6.621	34.9	0.000	8.952	8.952	0.0	0.999
Last_awork_north	0.484	0.568	-16.8	0.000	0.482	0.482	0.0	1.000
Last_awork_center	0.179	0.176	0.8	0.735	0.182	0.182	-0.0	1.000
Last_awork_south&Isl.	0.336	0.256	17.8	0.000	0.336	0.336	0.0	1.000
Last_awork_abroad	0	0.002	-2.2	0.539	0	0	.	.
Last_apprentice	0.001	0.017	-17.3	0.000	0	$3.6e^{(-05)}$	-0.2	0.810
Last_bluecollar	0.994	0.976	15.3	0.000	0.996	0.996	0.1	0.986
Last_whitecollar	0.005	0.007	-3.1	0.247	0.004	0.004	0.0	1.000
Last_manager	0	$6.0e^{(-05)}$	-1.1	0.755	0	$3.3e^{(-06)}$	-0.1	0.942
Last_director	0	$3.1e^{(-05)}$	-0.8	0.822	0	$1.1e^{(-06)}$	0.0	0.966
Last_firm_015	0.297	0.368	-15.2	0.000	0.298	0.298	0.0	0.999
Last_firm16250	0.431	0.414	3.4	0.175	0.431	0.431	0.0	1.000
Last_firm_250	0.273	0.218	12.8	0.000	0.271	0.271	0.0	1.000

Source: WHIP&Health. Notes: The standardised % bias is the % difference of the sample means between treated and controls sub-samples as a percentage of the square root of the average of the sample variances in the treated and non-treated groups.

	Pre-matching				Post-matching			
	Mean				Mean			
	Treated (1629)	Controls (769174 obs.)	%bias	p-value	Treated (1596)	Controls (294862 obs.)	%bias	p-value
Last_sec_agriculture	0.001	0.0004	1.1	0.626	0.001	0.001	0.0	1.000
Last_sec_manufac	0.416	0.493	-15.5	0.000	0.420	0.420	0.0	1.000
Last_sec_construc	0.169	0.172	-0.7	0.784	0.170	0.170	0.0	1.000
Last_sec_extraction	0.008	0.005	3.4	0.128	0.008	0.008	0.0	1.000
Last_sec_energy	0.018	0.011	6.0	0.006	0.019	0.019	0.0	1.000
Last_sec_trade	0.069	0.101	-11.5	0.000	0.068	0.068	0.0	1.000
Last_sec_foodservices	0.043	0.046	-1.6	0.531	0.043	0.043	0.0	1.000
Last_sec_transports	0.144	0.088	17.6	0.000	0.143	0.143	0.0	1.000
Last_sec_finance	0.123	0.076	15.7	0.000	0.119	0.119	0.0	1.000
Last_sec_realestate	0.006	0.003	3.8	0.069	0.006	0.006	0.0	1.000
Last_public	0.004	0.005	-1.7	0.516	0.003	0.003	0.0	1.000
Last1_lab_income	22310	20835	14.1	0.000	22429	22429	0.0	1.000
Last2_lab_income	21822	20344	14.1	0.000	21922	21922	0.0	1.000
Last3_lab_income	21491	19851	15.0	0.000	21620	21619	0.0	0.999
Last4_lab_income	21222	19002	20.2	0.000	21337	21337	0.0	1.000
Last1_hwage	11.83	11.34	9.2	0.002	11.85	11.85	0.0	1.000
Last2_hwage	11.69	11.14	9.9	0.001	11.72	11.72	0.0	1.000
Last3_hwage	11.65	10.98	9.0	0.005	11.67	11.67	0.0	1.000
Last4_hwage	11.56	10.82	6.9	0.044	11.61	11.61	0.0	1.000
Last1_fulltime	0.950	0.962	-6.0	0.009	0.956	0.956	0.0	1.000
Last2_fulltime	0.952	0.965	-6.7	0.004	0.956	0.956	0.0	1.000
Last3_fulltime	0.956	0.965	-4.7	0.046	0.961	0.961	0.0	1.000
Last4_fulltime	0.956	0.965	-4.3	0.069	0.960	0.960	0.0	1.000
Last1_LMP	0.981	0.976	3.2	0.219	0.984	0.984	0.0	0.999
Last2_LMP	0.964	0.964	0.0	0.985	0.966	0.966	0.0	1.000
Last3_LMP	0.949	0.953	-1.7	0.495	0.950	0.950	0.0	1.000
Last4_LMP	0.934	0.936	-0.8	0.746	0.937	0.937	0.0	1.000

Source: WHIP&Health. Notes: The standardised % bias is the % difference of the sample means between treated and controls sub-samples as a percentage of the square root of the average of the sample variances in the treated and non-treated groups.

We implement CEM on uncoarsened variable values, which results in an exact matching on: age, year, the distance (in years) from the previous time the individual was observed as employee[27], whether the individual had a past experience of acute CVD shock[28], whether working in a part-time or full-time contract, and whether under a fixed-term or open-ended contract as of $\bar{t}$-1. Two further variables included are instead coarsened: firm size (0-15/16-250/250+ employees) as of $\bar{t}$-1; and region of work, coarsened to a geographical area indicator (north-east, north-west, centre, south and islands). Job-specific variables are included as of $\bar{t}$-1, rather than as of the year of shock occurrence, to avoid the chance of introducing post-treatment bias, which would arise if they were themselves affected by the shock, a possibility that we cannot rule out for year $\bar{t}$. It is worth noting though that in the 89% of treated cases and the 88% of control cases, the employer does not change between $\bar{t}$-1 and $\bar{t}$.

Out of the 17,349 strata obtained, only 961 are retained. However, this corresponds to a loss of only 33 treated individuals, paired with a striking reduction in the number of control individuals (about

[27]In the 97.9% of cases, this corresponds to the previous year. For the other, including this variables allows then comparing individuals with lagged outcomes referable to the same past calendar year.

[28]Which would be captured in the available SDO data, i.e. since 2001.

the 60%). The ratio of #potential control/#treated individuals is reduced from 472 controls for every treated pre-CEM to 185 controls for every treated post-CEM (Table A2 in Appendix). To remove imbalances remaining in the larger set of potential confounders observed, we further apply EB matching on the CEM-retained samples of treated and control individuals. The EB procedure reweights observations so that the covariate distributions satisfy a set of specified moment conditions (Hainmueller et al., 2012), imposing ex-ante a desired level of sample moment adjustment. We impose, as usually chosen, a first moment condition on the extended set of variables, obtaining a remarkable overlap, as visible in the right panel of Table 2 (and Table A.3 in Appendix for further moments). In the preprocessed samples, the bias, measured as standardised percentage difference in means between treated and matched controls, is strikingly reduced to zero for all variables, with a few exceptions, where it anyway does not exceed a -0.2.

Indeed, lack of bias in observables does not address the chance of potential remaining bias stemming from unobservables, in particular time- varying unobservables (as potential bias from the time invariant ones is tackled through the inclusion of lagged outcomes), which would invalidate our identification strategy. However, while we cannot entirely rule out the chance of this particular source of bias, it is reassuring to observe in Figure 2 the post-preprocessing sample means for each labour outcome $Y^1_{i,t}$ and $Y^0_{i,t}$, over the years before the shock for the treated and matched controls. If time-varying unobservable were actually playing a role as confounders, that would presumably emerge in detectable differences in pre-shock outcomes between treated and successfully matched controls. Instead, no such difference is detectable in the four years before $\bar{t}$, i.e. the year of shock occurrence[29]. On the contrary, average outcomes for the two groups diverge since $\bar{t}+1$ in terms of employment and probability of full-time work; or even since $\bar{t}$ in the case of annual employment

[29]Many sensitivity analyses have been proposed by the empirical literature to test the strength of the 'selection on observed and unobserved confounders'. Rather than following the approach of Altonji, Elder and Taber (2005), based on a specific parametric setup like the Heckman selection model and assuming the joint normality of the error terms in the selection and outcome equation (Ichino et al. 2008), we thought the test implemented by Ichino et al. (2008) and Nannicini (2007) as the most suitable for our purposes. The idea is essentially to compare the ATT estimates - and thus reliability of CIA assumption - with and without an additional binary variable U aiming to simulate a potential unobserved confounding factor. More than other types of diseases, CVD shocks can be strongly related to risky behaviours like smoking, drinking or eating habits. Unfortunately, due to the administrative nature of the dataset, the lack of this information poses a serious threat to our analysis. Thought, the ATT estimates could be biased if treated individuals are selected on U, and at the same time, there is also a worsening effect on subsequent labour market outcomes. Such a kind of confounder can be somehow associated with the individual's pre-treatment predisposition to run risky choices, both in terms of personal life-styles but also on working activity. We run a preliminary sensitivity check where U follows two types of distributions, a first binary variable describing whether or not an individual has continuously worked during the five previous years, and another one telling in which part of the distribution (under/above the median value) of past weeks in sick leave the person is found. By considering the 'probability of working as an employee' up to t+7, the Nannicini test shows that the existence of a confounding factor like U, in the first case might account for a maximum of 9% of the baseline estimates, while in the second case is slightly increased but never above 11%. At first glance, such preliminary findings are not particularly worrisome, however, further checks will be implemented in future refinements.

income and hourly wages, signalling an immediate adjustment in the first months past the shock[30].

We finally proceed by estimating parametric models (OLS and probit according to the continuous or binary nature of outcome), to obtain the ATTs (measured by coefficients and marginal effects for the treatment indicator respectively) reported in the following results section[31]. With respect to taking a simple difference in outcomes sample means on the post-preprocessing treated and control samples (anyway visible in Figure 2 for each outcome, for the shock year $\bar{t}$ and the following years), the parametric estimation controls for any possibly remaining imbalance in the larger set of all included covariates' distribution.

[30] In Figure 2, continuous lines connect time-specific sample means. It would be incorrect though to interpret figures on earnings and wages as revealing a drop in outcomes for the treated since before the shock occurs; the apparent drop rather results from the treated outcome means in $\bar{t}$, which averages months before and months after the shock occurrence, being lower than in $\bar{t}$-1.

[31] The following regression model has been applied:

$$Y_{\bar{t}+\nu} = \alpha_0 + \alpha_1 T_{i,\bar{t}} + \beta_1' \mathbf{W}_i + \beta_2' \mathbf{X}_{i,\bar{t}-s} + \epsilon_{i,\bar{t}}$$

where ν goes from 1 to 7 (up to 9 in the longer term analysis), $T_{i,\bar{t}}$ is a dummy variable representing the treatment group, $\mathbf{W}_i$ indicates the individual time-invariant characteristics, while $\mathbf{X}_{i,\bar{t}-s}$ includes a selection of time-varying labour, social insurance and health histories variables, observed s years before the shock. Detailed list of variables: treatment dummy, age, abirth_north, abirth_center, abirth_south&Isl., abirth_abroad, hosp_other_cum, days_other_cum, inv_benefit_cum, sick_leave_cum, work_active_cum, jobloss_cum, new_firm_cum, nblue_collar_cum, nwhite_collar_cum, nunempl_cum, last_firm_size(0-15/16-250/250+), last_jtenure, last_awork (north, centre, south&islands, abroad), last_fix_term, last_sick_leave, last_sec_activity (full list of Table 1)

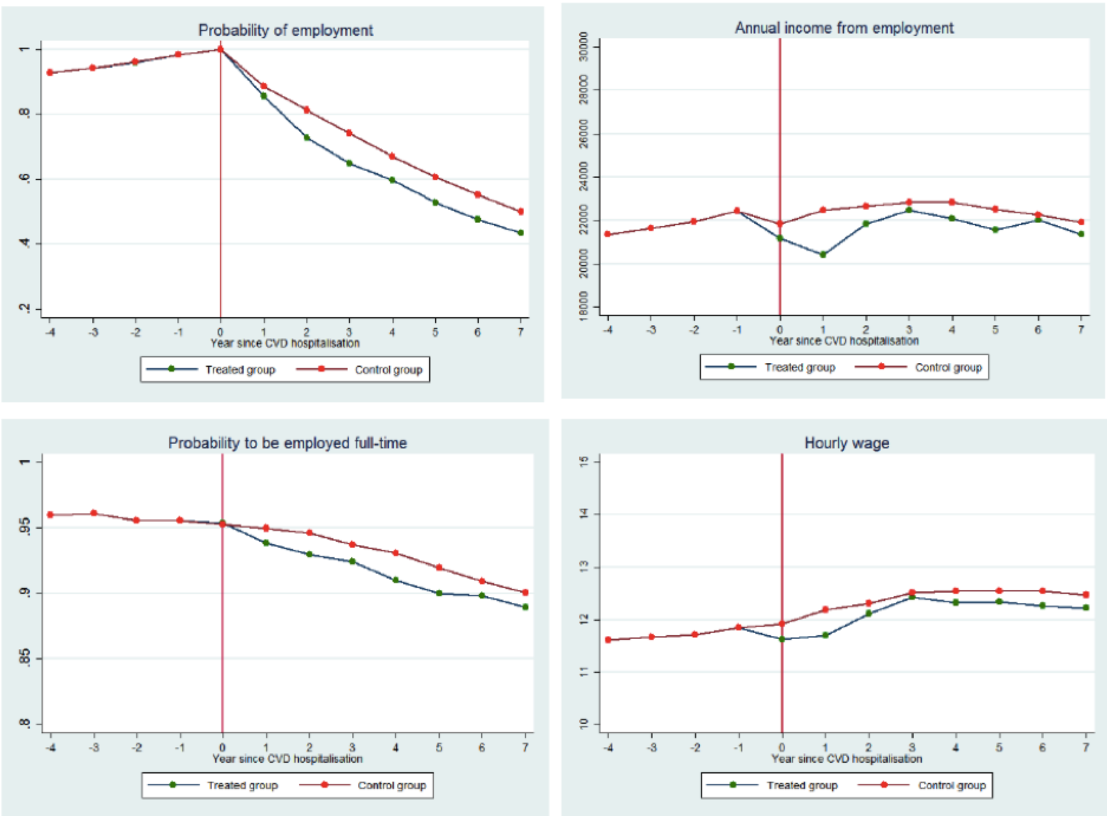

Figure 2: Sample means for labour outcomes, by treatment status, after CEM and EB adjustments
Source: WHIP&HEALTH. Notes: Control group sample means are computed on successfully matched controls only. Continuous lines connect time-specific sample means.

2.4 Results

2.4.1 Labour market outcomes

Table 3 reports the estimated ATTs ($\tau_{\bar{t}+\nu}$) for the probability of employment (i.e. working as an employee) and unconditional annual income from employment, together with the relative size effect, computed as the percentage ratio of each ATT $\tau_{\bar{t}+\nu}$ to the mean of the corresponding counterfactual outcome $Y^0_{i,\bar{t}+\nu}$ in matched controls sample. Estimated ATTs and corresponding 95% confidence intervals on these outcomes are also depicted in Figures 3-4.

In the Italian institutional setting, experiencing a CVD shock entails a remarkable reduction in blue-collar workers' employment probability, a results which is line with previous studies conducted in other countries[32]. Here, the employment probability reduction amounts to about -3 percentage points in the year immediately after the shock, but increases, and persists, over the following years. Actually, loss of employment peaks three years after the shock, reaching -9.3 percentage points, and displays only a very minor recovery thereafter. Seven years later, the consequence of having experienced a CVD shock amounts to a -6.8 percentage points lower probability of employment, thus reaching in the longer term a value that is almost twice the short-term (i.e. $\bar{t}$+1) effect. It is worth emphasising how, in terms of relative size effect, i.e. w.r.t. the average counterfactual outcome, the size of employment probability reduction exceeds 10 per cent from $\bar{t}$+2 onwards, reaching 13 per cent in $\bar{t}$+7.

In line with the majority of previous literature, loss of employment bears a substantial and immediate (i.e. since the shock year) loss of income from employment. But also, our longer-term analysis reveals how persistent this loss is, amounting, in any of the seven years past the shock, to more than 12 per cent of the earnings those blue collars would have obtained in the absence of the shock, up to a relative effect of about 13% in $\bar{t}$+7. The peak in earnings loss arises in the very short term (i.e. $\bar{t}$+1), plausibly in relation to the take-up of sickness leave, which is only partially covered by the employer (the remaining replacement being granted trough public transfers).

[32]Note that a potential threat for our findings may arise due to selective mortality. The estimated ATT for the probability of employment and of labor market activity might be potentially biased upward if the probability to die is higher among the treated than among the controls. Remember that we are not in the condition to identify exits due to death. In the introduction, we outlined that CVD are among the leading causes of death in developed countries, including Italy. A sizeable quota - amounting to 30-40% - of fatal events in the age range 35-64 occur right after the symptoms start and before reaching the hospital (Ministry of Health, 2010). Furthermore, we are able to select into the analysis survivors after the period of hospitalisation. The Italian Ministry of Health (2017) reports that the 30-days mortality rate for myocardial infarctions is equal to 8.3%, while the 1-year mortality is equal to 10.2%, only 1.9 percent higher. This means that after the first month from the health shock, the probability to die is rather low. Based on these data and considerations, we believe that the mortality-based selectivity issue does not sizeably bias our findings.

Table 3: Employment-related unconditional outcome: ATT and Relative Effect

Time	Probability of Employment		Annual income from employment	
	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$
$\bar{t}$	-	-	-693.2***	-3.17
Rob. SE.	-	-	(202.4)	
N. treated	-	-	1.594	
$\bar{t}$ +1	-0.030***	-3.35	-2540.4***	-12.8
Rob. SE.	(0.009)		(278.7)	
N. treated	1596		1.596	
$\bar{t}$+2	-0.085***	-10.41	-2584.9***	-14.11
Rob. SE.	(0.011)		(303.8)	
N. treated	1596		1.596	
$\bar{t}$+3	-0.093***	-12.59	-2337.4***	-13.9
Rob. SE.	(0.011)		(311.6)	
N. treated	1596		1.596	
$\bar{t}$+4	-0.076***	-11.38	-2195.9***	-14.4
Rob. SE.	(0.012)		(317.5)	
N. treated	1596		1.596	
$\bar{t}$+5	-0.080***	-13.17	-2229.7***	-16.4
Rob. SE.	(0.012)		(310.3)	
N. treated	1596		1.596	
$\bar{t}$+6	-0.078***	-13.90	-1761.6***	-14.5
Rob. SE.	(0.000)		(305.5)	
N. treated	1596		1.596	
$\bar{t}$+7	-0.068***	-13.60	-1665.6***	-12.9
Rob. SE.	(0.011)		(291.6)	
N. treated	1596		1.596	

Source: WHIP&Health. Notes: marginal effects are reported for the Probability of employment (ATTs); by sample selection all individuals are employed in $\bar{t}$, thus the probability of employment in that year is 1 by construction.

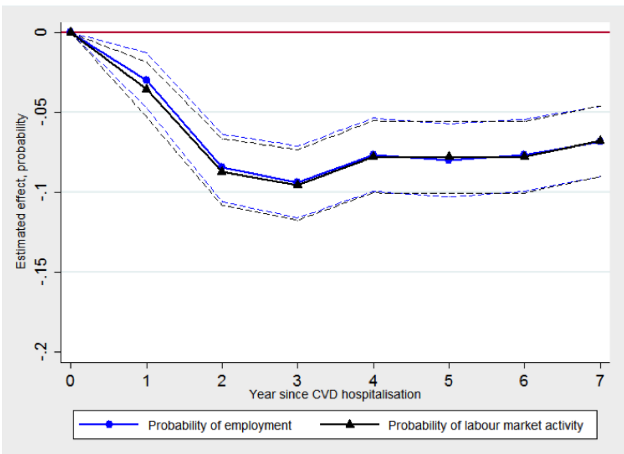

Figure 3: ATTs by year since CVD hospitalization: employment and labour market activity
Source: WHIP&Health. Notes: ATTs: point estimates (connected lines) and 95% confidence intervals (dashed lines); marginal effects are reported; by sample selection all individuals are employed in the year of the shock, thus the ATT is set to 0 in that year

Table 4: Labour activity and transition to self-employment/atypical work: ATT and Relative Effects

Time	**Probability of labour market activity**		**Probability of working as self-employed/atypical worker**	
	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$
$\bar{t}$	-	-	-	-
Rob. SE	-	-	-	-
N. treated	-	-	-	-
$\bar{t}+1$	-0.036***	-4.02	-0.009***	-45.48
Rob. SE	(0.009)		(0.002)	
N. treated	1.596		1.596	
$\bar{t}+2$	-0.087***	-10.5	-0.002	-8.14
Rob. SE	(0.011)		(0.004)	
N. treated	1.596		1.596	
$\bar{t}+3$	-0.095***	-12.5	-0.003	-11.40
Rob. SE	(0.011)		(0.004)	
N. treated	1.596		1.596	
$\bar{t}+4$	-0.078***	-11.3	-0.003	-9.20
Rob. SE	(0.011)		(0.004)	
N. treated	1.596		1.596	
$\bar{t}+5$	-0.078***	-12.3	-0.002	-6.97
Rob. SE	(0.012)		(0.004)	
N. treated	1.596		1.596	
$\bar{t}+6$	-0.078***	-13.5	-0.005	-13.83
Rob. SE	(0.011)		(0.004)	
N. treated	1.596		1.596	
$\bar{t}+7$	-0.068***	-12.9	-0.002	-6.38
Rob. SE	(0.011)		(0.004)	
N. treated	1.596		1.596	

Source: WHIP&Health. Notes: marginal effects are reported for the Probability of labour market activity and for the Probability of working as self-employed/atypical worker (ATTs); by sample selection all individuals are employed in $\bar{t}$, thus the probability of labour market activity in that year is 1 by construction, and for the same reason the probability of working as self-employment/atypical work is 0.

In Table 4, we consider a wider concept of labour market activity, which includes, beside employment, possible transitions to other forms of labour supply, i.e. self-employment or atypical work. In the year after the shock, the size of the negative ATT for labour market activity (Table 4, first column) is even larger than for employment (Table 3, first column), which is explained by a shock-induced reduction in the probability of switching from employment to other forms of labour, at least in the short term (Table 4, right-hand panel). This finding might appear at odds with the argument that individuals might be "pushed" into self-employment by lack of opportunities or perspectives as employees (see e.g. Blanchflower and Oswald, 1998). In this literature, some studies identify health-related limitations to work ability as a main driver of switches to self-employment; and a higher quota of disable persons among the self-employed, better able to accommodate their own condition (see, e.g., Zissimopoulos and Karoly, 2005). However, in the Italian institutional context, our finding can be plausibly explained by the short-run health-related protection granted under employment (i.e. sickness leave paid for six months, allowing to stop working while maintaining the contract, and the option to resume that work later on). Such employment-related protection plausibly lowers the incentive to switch to other forms of work, which, although possibly more flexible, grant lower income protection. In the following years though, the ATTs on employment and labour market activity are roughly comparable in size, consistently with the evidence of no significant response in the probability of switching to self-employment or atypical work from $\bar{t}+2$ onwards.

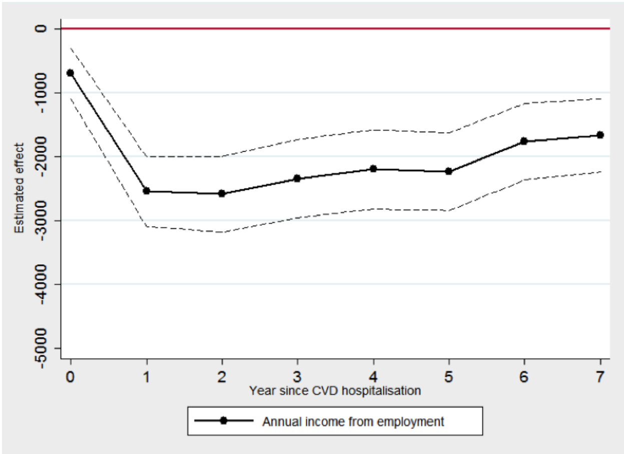

Figure 4: ATTs by year since CVD hospitalization: (unconditional) annual income from employment
Source: WHIP&Health. Notes: ATTs: point estimates (connected line) and 95% confidence intervals (dashed lines).

Table 5: Conditional employment-related outcomes: ATT and Relative Effect

Time	Annual income from employment		Probability to be employed full-time		Hourly wage		Probability of working with the same employer as in $\bar{t}$	
	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$
$\bar{t}$	-693.2***	-3.17	0.003	0.32	-0.295***	-2.48	-	-
Rob. SE.	(202.4)		(0.005)		(0.099)	-	-	-
N. Treated	1,594		1,594		1,594	-	-	-
$\bar{t}+1$	-2138.1***	-9.50	-0.007	-0.74	-0.551***	-4.52	0.019**	2.18
Rob. SE.	(255.6)		(0.006)		(0.119)		(0.008)	
N. Treated	1.349		1.349		1349		1361	
$\bar{t}+2$	-1081.9***	-4.76	-0.015**	-1.59	-0.297**	-2.41	0.004	0.49
Rob. SE.	(273.9)		(0.007)		(0.116)		(0.015)	
N. Treated	1.144		1.144		1.144		1152	
$\bar{t}+3$	-606.8**	-2.64	-0.011	-1.17	-0.198	-1.58	-0.014	1.96
Rob. SE.	(283.5)		(0.008)		(0.129)		(0.014)	
N. Treated	1.020		1.020		1.020		1031	
$\bar{t}+4$	-860.4**	-3.75	-0.017*	-1.83	-0.274**	-2.18	-0.022	-3.43
Rob. SE.	(322.1)		(0.009)		(0.124)		(0.015)	
N. Treated	932		932		932		945	
$\bar{t}+5$	-983.3***	-4.33	-0.016*	-1.74	-0.281*	-2.24	0.003	0.48
Rob. SE.	(345.5)		(0.010)		(0.146)		(0.016)	
N. Treated	826		826		826		840	
$\bar{t}+6$	-528.6	-2.35	-0.007	-0.77	-0.356**	-2.83	-0.008	-1.50
Rob. SE.	(362.7)		(0.011)		(0.145)		(0.017)	
N. Treated	749		749		749		756	
$\bar{t}+7$	-742.6*	-3.35	-0.005	-0.56	-0.323**	-2.59	-0.001	-0.23
Rob. SE.	(348.9)		(0.012)		(0.158)		(0.018)	
N. Treated	675		675		675		685	

Source: WHIP&Health. Notes: marginal effects are reported for the Probability to be employed full-time and for the Probability of working with the same employer as in $\bar{t}$ (ATTs); the probability of working with the same employer in that year is 1 by construction.

