The impact of acute health shocks on the labour supply of older workers: evidence from sixteen European countries

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Abstract

We investigate the consequences of experiencing an acute health shock, namely the first onset of myocardial infarction, stroke or cancer, on the labour supply of older workers in Europe. Despite its policy relevance to social security sustainability, the question has not yet been empirically addressed in the European context. We combine data from the the English Longitudinal Study of Ageing and the Survey of Health, Ageing and Retirement in Europe and cover sixteen European countries, representative of different institutional settings, in the years spanning from 2002 to 2013. The empirical strategy builds on the availability of an extremely rich set of health and labour market information as well as of panel data. To remove the potential confounding bias, a selection on observables strategy is adopted, while the longitudinal dimension of data allows controlling for time invariant unobservables. Implementation is based on a combination of stratification and propensity score matching methods. Results reveal that experiencing an acute health shock on average doubles the risk of an older worker leaving the labour market, and is accompanied by a deterioration in physical functioning and mental health, as well as by a reduction in perceived life expectancy. Men's labour market response appears driven by the onset of impairment acting as a barrier to work. In in the case of women, preferences for leisure and financial constraints seem to play a prominent role. Heterogeneity in behavioural responses across countries – with the largest labour supply reductions observed in the Nordic and Eastern countries, and England – are suggestive of a relevant role played by social security generosity.

Keywords: health shocks, labour supply, Europe, older workers, propensity score matching

JEL CODES: J22, J18, I10, C14

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Acknowledgements.
We are grateful to Ana Rute Cardoso, Axel Börsch-Supan, Michael Hurd, Andrew Jones, Stefania Maggi, Elena Meschi, Pedro Mira, Kenneth Nelson, Marianna Noale, Nigel Rice, Thomas Siedler, Peter Simmons, James Smith, Gugliemo Weber, Jefferey Wenger and to participants in the RAND 'Comparative International Research Based on the HRS Family of Data' Conference, the International Health Economics Association 11th World Congress, the XIX Health Economics Italian Association Conference, the 4th International SHARE User Conference and a seminar held at SOFI (University of Stockholm), for useful comments. Financial support from the University of Padua, through the 'Progetto Strategico di Ateneo' Grant on 'Population ageing: Economics, health, retirement and the welfare state', from the Ca' Foscari University of Venice, and from the European Commission's 7th Framework Programme (FP7/2013-2017) Grant n°312691, InGRID – Inclusive Growth Research Infrastructure Diffusion, is gratefully acknowledged.
Data from The English Longitudinal Study of Ageing, obtained through the UK data Archive, have been used with permission. The paper uses also data from SHARE Wave 5 release 1.0.0, as of March 31st 2015 (DOI: 10.6103/SHARE.w5.100) and SHARE Wave 4 release 1.1.1, as of March 28th 2013 (DOI: 10.6103/SHARE.w4.111) and SHARE Waves 1 and 2 release 2.6.0, as of November 29th 2013 (DOI: 10.6103/SHARE.w1.260 and 10.6103/SHARE.w2.260). The SHARE data collection has been primarily funded by the European Commission through the 5th Framework Programme (project QLK6-CT-2001-00360 in the thematic programme Quality of Life), through the 6th Framework Programme (projects SHARE-I3, RII-CT-2006-062193, COMPARE, CIT5- CT-2005-028857, and SHARELIFE, CIT4-CT-2006-028812) and through the 7th Framework Programme (SHARE-PREP, N° 211909, SHARE-LEAP, N° 227822 and SHARE M4, N° 261982). Additional funding from the U.S. National Institute on Aging (U01 AG09740-13S2, P01 AG005842, P01 AG08291, P30 AG12815, R21 AG025169, Y1-AG-4553-01, IAG BSR06-11 and OGHA 04-064) and the German Ministry of Education and Research as well as from various national sources is gratefully acknowledged (see www.share-project.org for a full list of funding institutions).
All responsibility for the analysis and interpretation of the results lies with the authors.