Table 5 and Figures 5 to 8 report the estimated ATTs (and corresponding relative size effects) for outcomes observed conditionally on remaining in employment: in more detail, we consider annual income from employment, the probability to be employed full- (versus part-) time, hourly wage[33] and the probability of working with the same employer as in $\bar{t}$ (the year of the shock). The blue-collar workers that continue employment after a CVD shock still bear a significant loss in earnings, again with a peak in $\bar{t}$+1 plausibly related to the take-up of sickness leave. In relative terms, the loss amounts to about -9 per cent in the first year; later, while reduced in size (up to -3% in $\bar{t}$+7), it remains significant throughout the longer run (see also Figure 5). Clearly, exit from employment explains the quantitative difference observable between the relative effect measured on unconditional (Table 3) and conditional (Table 5) earnings. Further columns in Table 5 contribute to shed some light on the possible channels explaining why a reduction in earnings might occur despite remaining employed. First, we consider the possibility of an adjustment in working times. The probability of switching from full- to part-time is substantially unaltered (see also Figure 6) with respect to what would have happened in the absence of the CVD shock. In a few years only ($\bar{t}$+2,$\bar{t}$+4,$\bar{t}$+5) the ATT of full- (versus part-) time employment is significant and negative, yet pretty small in size: the relative effect in those years does not exceeds the two percentage points.

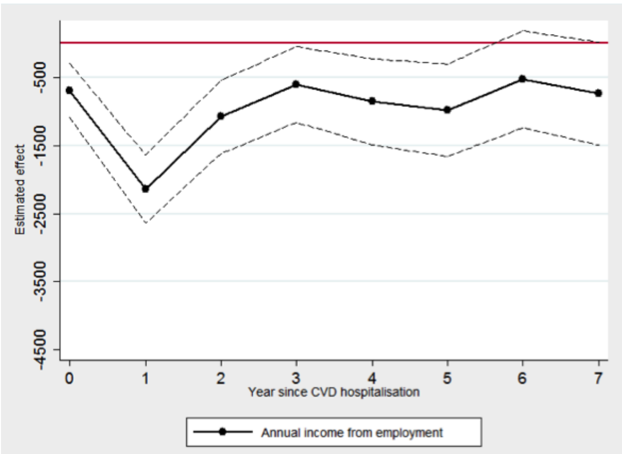

Figure 5: ATTs by year since CVD hospitalisation: (conditional) annual income from employment
Source: WHIP&Health. Notes: ATTs: point estimates (connected line) and 95% confidence intervals (dashed lines)

[33]We compute hourly wages combining information on labour income, paid weeks and the working time (part-time or full-time). We do not observe the number of hours worked in the WHIP data. However, we do recover the distribution of hours worked for male blue-collar workers from the EU-QLFS data. We do find that this distribution is highly concentrated around two mass points: 20 hours for part timers and 40 hours for full time workers (with no dispersion in the latter case, consistently with legal provisions). When computing the hourly wage, we attribute 20 hours of work to part time contracts and 40 hours to full time contracts. It is worth noticing that 94,34% of all annual prevalent contracts in our data are full-time.

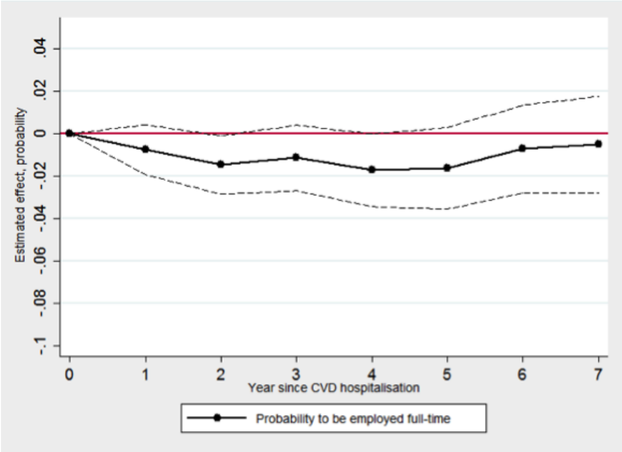

Figure 6: ATTs by year since CVD hospitalisation: probability of full- (versus part-) time
Source: WHIP&Health. Notes: ATTs: point estimates (connected lines) and 95% confidence intervals (dashed lines); marginal effects are reported.

Second, we investigate hourly wage adjustments (see also Figure 7). Hourly wage shows negative and significant ATTs. In relative terms, the magnitude is low, ranging from less than 2% to 4% in the first year past the shock. The later wage dynamics observed for individuals in the treatment and control groups reveal, consistently with a downward wage rigidity scenario, that the negative effect is mostly to be traced to a lower nominal growth experienced by individuals' hit by the CVD shock, with respect to matched controls.

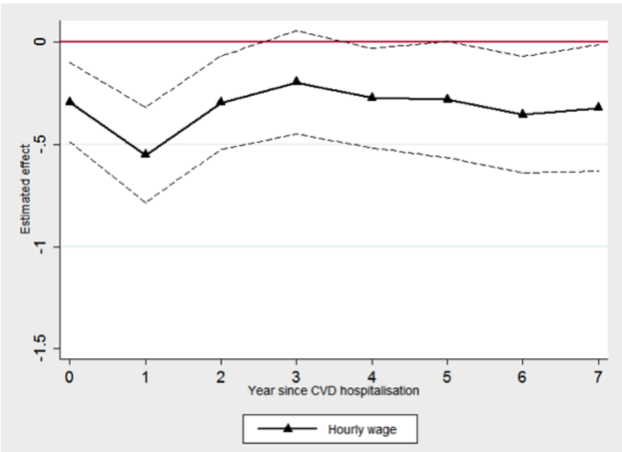

Figure 7: ATTs by year since CVD hospitalisation: hourly wage
Source: WHIP&HEALTH. Notes: ATTs: point estimates (connected line) and 95% confidence intervals (dashed lines).

A further mechanism through which labour income losses might occur entails transitions to other jobs (with a different employer), motivated by the search for tasks more suited to accommodate disability, acceptable even under a lower pay. Interestingly, the probability of working with the same employer as at the time of the shock registers a significant, yet small, increase only in $\bar{t}+1$ (see also Figure 8). The timing of this increase matches that observed for the reduction in transitions to self-employment or atypical work (Table 4), and correspond to the time when sickness protection is being granted under employment. However, in the following years, transitions to other jobs do not appear as an adjustment channel actually pursued by Italian blue-collar workers.

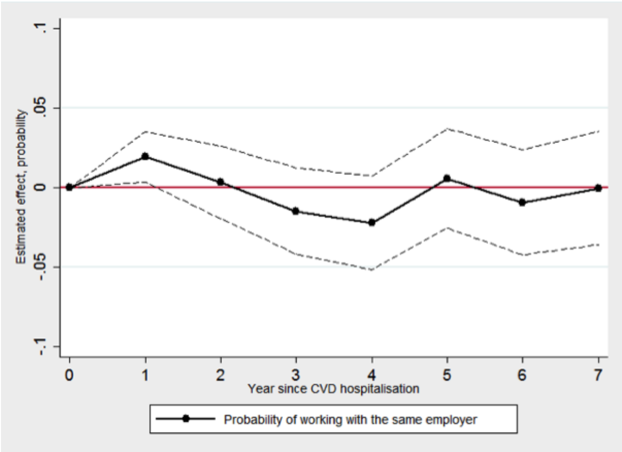

Figure 8: ATTs by year since CVD hospitalisation: (conditional) probability of working with the same employer as in $\bar{t}$
Source: WHIP&HEALTH. Notes: point estimates (connected lines) and 95% confidence intervals (dashed lines); marginal effects are reported.

2.4.2 The long(er) run

Table 6 reports the relative effects of the probability of employment and unconditional annual earnings in the (even) longer run, i.e. up to $\bar{t}$+8 and $\bar{t}$+9, which can be estimated only on workers hit by CVD shocks occurred respectively in 2003-2004 and 2003 (corresponding ATTs are shown in Appendix Table A4). To enhance comparability across results obtained from these restricted subsamples, in the first two columns we repeat results reported in Table 3, obtained on the full treatment sample covering also the CVD shocks experienced in 2005.

Exploiting the two subsamples for which long-run outcomes can be observed, columns 3-4 illustrate results extended up to $\bar{t}$+8, while columns 5-6 reports results extended up to $\bar{t}$+9. Notice that only in the latter case a one-to-one relationship between distance from the shock and calendar year can be established: in more detail, $\bar{t}$+8 corresponds to the calendar year 2011 and $\bar{t}$+9 to the calendar year 2012. Overall, results highlight the long-term effect persistence for both outcomes.

It is interesting to note how the effects in $\bar{t}$+9 deviate somehow from those registered in previous years/periods: the relative reduction in employment probability jumps to -22% (from a value of -14% in 2011). Similarly, annual earnings suddenly drop, in relative size effect terms, from -22% to -29%. While we cannot entirely rule out the chance of effect dynamics specific to the ninth year past the shock, the 2012 evidence nicely fits the important legislated changes outlined in section 2.2, namely the Monti-Fornero reform of labour law (and partly the September 2011 Berlusconi reform) which significantly reduced firing restrictions in medium and large firms.

Table 6: Long(er) term unconditional employment-related outcomes: Relative Effect

Time	*CVD shock experienced in 2003/2004/2005*		*CVD shock experienced in 2003/2004*		*CVD shock experienced in 2003*	
	Probability of employment	**Annual income from employment**	**Probability of employment**	**Annual income from employment**	**Probability of employment**	**Annual income from employment**
$\bar{t}$	-	-3.17***	-	-4.34***	-	-5.94***
N. treated	-	1594	-	1042	-	503
$\bar{t}$+1	-3.35***	-12.8***	-4.41***	-13,43***	-4.59**	-14.88***
N. treated	1596	1956	1043	1043	503	503
$\bar{t}$+2	-10.41***	-14.11***	-10.95***	-14.07***	-9.86***	-15.93***
N. treated	1596	1956	1043	1043	503	503
$\bar{t}$+3	-12.59***	-13.9***	-13.10***	-14.18***	-15.25***	-14.16***
N. treated	1596	1956	1043	1043	503	503
$\bar{t}$+4	-11.38***	-14.4***	-12.18***	-14.60***	-14.04***	-16.87***
N. treated	1596	1956	1043	1043	503	503
$\bar{t}$+5	-13.17***	-16.4***	-13.15***	-16.56***	-11.29***	-18.38***
N. treated	1596	1956	1043	1043	503	503
$\bar{t}$+6	-13.90***	-14.5***	-12.67***	-14.81***	-12.06***	-17.76***
N. treated	1596	1956	1043	1043	503	503
$\bar{t}$+7	-13.60***	-12.9***	-13.35***	-15.08***	-12.76***	-18.80***
N. treated	1596	1956	1043	1043	503	503
$\bar{t}$+8	-	-	-12.54***	-16.52***	-13.95***	-21.82***
N. treated	-	-	1043	1043	503	503
$\bar{t}$+9	-	-	-	-	-21.86***	-28.56***
N. treated	-	-	-	-	503	503

Source: WHIP&Health
Notes: Relative effects are reported (corresponding ATT are reported in Table A4); by sample selection all individuals are employed in $\bar{t}$, thus the probability of employment in that year is 1 by construction.

2.4.3 Heterogeneity: age, CVD shock type, firm size

In this section, we explore effect heterogeneity along three dimensions: workers' age, type of CVD shock, and firm dimension. A priori, age might be expected to affect findings, both in terms of size and time trend. Older individuals might be less attached to the labour market in the light of their higher chances of exploiting available routes of permanent exit from the labour market, such as early-retirement or disability pensions. Besides, in a model of health capital formation, investments in health-specific human capital fostering labour recovery may be more attractive for by that younger individuals, given expected earnings-related returns over a longer time horizon (Charles, 2003). Table 7 reports results for employment and unconditional earnings, distinguishing workers aged 52 (i.e. the median sample age at the time of the shock) or younger, from workers older than 52. Consistently with previous studies conducted in other countries (see e.g. Jones et al., 2019) older workers' shock-induced loss, both in employment and in unconditional earnings, is substantially higher than younger workers'. In the short term, the relative size effects for older workers, in both outcomes, is at least twice the one observed for younger workers. A similar age gradient (i.e. a relative effect for older workers more than doubling that for younger workers) is visible in Table 8 for conditional outcomes in the short term. In the longer run, apparent gradients for conditional outcomes are to be interpreted with caution, as reflecting also the higher chances of previous employment exit suffered by older workers.

Next, in Table 9, we consider the specific type of CVD shock experienced, distinguishing myocardial infarction from stroke, which often turns out as a more severe condition, possibly leading to stronger impairment to work[34]. Indeed, we find stroke to bring about a much stronger reduction in the probability of employment than myocardial infarction, systematically over time: for instance, the relative effect in $\bar{t}$+3 amounts to -21 per cent for the former and -8 per cent for the latter. For both CVD conditions, the shock-induced loss of employment is persistent over time. Similar findings are obtained for other labor market outcomes in the short term; again, longer terms gradients on outcomes measured conditional on being employed will also reflect the higher chances of previous exit suffered in case of stroke, and for this reason are to be interpreted with caution. Bearing this limitation in mind, results - presented in Table 10 - for the probability of working full- (versus part-) time suggest that the small but significant result previously obtained on the full sample (in Table 5) for $\bar{t}$+4 and $\bar{t}$+5 is mostly attributable to individuals hit by stroke.

The third type of heterogeneity we investigate, novel in this literature to our knowledge, concerns firm size just before the shock onset. Firm size is of particular policy interest in the light of the differing extent of employment protection granted in the country, and related hiring rates (to give a figure, based on Contini (2009): 50 percent in small firms, declining to a value of 25

[34]Shock severity has an a priori undefined effect on preference for leisure/work. In fact, a more severe shock may, on the one hand, increase the value of leisure as a consequence of an expected lowered life expectancy; on the other hand, it may reduce its value by limiting the possibility of performing or enjoying leisure activities.

percent for firms with more than 200 employees). Also, because organisational practices fostering disabled workers' inclusion, for example workplace training, disability accommodation, reallocation to different tasks or branches, increase with firm size (see e.g. Bassanini et al., 2007). Table 11 shows ATTs for employment probability and unconditional earnings, distinguishing firms with a) up to 15 employees; b) from 16 to 250 employees; c) with more than 250 employees[35].The shock-induced reduction in employment is particularly evident in small firms, with a relative effect increasing over time from -9.7 per cent in $\bar{t}$+1 up to -23 per cent in $\bar{t}$+7. Indeed, firms with up to 15 employees are those not subject to the Worker's Statute[36], thus bearing a cost, for firing workers under open-ended contracts, which is much lower than for larger firms[37]. At the same time, within-firm reallocations are very difficult to implement in small firms.

The reduction in the employment probability following a CVD shock is systematically smaller in medium-big firms; even smaller in firms with 250+ employees, where actually no significant reduction takes place, before two years past the shock. A qualitatively similar gradient emerges when looking at annual earnings (unconditional, see Table 11; conditional, see Table 12). The ATTs for the conditional probability of being employed full- (versus part-) time is never significant in small firms. Results for hourly wage by firm size, reported in Table 13, display a clear negative association between firm dimension and the size of differential wage adjustment, suggesting that most of the effect reported in Table 5 for the full sample occurs in smaller firms, featuring larger scope for firm-level bargaining.

Finally, we report in Appendix (Tables A5 and A6) results obtained from heterogeneity analyses for labour activity, by the type of contract (open-ended versus fixed-term) and hours worked (part- versus full-time) just before the shock onset. In both cases, the sample numbers for one subgroup (fixed-term contracts and part-time contracts respectively) is definitely low, given the limited sample prevalence of such types, with a consequent possible loss of significance. Bearing this limitation in mind, results visible in Table A5 are consistent with the lower protection granted to blue collar workers hired under fixed term contracts, visible since the short run. The fact that, in Table A6, no significant reduction in labour activity is ever experienced by part-timers, as opposed to full-timers, appears suggestive of a role for reduced working times in facilitating labour inclusion.

[35]The sample distribution of firm size emerging from Table 11 (and shown in Table 2) is very different from that reported in footnote 13, which provides evidence of a very high percentage of micro and small firms. This is because WHIP&Health offers a sample representative of workers, rather than firms, thus over representing larger firms.

[36]See section 2.2, footnote 12.

[37]The effects of a differential workers' protection on the probability to exit employment is confirmed when disaggregating the sample according to the worker' contract type. Table A5 illustrates that workers with a fixed-term contract have a much higher probability to exit employment in the short run (i.e. until t+3) than workers with a permanent job. The effect for fixed-term jobs is so striking to emerge even in a sample of constituted of about 55 observations.

Table 7: Unconditional employment-related outcomes by age group: ATT and Relative Effect

	Age ≤ Median (52)				*Age > Median (52)*			
	Probability of employment		**Annual income from employment**		**Probability of employment**		**Annual income from employment**	
Time	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$
$\bar{t}$	-	-	-392.1	-1.75	-	-	-1082.5***	-5.11
Rob. SE.	-	-	(261.0)		-	-	(304.2)	
N. treated	-	-	870		-	-	724	
$\bar{t}$+1	-0.015*	-1.62	-1965.3***	-8.98	-0.047***	-5.73	60974	-18.76
Rob. SE.	(0.009)		(347.9)		(0.015)		(425.2)	
N. treated	871		871		725		725	
$\bar{t}$+2	-0.058***	-6.39	-2036.0***	-9.46	-0.119***	-17.10	-3324.6	-22.91
Rob. SE.	(0.012)		(378.1)		(0.018)		(450.2)	
N. treated	871		871		725		725	
$\bar{t}$+3	-0.072***	-8.11	-2121.8***	-9.98	-0.119***	-20.78	-2667.1***	-23.02
Rob. SE.	(0.013)		(396.9)		(0.018)		(437.3)	
N. treated	871		871		725		725	
$\bar{t}$+4	-0.072***	-8.44	-2296.9***	-11.22	-0.080***	-17.54	-1820.3***	-24.08
Rob. SE.	(0.014)		(426.0)		(0.018)		(361.3)	
N. treated	871		871		725		725	
$\bar{t}$+5	-0.079***	-9.68	-2637.1***	-13.65	-0.081***	-22.34	-941.9**	-27.08
Rob. SE.	(0.015)		(437.3)		(0.016)		(333.8)	
N. treated	871		871		725		725	
$\bar{t}$+6	-0.089***	-11.52	-2516.2***	-13.87	-0.063***	-21.84	-941.9**	-18.63
Rob. SE.	(0.016)		(444.9)		(0.015)		(333.8)	
N. treated	871		871		725		725	
$\bar{t}$+7	-0.090***	-12.37	-2465.4***	-14.73	-0.046***	-19.72	-786.6**	-20.73
Rob. SE.	(0.016)		(441.4)		(0.014)		(287.9)	
N. treated	871		871		725		725	

Source: WHIP&Health. Notes: marginal effects are reported for the Probability of employment (ATTs); by sample selection all individuals are employed in $\bar{t}$, thus the Probability of employment in that year is 1 by construction.

Table 8: Conditional employment-related outcomes by age group: ATT and Relative Effect

	Age ≤ Median (52)						*Age > Median (52)*					
	Probability to be employed full-time		**Annual income from employment**		**Hourly wage**		**Probability to be employed full-time**		**Annual income from employment**		**Hourly wage**	
Time	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$		
$\bar{t}$	0.002	0.21	-392.1	-1.75	-0.246**	-2.07	0.008	0.85	-1082.5***	-5.11	-0.383**	-3.21
Rob. SE.	(0.006)		(261.0)		(0.116)		(0.008)		(304.2)		(0.163)	
N. treated	852		870		870		724		724		724	
$\bar{t}$+1	-0.009	-0.94	-1553.29**	-6.65	-0.453***	-3.70	-0.003	-0.32	-3074.3***	-14.41	-0.775***	-6.38
Rob. SE.	(0.007)		(314.1)		(0.141)		(0.010)		(408.5)		(0.197)	
N. treated	795		795		795		554		554		554	
$\bar{t}$+2	-0.009	-0.94	-837.6**	-3.54	-0.345**	-2.78	-0.023*	-2.48	-1708.6***	-8.07	-0.313	-2.57
Rob. SE.	(0.007)		(334.5)		(0.134)		(0.014)		(450.3)		(0.206)	
N. treated	734		734		734		410		410		410	
$\bar{t}$+3	-0.013	-1.36	-673.7**	-2.79	-0.202	-1.60	-0.004	-0.44	-659.5	-3.18	-0.268	-2.19
Rob. SE.	(0.008)		(339.7)		(0.143)		(0.016)		(480.9)		(0.252)	
N. treated	701		701		701		319		319		319	
$\bar{t}$+4	-0.014	-1.47	-769.6**	-3.18	-0.191	-1.50	-0.030	–3.40	-1375.6**	-6.81	-0.527**	-4.35
Rob. SE.	(0.009)		(375.3)		(0.142)		(0.021)		(596.0)		(0.236)	
N. treated	667		667		667		265		265		265	
$\bar{t}$+5	-0.017*	-1.80	-1110.2**	-4.61	-0.280*	-2.19	-0.018	-2.12	-975.2	-5.12	-0.336	-2.83
Rob. SE.	(0.009)		(391.6)		(0.157)		(0.026)		(713.3)		(0.329)	
N. treated	627		627		627		199		199		199	
$\bar{t}$+6	-0.014	-1.49	-882.1**	-3.71	-0.290*	-2.26	0.013	1.60	295.7	1.63	-0.703**	-6.02
Rob. SE.	(0.010)		(403.0)		(0.161)		(0.029)		(783.8)		(0.310)	
N. treated	586		586		586		199		199		199	
$\bar{t}$+7	-0.008	-0.86	-1060.9**	-4.52	-0.305*	-2.39	0.004	0.51	72.11	0.42	-0.473	-4.15
Rob. SE.	(0.011)		(413.2)		(0.175)		(0.034)		(930.6)		(0.363)	
N. treated	544		544		544		131		131		131	

Source: WHIP&Health. Notes: marginal effects are reported for the Probability to be employed full-time.

Table 9: Unconditional employment-related outcomes by type of CVD shock: ATT and Relative Effect

	Ischemic heart diseases (ICD-9: 410-414)				*Cerebrovascular diseases (ICD-9: 430-434/436-437)*			
	Probability of employment		**Annual income from employment**		**Probability of employment**		**Annual income from employment**	
Time	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$
$\bar{t}$	-	-	-658.3**	-3.01	-	-	-817.0**	-0.07
Rob. SE	-	-	(232.1)		-	-	(394.2)	
N. treated	-	-	1225		-	-	369	
$\bar{t}$+1	-0.014	-1.62	-2032.8***	-10.21	-0.087***	-5.73	-4269.4***	-21.45
Rob. SE	(0.009)		(312.5)		(0.020)		(569.9)	
N. treated	1227		1.227		369		369	
$\bar{t}$+2	-0.062***	-6.39	-2008.7***	-10.97	-0.164***	-17.10	-4578.2***	-24.99
Rob. SE	(0.012)		(342.4)		(0.024)		(614.9)	
N. treated	1227		1.227		369		369	
$\bar{t}$+3	-0.065***	-8.11	-1632.9***	-9.70	-0.189***	-20.78	-4740.2***	-28.14
Rob. SE	(0.013)		(353.3)		(0.025)		(612.8)	
N. treated	1227		1.227		369		369	
$\bar{t}$+4	-0.056***	-8.44	-1642.1***	-10.79	-0.146***	-17.54	-4084.7***	-26.84
Rob. SE	(0.013)		(361.9)		(0.024)		(617.6)	
N. treated	1227		1.227		369		369	
$\bar{t}$+5	-0.060***	-9.68	-1798.9***	-13.26	-0.151***	-22.34	-3709.1***	-27.35
Rob. SE	(0.013)		(354.2)		(0.023)		(605.2)	
N. treated	1227		1.227		369		369	
$\bar{t}$+6	-0.058***	-11.52	-1438.8***	-11.83	-0.143***	-21.84	-2877.8***	-23.66
Rob. SE	(0.013)		(348.7)		(0.023)		(599.0)	
N. treated	1227		1.227		369		369	
$\bar{t}$+7	-0.052***	-12.37	-1417.5***	-13.10	-0.124***	-19.72	-2523.1***	-23.32
Rob. SE	(0.013)		(332.6)		(0.022)		(578.2)	
N. treated	1227		1.227		369		369	

Source: WHIP&Health. Notes: marginal effects are reported for the Probability of employment (ATTs); by sample selection all individuals are employed in $\bar{t}$, thus the Probability of employment in that year is 1 by construction.

Table 10: Conditional employment-related outcomes by type of CVD shock: ATT and Relative Effect

	Ischemic heart diseases (ICD-9: 410-414)						*Cerebrovascular diseases (ICD-9: 430-434/436-437)*					
	Probability to be employed full-time		**Annual income from employment**		**Hourly wage**		**Probability to be employed full-time**		**Annual income from employment**		**Hourly wage**	
Time	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$		
$\bar{t}$	0.008	0.84	-658.3**	-3.01	-0.266**	-2.23	-0.011	-1.15	-817.0**	-0.07	-0.397**	-3.33
Rob. SE.	(0.005)		(232.1)		(0.115)		(0.011)		(394.2)		(0.179)	
N. treated	1225		1225		1225		369		369		369	
$\bar{t}$+1	-0.003	-0.32	-1974.9***	-8.78	-0.655***	-5.37	-0.022	-2.32	-2784.9***	-12.38	-0.197	-1.62
Rob. SE.	(0.006)		(287.7)		(0.129)		(0.136)		(535.9)		(0.276)	
N. treated	1060		1060		1060		289		289		289	
$\bar{t}$+2	-0.012	-1.27	-1003.9***	-4.42	-0.286**	-2.32	-0.022	-2.33	-1464.2**	-6.45	-0.367	-2.92
Rob. SE.	(0.008)		(307.9)		(0.129)		(0.015)		(575.9)		(0.250)	
N. treated	905		905		905		239		239		239	
$\bar{t}$+3	-0.008	-0.85	-519.6	-2.26	-0.205	-1.64	-0.018	-1.92	-992.7*	-4.32	-0.216	-1.73
Rob. SE.	(0.009)		(319.0)		(0.145)		(0.017)		(584.6)		(0.244)	
N. treated	813		813		813		207		207		207	
$\bar{t}$+4	-0.008	-0.86	-818.2**	-3.56	-0.267*	-2.13	-0.054**	-5.81	-1085.9	-4.73	-0.317	-2.53
Rob. SE.	(0.009)		(365.0)		(0.139)		(0.022)		(664.5)		(0.258)	
N. treated	737		737		737		195		195		195	
$\bar{t}$+5	-0.010	-1.09	-971.6**	-4.28	-0.311*	-2.48	-0.046*	-5.00	-1031.4	-4.54	-0.166	-1.32
Rob. SE.	(0.011)		(389.1)		(0.162)		(0.024)		(729.6)		(0.312)	
N. treated	652		652		652		174		174		174	
$\bar{t}$+6	0.001	0.11	-581.3	-2.59	-0.385**	-3.07	-0.040	-4.40	-401.6	-1.79	-0.231	-1.84
Rob. SE.	(0.011)		(408.9)		(0.160)		(0.027)		(760.3)		(0.321)	
N. treated	587		587		587		162		162		162	
$\bar{t}$+7	-0.002	-0.22	-674.3	-3.05	-0.280	-2.25	-0.017	-1.89	-1051.4	-4.75	-0.474	-3.80
Rob. SE.	(0.013)		(435.1)		(0.178)		(0.026)		(807.2)		(0.331)	
N. treated	524		524		524		151		151		151	

Source: WHIP&Health. Notes: marginal effects are reported for the Probability to be employed full-time (ATTs).

Table 11: Unconditional employment-related outcomes by firm dimension: ATT and Relative Effect

	Probability of employment						**Annual income from employment**					
	0-15 employees		*16-250 employees*		*250+ employees*		*0-15 employees*		*16-250 employees*		*250+ employees*	
	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$
$\bar{t}$	-	-	-	-	-	-	-813.9**	-4.57	-390.6	-1.79	-1008.7**	-3.84
Rob. SE.	-	-	-	-	-	-	(308.3)		(301.7)		(409.2)	
N. treated	-	-	-	-	-	-	475		687		432	
$\bar{t}+1$	-0.084***	-9.71	-0.021*	-2.37	0.018	2.04	-3607.5***	-22.58	-2099.9***	-10.39	-2002.4***	-8.44
Rob. SE.	(0.018)		(0.012)		(0.014)		(423.4)		(406.8)		(592.1)	
N. treated	476		688		432		476		688		432	
$\bar{t}+2$	-0.133***	-16.84	-0.083***	-9.96	-0.034*	-4.28	-3556.1***	-24.26	-2354.6***	-12.53	-1766.8**	-8.18
Rob. SE.	(0.021)		(0.015)		(0.019)		(444.8)		(442.8)		(662.8)	
N. treated	476		688		432		476		688		432	
$\bar{t}+3$	-0.136***	-18.66	-0.093***	-12.27	-0.049**	-6.69	-2947.6***	-21.65	-2387.4***	-13.74	-1624.8**	-8,31
Rob. SE.	(0.021)		(0.017)		(0.021)		(444.3)		(447.8)		(701.9)	
N. treated	476		688		432		476		688		432	
$\bar{t}+4$	-0.107***	-16.21	-0.077***	-11.06	-0.040*	-6.26	-2708.4***	-21.82	-2486.9***	-15.66	-1154.0	-6.69
Rob. SE.	(0.021)		(0.017)		(0.021)		(442.9)		(459.4)		(701.2)	
N. treated	476		688		432		476		688		432	
$\bar{t}+5$	-0.119***	-19.82	-0.078***	-12.39	-0.045**	-7.91	-2801.6***	-25.16	-2414.9***	-17.01	-1316.2*	-8.65
Rob. SE.	(0.021)		(0.017)		(0.021)		(442.7)		(456.8)		(687.2)	
N. treated	476		688		432		476		688		432	
$\bar{t}+6$	-0.122***	-22.37	-0.075***	-13.00	-0.033	-6.46	-2443.8***	-24.46	-1584.4***	-13.37	-1265.8*	-9.35
Rob. SE.	(0.021)		(0.017)		(0.020)		(439.7)		(454.9)		(668.9)	
N. treated	476		688		432		476		688		432	
$\bar{t}+7$	-0.114***	-22.89	-0.053***	-10.20	-0.044**	-9.61	-2102.1***	-23.81	-1418.9***	-12.31	-1550.4*	-13.04
Rob. SE.	(0.020)		(0.017)		(0.020)		(418.7)		(435.0)		(635.6)	
N. treated	476		688		432		476		688		432	

Source: WHIP&Health. Notes: marginal effects are reported for the Probability of employment (ATTs); by sample selection all individuals are employed in $\bar{t}$, thus the Probability of employment in that year is 1 by construction.

Table 12: Conditional employment-related outcomes by firm dimension: ATT and Relative Effect

	Probability to be employed full-time						**Annual income from employment**					
	0-15 employees		*16-250 employees*		*250+ employees*		*0-15 employees*		*16-250 employees*		*250+ employees*	
	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$
$\bar{t}$	0.007	0.75	0.0002	0.02	0.009	0.94	-813.9**	-4.57	-390.6	-1.79	-1008.7**	-3.84
Rob. SE.	(0.010)		(0.007)		(0.006)		(308.3)		(301.7)		(409.2)	
N. treated	475		687		432		475		687		432	
$\bar{t}+1$	-0.017	-1.83	-0.010	-1.04	0.012*	1.27	-2411.7***	-13.08	-1879.4***	-8.36	-2328.4***	-8.64
Rob. SE.	(0.013)		(0.008)		(0.007)		(392.9)		(372.3)		(526.3)	
N. treated	369		599		381		369		599		381	
$\bar{t}+2$	-0.025	-2.70	-0.020**	-2.08	0.009	0.95	-1733.2***	-9.32	-889.7**	-3.92	-917.6*	-3.37
Rob. SE.	(0.016)		(0.010)		(0.008)		(438.1)		(390.1)		(539.7)	
N. treated	312		508		324		312		508		324	
$\bar{t}+3$	-0.001	-0.11	-0.025**	-2.62	0.011	1.17	-859.6**	-4.59	-895.7**	-3.88	-278.9	-1.02
Rob. SE.	(0.016)		(0.012)		(0.010)		(417.1)		(397.6)		(609.8)	
N. treated	282		456		282		282		456		282	
$\bar{t}+4$	-0.015	-1.66	-0.029**	-3.06	0.001	0.11	-1390.9***	-7.38	-1418.6***	-6.14	252.5	0.92
Rob. SE.	(0.018)		(0.013)		(0.014)		(450.5)		(459.1)		(695.8)	
N. treated	263		420		249		263		420		249	
$\bar{t}+5$	-0.013	-1.47	-0.027*	-2.87	0.0005	0.05	-1324.5**	-7.11	-1131.1**	-4.96	-481.9	-1.76
Rob. SE.	(0.020)		(0.014)		(0.015)		(484.7)		(493.2)		(737.7)	
N. treated	232		370		224		232		370		224	
$\bar{t}+6$	-0.003	-0.34	-0.025	-2.70	0.011	1.20	-765.8	-4.16	-399.3	-1.77	-643.7	-2.37
Rob. SE.	(0.022)		(0.016)		(0.015)		(555.2)		(512.8)		(789.6)	
N. treated	204		346		199		204		346		199	
$\bar{t}+7$	-0.004	-0.47	-0.013	-1.42	0.006	0.65	-938.5	-5.24	-826.6	-3.69	-658.8	-2.46
Rob. SE.	(0.024)		(0.016)		(0.017)		(598.9)		(528.9)		(822.8)	
N. treated	185		321		169		185		321		169	

Source: WHIP&Health. Notes: marginal effects are reported for the Probability to be employed full-time (ATTs).

Table 13: Conditional employment-related outcomes by firm dimension: ATT and Relative Effect

	Hourly Wage					
	0-15 employees		*16-250 employees*		*250+ employees*	
	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$
$\bar{t}$	-0.291*	-2.81	-0.256*	-2.17	-0.320	-2.31
Rob. SE.	(0.148)		(0.141)		(0.213)	
N. treated	475		687		432	
$\bar{t}+1$	-0.699***	-6.57	-0.451**	-3.76	-0.631**	-4.45
Rob. SE.	(0.192)		(0.164)		(0.247)	
N. treated	369		599		381	
$\bar{t}+2$	-0.731***	-6.80	-0.104	-0.86	-0.259	-1.81
Rob. SE.	(0.181)		(0.156)		(0.237)	
N. treated	312		508		324	
$\bar{t}+3$	-0.343	-3.13	-0.242	-1.96	-0.164	-1.13
Rob. SE.	(0.208)		(0.169)		(0.273)	
N. treated	282		456		282	
$\bar{t}+4$	-0.463**	-4.23	-0.354**	-2.85	-0.115	-0.79
Rob. SE.	(0.175)		(0.171)		(0.260)	
N. treated	263		420		249	
$\bar{t}+5$	-0.292	-2.66	-0.474**	-3.81	-0.092	-0.63
Rob. SE.	(0.238)		(0.193)		(0.310)	
N. treated	232		370		224	
$\bar{t}+6$	-0.768***	-6.98	-0.394**	-3.16	-0.101	-0.69
Rob. SE.	(0.200)		(0.195)		(0.318)	
N. treated	204		346		199	
$\bar{t}+7$	-0.635***	-5.80	-0.474**	-3.80	0.178	1.24
Rob. SE.	(0.197)		(0.205)		(0.395)	
N. treated	185		321		169	

Source: WHIP&Health

2.5 Conclusions

The findings reported in the previous sections offer a novel representation of the long-term consequences of acute CVD shocks in a highly regulated labour market, featuring strong downward wage rigidity. In the Italian case, the onset of acute health conditions suffered by blue-collar workers results in frictions that find little scope for adjustment along the hours or wage margins. The bulk of response emerges instead along the extensive margin, in terms of a sizeable and persistent employment loss. It is important to stress how employment exit happens in a setting where low hiring rates hamper later return to work. Indeed, among those who leave employment within the first year past the shock, we observe only the 16 per cent to resume employment within the following three years. Relatedly, transitions to possibly less demanding jobs do not generally offer a viable route of adjustment in the medium to long-term, suggesting that employment exit might likely become an absorbing state. Indeed, our long-term analysis has clarified that loss of employment persists for at least nine years past the health shock, and presumably thereafter.

Should we be concerned about the consequences? On the one hand, loss of employment entails a loss of market earnings. Arguably, in Italy, a relatively generous social insurance system compensates such earnings loss: substantial renewable or permanent disability-related transfers are granted to workers satisfying mild contributory conditions. Yet, in the face of such protection, there are further losses entailed. Besides the fiscal cost of the public transfer programmes used to replace market earnings, losing employment means losing social inclusion opportunities. Several studies in psychology have related work activity to wellbeing through self-esteem, motivation, sense of purpose, and social interactions (e.g. Spelten et al., 2002; Hackett et al., 2012; Vestling et al., 2013), while clinical studies use return to work as indicative of recovery after a major health shock (Daniel et al., 2009; Trygged et al., 2011).

In practice, remaining at work might actually be problematic for individuals experiencing severe health deteriorations, particularly if they cannot reduce working times, not even when prepared to accept a remuneration adjustment reflecting lower productivity. In this respect, a first policy recommendation, viable even in the short-term, would be providing public incentives for firms to agree on voluntary (on the employee side) part-time work, as a way to reconcile working activity with health related limitations (Devicienti et al., 2018). Currently, in the country, firms rather avoid offering part-time options, because entailing lower productivity (e.g. in relation to the fixed cost of hiring each worker) and ultimately higher costs, in a setting where there is no chance of compensating them through wage adjustments (Devicienti et al., 2018). Acting on the wage mobility side appears a less viable option, at least in the short term, given the extensive role played by collective bargaining in the country.

The evidence we offer is subject to several potential limitations. To begin with, it concerns only a segment of the labour force, i.e. blue-collar workers, although the one presumably more exposed to the risk of experiencing work-ability limitations as generally employed in more physically demanding tasks. Second, it only concerns individuals hit by acute CVD conditions, while also several other types of health deteriorations might affect workers. Moreover, while using administrative data presents major advantages, it also entails drawbacks. The limited coverage of relevant topic areas has hampered the scope for further heterogeneity analyses, and limited the range of observed confounders we could exploit for identification. Last, but not least, lack of information on later mortality implies exposure to bias possibly stemming from selective mortality.

Bearing these limitations in mind, the novel evidence produced, for the labour effects of health shocks over the longer term in a highly regulated institutional setting, will hopefully contribute to inform policy design on the timely and challenging issue of disabled workers' social inclusion.

Bibliography

[1] Altonji J.G., Elder T.E., and Taber C.R. (2005). *Selection on Observed and Unobserved Variables: Assessing the Effectiveness of Catholic Schools.* Journal of Political Economy, vol.113, 1, 151-184.

[2] Au, D. W. H. Crossley, T. F. Schellhorn, M. (2005). *The effect of health changes and long-term health on the work activity of older Canadians Health Economics.* Quantitative Studies in Economics and Population Research Reports 397, McMaster University.

[3] Arpaia, A. and Mourre, G. (2012). *Institutions and performance in European labor markets: taking a fresh look at the evidence.* Journal of Economic Surveys 26: 1-41.

[4] Baker, M., Stabile, M., Deri, C. (2004). *What Do Self-Reported, Objective, Measures of Health Measure?.* Journal of Human Resources, 39(4): 1067-1093.

[5] Bassanini A, Booth A, Brunello G, De Paola M, Leuven E (2007). *Workplace training in Europe.* In: Brunello G, Garibaldi P, Wasmer E (eds) Education and training in Europe. Oxford University Press, Oxford, pp 8-13

[6] Becker G.S. (1964). *Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education.* (3rd Edition), NBER Books, National Bureau of Economic Research, Inc, number beck94-1.

[7] Benitez-Silva, H., Buchinsky, M., Man Chan, H., Cheidvasser, S. , Rust, J. (2004). *How large is the bias in self reported disability?.* Journal of Applied Econometrics, 19(4): 649-670.

[8] Berton F., Richiardi, M., Sacchi S. (2012). *The Political Economy of Work Security And Flexibility: Italy In Comparative Perspective.* The Policy Press, University of Bristol.

[9] Blanchflower, D.G., Oswald, A.J. (1998). *What makes an entrepreneur?* Journal of Labor Economics 16 (1), 26-60.

[10] Bradley, C.J., D. Neumark, H.L., Barkowski, S. (2013). *Does employer provided health insurance contraint labour supply adjustments to health shocks? New evidence on women diagnosed with Breast cancer.* Journal of Health Economics, 32(5): 833-849.

[11] Braunwald, E., Mann, D. L., Zipes, D. P., Libby, P., Bonow, R. O. (2015). *Braunwald's heart disease: a textbook of cardiovascular medicine.* Philadelphia, PA: Elsevier/Saunders.

[12] Cai, L. (2010). *The relationship between health and labour force participation: Evidence from a panel data simultaneous equation model.* Labour Economics, 17(1): 77-90.

[13] Cai, L., Mavromaras, K. Oguzoglu, U. (2014). *The effects of Health and Health Shocks on Hours Worked.* Health Economics, 23(5): 516-528.

[14] Charles, K. (2003). *The longitudinal structure of earnings losses among work-limited disabled workers.* Journal of Human Resources. 38 (3), 618-646.

[15] Coile, C. (2004). *Health Shocks and Couples? Labour Supply Decisions.* NBER Working Paper No. 10810.

[16] Contini, B. (2019). *Dai "lavori usa e getta" al Jobs Act.* Aracne editrice, Roma.

[17] Currie, J., Madrian, B.C. (1999). *Health, Health Insurance and the Labor Market* in Handbook of Labor Economics vol. 3C, ed. Orley Ashenfelter and David Card, 3309-3416. New York: Elsevier Science.

[18] Daniel, K., Wolfe, C.D., Busch, M.A., McKevitt, C., (2009). *What are the social consequences of stroke for working-aged adults? A systematic review* Stroke 6, 431-40.

[19] Dano, A. M. (2005). *Road injuries and long-run effects on income and employment.* Health Economics, 14(9): 955-970.

[20] Devicienti, F., Maida, A., P. Sestito (2007). *Downward Wage Rigidity in Italy: Micro-Based Measures and Implications.* The Economic Journal, 117 (November), F530-F552.

[21] Devicienti, F., Grinza, E., Vannoni, D. (2018). *The Impact of Part-Time Work on Firm Total Factor Productivity: Evidence from Italy.* Industrial and Corporate Change 27(2):321-347

[22] Dobkin C, Finkelstein A, Kluender R, Notowidigdo M J (2018). *The economic consequences of hospital admissions.* American Economic Review, volume 108, issue 2, p. 308 - 52

[23] European Commission (1999). *Compendium - Good practice in employment of people with disabilities.* Office for Official Pubblications of the European Communities: Luxemburg.

[24] European Commission (2009). *Employment in Europe.* Office for Official Pubblications of the European Communities: Luxemburg.

[25] Eurostat (2019). Employment and unemployment; LFS ad-hoc modules: 2002, Employment of disable persons; series: Employment by type of disability, sex, age and full-time/part-time employment.

[26] Flores M, Fernańdez M, Pena-Boquete Y. (2019). *The impact of health on wages: Evidence from Europe before and during the Great Recession.* Oxford Economic Papers, 1-28 (DOI: 10.1093/oep/gpz033) (available here)

[27] García-Gòmez P., Lopez Nicolaś, A. (2006). *Health shocks, employment and income in the Spanish labour market.* Health Economics, 15(9): 997-1009.

[28] García-Gòmez P., Jones, A.M., Rice, N. (2010). *Health effects on labour market exits and entries*. Labour Economics, 17(1): 62-76.

[29] García-Gòmez, P. (2011). *Institutions, health shocks and labour market outcomes across Europe*. Journal of Health Economics, 30(1): 200-213.

[30] Garciá-Gòmez, P., Van Kippersluis, H., O'Donnell, O., van Doorslaer, E. (2013). *Long-term and spillover effects of health shocks on employment and income*. Journal of Human Resources. 48 (4), 873-909.

[31] Grossman M. (1972). *On the concept of health capital and the demand for health*. Journal of Political Economy, 80(1): 223-255.

[32] Gupta ND, Kleinjans KJ, Larsen M. (2015). *The effect of a severe health shock on work behavior: evidence from different health care regimes*. Soc Sci Med 2015; 136:44-51.

[33] Haan, P., Myck, M. (2009). *Dynamics of health and labour market risks*. Journal of Health Economics, 28(6): 1116-1125.

[34] Hackett, M., Glozier, N., Jan, S., Lindley, R. (2012). *Returning to Paid Employment after Stroke: The Psychosocial Outcomes* in Stroke (POISE) Cohort Study. PloS ONE 7(7), e41795.

[35] Hainmueller, J. (2012). *Entropy balancing for causal effects: a multivariate reweighting method to produce balanced samples in observational studies*. Political Analysis, 20(1): 25-46.

[36] Hainmueller, J., Xu, Y. (2013). *ebalance: A Stata package for entropy balancing*. Journal of Statistical Software, 54, Issue 7: 1-18.

[37] Halla, M., Zweimüller, M. (2013). *The effect of health on earnings: Quasi-experimental evidence from commuting accidents*. Labour Economics, 24: 23-38.

[38] Heinesen, E., Kolodziejczyk, C. (2013). *Effects of breast and colorectal cancer on labour market outcomes-average effects and educational gradients*. Journal of Health Economics, 32(6): 1028-1042.

[39] Ho D., Imai K., King G., Stuart E. A., (2007). *Matching as Nonparametric Preprocessing for Reducing Model Dependence in Parametric Causal Inference*. Political Analysis, 15: 99-236.

[40] Holmlund B. (2014). *What do labor market institutions do?*.Labour Economics, 30 (2014), pp. 62-69

[41] Iacus, S. M., King, G., Porro, G. (2011). *Multivariate Matching Methods That Are Monotonic Imbalance Bounding*. Journal of the American Statistical Association, 106: 345-361.

[42] Ichino, A., F. Mealli, and T. Nannicini, (2008). *From Temporary Help Jobs to Permanent Employment: What Can We Learn from Matching Estimators and their Sensitivity?*. Journal of Applied Econometrics 23 (3): 305?27.

[43] ISTAT (2017), *Annuario Statistico Italiano*, chapter 14, Rome.

[44] Jačkle R., Himmler O. (2010). *Health and Wages: Panel Data Estimates Considering Selection and Endogeneity.* Journal of Human Resources, University of Wisconsin Press, vol. 45(2).

[45] Jones A.M., Rice N., Zantomio F. (2019). *Acute health shocks and labour market outcomes: evidence from the post crash era.* Economics and Human Biology, forthcoming (online version available at https://doi.org/10.1016/j.ehb.2019.100811).

[46] Lindeboom, M., Llena-Nozal, A., van der Klaauw, B. (2016). *Health shocks, disability and work.* Labour Economics 43, 185-200.

[47] Lundborg,P., Nilsson, M., Vikstrom̈, J. (2015). *Heterogeneity in the impact of health shocks on labour outcomes: evidence from Swedish workers.* Oxford Economic Papers, 67(3): 715-739.

[48] Maczulskij, T., Bočkerman, P. (2019). *Harsh times: do stressors lead to labor market losses?.* The Euroepan Journal of Health Economics, 20:357-373.

[49] Ministry of Health, (2018). *Programma Nazionale Esiti - PNE 2018*, available at https://pne.agenas.it/index.php

[50] Ministry of Health, (2010). *Relazione sullo Stato Sanitario del Paese: 2009-2010.* Chapter 2.1. Rome.

[51] Moran, J., Farley-Short, P., Hollenbeack, C.S. (2011). *Long term employment effects of surviving cancer.* Journal of Health Economics, 30(3): 505-514.

[52] Nannicini. T, (2007) *Simulation-based sensitivity analysis for matching estimators.* STATA Journal, 7 (3) (2007), pp. 334-350

[53] European Commission (2009). *Employment in Europe 2009.* Directorate-General for Employment, Social Affairs and Equal Opportunities.

[54] OECD, (1994). *The Employment Outlook*, chapter 5.

[55] OECD, (2014). *Older workers scoreboard.* Accessed on 16/07/2015 from http://www.oecd.org.

[56] OECD, (2016). *Older Workers Scoreboard*, accessed on 05/09/2019

[57] OECD, (2017). *Structural and Demographic Business Statistics: Structural business statistics* ISIC Rev. 4. Available at: https://data.oecd.org/entrepreneur/enterprises-by-business-size.htm

[58] OECD, (2019). *Labor Force Statistics.* Available at: OECD.Stat accessed on 6/9/2019. Series: Incidence of FTPT employment - common definition; Incidence of involuntary part time workers

[59] O'Neill, S., Kreif, N., Greive, R., Sutton, M., Sekhon, J. (2016). *Estimating causal effects: considering three alternatives to difference-in-differences estimation.* Health Services and Outcomes Research Methodology, 16, 1-21

[60] Rosenbaum, P.R., Rubin, D.B. (1983). *The central role of the propensity score in observational studies for causal effects.* Biometrika, 70(1): 41-55.

[61] Smith, J. P. (1999). *Healthy Bodies and Thick Wallets: The Dual Relation between Health and Economic Status.* Journal of Economic Perspectives, 13(2): 145-166.

[62] Smith, J. (2005). *Consequences and Predictors of New Health Events* in Wise, D. (ed) Analyses in the Economics of Ageing, University of Chicago Press.

[63] Spelten, E.R., Sprangers, M.A., Verbeek, J.H., (2002). *Factors reported to influence the return to work of cancer survivors: a literature review.* Psycho-oncology 11, 124-131.

[64] Trevisan E., Zantomio F., (2016). *The impact of acute health shocks on the labour supply of older workers: Evidence from sixteen European countries.* Labour Economics, 43, 171-185.

[65] Trygged, S., Ahacic, K., Kareholt, I., (2011). *Income and Education as predictors of return to working life among younger stroke patients.* BMC Public health 11: 742.

[66] Vestling, M., Ramel, E., Iwarsson, S., (2013). *Thoughts and experiences from returning to work after stroke.* Work 45, 201-211.

[67] Wilkins E, Wilson L, Wickramasinghe K, Bhatnagar P, Leal J, Luengo-Fernandez R, Burns R, Rayner M, Townsend N, (2017). *European Cardiovascular Disease Statistics 2017.* European Heart Network, Brussels.

[68] Wu, S. (2003). *The Effects of Health Events on the Economic Status of Married Couples.* Journal of Human Resources 38(1): 219-30.

[69] Zissimopoulos, J.M. Karoly L.A. (2007). *Transitions to self-employment at older ages: The role of wealth, health, health insurance and other factors.* Labour Economics 14 (2007) 269-295.

[70] Zucchelli, E. , Jones, A.M., Rice, N., Harris, A. (2010). *The Effects of Health Shocks on labour Market Exits: Evidence from the HILDA Survey.* Australian Journal of Labour Economics, 13(2): 191-218.