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1. Introduction

The influence of health on labour supply behaviour has long been recognised in the economic literature, mostly with respect to older workers approaching retirement age (Currie and Madrian, 1999; Lumsdaine and Mitchell, 1999). Poor health and health deteriorations have been shown to increase the hazard of early labour market exit in a variety of countries and institutional settings (for example, Bound *et al.* 1999; Disney *et al.*, 2006; Kalwij and Vermeulen, 2008; Zucchelli *et al.*, 2010). Multiple reasons explain why the bulk of existing literature focuses on older workers. First, older workers face a higher morbidity risk due to longer exposure to risk factors and insults that accumulate through the life course (Ben-Shlomo and Kud, 2002). Indeed, wide epidemiological evidence shows that the chance of experiencing chronic and acute health conditions increases dramatically at older ages (Ward and Schiller, 2013; Feigin *et al.*, 2013; IARC, 2012). Second, older workers are at the core of the current social security reform agenda. In the event of health shock, while facing lower incentives to invest in re-training towards less physically demanding jobs, (Charles, 2003; Newmark and Song, 2012), older workers typically benefit from wider labour market exit options. The widespread take-up of early retirement or other paths of exit from the labour market, such as disability benefits, has been indeed well documented (for example by Blundell *et al.*, 2004; Autor and Duggan, 2006; Euwals *et al.*, 2010; Koning and Lindeboom, 2015).

Economic interest in the topic is motivated, first, by a concern that early labour market exit might bear severe and enduring consequences on individuals' financial wellbeing in later life, though reduced contributions histories resulting in lower pension entitlements (Angelini *et al.*, 2009). No less important comes the concern that early exits might threaten the fiscal sustainability of social security systems, already challenged by population ageing. Beyond financial concerns, working is identified in the psychological literature as a positive contributor to personal and social wellbeing (Spelten *et al.*, 2002; Hackett *et al.*, 2012; Vestling *et al.*, 2013), as it typically fosters individuals' self esteem and sense of purpose while providing a daily routine and opportunities for social interactions. Not surprisingly, in clinical studies return to work is regarded as an indicator for the success of recovery after the onset of major health conditions (Daniel *et al.*, 2009; Trygged *et al.*, 2011).

Institutional settings represent the first levers governments can activate to promote the labour market inclusion of older and disabled workers. Institutions might influence labour supply adjustments to health shocks, not only through social security generosity (Börsch-Supan, 2008; Gruber and Wise 1999, 2004; Garcìa-Gòmez, 2011) but also in terms of labour market structure (Cai *et al.*, 2014) and, last but not least, healthcare provision arrangements. For example, the job lock literature developed in the US illustrates how

individuals under employment-contingent health insurance might increase their labour supply after an adverse health shock because of the envisaged rise in future healthcare costs (Madrian, 1994; Kapur, 1998; Bradley *et al.*, 2013). The same pattern could headily be expected though in most European countries, where a national health service is in place and out of pocket expenditures play a limited role in the funding of healthcare (WHO, 2015).

The design of potentially effective policy interventions requires appropriate and up to date evidence on individuals' response to health shocks, and on the mechanisms lying behind the observed adjustments. Multiple mechanisms could be in place. First, poor health might result in the onset of physical and mental impairment limiting the ability to work, especially in the case of heavy manual occupations, and in contexts where job accommodations are not available (Hogelund and Holm, 2014). This would call for interventions aimed at supporting workers' reallocation to less strenuous jobs, or mandatory requirements for on-the-job accommodations. Second, irrespective of impairment-related barriers to work, or even in the absence of impairment, health deteriorations might reduce the optimal level of labour supply, as individuals update expectations about their remaining lifespan, or because of increased preferences for leisure, or more impatient time preferences (Becker and Mulligan, 1997). Were these the prevailing mechanism, as opposed to impairment acting as a barrier to work, clearly different types of policy interventions would be required.

While labour market policy targets are becoming increasingly integrated across European countries (Turrini *et al.*, 2014), there is a lack of systematic and up to date evidence on the labour market impact of health deteriorations for older workers in Europe. Several works have investigated the issue in specific national settings (see, among others, Riphanan, 1999 and Shurer, 2014 for Germany; García-Gómez *et al.*, 2010 for the UK; Datta Gupta *et al.*, 2011 for Denmark, compared to the US; García-Gómez *et al.* , 2013 for Netherlands; García-Gómez and López, 2006 for Spain). The only work that, to our knowledge, has approached the subject adopting a systematic framework for a set of European countries is García-Gómez (2011) [2]. She studies the impact of health shocks, measured as drop in self-assessed health and onset of illness, in nine European countries between 1994 and 2001, and stresses the role of institutional differences as explanatory mechanisms. However, the time span considered dates back more than a decade, well before the onset of the Great Recession that has posed further challenges to older workers employability (Eichhorst *et al.*, 2013; Johnson, 2012; Newmark and Button, 2014).