Appendices

Table A1: Descriptive Statistics

	Treated		Controls	
	Mean	*Sd*	Mean	*Sd*
Year	2004	0.811	2004	0.816
Age	50.73	7.402	39.77	9.591
Abirth_north	0.271	0.445	0.359	0.480
Abirth_center	0.142	0.349	0.133	0.339
Abirth_south&Isl.	0.508	0.500	0.354	0.479
Abirth_abroad	0.079	0.270	0.154	0.361
Country_underdev	0.073	0.260	0.140	0.346
Hosp_cvd_cum	0.037	0.190	0.001	0.034
Days_cvd_cum	0.409	2.870	0.012	0.451
Hosp_other_cum	0.311	0.463	0.190	0.392
Days_other_cum	2.814	7.280	6.211	1.303
Hosp_other_($\bar{t}$-1)	0.207	0.611	0.096	0.392
Days_other_($\bar{t}$-1)	0.993	4.132	0.440	3.349
Inv_benefit_cum	0.077	0.266	0.007	0.082
Sick_leave_cum	19.28	26.87	10.70	15.87
Work_active_cum	12.37	2.865	10.99	3.542
Nemployee_cum	14.23	3.843	13.20	4.295
Rate_employee_cum	97.01	11.01	97.90	8.996
Jobloss_cum	0.312	0.610	0.324	0.631
New_firm_cum	2.843	2.565	2.937	2.431
Nblue_collar_cum	12.78	4.052	10.84	4.739
Nwhite_collar_cum	0.281	1.430	0.261	1.277
Nmanager_cum	0.001	0.035	0.002	0.082
Rate_perm_cum	94.88	14.67	89.86	20.64
Rate_fullt_cum	96.39	13.59	96.55	12.80
Ever_CIG	0.384	0.486	0.335	0.472
Nunempl_cum	0.393	1.219	0.381	1.116
Unempl_($\bar{t}$-1)	0.039	0.193	0.059	0.236
Rate_selfempl_cum	3.699	13.08	2.596	10.95
Days_self_cum	165.5	613.8	130.6	562.9
Rate_atypical_cum	0.403	3.206	0.632	4.258
N_atypical_cum	0.050	0.425	0.062	0.441
Dist_last1_employee	1.044	0.360	1.056	0.386
Dist_last2_employee	2.141	0.796	2.153	0.784
Dist_last3_employee	3.261	1.093	3.267	1.104
Dist_last4_employee	4.391	1.376	4.413	1.408
Last_sick_leave	2.202	5.330	1.156	3.375
Last_weeks_paid	47.57	10.28	45.95	12.01
Last_fix_term	0.041	0.197	0.081	0.272
Last_jtenure	8.911	7.046	6.621	6.053
Last_awork_north	0.484	0.499	0.568	0.495
Last_awork_center	0.179	0.384	0.176	0.381
Last_awork_south&Isl.	0.336	0.473	0.256	0.426
Last_awork_abroad	0	0	0.002	0.015
Last_apprentice	0.001	0.025	0.017	0.127
Last_bluecollar	0.994	0.074	0.976	0.152
Last_whitecollar	0.005	0.070	0.007	0.086
Last_manager	0	0	$6.0e^{(-05)}$	0.008
Last_director	0	0	$3.1e^{(-05)}$	0.006

Source: WHIP&Health

(*continue*)

	Treated		Controls	
	Mean	*Sd*	Mean	*Sd*
Last_firm_015	0.297	0.457	0.368	0.482
Last_firm_16250	0.431	0.495	0.414	0.493
Last_firm_250	0.273	0.445	0.218	0.413
Last_sec_agriculture	0.001	0.025	0.0004	0.019
Last_sec_manufac	0.416	0.493	0.493	0.499
Last_sec_construc	0.169	0.375	0.172	0.377
Last_sec_extraction	0.008	0.089	0.005	0.072
Last_sec_energy	0.018	0.134	0.011	0.105
Last_sec_trade	0.069	0.253	0.101	0.301
Last_sec_foodservices	0.043	0.203	0.046	0210
Last_sec_transports	0.144	0.351	0.088	0.283
Last_sec_finance	0.123	0.329	0.076	0.266
Last_sec_realestate	0.006	0.074	0.003	0.055
Last_public	0.004	0.061	0.005	0.070
Last1_lab_income	22,310	9,468	20,835	11,403
Last2_lab_income	21,822	9,466	20,344	11,340
Last3_lab_income	21,491	9,636	19,851	12,070
Last4_lab_income	21,222	9,918	19,002	11,961
Last1_hwage	11.83	3.785	11.34	6.596
Last2_hwage	11.69	3.701	11.14	6.977
Last3_hwage	11.65	4.459	10.98	9.564
Last4_hwage	11.56	3.796	10.82	15.24
Last1_fulltime	0.950	0.219	0.962	0.191
Last2_fulltime	0.952	0.215	0.965	0.184
Last3_fulltime	0.956	0.204	0.965	0.183
Last4_fulltime	0.956	0.204	0.965	0.184
Last1_LMP	0.981	0.137	0.976	0.152
Last2_LMP	0.964	0.187	0.964	10.87
Last3_LMP	0.949	0.220	0.953	0.212
Last4_LMP	0.934	0.248	0.936	0.244
Main outcome variables				
f1_LMP	0.857	0.350	0.946	0.227
f2_LMP	0.738	0.440	0.917	0.276
f3_LMP	0.665	0.472	0.894	0.308
f4_LMP	0.616	0.487	0.868	0.339
f5_LMP	0.554	0.497	0.839	0.367
f6_LMP	0.502	0.500	0.811	0.392
f7_LMP	0.459	0.498	0.783	0.412
f1_lab_income	20311	10670	21754	9318
f2_lab_income	21744	10554	22219	9585
f3_lab_income	22390	10446	22735	9766
f4_lab_income	21993	11119	22787	10040
f5_lab_income	21496	11395	22819	10381
f6_lab_income	21920	11300	22771	10643
f7_lab_income	21311	11243	22743	10851
f1_fulltime	0.984	0.250	0.959	0.199
f2_fulltime	0.926	0.262	0.957	0.202
f3_fulltime	0.921	0.271	0.955	0.208
f4_fulltime	0.906	0.292	0.951	0.217
f5_fulltime	0.896	0.306	0.947	0.227

Source: WHIP&Health

(*continue*)

	Treated		Controls	
	Mean	*Sd*	Mean	*Sd*
f6_fulltime	0.896	0.306	0.941	0.237
f7_fulltime	0.888	0.316	0.935	0.247
f1_hwage	11.69	4.696	11.71	3.674
f2_hwage	12.10	4.312	11.89	3.752
f3_hwage	12.40	4.428	12.16	3.812
f4_hwage	12.30	4.149	12.23	3.912
f5_hwage	12.31	4.548	12.34	4.044
f6_hwage	12.22	4.327	12.40	4.140
f7_hwage	12.21	4.411	12.42	4.223

Source: WHIP&Health

Table A2: Post-CEM reached balance

	Pre-CEM				Post-CEM			
	Mean				Mean			
	Treated	Controls	%bias	p-value	Treated	Controls	%bias	p-value
Year	2004	2004	1.7	0.503	2004	2004	0.0	1.000
Age	50.73	39.77	127.9	0.000	50.68	50.68	0.0	1.000
Hosp_cvd_cum	0.037	0.001	26.6	0.000	0.024	0.024	0.0	1.000
Dist_last1_employee	1.044	1.056	-3.3	0.205	0.036	0.036	0.0	1.000
Last_fix_term	0.041	0.081	-16.9	0.000	0.036	0.036	0.0	1.000
Last_awork_north	0.484	0.568	-16.8	0.000	0.482	0.482	0.0	1.000
Last_awork_center	0.179	0.176	0.8	0.735	0.182	0.182	0.0	1.000
Last_awork_south&Isl.	0.336	0.256	17.8	0.000	0.336	0.336	0.0	1.000
Last_awork_abroad	0	0.002	-2.2	0.539	0	0	.	.
Last_firm_015	0.297	0.368	-15.2	0.000	0.298	0.298	0.0	1.000
Last_firm_16250	0.431	0.414	3.4	0.175	0.431	0.431	0.0	1.000
Last_firm_250	0.273	0.218	12.8	0.000	0.271	0.271	0.0	1.000

Source: WHIP&Health

Table A3: Post-EB moments balance

	Treated group			Control group		
	Mean	Variance	Skewness	Mean	Variance	Skewness
Year	2004	0.661	-0.057	2004	0.660	-0.057
Age	50.68	54.73	-0.688	50.68	56.29	-0.673
Abirth_north	0.273	0.199	1.018	0.273	0.199	1.018
Abirth_center	0.507	0.250	-0.028	0.507	0.250	-0.026
Country_underdev	0.072	0.0670	3.31	0.072	0.067	3.310
Hosp_other_($\bar{t}$-1)	0.204	0.370	4.536	0.204	0.520	16.08
Days_other_($\bar{t}$-1)	0.979	17.05	7.727	0.979	21.54	11.94
Hosp_cvd_cum	0.024	0.024	6.16	0.024	0.024	6.160
Days_cvd_cum	0.282	6.183	13.03	0.282	4.675	9.357
Hosp_other_cum	0.308	0.213	.8336	0.308	0.213	0.834
Days_other_cum	2.766	52.54	4.647	2.766	78.34	8.239
Inv_benefit_cum	0.068	0.064	3.423	0.068	0.063	3.423
Sick_leave_cum	19.10	711.9	3.095	19.09	859.1	3.650
Work_active_cum	12.41	8.049	-1.496	12.41	7.983	-1.469
Nemployee_cum	14.27	14.71	0.008	14.27	14.86	0.710
Rate_employee_cum	96.98	123	-4.038	96.98	125.5	-4.102
Jobloss_cum	0.315	0.371	2.184	0.315	.4247	3.886
New_firm_cum	2.846	6.645	2.731	2.847	6.495	2.463
Nblue_collar_cum	12.82	16.26	-0.24	12.82	15.53	-0.224
Nwhite_collar_cum	0.271	1.995	7.908	0.271	1.921	9.001
Nmanager_cum	0.001	0.001	28.2	0.001	0.003	67.35
Rate_perm_cum	95.11	202.5	-3.851	95.11	214.4	-3.903
Rate_fullt_cum	96.64	170.9	-5.045	96.64	172.4	-4.967
Ever_CIG	0.385	0.237	0.474	0.385	0.237	0.474
Nunempl_cum	0.384	1.398	4.285	0.384	1.394	4.171
Unempl_($\bar{t}$-1)	0.039	0.037	4.773	0.039	0.037	4.773
Rate_selfempl_cum	3.748	173.4	3.876	3.748	180.3	4.039
Days_self_cum	168.4	3837	4.341	168.4	3974	4.485
Rate_atypical_cum	0.374	9.055	10.79	0.374	10.25	11.97
N_atypical_cum	0.046	0.153	12.39	0.046	0.200	19.63
Dist_last1_employee	1.036	0.106	11.18	1.036	0.103	11.06
Dist_last2_employee	2.130	0.600	8.096	2.130	0.560	7.724
Dist_last3_employee	3.249	1.161	5.538	3.249	1.189	5.605
Dist_last4_employee	4.375	1.843	4.574	4.375	1.850	4.475
Last_sick_leave	2.167	27.73	4.404	2.167	31.37	6.268
Last_jtenure	8.952	49.57	0.331	8.952	49.18	0.338
Last_weeks_paid	47.65	102.9	-2.644	47.65	105	-2.625
Last_fix_term	0.036	0.034	5.004	0.036	0.034	5.002
Last_awork_north	0.182	0.149	1.651	0.182	0.149	1.651
Last_awork_center	0.336	0.223	0.695	0.3358	0.223	0.695
Last_apprentice	0	0	.	0.00004	0.00003	165.9
Last_bluecollar	0.996	0.004	-15	0.996	0.004	-14.93
Last_whitecollar	0.004	0.004	15	0.004	0.004	15
Last_manager	0	0	.	$1.12e^{-06}$	$1.12e^{-06}$	944.7
Last_firm_015	0.298	0.209	0.882	0.298	0.209	0.882
Last_firm_16250	0.431	0.245	0.278	0.431	0.245	0.278

Source: WHIP&Health

(*continue*)

	Treated group			Control group		
	Mean	Variance	Skewness	Mean	Variance	Skewness
Last_sec_agriculture	0.001	0.002	39.91	0.001	0.001	39.91
Last_sec_extraction	0.008	0.008	10.94	0.008	0.008	10.94
Last_sec_manufac	0.420	0.244	0.325	0.420	0.244	0.325
Last_sec_energy	0.019	0.018	7.087	0.019	0.018	7.087
Last_sec_construc	0.170	0.141	1.759	0.170	0.141	1.759
Last_sec_trade	0.068	0.064	3.423	0.068	0.064	3.423
Last_sec_foodservices	0.043	0.041	4.492	0.043	0.041	4.492
Last_sec_transports	0.144	0.123	2.034	0.1435	0.123	2.034
Last_sec_finance	0.119	0.105	2.353	0.119	0.104	2.353
Last_sec_realestate	0.006	0.006	13.20	0.006	0.006	13.20
Last1_lab_income	22429	$8.86e^{+07}$	0.529	22429	$3.02e^{+08}$	118.6
Last2_lab_income	21922	$8.91e^{+07}$	0.330	21922	$1.06e^{+08}$	34.40
Last3_lab_income	21620	$9.19e^{+07}$	0.220	21619	$1.11e^{+08}$	13.91
Last4_lab_income	21337	$9.72e^{+07}$	0.153	21337	$9.99e^{+07}$	0.491
Last1_fulltime	0.956	0.043	-4.419	0.956	0.043	-4.419
Last2_fulltime	0.956	0.043	-4.419	0.956	0.043	-4.419
Last3_fulltime	0.961	0.037	-4.773	0.960	0.037	-4.773
Last4_fulltime	0.960	0.039	-4.688	0.960	0.038	-4.688
Last1_LMP	0.984	0.015	-7.801	0.984	0.015	-7.799
Last2_LMP	0.966	0.033	-5.157	0.966	0.033	-5.157
Last3_LMP	.0950	0.048	-4.123	0.950	0.048	-4.123
Last4_LMP	0.937	0.059	-3.609	0.937	0.059	-3.609
Last1_hwage	11.85	14.30	1.211	11.85	84.27	111.1
Last2_hwage	11.72	13.69	1.033	11.72	25.52	73.04
Last3_hwage	11.67	20.01	7.690	11.67	223.6	215.2
Last4_hwage	11.61	14.24	1.035	11.61	15.11	2.313

Source: WHIP&Health

Table A4: Unconditional employment-related outcomes: ATTs

	CVD shock experienced in 2003/2004		*CVD shock experienced in 2003*	
	Probability of employment	**Annual income from employment**	**Probability of employment**	**Annual income from employment**
Time	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$
$\bar{t}$	-	-951.2***	-	-1290.6***
Rob. SE.	-	(241.5)	-	(324.5)
N. treated	-	1042	-	503
$\bar{t}$+1	-0.039***	-2661.5***	-0.040**	-2914.7***
Rob. SE.	(0.011)	(339.5)	(0.015)	(460.4)
N. treated	1043	1043	503	503
$\bar{t}$+2	-0.088***	-2549.4***	-0.078***	-2808.1***
Rob. SE.	(0.013)	(367.2)	(0.019)	(503.5)
N. treated	1043	1043	503	503
$\bar{t}$+3	-0.097***	-2391.8***	-0.111***	-2307.0***
Rob. SE.	(0.014)	(380.2)	(0.020)	(528.8)
N. treated	1043	1043	503	503
$\bar{t}$+4	-0.082***	-2259.5***	-0.093***	-2555.6***
Rob. SE.	(0.014)	(390.1)	(0.020)	(539.2)
N. treated	1043	1043	503	503
$\bar{t}$+5	-0.080***	-2271.3***	-0.067***	-2490.8***
Rob. SE.	(0.014)	(380.7)	(0.020)	(525.9)
N. treated	1043	1043	503	503
$\bar{t}$+6	-0.070***	-1816.1***	-0.065***	-2105.8***
Rob. SE.	(0.014)	(368.4)	(0.020)	(497.3)
N. treated	1043	1043	503	503
$\bar{t}$+7	-0.067***	-1669.1***	-0.062***	-2016.9***
Rob. SE.	(0.014)	(363.5)	(0.019)	(485.2)
N. treated	1043	1043	503	503
$\bar{t}$+8	-0.057***	-1608.8***	-0.061***	-2086.9***
Rob. SE.	(0.013)	(344.6)	(0.019)	(456.5)
N. treated	1043	1043	503	503
$\bar{t}$+9	-	-	-0.086***	-2326.1***
Rob. SE.	-	-	(0.017)	(412.8)
N. treated	-	-	503	503

Source: WHIP&Health

Table A5: Employment-related unconditional outcomes by fixed-term jobs: ATT and Relative Effect

	Fixed-term job		*Permanent job*	
	Probability of labour market activity		**Probability of labour market activity**	
Time	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$
$\bar{t}$	-	-	-	-
Rob. SE.	-	-	-	-
N. treated	-	-	-	-
$\bar{t}$+1	-0.130***	-14.27	-0.033***	-3.65
Rob. SE.	(0.045)		(0.009)	
N. treated	54		1539	
$\bar{t}$+2	-0.138**	-16.34	-0.085***	-10.24
Rob. SE.	(0.055)		(0.011)	
N. treated	56		1539	
$\bar{t}$+3	-0.169**	-21.17	-0.093***	-12.18
Rob. SE.	(0.061)		(0.011)	
N. treated	56		1539	
$\bar{t}$+4	-0.068	-10.28	-0.078***	-11.23
Rob. SE.	(0.057)		(0.012)	
N. treated	57		1539	
$\bar{t}$+5	-0.058	-9.45	-0.079***	-12.56
Rob. SE.	(0.056)		(0.012)	
N. treated	57		1539	
$\bar{t}$+6	-0.045	-7.77	-0.080***	-13.76
Rob. SE.	(0.054)		(0.012)	
N. treated	57		1539	
$\bar{t}$+7	-0.124**	-23.45	-0.067***	-12.78
Rob. SE.	(0.057)		(0.011)	
N. treated	57		1539	

Source: WHIP&Health

Table A6: Employment-related unconditional outcomes by full-time jobs: ATT and Relative Effect

	Full-time job		*Part-time job*	
	Probability of labour market activity		**Probability of labour market activity**	
Time	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	$\hat{\tau}_{\bar{t}+v}$	$\frac{\hat{\tau}_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$
$\bar{t}$	-	-	-	-
Rob. SE.	-	-	-	-
N. treated	-	-	-	-
$\bar{t}$+1	-0.037***	-4.13	0.025	2.81
Rob. SE.	(0.009)		(0.040)	
N. treated	1525		70	
$\bar{t}$+2	-0.088***	-10.60	-0.052	-6.67
Rob. SE.	(0.011)		(0.054)	
N. treated	1525		71	
$\bar{t}$+3	-0.095***	-12.50	-0.073	-10.16
Rob. SE.	(0.011)		(0.058)	
N. treated	1525		71	
$\bar{t}$+4	-0.079***	-11.39	-0.023	3.42
Rob. SE.	(0.012)		(0.057)	
N. treated	1525		70	
$\bar{t}$+5	-0.078***	-12.30	-0.090	-14.94
Rob. SE.	(0.012)		(0.058)	
N. treated	1525		70	
$\bar{t}$+6	-0.077***	-13.34	-0.093	-16.86
Rob. SE.	(0.011)		(0.057)	
N. treated	1525		70	
$\bar{t}$+7	-0.069***	-13.03	-0.053	-10.63
Rob. SE.	(0.011)		(0.057)	
N. treated	1525		70	

Source: WHIP&Health

Chapter 3

How does health deterioration affect the receipt of Social Security programs?

Irene Simonetti *

Abstract: By following the setup used in the previous chapter, the present research investigates how the experience of an acute health shock drives individuals' choices in terms of Social Security Programs (SSP). So far little attention has been placed on studying the potential 'substitutability' offered by multiple SSP; however, the peculiarities of social security systems together with the local labour market opportunities may strongly address individuals' behaviours. Differently from the widespread literature pointing to early-retirement as one of the main exit channels after health deterioration, it appears somehow unfeasible for unhealthy blue-collar workers. Instead, their probability to receive a DI benefits - OIB in particular - is 22 percentage points higher in the very short-run, remaining significantly positive up to seven years later. At the same time - possibly as the consequence of post-shock economic difficulties - a positive gap in recipients of social assistance programs is found, while opposite trends appear in UI benefits as a result of compatibility constraints. In light of these findings and the huge employability loss emerged in the previous chapter, we point toward the importance of assessing the appropriateness of the labour inclusion policies as well as of social support programs.

Keywords: health shocks, social security programs, administrative data

JEL codes: C14, I10, I38

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3.1 Introduction

The role and the effectiveness of social security programs (SS programs) are often mentioned of primary importance in most public debates. However, the trade-off between the system's financial sustainability and the principle of providing individuals' welfare throughout each stage of their life without discouraging labour market participation, is one of the main challenges faced by most countries. Lot of effort has been placed in assessing the role of early retirement and disability benefits following health deterioration, while little work thus far has been devoted to studying the interaction and potential *substitutability* offered by additional SS programs, especially unemployment benefits (UI) and social assistance programs. This paper provides empirical evidence on how, following a severe health shock, male blue-collar workers make their choices among the available Italian Social Security schemes.

Multiple factors such as personal health, an individual's economic condition, preferences and eligibility criteria may drive one's choices when different SS options are available. If welfare benefits are low compared to disability transfers, unemployment benefits are of short duration, and little is available in terms of rehabilitation and job protection, it is likely that the demand of applicants for DI will be relatively high (Bound et al., 1999). On the contrary, where the opportunities of remaining on the labour market are more tempting than health-related programs, disability beneficiaries would decrease. In such a scenario, it is therefore an open question how workers can find the most suitable combination among their impairments, personal economic status and the available social security programs.

As extensively proved by the economic literature, the country-specific SS schemes - especially DI benefits - have an undeniable work-disincentive effect. Bound (1989) was among the first to consider "denied applicants" as the control group for DI beneficiaries [1]. He found that the employment rates of males aged between 45 and 64 years old receiving DI benefits could have been 35% higher if they never received them: DI programs account for about one-quarter of the overall decline of labour market participation (LMP) among older men. Some years later, by using a panel dataset spanning from 1990 to 1996, Chen et al. (2008) found a potential increase of the LMP, of about 20%, in the absence of DI benefits. Maestas et al. (2013) instead, compared the allowed and denied applicants whose only difference was their examiner: this kind of random assignment allows to observe an exogenous variation which is not related to either underlying impairment severity or to the labour market attachment. Their estimates show that two years after the application the employment rate would on average be 28% higher. When studying the discourage effect of various SS programs, the revision of factors such as eligibility criteria, screening process as well as benefits' amount, is essential to find better policy interventions. Halpen (1986) proved how an increased generosity of DI benefits between 1965-1975 lead to 18% increase in applications, an increase that is

[1] An upper bound estimate of the potential labour supply of DI recipients if they had not received benefits (Maestas et al. (2013))

even stronger when eligibility requirements are relaxed (39%). Black et al. (2002) takes advantage of the coal boom and bust of the 1970's and 1980's respectively in order to show that changes in underlying financial incentives can also partially explain variations in DI claimant rates. By considering the effect of eligibility uncertainty, Kreider (1998) showed that a 10% increase in the probability of being excepted would also increase the number of applicants for the DI benefit by about 6%. By studying the interaction between unemployment insurance benefits and DI applicants in the United States - a country where people out of work can potentially receive both benefits - Lindner (2014) find a negative association between the two programs: higher UI benefits reduce applications for DI. Interestingly, Ardito (2017) shows that increasing the retirement age -defined by the 1992 reform in Italy - did not have homogeneous positive effects on the employment of all older workers. Contextually, a significant increase in disability benefits take-up rates has been found (+ 155% compared to the pre-reform levels). Besides the huge effort made by the literature to state the DI effect on labour market attachment and the multiple channels through which it works, the economic consequences of the onset of a "disability", both in terms of consumption drops and monetary losses, have rarely been investigated by the literature. By mainly referring to monetary outcomes, García-Gòmez et al. (2013) measured a loss of personal income of about €7000 two years after the hospitalisation for people entering in DI, a relative fall which is broadly consistent with the 75% replacement rate settled by Dutch policies. Focussing on the US panorama, where there is not a universal public insurance against the economic risks following adverse health shocks, Dobkin et al. (2018) found interesting results, especially for those who are formally insured and older than 50 years old: while medical expenses are well-covered by the insurance, this is not the case if income declines. One year after the hospital admission, by considering the two types of expenses - medical costs and income losses - only 80% out of the total is compensated by the insurance, while by the end of the third year the coverage drops to 50%.

Despite strongly related to the previous chapter, this additional research contributes to the literature in multiple aspects. First of all, we shed light on the role played by severe health shocks on the take-up response of social security programs. Misleading results may appear when milder diseases are considered and working opportunities are only slightly affected. No less important, the analysis of blue-collars provides an interesting case of study due to they are potentially one of the most damaged categories of workers after an acute health shock, both in terms of reallocation of tasks and employment opportunities in general. Finally, by considering the peculiar Italian Social Security system, traditionally characterised by a long history of reforms, we feed the recent debate on the budget sustainability and the influence of pension, DI and UI reforms on individuals' behaviour.

As in the previous chapters, the research takes advantage from a new administrative dataset, namely WHIP&Health, which links work and health histories of a random sample drawn from the Italian population. Labour and social security histories - encompassing private employees, self-employed and atypical workers registered at least once inside the national social security archives

- span over the period 1990 - 2012; while individual's hospitalisations are collected from 2001 onwards. We built our identification strategy upon the so-called Conditional Independence Assumption (CIA): according to it, once a full set of observed characteristics is controlled for, the probability to experience the *treatment* can be considered as good as random. Assuming conditional independence, we compare people having experienced an acute CVD disease and those who have not, who share similar career and health paths up to the year before the shock. To retrieve an estimate of the Average Treatment Effect on the Treated (ATT), a combination of different matching procedures will be used to identify the proper counterfactual group.

Upon this setting, we provide evidence of individuals' responses to CVD shocks in terms of social security benefits, additionally exploring the potential mechanisms that may underlie these responses. Unsurprisingly, we find a significant and positive probability of getting DI benefits among severely shocked blue-collar workers with respect to their counterpart: two years after the CVD shock, the ATT estimate is 22 percentage points higher. Instead, counter-intuitive trends are found among those who transit into old-age and seniority pensions. Differing from expectations, people experiencing an acute shock strongly reduce their probability of retirement, irrespective of their age. Such negative magnitudes are even stronger as time passes, suggesting how the increased economic difficulties (also proved in the previous chapter) faced by severely shocked workers, make early or regular retirement potentially unaffordable. A partial confirmation is given by the other two types of SS programs, UI benefits are rarely considered an option (they are also incompatible with DI benefits) while social assistance is claimed as soon as they met the eligibility requirements (age in particular). Despite the multiple heterogeneity analyses, the baseline trends are essentially the same, and the reason can be related to the specific category of worker we are considering.

The next section provides an overview of the main social security programs available in Italy. Section 3.3 shortly revises the dataset and the empirical strategy, both of them similar to the previous chapter. Section 3.4 contains the main results and some heterogeneous analyses. Section 3.5 offers some conclusive remarks.

3.2 Italian Social Security Programs

The Italian social security system is based on a variety of institutions aimed to cover risks such as old age, disability, loss of spouse or parent, low income and unemployment. Since the 1980s, many changes have been implemented to ensure the financial sustainability of the system[2]. While welfare programs like old-age and seniority pensions, initially characterised by extremely favourable early

[2]According to a report of the Italian Institute of Statistics (ISTAT, 2014), in 2012 the total expenditure on welfare reached the 17,28% of GDP, with an increase of about 1.8% with respect to the previous year. In particular, old-age pensions were absorbing 71,8% of the total, the survivor benefits 14,7%, invalidity pensions, social assistance benefits and the so-called "indennitaria", are around 4%, 7,9%, and 1,7% respectively.

retirement schemes, were entirely overhauled; the DI and unemployment insurance systems have undergone minor changes, at least during our observational window. In the following sections, the main benefits and their reforms will be discussed (a short summary is given in Table 2). Social security programs such as survivor benefits and the so-called "indennitaria", the former being paid to the dead worker's relatives while the latter to workers with a professional disease, won't be revised.

3.2.1 Old-age and seniority pension

The Italian social security system offers both an old-age and an early-retirement (or seniority) pension; the first one mainly depends on age-requirements while the second one is based on the years of contributions (Brugiavini et al. (2016)). Before the long process of reforms started in the 1990s, besides the old-age pension - whose statutory retirement age was sixty for men and fifty-five for women - also the early retirement option was extremely generous: the benefit was granted to all individuals with at least thirty-five years of contributions, irrespectively of age [3]. The most significant reforms showing their effects throughout the paper's observational window are the Amato and Dini reforms. The 1992 reform, commonly referred to as the Amato reform, drastically reduced the benefits by changing the indexation mechanism from wage-based to price-based. Moreover, the eligibility requirements for the old-age pension were sizeably increased: starting from 1994, the minimum age was gradually increased by one year, reaching the maximum level of sixty-five and sixty years old, for men and women respectively. Fifteen years of contributions was the threshold settled by the policymaker to distinguishing among those undergoing the new rules and those kept under the past status quo. The Dini reform implemented in 1995 instead, has completely modified the system by changing the way of computing benefits from a defined-benefit (DB) to a notional defined contribution basis (NDC). Again, a different implementation of the new rule was planned according to the years of contribution: with the exception of the eligibility rules defined by the previous reform, very few changes were applied to workers with at least eighteen years. On the contrary, major changes were applied to those who had less than eighteen years of contribution at that time. As a consequence of the economic crises a new reform - commonly known as Fornero reform (2011) - set three additional measures: (i) a transition to the pro-rata contributive system starting from the 1st January 2012; (ii) a progressive increase of the age-requirement (old-age pension) by 2018, reaching sixty-nine and nine months for all types of workers by the end of 2050, irrespectively of gender; (iii) the number of years of contribution has been further increased, reaching forty-six and forty-five for men and women by the end of 2050. We remind to Brugiavini and Peracchi (2016) for a complete overview of all the mentioned reforms. Table 1 summarises the progressive changes of age and seniority requirements over time.

[3] Female public-sector employees were allowed to retire even earlier.

Table 1: Age and years-of-contribution requirements

Year	*Old-age pension*			*Seniority pension*	
	Age		Years	Age +	Years
	Males	Females	contribution	Years contribution	contribution (only)
1985 - 1992	60	55	15	-	35
1993	60	55	16	-	35
1994	61	56	16	-	35
1995	61	56	17	-	35
1996	62	57	17	52+35	36
1997	63	58	18	52+35	36
1998	63	58	18	54+35	36
1999	64	59	19	55+35	37
2000	65	60	19	55+35	37
2001	65	60	20	56+35	37
2002 - 2003	65	60	20	57+35	37
2004 - 2005	65	60	20	57+35	38
2006 - 2007	65	60	20	58+35	39
2008 - 2009	65	60	20	58+35	40
2010	65	60	20	59+36 or 60+35 (quota 95)	40
2011	65	60	20	60+36 or 61+35 (quota 96)	40
2012	66	62	20	66/62+42/41(males/females)	-

Sources: Italian Social Security Institute, Belloni and Alessie (2009), Brugiavini and Peracchi (2009, 2016). Notes: the table represents the progressive change in *age* and "*years of contribution*" (seniority) requirements for private sector employees, males and females. The table do not extensively represents the legislation, many exceptions are also available depending on the *date* of the first contribution payment and the *type* of job.

3.2.2 Disability Insurance

The history of DI insurance in Italy starts in 1919 when a public invalidity pension was thought for people with reduced working capabilities. At that time the eligibility for this benefit was based on a rather vague concept of "loss of earning ability", i.e. the inability to earn more than one-third of the normal wage for a worker in the same activity and country-area. Taking advantage of this criteria, up until the mid-1980s the disability pension was strongly abused by workers as an alternative way of early retirement: the discretion of doctors in their diagnoses, together with a convenient computation based on the same rules of the old-age and seniority pensions, provided a tempting choice for many. The number of disability pension requests, especially among people between 50 and 59 years old, drastically decreased after the 1984 reform: the idea of "loss of working ability" was replaced with the concept of "loss of working capacity". Thereafter, two alternative measures were implemented and they are still very similar nowadays. First of all, an *ordinary incapacity benefit* (OIB) is granted to individuals with a certified mental or physical impairments whose working capacity is reduced by at least two-thirds. Unlike in the past scenarios, its eligibility must be renewed every three years, becoming permanent after three renewals. To be eligible, a worker is required to have paid at least 260 weekly contributions, of which 156 must have occurred in the 5 years before the date of the claim. Most importantly, the continuation of working activity is not forbidden and starting from September 1st 1995, when labour incomes (deriving from independent work or paid by a company) are also available, the amount of OIB benefit is reduced by a percentage varying between 25 and 50%. This is not the case for benefits started before September 1995. This type of SS program is incompatible with UI benefits and it is automatically converted into an old-age pension once the legal retirement age has been reached. Besides the ordinary incapacity benefit, a "disability pension" is also permanently granted to people aged between eighteen and sixty-five years old who cannot perform any type of work: elected doctors by the Social Security Institute must certify a reduction of 100% of individual's working capability. The same contributory requirements as for the OIB benefits, hold. According to further restrictions that were introduced in 1995, it is forbidden to collect a disability pension together with life annuities deriving from job injuries or professional diseases. The amount of DI benefits (both) is determined according to a 'mixed system' (a quota calculated with the remuneration system and a quota with the contributory system) if the working activity has started before December 31st 1995; otherwise, they are entirely computed according to the contributory system. Moreover, when additional labour incomes[4] - in the case of OIB - or alternative forms of social welfare programs[5] - in the case of DI pension - are granted, the amount of benefit will be reduced accordingly. Both temporary and permanent DI benefits allow cumulating the so-called 'figurative contributions'[6], useful to reach old-age pension requirements but not the seniority one. In this case, despite their cumulation, they do not determine the amount of the future pension, which is instead computed according to the 'effective' contribution history.

3.2.3 Social Assistance

The Italian Social Security system provides a variety of social assistance programs for people with a low income, independently from their contributory history. Some of them are conditioned to reach minimum age-requirements (*social allowance*), some others instead, are granted to individuals unable to perform working and daily life activities (*civil incapacity pension*) or people suffering severe war injuries (*war pension*)[7]. The first social assistance program that is potentially relevant in this setting is the so-called "social allowance" (social pension before 1996). It is temporary in nature and addressed to all Italian and foreign citizen in difficult economic conditions, whose income is below a specific threshold, annually defined by the legislator. Just like many other social protection programs, this has undergone a series of refinements over time in order to achieve a balance between the worker's real needs and the welfare budget goals. However, throughout the entire period coinciding with the present research, it was granted to all individuals aged 65 (or

[4] If the income exceeds 4 (5) times the current level of minimum payment (defined by INPS), the OIB is reduced by 25%(50%) compared to the basic benefit

[5] The waiver of unemployment benefits or any supplementary income benefits is necessary

[6] Accredited contributions, not at the expense of workers, for periods in which the person is forced to interrupt work for different reasons (pregnancy, illness, unemployment).

[7] The Italian Social Security codification does not allow a precise distinction among the different programs. However, we guess the "war pensions" are a minor component.

more) with no contribution history and low income. The amount of the benefit is fixed and it has been partially adjusted over time: in 2012, for an unmarried person the maximum annual benefit was 5,577 €(429 €for 13 months), while in the case of a married individual the amount of money is almost double, reaching 11.154 €. These values are adjusted when further labour incomes are available. Moreover, the recipient must be permanently located in the country, meaning that the benefit can be suspended when he/she is abroad for more than 30 days. An additional SS program, absorbing a notable part of public finances, is the "civil incapacity pension"[8]. This type of benefit is provided to people who need an economic support, and most importantly, who are totally (and permanently) unable to work. The reduction of working capabilities must not derive from work injuries or professional diseases. All the people aged between 18 and 67 years old who satisfy both health and income requirements can ask for it, no matter their contributory history. Eventually, the Italian Ministry of Economic and Finance provides a special type of welfare support called "war pension". This benefit is addressed to people affected by a disability following a war event or to survivors of individuals dead for similar events.

3.2.4 Unemployment Insurance

The Italian unemployment insurance system provides various benefits for those who have lost their job, but not to first-time job seekers. Some of them are comprehensive grants (UI) while some others are only a 'partial insurance'. UI benefits are paid to private-sector employees who have been individually or collectively laid off; the former are called ordinary unemployment benefits while the latter mobility benefits. In particular, these are granted to people who had paid contributions for at least fifty-two weeks during the two years prior to the unemployment spell. An alternative option, with limited requirements as well as benefits, is called "reduced unemployment benefit" and is provided to workers with at least seventy-eight days of contributions over the last year. More recently the legislator has extended the maximum period of coverage: with the exception of unemployed workers older than fifty who are paid for up to twelve months (nine months before 2008), for all other workers the period of payment generally lasts up to eight months (six months before 2008). The benefit stops once the worker finds a new job, refuses a job similar to the previous one, or refuses to perform a socially useful activity. The amount of money unemployed workers receive is a percentage of the average earnings in the last-three-months, up to specific thresholds. Over the last decades the rules have been strongly revised, however, before the Fornero reform workers would usually be granted 60% of the average wage for the first six months, then 50% for the seventh and eighth month, and 40% for all subsequent months up to a maximum of €886 for wages below €1917, and €1065 for wages exceeding this amount (Brugiavini et al. (2012)). Despite of secondary importance in this context of analysis, a comprehensive overview of the available social security programs cannot avoid mentioning a partial insurance measure, the so-called "cassa

[8]Depending on the type and level of disability, age and economic situation, different benefits are provided.

integrazione guadagni" (CIG). This is a special government benefit paid to firms passing through recessional phases with more than fifteen employees and working in specific sectors. Workers receiving such benefits are still formally employed, as their contract is still in charge. When the reduction of the firm's activity is only temporary, employees receive an ordinary CIG, while in case of long-lasting difficulties they officially get an extraordinary CIG. With some exceptions, the amount of the benefits is 80% of the foregone earnings, in other words, the non-worked hours between zero and the upper limit imposed by the labour agreement.

Table 2: Summary of SS programs

Social Security Programs	Program Name	Entitlement Criteria	Amount	Duration
Unemployment benefits	(1) Ordinary unemployment benefit, (2) Reduced-unemployment benefits, (3) Mobility benefits	**Ordinary unemployment benefit**: private sector employees with at least 52 weeks of contributions in the last 2 years, and who have paid the first contribution at least 2 years prior to dismissal. **Reduced unemployment benefits**: private sector employees with at least 78 days in the last 12 months, and who have paid the first contribution at least 2 years prior to dismissal. **Mobility**: permanent employees subjected to a collective dismissal or after the end of the "cassa integrazione guadagni straordinaria", and at least 12 months of firm seniority. **Incompatibility (all the types): old-age and seniority pensions, disability pension, OIB, civil incapacity pension**	**Ordinary unemployment benefit**: 60% of the average 3-months earnings for the first 6 months; 50% from the seventh to the eighth month; 40% until the end of the period. **Reduced unemployment benefits**: 35% for the first 120 days; 40% for the following period. **Mobility**: 100% of "cassa integrazione guadagni" for 12 months, 80% thereafter.	**Ordinary unemployment benefit**: 8 months if younger than 50 years old; 12 months if older or equal 50 years old. **Reduced unemployment benefits**: single payment. **Mobility**: it depends on the individual's age and firm's geographical area: 12, 24 and 36 months for those who are younger than 39 years old, between 40 and 50, and older than 50, respectively (*north* and *central regions*); 24, 36 and 48 months for those who are younger than 39 years old, between 40 and 50, and older than 50, respectively (*southern regions*) [Law 223/1991, article 7, paragraph 4]
DI benefits	(1) Ordinary incapacity benefit (OIB), (2) Disability pension	**Ordinary incapacity benefit**: working ability reduced of at least 66%. OIB is compatible with working activity; in that case the amount of benefit is reduced. **Disability pension**: working ability reduced of 100%. At least 260 weeks of social contributions and 156 in the 5 years prior the disability event (both types of benefits). **Incompatibility (all the types): UI benefits**	If the working activity has started after December 31st 1995 the amount is computed according to the remuneration system and the contributory system. If it has started after December 31st 1995 the amount is entirely computed according to the contributory system (both types of benefits)	**Ordinary incapacity benefit**: up to 3 years, renewable up to the retirement age (then it is automatically converted into old-age pension). **Disability pension**: permanent.
Social Assistance	(1) Social allowance (social pension before 1996), (2) Civil incapacity pension (*depending on the type and level of disability, age and economic situation, different types of benefits are provided), (3) War pension	**Social Allowance**: it is provided to people older than 65 years old, who need an economic support and without a contribution history. The person must be permanently located in the country. **Civil Incapacity pension**: working ability reduced of 100% (permanently) due to, e.g., congenital or acquired mutilations (specific laws are available for blindness and deafness). It is provided to people who need an economic support aged between 18 and 65 years old, who are firmly located in Italy. Income requirements are annually verified. This benefits *potentially* compatible with work activity and it can be accumulated with other types of DI benefits. **War pension**: it is provided to people who became disable after a war event, or to their relatives.	**Social Allowance**: a maximum annual benefit of 5.577€if unmarried; 11.154€if married (up until 2012). **Civil incapacity pension**: 267,57€per month (personal income<15.627,22€) [value in 2012]. **War pension**: depending on the person receiving the benefit, i.e. the disable person, his/her widow, his/her sons, the amount of benefit change. The income limit is 15.373,21€in 2012 (the threshold is common for all the recipients)	**Social Allowance**: it is temporary, and both income and residence requirements are yearly verified. **Civil incapacity pension**: the benefit becomes "social allowance" after 65 years old. **War pension**: permanent

Sources: Italian Social Security Institute (INPS), Pacifico et al. (2018). Notes: The table reports the main benefits provided by the Italian legislator, however, depending on a wide range of criteria additional measures are also available. The entitlement criteria, the duration and the amount of each type of benefit refer to the regulation in 2012.

3.3 Data and Empirical Strategy

The dataset structure, the sample selection and the methodological approach of this chapter are the same as in the previous one. Therefore, a quick review of the dataset and the sample statistics is provided to the reader, while most of the effort is devoted to setting the bases of a reliable identification strategy.

3.3.1 Data, sample selection and descriptives

Many empirical research are challenged by the endogeneity issues arising from the relationship between health and labour market outcomes. Previous works have adopted a variety of approaches, from variations in self-reported health (Garcia-Gomez (2011)), to road injuries or commuting accidents (Dano, (2005); Halla and Zweimüller, (2013)), or acute hospital admissions (García Gòmez et al. (2013)). This paper follows that part of the literature such as Wu(2003), Jones et al. (2019), Trevisan et al. (2016), where the empirical analysis explores the economic effects following severe and objectively diagnosed health shocks such as heart attacks, strokes, and cancers. In this chapter, only acute forms of cardiovascular diseases have been selected: to the virtue of being unexpected - at least the timing of occurrence - their exogeneity can be claimed. Besides the methodological reasons behind this particular selection, an extensive analysis of their economic consequences should be seriously placed at the top of the national and international agendas. In a context where increasing the economic activity of middle-aged and older individuals is essential, it is also important to take into account the increasing incidence of CVD shocks (EHN,2017) and the multiple impairments they lead to. Evidence on the economic pressure that social security programs suffer as a consequence of acute health shock can increase the awareness of how future resources could be burned.

The analysis is based on WHIP&Health, a 7% random sample drawn from the administrative archives of the Italian Social Security Institute (INPS), subsequently linked with the hospital discharge registers (SDO, "Schede di Dimissione Ospedaliera" in Italian) provided by the Ministry of Health. The original version of the dataset also collects information on an individual's job injuries and professional diseases, which are commonly dealt with by the National Work Insurance Administration (INAIL). Despite the broad observational window of WHIP (1990 - 2012), the two sources of data perfectly overlap from 2001 onward (Figure 1 (chapter 2) provides a comprehensive picture of the overall dataset structure). Upon these unchangeable characteristics, the sample selection has been done accordingly.

The overall sample is characterised by male individuals aged between 18 and 64 years old who have experienced or not a cardiovascular shock in a year between 2003 and 2005 ($\bar{t}$): acute and non-fatal forms of cardiovascular diseases have been chosen[9]. As additional health requirement, no similar hospitalisations in the two previous years must be observed. Hence, the only difference between treated and controls refers to the experience of the reference CVD hospitalisation at time $\bar{t}$. Both groups of people are free to experience any type of hospitalisation over the subsequent years. Among the labour requirements, they must be all blue-collar workers at the time of shock, not employed either in the agriculture nor in the public sector. The final working sample is characterised by 408,396 individuals[10]: the huge set of controls (406,604) will be subsequently explored in order to match treated individuals' characteristics (1,792) as well as possible.

We collect information on some demographic characteristics, on individuals' health and labour histories, as well as on their last observed labor contract as an employee before the reference CVD hospitalisation[11]. Table A1 in the Appendix offers an extensive explanation of all of them. By referring to Table 3 (*pre-matching*), it is clear how the two groups of people strongly differ in their health and labour characteristics. Thinking about the specific selection imposed on treated individuals, the differences between the two groups of people are not extremely surprising. Being cardiovascular diseases more common among the elderly, the age difference between treated and controls is more than ten years (50 and 38 years old, respectively). As is also to be expected, substantial deviations appear by looking at the prior health conditions: the averages of past days spent in hospitals for CVD shocks and for other types of diseases (variables $days\_cvd\_cum$ and $days\_others\_cum$) are more than double among the treated. Worst health conditions, combined with longer working careers, are among the possible explanations of the huge gap in cumulated sickness absence (almost nine weeks). About 1% of the shocked blue-collar workers have already received an ordinary incapacity benefit (OIB) in the past, while less than 0.01% of controls have benefited from that ($inv\_benefit\_cum$). As a consequence of a higher average age, and thus a longer working career, we observe significant differences in past labour characteristics. On average, treated individuals appeared in INPS archives more than 11 years before the occurrence of the CVD shock, two years before the time controls start to be observed ($work\_active\_cum$). Accordingly,

[9]In particular, acute forms of ischemic heart diseases (ICD-IX 410-414) and cerebrovascular diseases (ICD-IX 430-434 and 437-438) are considered. The former group counts 76,95% of cases, while the other one only 23,05%.

[10]It is worth noticing the difference in the number of observations with respect to the previous chapter. When a 'selection on observables' approach is applied, the inclusion of time-specific lagged outcomes is important to remove any bias that would stem from time-invariant unobservables (O'Neill et al., 2016). However, before running pre-processing analysis such as coarsened exact matching and entropy balance, a preliminary cleaning of missing or inconsistent information on 'relevant' variables is needed. In this third chapter, an *ad hoc* empirical strategy has been addressed, that is why the different nature of outcome variables - and thus pre-treatment outcomes - lead to lower losses in terms of observations. Instead of conditioning the analysis to the information on the last observed job as an employee, the second-last job etc., whether or not an individual had received one or more among the SS programs in a given (past) year, is always available.

[11]When the person does not work as an employee the year before the CVD shock (the real $\bar{t}-1$), the characteristics of the last observed labour contract as an employee are taken as reference. Later on, an exact matching on the distance between the year of treatment and the year of the "last observed job", will be performed.

they had more time to change jobs, particularly as a blue-collar worker (*nblue_collar_cum*) as well as a higher likelihood to experience unemployment spells (*nunempl_cum*). Finally, although our sample selection ensures they are all blue-collar workers during the treatment year, more than 99% of treated people had the same job-qualification before the CVD hospitalisation, while a lower percentage is found among the controls (97%).

3.3.2 Empirical approach: design & implementation

By following the same empirical strategy as in the previous chapter, the goal of this paper is to assess the causal effect of an acute health shock on the likelihood of receiving one of the social security programs available. Thus, as in a dynamic treatment assignment setting (Sianesi (2004), Trevisan et al. (2016)), the comparison group at $\bar{t}$ is made up of all those who have not yet experienced an acute hospitalisation, irrespective of what happens after $\bar{t}$. Some of them may experience a CVD shock later on, whereas some others may not. This identification approach relies on the standard "conditional independence assumption" (CIA), according to which conditioning on a wide set of observed confounders is sufficient to consider the occurrence of a health shock as good as random:

$$(Y^0_{i,t}, Y^1_{i,t}) \perp T_{i,\bar{t}} | (W_i, X_{i,\bar{t}-s}) \quad s = 1....S$$

where W_i represents the individual time-invariant characteristics, while $X_{(i,\bar{t}-s)}$ are time-varying covariates including labour, social insurance and health histories observed s years before the CVD shock, up to time S. Following this strategy, while "time-varying unobservables" are controlled to the extent they are correlated with the included observed confounders, lagged outcomes[12] allow to take into account time-invariant unobservables, which reasonably affect all the past, current and future labour market outcomes. When unobservable factors systematically persist between the two groups, the assumption is violated. To ensure the success of this approach, retrospective health and labour information have been extensively explored: as an example, the number of labour contracts as an employee or the number of unemployment spells experienced are both reliable indicators of the unobserved individuals' labour market attachment. In a similar vein, many other labour characteristics have been built starting from 1990. The full list of variables can be found in the Appendix (Table A1). Under the CIA, the Average Treatment Effect on Treated ($\tau_{\bar{t}+\nu}$) is identified as follows:

$$\tau_{\bar{t}+\nu} \equiv E[Y^1_{i,\bar{t}+\nu} - Y^0_{i,\bar{t}+\nu} | W_i = w, X_{i,\bar{t}-s} = x]$$

$$\equiv E[Y^1_{i,\bar{t}+\nu} | W_i = w, X_{i,\bar{t}-s} = x] - E[Y^0_{i,\bar{t}+\nu} | W_i = w, X_{i,\bar{t}-s} = x]$$

This paper follows the way of computing ATTs set out in Ho et al. (2007); according to which,

[12] As lagged outcomes we include whether they received an old-age/seniority pension, a DI benefit, a social assistance program or a UI benefit, from one to four years before the reference CVD shock

after processing data using matching methods, estimates are robust to model misspecification[13]. Therefore, the approach involves a combination of non-parametric procedures to ensure an adequate covariate balance, followed by a parametric regression analysis (probit) on the balanced data.

The non-parametric part combines two types of matching techniques: similar to the second chapter, treated and controls are initially stratified according to specific variables; subsequently, the distribution of all the other covariates is adjusted by an entropy balance matching (Hainmueller (2012)). More precisely, we take advantage of the "coarsened exact matching" (CEM) in order to stratify our observations on age, year of treatment and having (or not) experienced other hospitalisations for CVD shocks in the past. Moreover, by referring to the last observed labour contract as an employee i also include its distance from the treatment year, the geographical area, the number of contractual hours worked (part-time/full-time), the type of job (permanent or not) and the total number of people employed in that firm divided into three categories[14]. According to the values of covariates, the algorithm first creates a stratum for each possible combination, and then, allocates treated and control individuals among them. Those strata without at least one observation for each group will be deleted. The greater is the number of confounders the more difficult becomes the allocation process due to it is unlikely to found overlapped values. After CEM implementation, 1758 treated and 198,712 controls individuals remain. As mentioned before, an additional step has been performed to reach an adequate balance across all the other covariates. To this purpose, a crucial characteristic of the entropy balance matching is exploited: the algorithm allows to reweight the dataset such that the covariate distributions in the reweighted data satisfy a set of specified moment conditions (Hainmueller et al. (2013)). Differing from the propensity score methods, it is possible to impose an ex-ante desired level of sample moment adjustment up to the third one: in this case the optimisation process was able to adjust only the first. i.e. the sample mean. Table A2 in the Appendix helps to clarify how the entropy balance matching works and its efficiency in adjusting the overall covariates' distribution. The balancing achieved for each confounder, in terms of equality of means and bias, is presented by the right-hand side of Table 3 (*post-matching*): the null hypothesis of equality of means is not rejected for any confounder. Despite the CIA is impossible to test, yet we can partially address this issue by comparing the pre-treatment trends of

[13]This two-step approach is regarded as doubly robust as consistency only requires that either the parametric or the nonparametric component is consistently estimated (Ho et al., 2007).

[14]Firms with less than 15 employees, those with a number of workers between 16 and 250, and those firms with more than 250 employees

the studied outcomes[15]. Figures 1 and 2[16] show the weighted and unweighted outcomes four years prior and seven years after the acute CVD hospitalisation. The comparison with the pre-matching version is helpful to asses how the implementation of pre-processing steps had worked: this is formally confirmed by the p-values on pre-treatment outcomes available in Table A3.

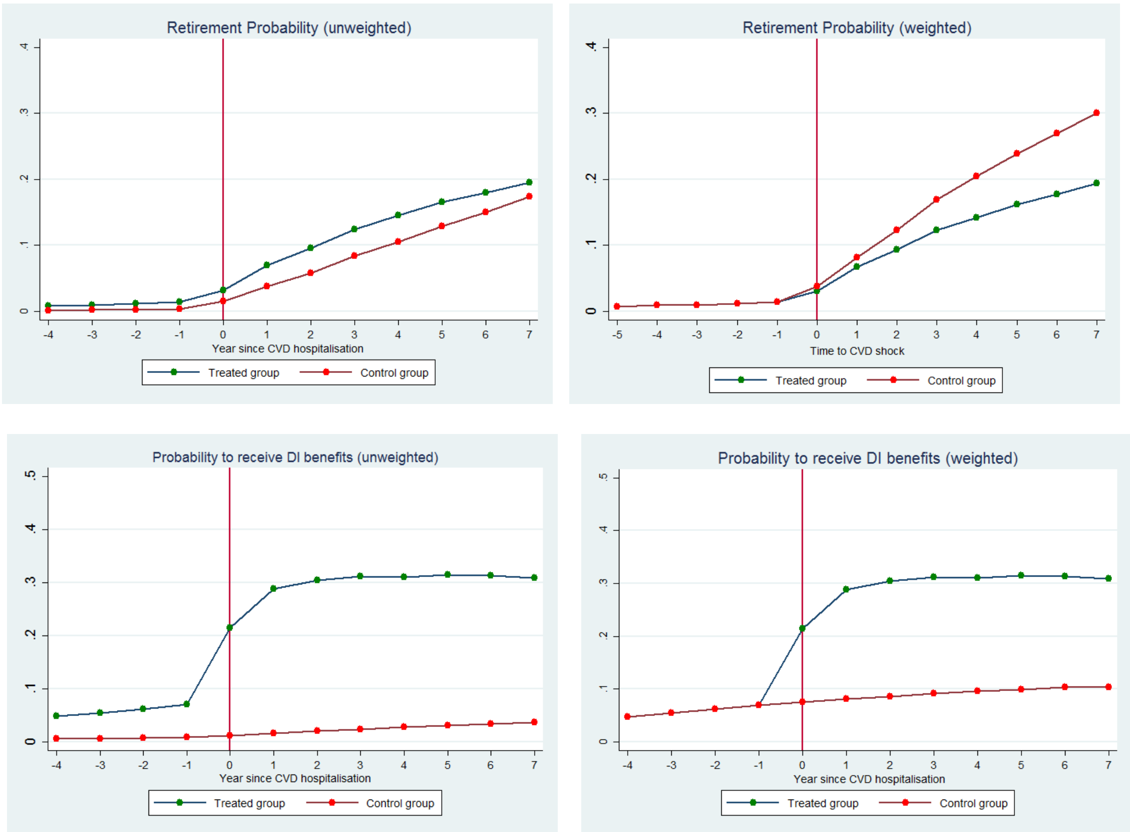

Figure 1: Pre and post-shock trends of retirement probability (old-age/seniority pensions) and their likelihood to receive a DI benefit (OIB/disability pension). Weighted (post-matching) and unweighted (pre-matching) trends are reported.

[15]As in the previous chapter, I make use of 'Nannicini Test' in order to understand whether or not there exists an unobserved confounding factor U which determines the selection into the treatment (s) and at the same time, leads to worse outcomes for controls (d) (Cardon 2015). I refer to Ichino et al (2008) and Nannicini (2007) for a rigorous explanation of the test. As before, even in this new setting, it is reasonable to consider individuals' risk attitude as a common factor for selection into the treatment (the occurrence of a CVD shock) and simultaneously, the subsequent probability of asking for certain types of SS programs. In its preliminary version, the unobserved confounder U is defined to follow the same distribution of 'having (or not) work continuously during the five years before the CVD shock'. The results show that, by including (or not) the U factor, the discrepancy in ATT estimates is never above 9%, and very low values of s and d are produced.

[16]In both figures, continuous lines connect time-specific sample means. It would be incorrect to interpret weighted trends as revealing a drop in outcomes for the treated group since before the shock occurs; the apparent gap observed in $\bar{t}$ results from what happens before and after the shock occurrence.

Table 3: Pre and post matching covariates balance

	Pre-matching				*Post-matching*			
	Mean				**Mean**			
	Treated	Controls	%bias	p-value	Treated	Controls	%bias	p-value
year	2004	2004	2.5	0.286	2004	2004	-0.0	1.000
age	50.49	38.39	135.4	0.000	50.45	50.45	-0.0	1.000
abirth_north	0.260	0.311	-11.3	0.000	0.262	0.262	-0.0	1.000
abirth_center	0.136	0.119	5.1	0.028	0.137	0.137	-0.0	1.000
abirth_south&islands	0.502	0.336	34.2	0.000	0.501	0.501	0.0	1.000
abirth_abroad	0.102	0.234	-35.9	0.000	0.100	0.100	-0.0	1.000
country_underdev	0.095	0.220	-34.8	0.000	0.094	0.094	-0.0	1.000
hosp_cvd_cum	0.036	0.001	26.2	0.000	0.023	0.023	0.0	1.000
days_cvd_cum	0.395	0.010	19.2	0.000	0.261	0.261	0.0	1.000
hosp_other_cum	0.304	0.177	30.1	0.000	0.300	0.300	0.0	1.000
days_other_cum	2.699	1.218	22.4	0.000	2.649	2.649	0.0	1.000
other_hosp_($\bar{t}$-1)	0.200	0.090	21.9	0.000	0.196	0.196	0.0	1.000
other_days_($\bar{t}$-1)	0.957	0.417	14.7	0.000	0.951	0.951	0.0	1.000
inv_benefit_cum	0.071	0.006	34.4	0.000	0.065	0.065	0.0	1.000
sick_leave_cum	17.72	8.890	41.5	0.000	17.53	17.53	0.0	1.000
work_active_cum	11.70	9.430	53.7	0.000	11.73	11.73	0.0	1.000
nemployee_cum	13.30	11.42	36.7	0.000	13.34	13.34	0.0	1.000
rate_employee_cum	95.24	97.13	-13.4	0.000	95.30	95.30	0.0	1.000
jobloss_cum	0.297	0.290	1.3	0.580	0.299	0.299	0.0	1.000
new_firm_cum	2.693	2.606	3.6	0.115	2.696	2.696	0.0	1.000
nblue_collar_cum	11.87	9.228	50.8	0.000	11.91	11.91	0.0	1.000
white_collar_cum	0.260	0.221	3.1	0.157	0.251	0.251	-0.0	0.999
nmanager_cum	0.001	0.002	-0.8	0.799	0.001	0.001	-0.0	0.989
rate_perm_cum	93.68	87.23	29.8	0.000	93.87	93.87	0.0	1.000
rate_fullt_cum	94.93	94.35	3.2	0.186	95.15	95.15	0.0	1.000
ever_CIG	0.360	0.298	13.2	0.000	0.361	0.361	0.0	1.000
nunempl_cum	0.436	0.350	6.8	0.001	0.429	0.429	0.0	1.000
unempl_($\bar{t}$-1)	0.039	0.055	-7.6	0.003	0.040	0.040	-0.0	1.000
rate_selfempl_cum	5.367	3.223	13.8	0.000	5.338	5.338	-0.0	1.000
days_self_cum	235.9	149.8	12.0	0.000	236.67	236.67	-0.0	1.000
rate_atypical_cum	0.559	0.973	-7.6	0.008	0.517	0.517	-0.0	1.000
n_atypical	0.060	0.066	-1.4	0.569	0.056	0.056	-0.0	1.000
dist_empl	1.047	1.080	-7.9	0.002	1.038	1.038	-0.0	0.999
last_lab_income	21462	19115	1.7	0.620	21562	21643	-0.0	0.965
last_hwage	11.62	11.03	0.9	0.789	11.66	11.70	-0.0	0.965
last_sick_leave	2.079	1.041	24.2	0.000	2.046	2.046	0.0	1.000
last_jtenure	8.212	5.564	40.6	0.000	8.241	8.241	0.0	1.000
last_fullt	0.936	0.941	-2.0	0.391	0.940	0.940	0.0	1.000
last_paid_weeks	46.62	43.14	26.7	0.000	46.71	46.71	0.0	1.000
last_fixed_term	0.050	0.107	-21.2	0.000	0.047	0.047	-0.0	1.000
last_awork_north	0.485	0.567	-16.4	0.000	0.485	0.485	-0.0	1.000
last_awork_center	0.184	0.178	1.4	0.556	0.186	0.186	-0.0	1.000
last_awork_south&Islands	0.331	0.254	16.9	0.000	0.329	0.329	0.0	1.000
last_awork_abroad	0	0.0002	-2.0	0.541	0	0	.	.
last_apprentice	0.001	0.024	-20.6	0.000	0.001	0.001	-0.0	0.998
last_bluecollar	0.994	0.968	19.2	0.000	0.995	0.995	-0.0	0.998
last_whitecollar	0.005	0.008	-4.2	0.114	0.005	0.005	-0.0	1.000
last_manager	0	$5.5e^{-05}$	-1.0	0.754	0	$3.4e^{-06}$	-0.1	0.938
last_director	0	$3.4e^{-05}$	-0.0	0.805	0	$1.2e^{-06}$	-0.0	0.963
last_nempl_015	0.314	0.404	-18.8	0.000	0.316	0.316	-0.0	1.000
last_nempl_16250	0.427	0.395	6.5	0.006	0.428	0.428	0.0	1.000
last_nempl_250+	0.259	0.201	13.8	0.000	0.256	0.256	0.0	1.000
last_sec_manufac	0.405	0.455	-10.0	0.000	0.410	0.410	0.0	1.000
last_sec_construc	0.175	0.191	-4.3	0.073	0.175	0.175	-0.0	1.000

Notes: the table reports the balance of the covariates before and after matching implementation. The post-matching balance is the result of both "coarsened exact matching"(CEM) and "entropy balance matching". The full set of covariates includes also other types of sectors of activity and lagged outcomes. The %bias is measured as the difference of the sample means in the treated and non-treated subsamples as a percentage of the square root of the average of the sample variances in the treated and potential controls groups.

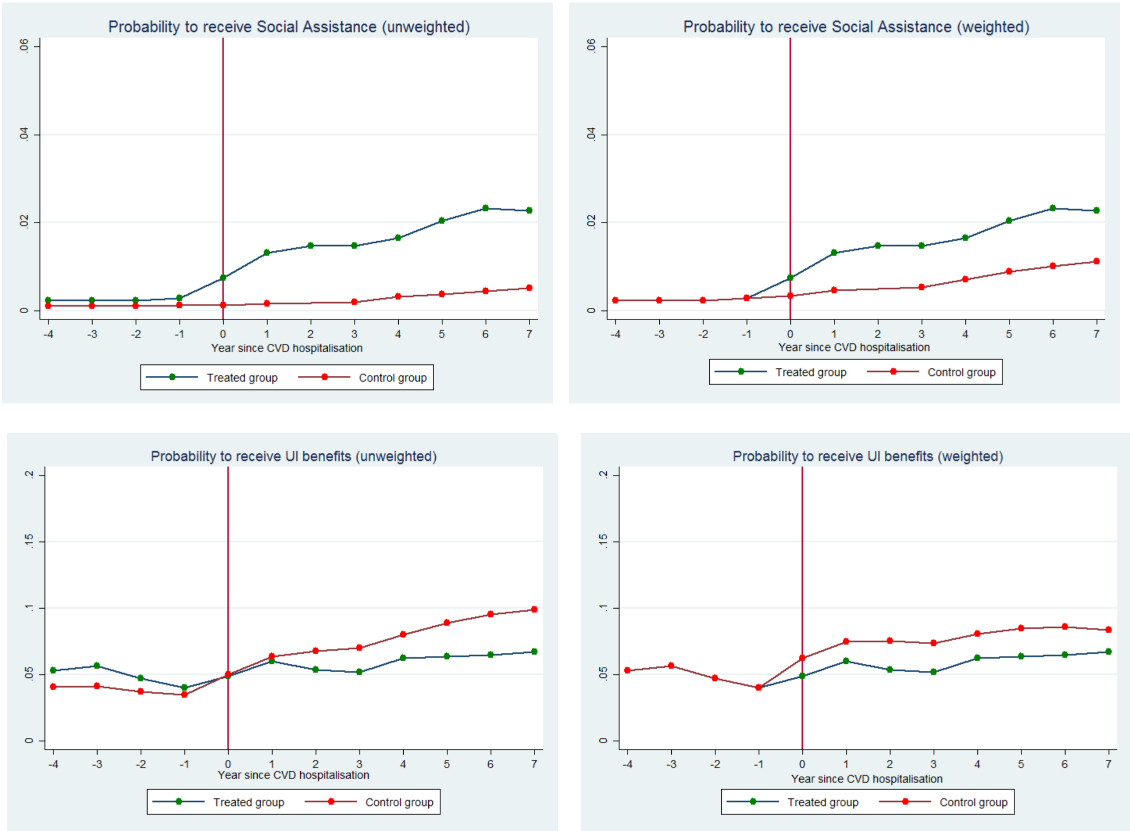

Figure 2: Pre and post-shock trends of probability to receive a social assistance program and their likelihood to get a UI benefit. Weighted (post-matching) and unweighted (pre-matching) trends are reported.

3.4 Empirical Analysis

3.4.1 Overall Results

Once an acute health shock occurs and one's ability to work is affected, important job-related decisions are made by workers. Whether or not to remain (at least partially) on the labour market is strongly related to the country's social security programs. On the background of what we found in the previous chapter - a significant drop of employment probability both in short as well as in the long-run - we are going to investigate the take-up responses of SS programs comparing people who experienced an acute CVD shock and who had not. The institutional overview of Section 3.2 settled the bases for a conscious interpretation of the empirical findings available in Table 4 and Table 5: the first one makes a broad picture of the main social security programs, while the second one focuses on two types of DI benefits and their temporary/permanent nature.

Table 4 reports the average treatment effects (ATT) of five different outcomes: besides the probability to receive each of the aforementioned four types of SS programs (columns 2-5)[17], the first

[17] The outcome variable labelled as "pension" refers to both the old-age and seniority pensions;

column considers the probability of receiving at least one among them. This additional outcome provides a useful insight to realise the economic impact of acute health shocks in term of SS programs sustainability. As partially expected, people who had an acute CVD hospitalisation in $\bar{t}$ are also more likely to receive at least one among the social security programs, especially in the very short-run: on average, one/two years after the shock the probability of getting access to a welfare scheme increases of about 17 percentage points, while seven years after the difference in probabilities wears thin becoming less than a half (7.8 points). In relative terms (Table A4 in Appendix), compared to the people in the control group, the experience of an acute CVD shock increases the chance of receiving welfare supports of almost 74% in $\bar{t}+1$. Although such a relative effect substantially decreases in the long-run, treated individuals are still 16% more likely to get a SS programs seven years after. This trend may reflect different dynamics: on the one hand, the immediate difficulties faced by the workers hit by CVD shocks might be alleviated over time, leading to reduce temporary SS programs recipients[18]; on the other hand, there could also be an increase of beneficiaries among control individuals as far as they become older. A detailed overview of the available programs (columns 2-5) makes clear how disability benefits provide the most tempting (and immediate) opportunity for shocked blue-collar workers to compensate the losses of a reduced working activity. Starting from the year following the CVD shock, the ATT estimates are stable over 20 points. By the end of the observational window, i.e. the seventh year, with respect to the control group they are almost twice more likely to get a DI benefit. Differing from expectations, the normal and early-retirement options seem a secondary choice: instead of decreasing over time, the negative (and significant) difference in the probability of retirement between treated and controls becomes wider. Surprisingly, seven years after the unplanned hospitalisation, treated blue-collar workers are 10 percentage points less likely to enter in an old-age or seniority pension.

Our results are partially in line with the findings of García Gòmez et al. (2013). By focussing on acute hospitalisations lasting more than three days, they found an increase in the probability of entering in DI benefits of two and almost eight points, one and six years after respectively. However, an increase - despite small - in retirement probability among treated individuals is found. By comparing the two sets of results, while the huge ATT magnitudes we found in DI recipients can be easily explained by the type of health shock considered, the negative trends of pension recipients are somewhat puzzling. Eligibility criteria as well as individuals economic conditions can strongly discourage such a type of "exit-pattern". Almost half of them are less than fifty years old, so they are reasonably excluded from either for seniority and the old-age pension. Moreover, given the type of worker we are considering (males and blue-collars), getting out of the labour market loosing any additional form of income may not be economically sustainable. Subsequent

"DI benefits" means you can get either a disability pension or an ordinary invalidity benefit, while "UI benefits" refers to one of the comprehensive grants described in Section 3.2 (i.e. partial insurance benefits are not considered).

[18]Despite the ending date of a benefit can be observed, attritions in the dataset make impossible to understand the reason of a non-renewal case.

Table 4: ATT estimates

		Social Security Programs	Pension	DI benefits	Social Assistance	UI benefits
$\bar{t}$	$\hat{\tau}_{\bar{t}+v}$	0.115***	-0.007**	0.143***	0.003*	-0.014**
	Rob. SE	(0.010)	(0.004)	(0.010)	0.002	(0.005)
	N. treated	1758	1758	1757	1757	1758
$\bar{t}$+1	$\hat{\tau}_{\bar{t}+v}$	0.173***	-0.013**	0.210***	0.007***	-0.012**
	Rob. SE	(0.011)	(0.005)	(0.010)	(0.002)	(0.006)
	N. treated	1758	1758	1757	1757	1758
$\bar{t}$+2	$\hat{\tau}_{\bar{t}+v}$	0.160***	-0.030***	0.220***	0.008***	-0.021***
	Rob. SE	(0.011)	(0.006)	(0.011)	(0.003)	(0.005)
	N. treated	1758	1758	1758	1757	1758
$\bar{t}$+3	$\hat{\tau}_{\bar{t}+v}$	0.149***	-0.046***	0.222***	0.006**	-0.023***
	Rob. SE	(0.011)	(0.007)	(0.011)	(0.003)	(0.005)
	N. treated	1758	1758	1758	1757	1758
$\bar{t}$+4	$\hat{\tau}_{\bar{t}+v}$	0.126***	-0.062***	0.216***	0.008**	-0.018***
	Rob. SE	(0.011)	(0.007)	(0.011)	(0.003)	(0.006)
	N. treated	1758	1758	1758	1757	1758
$\bar{t}$+5	$\hat{\tau}_{\bar{t}+v}$	0.113***	-0.076***	0.217***	0.010***	-0.020***
	Rob. SE	(0.011)	(0.007)	(0.011)	(0.003)	(0.006)
	N. treated	1758	1758	1758	1757	1758
$\bar{t}$+6	$\hat{\tau}_{\bar{t}+v}$	0.095***	-0.092***	0.212***	0.012***	-0.020***
	Rob. SE	(0.011)	(0.008)	(0.011)	(0.003)	(0.006)
	N. treated	1758	1758	1758	1757	1758
$\bar{t}$+7	$\hat{\tau}_{\bar{t}+v}$	0.078***	-0.104***	0.206***	0.010***	-0.016***
	Rob. SE	(0.011)	(0.008)	(0.011)	(0.003)	(0.006)
	N. treated	1758	1758	1758	1757	1758

Source: WHIP&Health. Notes: the marginal effects of five main outcomes (ATTs) are reported: "social Security programs" refers to the probability to receive at least one among the subsequent SS programs. "Pension" refers to the probability to receive an old-age or a seniority pension. "DI benefits" refers to the probability to receive ordinary invalidity benefits or an inability pension. "Social Assistance" refers to the probability to get one of the available social assistance programs. "UI benefits" refers to the probability to get an unemployment benefit. $\bar{t}$ is the year the reference CVD hospitalisation occurs. Matching weights and robust standard errors have been used in probit models.

heterogeneity analyses may help to clarify these points.

By looking at the social assistance and UI benefits trends, we get some further insights. In line with the significant drop in labour market participation detected in the previous chapter, now we find a positive - and significant - gap in the probability to receive some forms of social assistance from treated individuals: this is an alternative way to capture the increasing difficulties faced by shocked blue-collar workers. Six year later, the consequence of a CVD shock amounts to a 1.2 percentage points higher probability to receive an income-support programs, a value that is almost twice the short-run measure (in $\bar{t}$+3 the ATT estimate is equal to 0.6 points). It is worth mentioning how, with respect to the control group, in $\bar{t}$+7 they are still 89 per cent more likely to get one of the previously described supports. Rather unexpected instead, the lower and significant probability to get an unemployment benefit both in the short as well as in the long run; in the absence of the CVD shock, in $\bar{t}$+3 they would have had 2.3 points more likely to formally enter in unemployment. Although the results highlighted in the previous chapter suggests a significant drop in LMP, potentially addressed in the very short-run by unemployment benefits, they seem rarely claimed. Their incompatibility with DI benefits offers a possible explanation. Given the type of health shock occurred, the timing of claiming DI benefits is reasonably before the needed of UI benefits, especially if they are permanent workers undergoing the strict rules of the Italian EPL. Despite approaching this issue in a slightly different way, Brugiavini et al. (2012) partially confirm our finding stressing how unemployment is not a major component of welfare assistance when people are out of the labour market.

If the results of Table 4 pointed out DI programs as the 'preferred' alternative by people whose health status has been strongly compromised by an acute CVD shock, a negative relationship with employment opportunities it is also plausible. As described in Section 3.2, while disability pension does not allow to continue working-activity, ordinary invalidity benefits do. Therefore, instead of considering the probability to receive DI benefits as a whole, a clear distinction between the two types of benefits will provide further insights on individuals' behaviours. The results are reported in Table 5. As is clear by looking at the magnitudes of ATT estimates, most of the treated individuals receive temporary DI benefits; three years after the reference CVD hospitalisation they are almost 20 points more likely to get an OIB than their healthy counterpart, while the difference in disability pension never reaches 3 points. On a different perspective, these results show how there is still a substantial part of people who is not entirely unable to work. Hence, an appropriate combination between DI benefits and employment support programs (specifically addressed to people with disabilities as well as people affected by chronic conditions), could potentially reduce the drop in labour market participation first, also preventing significant income losses. Whether or not these types of social welfare programs fit their goals, i.e. fruitfully compensate the losses of labour incomes, is something we cannot explore in our dataset. However, as mentioned during the introduction, only partial compensations appear (García Gòmez et al. (2013), Dobkin et al. (2018)).

A broader discussion of these findings - despite not fully comparable - is possible thinking to the previous chapter. As seen, when a highly regulated labour market is explored, the onset of a CVD shock may result into sizeable employment losses for blue-collar workers, with little scope for adjustments along with the hours and wage margins. Most importantly, on a longer observational window, only a slight recovery of employment is found. With this in mind, if DI benefits are considered a way to partially compensate income losses in case of a reduction of working activity, or even a drop out of the job, the huge increase of DI claimants, especially in the very short-run, is rather predictable. The severity of the shock makes reasonable they are eligible at least for temporary DI benefits. However, if entering in DI insurance offers a tempting and immediate safeguard for unhealthy workers, the risk of traps is just beyond the corner, especially in a country where the level of labour market turnover is very low, and looking for a new job is extremely difficult at older ages. As a consequence, people who are not eligible for normal/early retirement - or it is not economically affordable - might initially (try to) remain active on the labour market experiencing negative effects on their subsequent opportunities: both in term of earnings and retirement. It is worth mentioning that 'figurative contributions' are paid to DI recipients and they are useful to determine old-age (years) requirements but not the amount of the subsequent pension benefit. Hence, that period of 'inactivity' can strongly affect the contributory history first, and then on the amount of benefit. The positive gap found on social assistance programs among treated individuals fit the idea of increasing economic difficulties derived from permanent losses in employment as well as earnings.

Table 5: ATT estimates on DI benefits

		Disability pension	Ordinary Invalidity benefits
$\bar{t}$	$\hat{\tau}_{\bar{t}+v}$	0.023***	0.121***
	Rob. SE	(0.005)	(0.009)
	N. treated	1757	1757
$\bar{t}$+1	$\hat{\tau}_{\bar{t}+v}$	0.029***	0.183***
	Rob. SE	(0.005)	(0.010)
	N. treated	1757	1757
$\bar{t}$+2	$\hat{\tau}_{\bar{t}+v}$	0.029***	0.193***
	Rob. SE	(0.005)	(0.010)
	N. treated	1757	1758
$\bar{t}$+3	$\hat{\tau}_{\bar{t}+v}$	0.027***	0.197***
	Rob. SE	(0.005)	(0.010)
	N. treated	1757	1758
$\bar{t}$+4	$\hat{\tau}_{\bar{t}+v}$	0.026***	0.192***
	Rob. SE	0.005	(0.010)
	N. treated	1757	1758
$\bar{t}$+5	$\hat{\tau}_{\bar{t}+v}$	0.024***	0.194***
	Rob. SE	(0.005)	(0.010)
	N. treated	1757	1758
$\bar{t}$+6	$\hat{\tau}_{\bar{t}+v}$	0.024***	0.188***
	Rob. SE	(0.005)	(0.010)
	N. treated	1757	1758
$\bar{t}$+7	$\hat{\tau}_{\bar{t}+v}$	0.025***	0.182***
	Rob. SE	(0.005)	(0.010)
	N. treated	1751	1758

Source: WHIP&Health. Notes: the marginal effects (ATTs) of two alternative forms of DI benefits are reported: the "disability pension" and "ordinary invalidity benefits" (OIB). T is the year the reference CVD hospitalisation occurs. Matching weights and robust standard errors have been used in probit models.

3.4.2 Heterogeneous Effects

Age-relate Choices

In order to explore the potential mechanisms behind the previous findings, some heterogeneity analyses are necessary. Although they all experienced an acute health shock, we claim that younger and older people might behave very differently: eligibility requirements as well as different perspectives in future health and labour market activity, may strongly affect their choices in terms of SS programs. For instance, the post-shock recovery of the elderly is likely to be extremely demanding and thus, both early-retirement and DI benefits are tempting opportunities to exit from the labour market. On the contrary, because of minimum age-requirements and shorter career paths, younger individuals are probably excluded from some social security programs such as old-age and seniority pensions, as well as some social assistance measures like the social allowance. Therefore, besides disability supports, unemployment benefits are among their available welfare support programs. With this in mind, we first compute the average treatment effects on treated by splitting the sample into two groups according to their median age, 52 years old.

Figure 3 provides a graphical representation of the estimated ATTs by age groups (the full estimates are available in Table A5). The results on the probability to retire (old-age/seniority pensions) are somewhat surprising: while younger individuals, potentially not even eligible before, show significant (and negative) effects starting from the fourth year onwards, the negative trend previously found seems to be mainly driven by the elderly. Indeed, three years after the shock their retirement probability is reduced by 9.5 percentage points with respect to their counterpart, reaching a difference of about 19 points in $\bar{t}+7$. Less pronounced instead, are the magnitudes observed for the youngest group. By the time people experience an acute CVD hospitalisation, the continuation of labour market activity becomes tough, and DI benefits appear as the only 'convenient' choice: ceasing their working activity permanently is often unfeasible. One year after the shock, the elderly are 24,7 points more likely to enter in DI programs, slightly more than people under the age of 52. The type of workers analysed, together with the selected health shock, lay grounds for a reasonable explanation of our results: when acute health shocks make labour market activity difficult and unstable, the path towards retirement can be significantly altered; or, in other words, delayed by a discontinuous contributory history which makes the retirement unfeasible. As before, our concern is partially confirmed by the higher and significant probability of older individuals getting some forms of social assistance. Finally, if temporary unemployment benefits seem wholly ignored by the elderly in the treated group, they are still an opportunity for the youngest people when their working capability is above a certain threshold, i.e. they do not match DI requirements. By referring to the latter group, significant differences in probabilities rarely show up: few (negative) exceptions appear five and six years after the shock, where the difference is less than 3 percentage points.

Regional Differences

Regional differences are strongly pronounced in Italy, especially by referring to the development of the labour market and the opportunities provided to the working-age population; as a consequence, individuals' access to SS programs can be also very different. The whole sample has been now divided into three groups according to the geographical area where the individual was working during the last job as employee. Figure 4 offers a graphical representation of the ATT estimates (Table A6 shows the estimated magnitudes). Although the overall trends of all outcomes

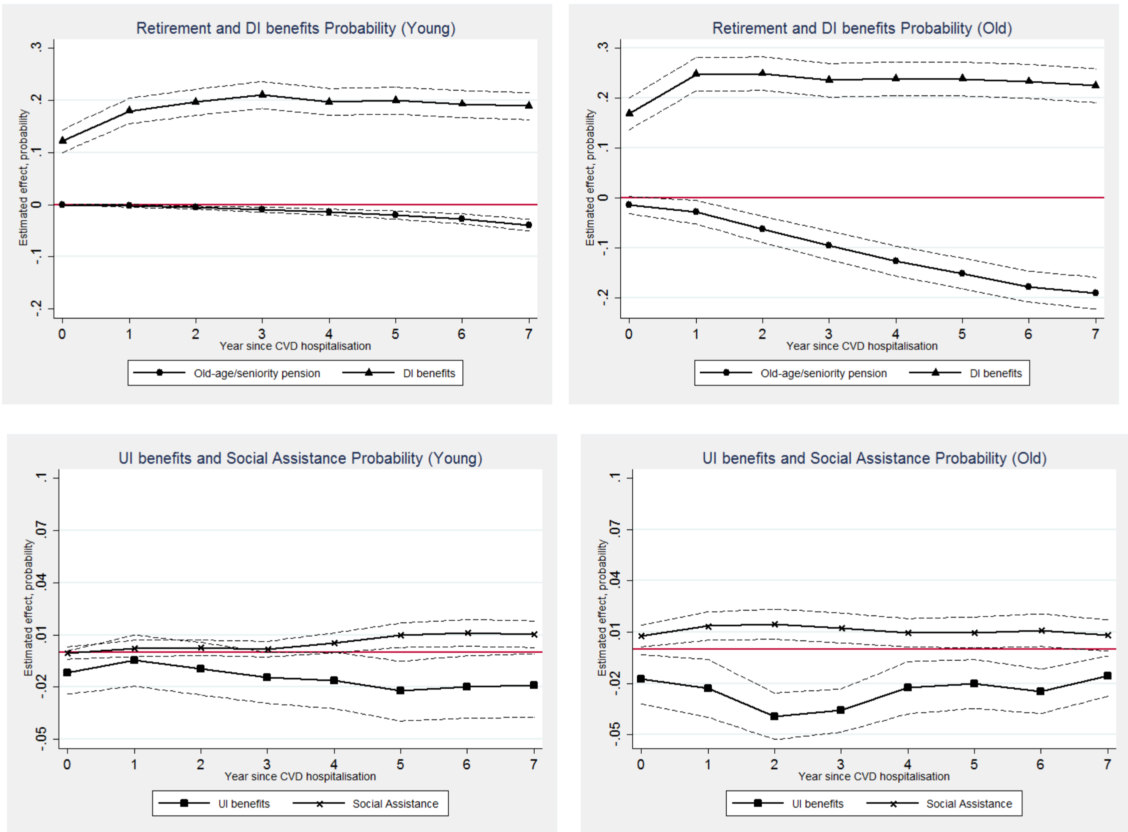

Figure 3: Effect of an acute CVD hospitalisation on the probability to receive one of the SS programs *by age*. Notes: The sample has been divided into two parts according to the median age of treated individuals. 95% confidence intervals are represented by dashed lines

are similar to the baseline results, sizeable differences in magnitudes appear among the southern regions. Three years after the CVD shock, people working (and presumably living) in the north of Italy have an increase of their likelihood to receive DI benefits of about 15 points, while the value doubles looking at people in the south (31 points). Such a difference is statistically different and pretty stable along our observational period. Similar considerations can be done by looking at the retirement probability, a negative and more pronounced gap appears. Overall considering the ATT estimates, especially the positive and significant probability to receive social assistance programs in the South and Islands, the picture is pretty clear: poor labour market opportunities can make their post-shock working life extremely tough, then, the income-supports and health-related benefits turn out as the only chances to top-up the economic losses derived by health deterioration.

Labour Income Inequalities

The decision to apply for some forms of SS programs is undoubtedly related to personal economic status. Despite the severity of the health shock occurred, poor people may find retirement unaffordable, and thus asking for temporary DI benefits while continuing to work. On the contrary, richer people may leave their job immediately, going into old-age or seniority pensions. Figure 5 (Table A7 in Appendix) reports the average treatment effects when the population has been divided into three subsamples according to the pre-shock labour income distribution. Although they do not statistically differ from one another, our findings on DI benefits recipients by income are somewhat coherent with the literature. Again, Garcia-Gomez et al. (2013) found that the poorest individuals almost exclusively enter DI, while the richest also exit into retirement. Here, possibly due to the homogeneity of workers and the slight differences in income distributions, they all avoid exiting through the old-age or seniority pension. Unsurprisingly, the low-income group shows significant ATTs all over the observational window in the probability to receive social assistance, while they are less likely to ask for UI benefits than their healthy counterpart. Sign of lower economic difficulties, insignificant trends appear in the other two upper distributions.

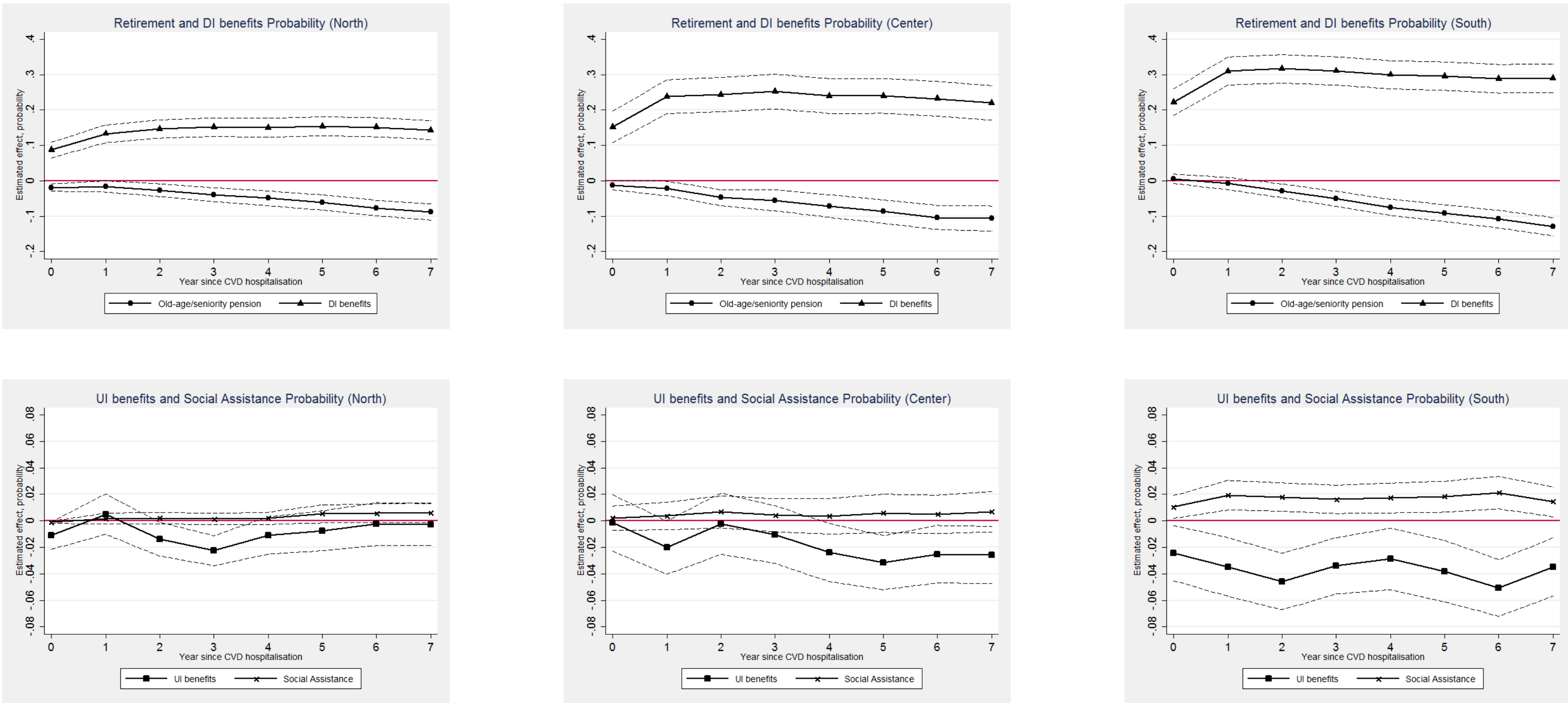

Figure 4: Effect of an acute CVD hospitalisation on the probability to receive one of the SS programs *by geographical area.*
Notes: The sample has been divided into three parts according to the geographical area corresponding to the last time the individual was observed as an employee (north, center, south&islands). 95% confidence intervals are represented by dashed lines

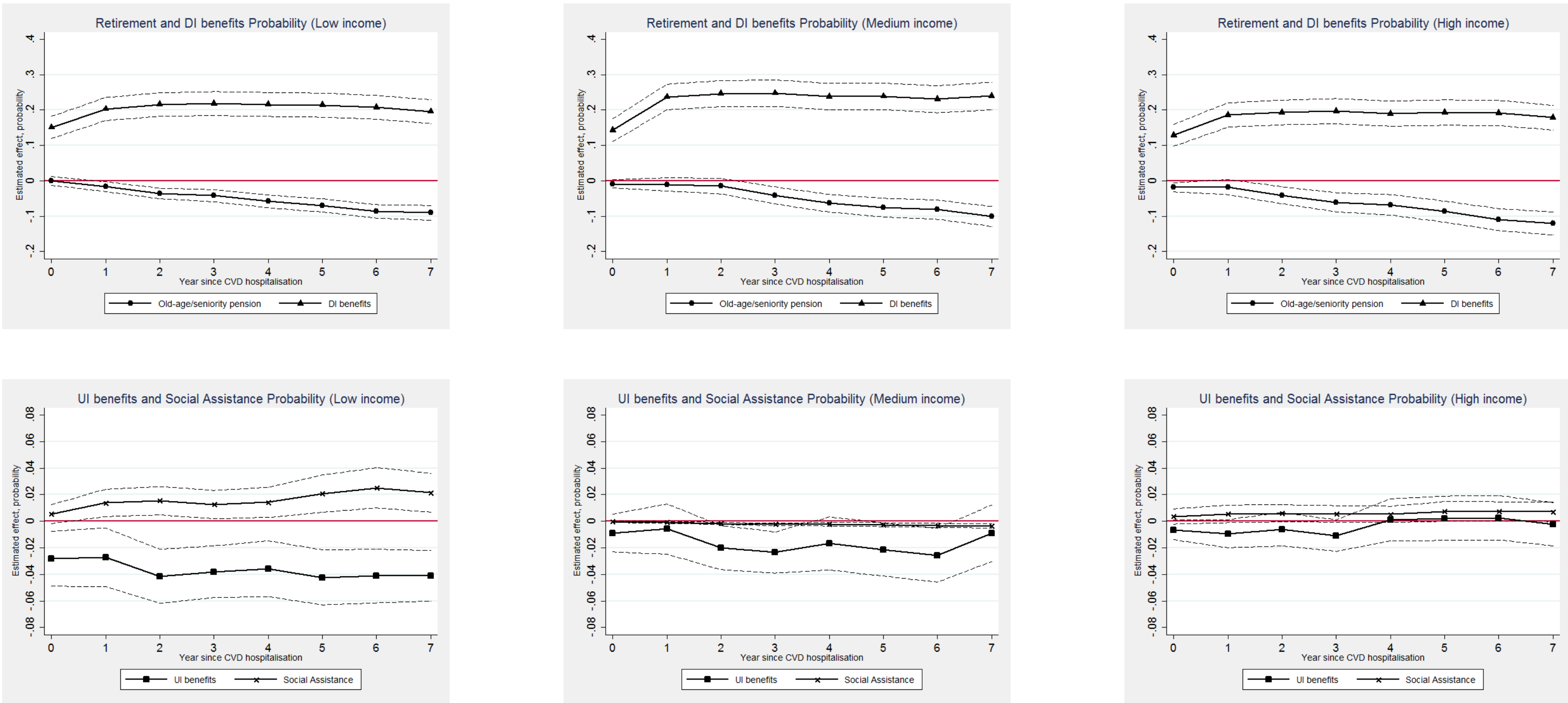

Figure 5: Effect of an acute CVD hospitalisation on the probability to receive one of the SS programs *by income distribution*.
Notes: The sample has been divided into three parts according to the distribution of incomes corresponding to the last time the individual was observed as an employee. 95% confidence intervals are represented by dashed lines

3.5 Conclusions

Thanks to a novel dataset linking individuals' labour and hospitalisation histories, this chapter provides evidence on how blue-collar workers hit by severe CVD shocks make their choices with respect to the available social security programs. The significant and persistent drop of labour market participation observed in the previous chapter offers a strong motivation for this research. Hence, is the experience of severe health shocks appropriately supported by the Italian social security system? Although the scarcity of the available information prevents us from evaluating the effectiveness of SS programs' compensations, individuals' behaviours and how they choose among them, offer important insights: beside health and economic conditions, preferences and eligibility criteria may drive their decisions. For this purpose, an extensive overview of the main available programs has been considered.

At first glance, the experience of an acute cardiovascular disease seems to alter individuals' working careers first, and then strongly reduce the retirement probability. Blue-collar employees are undoubtedly one of the most vulnerable categories of workers: the recovery of their previous labour market situation is often prevented by their job's peculiarities, often extremely demanding in terms of effort. As a consequence, DI programs permanently absorb their remaining working capacity, strongly decreasing their income (García Gòmez et al. (2013)) and thus preventing them from retirement. With respect to their healthy counterpart, three years after the shock treated blue-collars are 22 percentage points more likely to receive the benefits. The rate of outflow from DI status, possible with ordinary invalidity benefits for example, is partially excluded by the persistence of findings over time: in $\bar{t}+7$, the gap is still slightly above 20 percentage points. Contrary to the widespread literature pointing out early-retirement as one of the main exit channels exploited by severely shocked workers (Disney et al. (2006), Jones et al. (2010), among others), significant but negative estimates are found in this paper. Consistent with eligibility criteria, a deeper investigation clarified how these values are primarily driven by people aged 52 and older. The feeling of economic difficulties is somewhat confirmed by the higher probability of asking for social assistance, while the negative trends found for UI benefits are possibly explained by their incompatibility with DI benefits and in particular those allowing working activity, i.e. ordinary invalidity benefits. A few additional insights are also obtained from the heterogeneity analyses. Besides age differences, these gaps are even more pronounced when comparing the area of work. The rate of people entering in DI is significantly higher in southern regions than in the north; similarly, the negative trends for retirement are stronger, as well as the probability of asking for social assistance. Due to the homogeneity of workers, we are considering, the differences in income tertiles are slightly relevant.

An overall consideration of the previous findings should make the policymaker aware of the huge economic consequences derived from health deterioration. The experience of acute CVD shocks - whose rates of incidence are increasing despite lower rates of mortality all over European countries

(EHN, 2017) - poses a serious threat for societies, both in terms of general employment as well as additional pressure on public finances.

Bibliography

[1] Ardito (2017) *Rising pension age in Italy: employment response and program substitution.* LABOR Laboratorio Riccardo Revelli (Centre for Employment Studies) Working Papers No. 155

[2] Belloni M., Alessie R. (2009). *The importance of financial incentives on retirement choices: New evidence for Italy* Labour Economics, 6-5 (2009), pp. 578-588

[3] Black D., Daniel K., Sanders S. (2002). *The impact of economic conditions on participation in disability programs: Evidence from the coal boom and bust.* American Economic Review, 92 (1) (2002), pp. 27-50

[4] Brugiavini, A; Peracchi, F. (2016). *Health Status, Disability Insurance, and Incentives to Exit the Labor Force in Italy: Evidence from SHARE.* in D. Wise, Social Security Programs and Retirement Around the World: Disability Insurance Programs and Retirement, Chicago, Chicago University Press, pp. 411-454

[5] Brugiavini A.; Peracchi F. (2012). *Health Status, Welfare Programs Participation and Labor Force Activity in Italy* in David A. Wise, Historical Trends in Mortality and Health, Employment, and Disability Insurance Participation and Reforms, Chicago, The University of Chicago Press, pp. 175-216 (ISBN 9780226903095)

[6] Bound, J. (1989) *The Health and Earnings of Rejected Disability Insurance Applicants.* American Economic Review, 79 (3) (1989), pp. 482-503

[7] Bound, J.; Burkhauser, R.V. (1999). *Economic analysis of transfer programs targeted on people with disabilities.* Handbook of Labour Economics, 3C, 3417-3528

[8] Cadon T. (2015) *The effects of cancer on older workers in the English labour market.* Economics and Human Biology, 18 (2015), pp. 74-84

[9] Chen, S., Van Der Klaauw, W. (2008). *The work disincentive effect of the disability insurance program in the 1990s* Journal of Econometrics, 142, 757-784

[10] Dano, A.M., (2005). *Road injuries and long-run effects on income and employment.* Health Economics. 14, 955-970. American Economic Review, Vol. 108, No.2, pp.308-52

[11] Disney R., Emmerson C., Wakefield M. (2006). *Ill health and retirement in Britain, A panel data-based analysis.* Journal of Health Economics, 25 (2006), pp. 621-649

[12] Dobkin A., Finkelstein A., Kluender R., Notowidigdo M. (2018). *The Economic Consequences of Hospital Admissions*

[13] García Gòmez, P. (2011) *Institutions, health shocks and labour market outcomes across Europe.* Journal of Health Economics, 30(1): 200-213.

[14] García Gòmez, P., Van Kippersluis, H., O'Donnell, O., van Doorslaer, E. (2013). *Long-term and spillover effects of health shocks on employment and income.* Journal of Human Resources. 48 (4), 873-909.

[15] Hainmueller, J. (2012) *Entropy balancing for causal effects: a multivariate reweighting method to produce balanced samples in observational studies.* Political Analysis, 20(1): 25-46.

[16] Hainmueller, J., Xu, Y. (2013) *ebalance: A Stata package for entropy balancing.* Journal of Statistical Software, 54, Issue 7: 1-18.

[17] Halla, M., Zweimuller, M., (2013). *The effect of health on earnings: quasi-experimental evidence from commuting accidents.* Labour Economics. 24, 23-38.

[18] Halpern J., Hausman J., (1986) *Choice under uncertainty: A model of applications for the Social Security Disability Insurance program.* Journal of Public Economics, 31 (1986), pp. 131-161

[19] Ho D., Imai K., King G., Stuart E. A., (2007) *Matching as Nonparametric Preprocessing for Reducing Model Dependence in Parametric Causal Inference.* Political Analysis, 15: 99-236.

[20] Kreider B. (1998) *Workers' Applications to Social Insurance Programs When Earnings and Eligibility Are Uncertain* Journal of Labor Economics, Vol.16, No. 4, pp.848-877

[21] Ichino, A., F. Mealli, and T. Nannicini, (2008). *From Temporary Help Jobs to Permanent Employment: What Can We Learn from Matching Estimators and their Sensitivity?.* Journal of Applied Econometrics 23 (3): 305-27.

[22] Istituto Italiano di Statistica (ISTAT) (2008) *Trattamenti Pensioni ai Beneficiari al 31 Dicembre 2008.* Available at: https://www.istat.it/it/files//2011/01/testointegrale20100611.pdf

[23] Istituto Italiano di Statistica (ISTAT).(2014) *Trattamenti Pensioni e Beneficiari al 31 Dicembre 2014.* Available at: $https://www.istat.it/it/files//2015/12/Trattamenti-pensionistici-e-beneficiari\_2014.pdf$

[24] Jones A.M., Rice N., Roberts J. (2010). *Sick of work or too sick to work? Evidence on self-reported health shocks and early retirement from the BHPS.* Economic Modelling, 27 (2010), pp. 866-880

[25] Jones A.M., Rice N., Zantomio F. (2019). *Acute health shocks and labour market outcomes: evidence from the post crash era..* Economics and Human Biology, forthcoming.

[26] Lindner, S. (2016). *How do unemployment insurance benefits affect the decision to apply for social security disability insurance?* Journal of Human Resources, 51, 62? 94.

[27] Maestas, N., Mullen, K. J., Strand, A. (2013) *Does disability insurance receipt discourage work? Using examiner assignment to estimate causal effects of SSDI receipt* American Economic Review, 103, 1797-1829

[28] Nannicini. T, (2007) *Simulation-based sensitivity analysis for matching estimators.* STATA Journal, 7 (3) (2007), pp. 334-350

[29] O'Neill, S., Kreif, N., Greive, R., Sutton, M., Sekhon, J. (2016). *Estimating causal effects: considering three alternatives to difference-in-differences estimation.* Health Services and Outcomes Research Methodology, 16, 1-21

[30] Pacifico D., Browne J., Fernandez R., Immervoll H., Neumann D., Thevenot C. (2018). *Faces of Joblessness in Italy: A People-centred perspective on employment barriers and policies.* OECD Social, Employment and Migration Working Papers 208, OECD Publishing.

[31] Sianesi B. (2004) *An evaluation of the Swedish system of active labor market programs in the 1990s* The Review of Economics and Statistics, 86 (1) (2004), pp. 133-155

[32] Trevisan E., Zantomio F., (2016). *The impact of acute health shocks on the labour supply of older workers: Evidence from sixteen European countries.* Labour Economics, 43, 171-185.

[33] Wilkins E, Wilson L, Wickramasinghe K, Bhatnagar P, Leal J, Luengo-Fernandez R, Burns R, Rayner M, Townsend N (2017). *European cardiovascular disease statistics.* Vol. 2017. Brussels: European Heart Network; 2017.

[34] Wu, S. (2003). *The Effects of Health Events on the Economic Status of Married Couples.* Journal of Human Resources 38(1): 219-30.

Appendices

Table A1: Variables definition

Variable	**Definition**
Demographic characteristics	
year	Year of treatment
age	Age at the time of treatment
abirth_north	Area of birth (north)
abirth_center	Area of birth (center)
abirth_south&islands	Area of birth (south or islands)
abirth_abroad	Area of birth (abroad)
country_underdev	Equal to 1 if the person comes from an underdeveloped country
Health history	
hosp_cvd_cum	Equal to 1 if the person ever had a hospitalisation for cardiovascular diseases until ($\bar{t}$-1)
days_cvd_cum	Number of days spent in hospitals for a cardiovascular shock until ($\bar{t}$-1)
hosp_other_cum	Equal to 1 if the person ever had a hospitalisation for other diseases until ($\bar{t}$-1)
days_other_cum	Number of days spent in hospitals for other type of diseases until ($\bar{t}$-1)
other_hosp_($\bar{t}$-1)	Number of hospitalisations for other types of diseases in ($\bar{t}$-1)
other_days_($\bar{t}$-1)	Number of days spent in hospitals for other types of diseases in ($\bar{t}$-1)
inv_benefit_cum	Equal to 1 if the person ever received ordinary invalidity benefits until ($\bar{t}$-1)
sick_leave_cum	Number of weeks in sick leave until ($\bar{t}$-1)
Labour history	
work_active_cum	Number of years the person is observed as employee, self-employed or atypical worker, until ($\bar{t}$-1)
nemployee_cum	Number of contracts as employee until ($\bar{t}$-1)
rate_employee_cum	Percentage of years as an employee over the total observed as a worker, until ($\bar{t}$-1)
jobloss_cum	Number of involuntary job losses experienced until (t-1)
new_firm_cum	Number of firms changed until ($\bar{t}$-1)
nblue_collar_cum	Number of contracts as blue-collar until ($\bar{t}$-1)
white_collar_cum	Number of contracts as white-collar until ($\bar{t}$-1)
nmanager_cum	Number of contracts as manager until ($\bar{t}$-1)
rate_perm_cum	Percentage of permanent contracts on the total as an employee until ($\bar{t}$-1)
rate_fullt_cum	Percentage of full-time contracts and the total as an employee until ($\bar{t}$-1)
ever_CIG	Equal to 1 if the person ever been in "cassa integrazione guadagni" until ($\bar{t}$-1)
nunempl_cum	Number of unemployment benefits received until ($\bar{t}$-1)
unempl_($\bar{t}$-1)	Equal to 1 if the person received unemployment benefits in (t-1)
rate_selfempl_cum	Percentage of years as self-employed over the total observed as a worker until ($\bar{t}$-1)
days_self_cum	Total number of days as self-employed until ($\bar{t}$-1)
rate_atypical_cum	Percentage of years as atypical worker over the total observed as a worker until ($\bar{t}$-1)
n_atypical_cum	Total number of contracts as atypical worker until ($\bar{t}$-1)
Last available job characteristics	
dist_empl	Distance between the treatment year and the last job as employee
last_income	Annual earnings of the last job as employee
last_hwage	Hourly wage of the last job as employee
last_sick_leave	Number of weeks in sick leave corresponding to the last job as employee
last_fullt	Equal to 1 if the person is full-time employed in the last job as employee
last_jtenure	Number of years under the same employer up until the last job as employee
last_paid_weeks	Number of paid weeks corresponding to the last job as employee
last_fixed_term	Equal to 1 if the person is in a permanent contract during the last job as employee
last_awork_north	Area of work (north) of the last job as employee
last_awork_center	Area of work (center) of the last job as employee
last_awork_south&Islands	Area of work (south or islands) of the last job as employee
last_awork_abroad	Area of work (abroad) of the last job as employee

Variable	Definition
Characteristics of the last available job (continue)	
last_apprentice	Job qualification (apprentice) of the last job as employee
last_bluecollar	Job qualification (blue-collar) of the last job as employee
last_whitecollar	Job qualification (white-collar) of the last job as employee
last_manager	Job qualification (manager) of the last job as employee
last_director	Job qualification (director) of the last job as employee
last_nempl_015	Firm dimension (0 - 15 employees) corresponding to the last job as employee
last_nempl_16250	Firm dimension (16 - 250 employees) corresponding to the last job as employee
last_nempl_250+	Firm dimension (250+ employees) corresponding to the last job as employee
last_sec_manufac	Sector of activity (manufacturing) corresponding to the last job as employee
last_sec_construc	Sector of activity (construction) corresponding to the last job as employee
last_agriculture	Sector of activity (agriculture) corresponding to the last job as employee
last_extraction	Sector of activity (mineral extraction) corresponding to the last job as employee
last_energy	Sector of activity (energy) corresponding to the last job as employee
last_trade	Sector of activity (trade) corresponding to the last job as employee
last_foodservices	Sector of activity (food/hotel services) corresponding to the last job as employee
last_transports	Sector of activity (transports) corresponding to the last job as employee
last_finance	Sector of activity (finance services) corresponding to the last job as employee
last_realestate	Sector of activity (real estate services) corresponding to the last job as employee
last_public	Sector of activity (public services) corresponding to the last job as employee
Lagged Outcomes	
l1_SS_program	Equal to 1 if received at least one of the SS programs in ($\bar{t}$-1)
l2_SS_program	Equal to 1 if received at least one of the SS programs in ($\bar{t}$-2)
l3_SS_program	Equal to 1 if received at least one of the SS programs in ($\bar{t}$-3)
l4_SS_program	Equal to 1 if received at least one of the SS programs in ($\bar{t}$-4)
l1_pension	Equal to 1 if received a type of pension (old-age/seniority) in ($\bar{t}$-1)
l2_pension	Equal to 1 if received a type of pension (old-age/seniority) in ($\bar{t}$-2)
l3_pension	Equal to 1 if received a type of pension (old-age/seniority) in ($\bar{t}$-3)
l4_pension	Equal to 1 if received a type of pension (old-age/seniority) in ($\bar{t}$-4)
l1_DI_benefits	Equal to 1 if received a type of DI benefits (pension/OIB) in ($\bar{t}$-1)
l2_DI_benefits	Equal to 1 if received a type of DI benefits (pension/OIB) in ($\bar{t}$-2)
l3_DI_benefits	Equal to 1 if received a type of DI benefits (pension/OIB) in ($\bar{t}$-3)
l4_DI_benefits	Equal to 1 if received a type of DI benefits (pension/OIB) in ($\bar{t}$-4)
l1_s_assistance	Equal to 1 if received a social assistance benefits in ($\bar{t}$-1)
l2_s_assistance	Equal to 1 if received a social assistance benefits in ($\bar{t}$-2)
l3_s_assistance	Equal to 1 if received a social assistance benefits in ($\bar{t}$-3)
l4_s_assistance	Equal to 1 if received a social assistance benefits in ($\bar{t}$-4)
l1_UI_benefits	Equal to 1 if received a UI benefits benefits in ($\bar{t}$-1)
l2_UI_benefits	Equal to 1 if received a UI benefits benefits in ($\bar{t}$-2)
l3_UI_benefits	Equal to 1 if received a UI benefits benefits in ($\bar{t}$-3)
l4_UI_benefits	Equal to 1 if received a UI benefits benefits in ($\bar{t}$-4)

Table A2: Achieved balance of conditional moments (Entropy Balance)

After entropy balance						
	Treated			**Controls**		
	Mean	Variance	Skewness	Mean	Variance	Skewness
Year	2004	0.666	-0.048	2004	0.666	-0.048
Age	50.45	59.91	-0.776	50.45	61.76	-0.777
Abirth_north	0.501	0.250	-0.002	0.501	0.250	-0.002
Abirth_center	0.100	0.090	2.665	0.100	0.090	2.665
Country_underdev	0.094	0.085	2.785	0.094	0.085	2.785
Hosp_other_($\bar{t}$-1)	0.196	0.349	4.590	0.196	0.481	14.13
Days_other_($\bar{t}$-1)	0.951	16.14	7.767	0.951	21.41	12.52
Hosp_cvd_cum	0.022	0.022	6.401	0.022	0.022	6.401
Days_cvd_cum	0.261	5.663	13.55	0.261	4.260	9.461
Hosp_other_cum	0.300	0.210	0.871	0.300	0.210	0.871
Days_other_cum	2.649	49.65	4.738	2.649	74.53	8.582
Inv_benefit_cum	0.065	0.061	3.515	0.065	0.061	3.515
Sick_leave_cum	17.53	673.5	3.204	17.53	782.6	3.755
Work_active_cum	11.73	13.91	-1.420	11.73	13.52	-1.388
Nemployee_cum	13.34	22.92	-0.399	13.34	22.57	-0.141
Rate_employee_cum	95.30	250.7	-3.711	95.30	254.8	-3.724
Jobloss_cum	0.299	0.353	2.245	0.299	0.402	3.876
New_firm_cum	2.696	6.528	2.771	2.696	6.345	2.540
Nblue_collar_cum	11.91	23.75	-0.430	11.91	22.85	-0.433
Nwhite_collar_cum	0.251	1.822	8.271	0.252	1.725	8.790
Nmanager_cum	0.001	0.001	29.60	0.001	0.002	67.22
Rate_perm_cum	93.87	292.9	-3.559	93.87	305.6	-3.570
Rate_fullt_cum	95.15	296.1	-4.245	95.15	296.4	-4.215
Ever_CIG	0.361	0.231	0.578	0.361	0.231	0.578
Nunempl_cum	0.429	1.850	4.426	0.429	1.784	4.249
Unempl_($\bar{t}$-1)	0.040	0.038	4.707	0.040	0.038	4.707
Rate_selfempl_cum	5.338	298.1	3.492	5.338	309.8	3.580
Days_self_cum	236.7	640384	3.9	236.7	647328	3.886
Rate_atypical_cum	0.517	14.88	10.06	0.517	17.27	11.48
N_atypical_cum	0.056	0.173	10.74	0.056	0.217	14.25
Dist_last1_employee	1.038	0.109	10.86	1.038	0.107	10.91
Last_sick_leave	2.046	25.92	4.523	2.045	29.62	6.323
Last_jtenure	8.241	50.05	0.475	8.241	49.54	0.482
Last_weeks_paid	46.71	129.2	-2.324	46.71	129.5	-2.297
Last_fix_term	0.047	0.044	4.300	0.047	0.044	4.300
Last_fulltime	0.940	0.056	-3.716	0.940	0.056	-3.716
Last_awork_north	0.485	0.249	0.061	0.485	0.250	0.061
Last_awork_center	0.186	0.152	1.614	0.186	0.151	1.614
Last_apprentice	0.001	0.001	41.89	0.001	0.001	41.82
Last_bluecollar	0.995	0.005	-13.87	0.995	0.005	-13.86
Last_whitecollar	0.005	0.005	14.72	0.005	0.005	14.72
Last_manager	0	0	.	$1.25e^{-06}$	$1.25e^{-06}$	895.6
Last_firm_015	0.316	0.216	0.790	0.316	0.216	0.790
Last_firm16250	0.428	0.245	0.292	0.428	0.245	0.292
Last_sec_agriculture	0.001	0.001	41.89	0.001	0.001	41.89
Last_sec_extraction	0.007	0.007	11.50	0.007	0.007	11.5
Last_sec_manufac	0.409	0.242	0.370	0.409	0.243	0.370
Last_sec_energy	0.017	0.017	7.458	0.017	0.017	7.458
Last_sec_construc	0.175	0.145	1.709	0.175	0.145	1.709
Last_sec_trade	0.068	0.063	3.442	0.068	0.063	3.442
Last_sec_foodservices	0.048	0.046	4.211	0.048	0.046	4.211
Last_sec_transports	0.139	0.120	2.083	0.139	0.120	2.083
Last_sec_finance	0.126	0.110	2.250	0.126	0.110	2.250
Last_sec_realestate	0.006	0.006	13.15	0.006	0.006	13.15
Last_lab_income	21562	$9.37e^{+07}$	0.473	21644	$5.82e^{+09}$	2467
Last_hwage	11.66	14.28	1.179	11.70	1360	2429

Source: WHIP&Health. Notes: the entropy balance procedure reweights observations so that the covariate distributions satisfy the first moment condition (mean).

After entropy balance (continue)	Treated			Controls		
	Mean	Variance	Skewness	Mean	Variance	Skewness
l1_pension	0.014	0.013	8.382	0.014	0.013	8.378
l2_pension	0.011	0.011	9.215	0.011	0.011	9.209
l3_pension	0.009	0.009	10.34	0.009	0.009	10.33
l4_pension	0.009	0.008	10.69	0.008	0.008	10.69
l1_DI_benefits	0.070	0.065	3.372	0.070	0.065	3.372
l2_DI_benefits	0.061	0.058	3.653	0.061	0.058	3.653
l3_DI_benefits	0.055	0.052	3.920	0.055	0.052	3.921
l4_DI_benefits	0.048	0.046	4.240	0.048	0.046	4.240
l1_s_assistance	0.003	0.003	18.67	0.003	0.003	18.66
l2_s_assistance	0.002	0.002	20.89	0.002	0.002	20.88
l3_s_assistance	0.002	0.002	20.89	0.002	0.002	20.88
l4_s_assistance	0.002	0.002	20.89	0.002	0.002	20.89
l2_UI_benefits	0.047	0.045	4.270	0.047	0.045	4.270
l3_UI_benefits	0.056	0.053	3.849	0.056	0.053	3.849
l4_UI_benefits	0.053	0.050	3.995	0.053	0.050	3.995

Source: WHIP&Health. Notes: the entropy balance procedure reweights observations so that the covariate distributions satisfy the first moment condition (mean).

Table A3: Pre and post matching balance (lagged-outcomes)

	Pre-matching				*Post-matching*			
	Mean				**Mean**			
	Treated	Controls	%bias	p-value	Treated	Controls	%bias	p-value
l1_SS_program	0.128	0.065	21.6	0.000	0.123	0.122	0.1	0.973
l2_SS_program	0.124	0.061	21.9	0.000	0.119	0.119	0.1	0.971
l3_SS_program	0.123	0.058	22.9	0.000	0.119	0.119	0.2	0.965
l4_SS_program	0.110	0.052	21.4	0.000	0.107	0.107	-0.2	0.963
l1_pension	0.015	0.004	10.9	0.000	0.014	0.014	-0.0	0.997
l2_pension	0.012	0.003	10.3	0.000	0.011	0.011	-0.0	0.997
l3_pension	0.010	0.002	9.6	0.000	0.009	0.009	-0.0	0.997
l4_pension	0.009	0.002	10.2	0.000	0.009	0.009	0.0	1.000
l1_DI_benefits	0.075	0.006	35.7	0.000	0.070	0.070	0.0	1.000
l2_DI_benefits	0.066	0.005	33.6	0.000	0.061	0.061	0.0	1.000
l3_DI_benefits	0.057	0.004	31.2	0.000	0.055	0.055	0.0	1.000
l4_DI_benefits	0.049	0.004	28.7	0.000	0.048	0.048	0.0	1.000
l1_s_assistance	0.004	0.002	3.4	0.089	0.003	0.003	-0.0	0.999
l2_s_assistance	0.003	0.002	1.6	0.456	0.002	0.002	-0.0	0.999
l3_s_assistance	0.003	0.002	1.8	0.386	0.002	0.002	-0.0	0.999
l4_s_assistance	0.002	0.002	1.1	0.629	0.002	0.002	0.0	1.000
l1_UI_benefits	0.039	0.055	-7.6	0.003	0.040	0.040	-0.0	1.000
l2_UI_benefits	0.046	0.053	-3.2	0.188	0.047	0.047	-0.0	1.000
l3_UI_benefits	0.056	0.051	2.3	0.324	0.056	0.056	0.0	1.000
l4_UI_benefits	0.054	0.047	3.2	0.167	0.053	0.053	0.0	1.000

Source: WHIP&Health. Notes: the table reports the balance of lagged outcomes before and after matching implementation. The post-matching balance is the result of both "coarsened exact matching"(CEM) and "entropy balance matching". The full set of covariates includes also other types of sectors of activity and lagged outcomes. The %bias is measured as the difference of the sample means in the treated and non-treated subsamples as a percentage of the square root of the average of the sample variances in the treated and potential controls groups.

Table A4: Relative Effects of results in Table 4

$\frac{\tau_{\bar{t}+v}}{Y^0_{i,\bar{t}+v}}$	Social Security Programs	Pension	DI benefits	Social Assistance	UI benefits
$\bar{t}$	65.85	-18.30	188.42	89.08	-22.40
$\bar{t}$+1	73.71	-15.58	257.41	154.16	-16.04
$\bar{t}$+2	56.72	-23.63	255.14	151.01	-28.80
$\bar{t}$+3	44.88	-26.51	242.85	91.95	-31.20
$\bar{t}$+4	33.24	-29.48	226.17	113.76	-22.34
$\bar{t}$+5	26.76	-31.01	219.10	112.98	-23.57
$\bar{t}$+6	20.84	-33.43	206.31	117.92	-23.29
$\bar{t}$+7	16.08	-34.10	198.29	89.23	-19.13

Source: WHIP&Health. Notes: the relative effect is computed as (ATT/conterfactual outcome for reweighted control group)*100

Table A5: ATT estimates by *age group*

		Younger than 52 years old				Older than 52 years old			
		Pension	DI benefits	UI benefits	Social Assistance	Pension	DI benefits	UI benefits	Social Assistance
$\bar{t}$T	ATT	-	0.122***	-0.012*	-0.0003	-0.014	0.168***	-0.018**	0.008**
		-	(0.011)	(0.006)	(0.002)	(0.009)	(0.016)	(0.007)	(0.003)
	n. treated	0	969	970	969	788	788	788	771
$\bar{t}$+1	ATT	-0.002	0.179***	-0.005	0.002	-0.028**	0.247***	-0.023**	0.014***
		(0.001)	(0.012)	(0.007)	(0.002)	(0.012)	(0.017)	(0.009)	(0.004)
	n. treated	958	969	970	969	788	788	788	786
$\bar{t}$+2	ATT	-0.005***	0.196***	-0.010	0.003	-0.063***	0.249***	-0.039***	0.015***
		(0.001)	(0.013)	(0.008)	(0.002)	(0.013)	(0.017)	(0.007)	(0.004)
	n. treated	965	970	970	969	788	788	788	786
$\bar{t}$+3	ATT	-0.010	0.210***	-0.015*	0.002	-0.095***	0.235***	-0.036***	0.012**
		(0.002)	(0.013)	(0.007)	(0.002)	(0.015)	(0.017)	(0.006)	(0.004)
	n. treated	969	970	970	969	788	788	788	786
$\bar{t}$+4	ATT	-0.014***	0.197***	-0.016*	0.005*	-0.126***	0.238***	-0.023***	0.010**
		(0.003)	(0.013)	(0.008)	(0.003)	(0.015)	(0.017)	(0.008)	(0.004)
	n. treated	969	970	970	961	788	788	788	786
$\bar{t}$+5	ATT	-0.020***	0.199***	-0.022**	0.010**	-0.151	0.238***	-0.020**	0.010**
		(0.004)	(0.013)	(0.009)	(0.004)	(0.016)	(0.017)	(0.007)	(0.005)
	n. treated	969	969	970	969	788	788	788	788
$\bar{t}$+6	ATT	-0.027***	0.193***	-0.020**	0.011**	-0.177***	0.233***	-0.025***	0.011**
		(0.005)	(0.013)	(0.009)	(0.004)	(0.016)	(0.017)	(0.007)	(0.005)
	n. treated	969	970	970	969	788	788	788	788
$\bar{t}$+7	ATT	-0.039***	0.189***	-0.019**	0.010**	-0.190***	0.225***	-0.016***	0.008*
		(0.006)	(0.013)	(0.009)	(0.004)	(0.016)	(0.017)	(0.006)	(0.005)
	n. treated	969	970	970	969	788	788	788	788

Source: WHIP&Health

Table A6: ATT estimates by *area of work*

		North				**Center**				**South**			
		Pension	DI benefits	UI benefits	Social Assistance	Pension	DI benefits	UI benefits	Social Assistance	Pension	DI benefits	UI benefits	Social Assistance
$\bar{t}$T	ATT	-0.019***	0.087***	-0.011**	-0.001**	-0.002	-0.013*	0.152***	0.002	0.006	0.222***	-0.024**	0.010**
		(0.005)	(0.011)	(0.005)	(0.004)	(0.011)	(0.007)	(0.023)	(0.005)	(0.007)	(0.019)	(0.011)	(0.004)
	n. treated	852	852	852	852	327	327	327	319	574	578	579	571
$\bar{t}$+1	ATT	-0.016*	0.133***	0.005	0.002	-0.021*	0.238***	-0.020**	0.004	-0.008	0.310***	-0.035***	0.019***
		(0.008)	(0.013)	(0.008)	(0.002)	(0.010)	(0.024)	(0.010)	(0.005)	(0.009)	(0.020)	(0.011)	(0.006)
	n. treated	852	852	852	852	327	327	327	319	578	578	579	572
$\bar{t}$+2	ATT	-0.026***	0.146***	-0.014**	0.002	-0.048***	0.244***	-0.002	0.007	-0.028***	0.316***	-0.046***	0.018***
		(0.009)	(0.013)	(0.007)	(0.002)	(0.012)	(0.025)	(0.012)	(0.006)	(0.010)	(0.020)	(0.011)	(0.005)
	n. treated	852	852	852	852	327	327	327	319	578	579	579	574
$\bar{t}$+3	ATT	-0.039***	0151***	-0.023***	0.001	-0.055***	0.252***	-0.010	0.004	-0.051***	0.310***	-0.034***	0.016***
		(0.010)	(0.013)	(0.006)	(0.002)	(0.015)	(0.025)	(0.011)	(0.006)	(0.011)	(0.020)	(0.011)	(0.005)
	n. treated	852	852	852	852	327	327	327	319	579	579	579	574
$\bar{t}$+4	ATT	-0.049***	0.150***	-0.011	0.002	-0.071***	0.240***	-0.024**	0.003	-0.075***	0.300**	-0.028**	0.017***
		(0.011)	(0.014)	(0.007)	(0.002)	(0.016)	(0.025)	(0.011)	(0.007)	(0.012)	(0.020)	(0.012)	(0.006)
	n. treated	852	852	852	852	327	327	327	319	579	579	579	576
$\bar{t}$+5	ATT	-0.061***	0.154***	-0.007	0.005	-0.087***	0.240***	-0.031***	0.006	-0.091***	0.296***	-0.038***	0.018***
		(0.011)	(0.014)	(0.007)	(0.003)	(0.017)	(0.025)	(0.010)	(0.007)	(0.012)	(0.020)	(0.012)	(0.006)
	n. treated	852	852	852	852	327	327	327	319	579	578	579	578
$\bar{t}$+6	ATT	-0.077***	0.151***	-0.002	0.006	-0.103***	0.232***	-0.025**	0.005	-0.108***	0.288***	-0.051***	0.021***
		(0.011)	(0.014)	(0.008)	(0.004)	(0.017)	(0.025)	(0.011)	(0.007)	(0.013)	(0.021)	(0.011)	(0.006)
	n. treated	852	852	852	852	327	327	327	319	579	579	579	578
$\bar{t}$+7	ATT	-0.088***	0.143***	-0.003	0.006	-0.107***	0.220***	-0.026**	0.007	-0.130***	0.289***	-0.035***	0.014**
		(0.012)	(0.014)	(0.008)	(0.004)	(0.018)	(0.025)	(0.011)	(0.008)	(0.013)	(0.021)	(0.011)	(0.006)
	n. treated	852	852	852	852	327	327	327	319	579	579	579	578

Source: WHIP&Health

Table A7: ATT estimates by *income group*

		Low income				Medium income				High income			
		Pension	DI benefits	Social Assistance	UI benefits	Pension	DI benefits	Social Assistance	UI benefits	Pension	DI benefits	Social Assistance	UI benefits
$\bar{t}$T	ATT	-0.0004	0.151***	-0.028**	0.005	-0.008	0.143***	-0.009	-0.0003	-0.019**	0.129***	-0.006*	0.004
		(0.006)	(0.016)	(0.011)	(0.004)	(0.006)	(0.016)	(0.007)	(0.0003)	(0.007)	(0.016)	(0.004)	(0.003)
	n. treated	687	686	687	687	537	537	533	526	534	534	534	489
$\bar{t}$+1	ATT	-0.017**	0.203***	-0.027**	0.014**	-0.010	0.237***	-0.006	-0.001**	-0.017	0.186***	-0.009*	0.006
		(0.007)	(0.017)	(0.011)	(0.005)	(0.010)	(0.018)	(0.010)	(0.0003)	(0.011)	(0.018)	(0.005)	(0.003)
	n. treated	687	686	687	678	537	537	537	526	534	534	534	489
$\bar{t}$+2	ATT	-0.036***	0.216***	-0.041***	0.015**	-0.015	0.246***	-0.020**	-0.002***	-0.041***	0.193***	-0.006	0.006*
		(0.008)	(0.017)	(0.010)	(0.005)	(0.011)	(0.019)	(0.008)	(0.0004)	(0.012)	(0.018)	(0.006)	(0.003)
	n. treated	687	687	687	682	537	537	537	528	534	534	534	489
$\bar{t}$+3	ATT	-0.042***	0.218***	-0.038***	0.013**	-0.041***	0.248***	-0.0.23***	-0.002***	-0.061***	0.197***	-0.011*	0.006*
		(0.009)	(0.017)	(0.010)	(0.005)	(0.012)	(0.019)	(0.008)	(0.004)	(0.014)	(0.018)	(0.006)	(0.003)
	n. treated	687	687	687	682	537	537	537	528	534	534	534	519
$\bar{t}$+4	ATT	-0.058***	0.216***	-0.036***	0.014**	-0.064***	0.238***	-0.017	-0.002***	-0.068***	0.190***	0.001	0.005
		(0.009)	(0.017)	(0.011)	(0.006)	(0.013)	(0.019)	(0.010)	(0.001)	(0.015)	(0.018)	(0.008)	(0.003)
	n. treated	687	687	687	686	537	537	537	529	534	534	534	519
$\bar{t}$+5	ATT	-0.070***	0.214***	-0.042***	0.021***	-0.076***	0.239***	-0.021**	-0.003***	-0.087***	0.193***	0.002	0.007*
		(0.010)	(0.017)	(0.011)	(0.007)	(0.013)	(0.019)	(0.010)	(0.001)	(0.015)	(0.018)	(0.009)	(0.004)
	n. treated	687	687	687	687	537	537	537	529	534	534	534	526
$\bar{t}$+6	ATT	-0.086***	0.208**	-0.041***	0.025***	-0.081***	0.231***	-0.026**	-0.003***	-0.110***	0.192***	0.003	0.007*
		(0.010)	(0.017)	(0.010)	(0.008)	(0.014)	(0.019)	(0.010)	(0.001)	(0.016)	(0.018)	(0.009)	(0.004)
	n. treated	687	687	687	687	537	537	537	537	534	534	534	526
$\bar{t}$+7	ATT	-0.090***	0.196***	-0.041***	0.021**	-0.101***	0.240***	-0.009	-0.004***	-0.121***	0.178***	-0.002	0.007*
		(0.011)	(0.017)	(0.010)	(0.007)	(0.014)	(0.020)	(0.011)	(0.001)	(0.017)	(0.018)	(0.008)	(0.004)
	n. treated	687	687	687	686	537	537	537	537	534	534	534	526

Source: WHIP&Health

Conclusion

Acute health conditions pose a serious challenge to societies. The growing incidence of CVD shocks, together with their strong impact on productivity and individuals' labour market participation, makes the employment of people with reduced working capabilities the top priority. Therefore, increasing the awareness of the detrimental effects arising from health deterioration is an essential tool for implementing more effective strategies. As the pathway to promote employment integration is specific for each country, the Italian labour and institutional setting, traditionally characterised by a rigid labour market and high levels of employment protection legislation, offers a unique opportunity for analysis.

Throughout the thesis, the economic consequences of an acute health shock have been studied along different dimensions. First of all, the length of sick leave - an instrument designed by the policy maker to prevent the income losses derived from bad health - has been questioned to have a relationship with the early-exit from a specific job. Notwithstanding the peculiarities of the legislative framework and the protection ensured by the high level of the Italian EPL, it has been found that an extended absence after experiencing a CVD shock yields a significant increase in the risk of ceasing that labour contract. Besides the unknown preferences and labour market attachment - which are undoubtedly an important component - the paper strongly emphasises the lack of a clear and homogeneous regulation specifically addressed to people with chronic conditions who do not have a certified level of disability. Such legislative voids may lead to inadequate workplace accommodations and a lack of incentives or obligations for employers to make the continuation of working activity easier; even when open-ended contracts are in place.

By assuming a broader perspective instead, the second chapter analyses the potential adjustments channels which may appear on the labour market over nine years of follow-up. Indeed, multiple post-shock mechanisms can emerge over time: an immediate and temporary labour market exit for example, meant to foster recovery, can also become permanent when rigid institutional settings do not allow people to easily re-enter, especially for older people. Alternatively, the development of different forms of disability-specific human capital may facilitate the return to work or recovery in earnings over the medium/long-run. As expected, slight adjustments are found along the hours or wage margins, while the bulk of responses appear on a sizeable and persistent employment loss; within the last three years of observation, only 16 per cent of people previously hit by a CVD shock return to work as employees. Transitions to less demanding jobs do not generally offer a viable opportunity, thus the inactivity is likely to become permanent. With this in mind, a warning to the policy maker is needed. In a country where the role played by collective bargaining makes wage adjustments rather impossible, firms' incentives to facilitate an easier switch to a part-time work, seems to be a viable option.

A complete description of the economic consequences of an acute health shock cannot avoid mentioning an individual's take-up response to the available Social Security programs. Rather than focussing solely on DI claimants - as is often the approach of the literature - the analysis of how people behave among a wide range of support programs allows to focus on their "substitutability" role. Multiple factors such as personal health, individuals' economic condition, preferences and eligibility criteria may differently motivate one's choices. Unsurprisingly, people who experienced an acute health shock usually enter in disability insurance - especially the so-called ordinary invalidity benefits - a temporary income support which is compatible with working activity. Far from being expected, but potentially linked with the needs of prolonging working activity, is the negative gap in the probability of entering an old-age or seniority pension; a distance that further increases over the seven years of observation. Contextually, while UI benefits - incompatible with ordinary invalidity benefits - are rarely required by people who have had a CVD shock, social assistance supports seem to be more likely regardless of their strict eligibility criteria. Considering all these points, there are clear signals of increased economic difficulties following the onset of health deterioration. Hence, despite missing precise information about the monetary compensation provided by DI, UI and social assistance benefits, the final picture is rather discouraging.

Although the notable advantages of using an administrative dataset, some limitations must be also mentioned. The lack of information on the reason of a job-interruption is undoubtedly a concern, especially in the first chapter. Concerning this, additional data about subsequent job spells, or the receipt of some SS programs, could be helpful when attempting to disentangle the strength of individual preference and true working limitations leading to the closure of an open-ended contract. No less important, the absence of the rate of mortality is another undeniable drawback of the dataset, potentially affecting the findings of all three chapters. More detailed national and international statistics on the rate of mortality as a consequence of CVD shocks and its timing could be useful to better quantify the problem. Eventually, as previously mentioned throughout the third chapter, the economic consequences of health deterioration could be better analysed knowing the level of earnings replacement provided by the social welfare system. However, despite currently missing, they could be requested from the data provider.

Considering all the previous findings, a wide set of tools-for-discussion are given. More employmentoriented programs, i.e. focussed on the capacity to work instead of the inability to work, should be developed in order to avoid the economic burden of passive benefits as well as the social exclusion of people with lower capabilities. In addition, more flexible labour market policies should work to facilitate an easier exit and entry of people with serious health conditions, irrespectively to their certified level of disability. If on the one hand, the strictness of EPL can protect workers against discriminations and unfair dismissals, on the other one it may also strongly discourage the employers from the recruitment of less healthy people. Thus, reaching a more effective balance among the various institutional agents and the way how they interact, should be critically considered by the policy-maker.

Estratto per riassunto della tesi di dottorato

L'estratto (max. 1000 battute) deve essere redatto sia in lingua italiana che in lingua inglese e nella lingua straniera eventualmente indicata dal Collegio dei docenti.

L'estratto va firmato e rilegato come ultimo foglio della tesi.

Studente: Irene Simonetti

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Dottorato: Economia

Ciclo: 32°ciclo

Titolo della tesi: *"Health shocks, labour market outcomes and access to public transfer programs: evidence from Italian administrative data"*

Abstract: A relatively high consensus has been produced so far by the economic literature on the relationship between individuals' health and labour market activity. Still, the potential – short and long-term – mechanisms through which the association arises, remain pretty unexplored. By taking different perspectives, the thesis explores the causal relationship between acute health shocks such as cardiovascular diseases and a wide range of labour market outcomes. The socio-economic impact of CVD shocks is of primary importance in the policy agendas since health deterioration (i) significantly increases the present value of current and future public expenditures for health care and medical treatments and (ii), drives people into unemployment, poverty and social exclusion when the country-specific institutional setting does not accommodate their particular needs. The Italian Institutional and economic setting, characterised by a rigid labour market and a high degree of in-job worker protection by European standards, makes the analysis further interesting. Upon this background, the thesis addresses three different research topics. First of all, it studies the role played by the duration of sick leave absence in explaining the continuity of the labour contract that was in place at the time of the CVD shock. Secondly, it addresses the measurement of the long-term effects of acute health shocks on the probability of employment, annual labour income and wages, among other outcomes. Eventually, the last part of the thesis it is devoted to the analysis of how having experienced an acute health shock drives individuals' choices in terms of Social Security Programs-related decisions, such as early-retirement, DI or unemployment benefits.

Abstract (Italiano): Finora la letteratura economica ha prodotto un consenso relativamente elevato sulla relazione tra la salute e l'attività lavorativa delle persone. Tuttavia, i potenziali meccanismi – di breve e di lungo termine - attraverso i quali nasce tale associazione rimangono piuttosto inesplorati. Considerando diverse prospettive, la tesi esplora la relazione causale tra shock sanitari acuti come le malattie cardiovascolari e una vasta gamma di outcomes sul mercato del lavoro. L'impatto socioeconomico degli shock cardiovascolari è di primaria importanza nelle agende politiche poiché il deterioramento della salute (i) aumenta significativamente il valore

attuale e futuro delle spese pubbliche per l'assistenza sanitaria e le cure mediche e (ii), spinge le persone verso la disoccupazione, la povertà ed l'esclusione sociale quando il contesto istituzionale non soddisfa i loro bisogni particolari. Il contesto istituzionale ed economico italiano, caratterizzato da un rigido mercato del lavoro e da un alto grado di protezione dei lavoratori sul posto di lavoro secondo gli standard europei, rende ulteriormente interessante l'analisi. Su questo sfondo, la tesi affronta tre diversi argomenti di ricerca. Prima di tutto, studia il ruolo svolto dalla durata del congedo di malattia nello favorire (o meno) la continuità del contratto di lavoro che era in vigore al momento dello shock CVD. In secondo luogo, si occupa della misurazione degli effetti a lungo termine di shock sanitari acuti sulla probabilità di essere occupati, sul reddito da lavoro annuale e sui salari. L'ultima parte della tesi è invece dedicata all'analisi di come aver subito uno shock di salute acuto guida le scelte delle persone in termini di decisioni relative ai programmi di previdenza sociale, come pensionamento anticipato, diabilità o sussidi di disoccupazione.

Firma dello studente