This paper contributes to the literature by providing novel and up to date evidence on older workers' labour supply response to health shocks in a larger set of European countries, over the period spanning from 2002 to 2013. This represents a lively time of social security reforms, prompted also by the crisis that hit the

[2] Another contribution is that by Kalwij *et al.* (2005) which however remains rather descriptive in nature, because based on a single wave of data.

continent since 2008[3]. The analysis covers sixteen countries, showcasing different institutional models including the Nordic (Sweden, Denmark, Netherlands); the Anglo-Saxon (England); the Continental (Austria, Germany, France, Belgium, Switzerland); the Mediterranean (Spain, Italy, Greece); and the Eastern European (Czech Republic, Poland, Estonia and Slovenia) one. Nordic countries, in contrast with the Southern ones, are characterized by a strong welfare state, high labour and residential mobility, and relatively weak family ties. Continental countries have welfare and labour market features that are somehow in between Nordic and Southern countries. Finally, Eastern countries are usually grouped together since they all went though the transition from the former Soviet Union to more democratic regimes in the 1990s.

In the study of this subject, overcoming the endogeneity of health with respect to labour market behaviour (Haan and Myck, 2009) represents a major identification challenge. Previous works have adopted a variety of approaches, including variations in self-reported health (García-Gómez, 2011) or satisfaction with health (Riphahn, 1999), latent variables indicators (García-Gómez *et al.*, 2010), road injuries or commuting accidents (Dano, 2005; Halla and Zweimuller, 2013), or acute hospital admissions (García-Gómez *et al.*, 2013). In this work, we follow one approach adopted by a few authors (Smith, 1999, 2005; Coile, 2004; Datta Gupta *et al.*, 2011) which exploits the chance of individuals being hit by an acute health shock, typically myocardial infarction, stroke or cancer. The focus on these specific types of health events is motivated by their severity and still somehow unanticipated onset: even in the case individuals might envisage experiencing a similar health shock at some point in life, for example because of awareness about genetic or behavioural risk factors, uncertainty remains, if not on occurrence, on the timing of potential occurrence. Moreover, although typically self reported in population surveys, the same nature of these health shocks makes their onset less exposed to reporting bias (Baker *et al.*, 2004) than milder or progressive diseases, as well as plausibly less exposed to the chance of justification bias (Benitez-Silva *et al.*, 2004) than measures based on self- assessed health. The studies which have adopted this strategy have considered the case of the US and Denmark; they consistently find a significant reduction in the labour supply of older workers, both men and women, after an acute health shock. Less evidence exists though on socioeconomic heterogeneity in adjustments and on the underlying drivers of response[4].

In what follows, we offer novel comparable evidence for Europe, building on the availability of similar surveys of people aged 50 and older, namely the English Longitudinal Study of Ageing (ELSA) and the Survey of Ageing, Retirement and Health in Europe (SHARE). As illustrated in the following Section 2, both surveys

[3] For example, the Dutch government reformed the disability insurance in 2005; in 2006, both the Netherlands and Denmark raised the statutory retirement age. In Italy a structural reform, entailing a raise in retirement age, was passed in 2011. Germany underwent a pension system reform in 2014, moving from a Pay-As-You-Go (PAYG) to a Defined Contributions (DC) system.

[4] Based on five waves of US Health and Retirement Study (HRS) data, Smith (2005) found major health events to bear an immediate impact on labour market participation (-15%) accompanied by small additional declines in the following years. Also based on the same data, but focusing on couples, Coile (2004) found older male and female workers hit by an acute health shock to be respectively 35% and 23% more likely to leave the labour market, with a stronger adjustment for those reporting a larger decrease in functioning. Based on HRS and Danish register data, Datta Gupta et al. (2009) compared the labour market participation of older workers hit by an acute health shocks in the two different institutional contexts, and found a stronger reduction in participation for US older workers, which they attribute to differential mortality and baseline health differences.

are longitudinal in design and offer a generous sample size, combined with wide topic coverage. In particular, both are remarkably rich in terms of health information collected. With respect to previous works adopting the same strategy, we improve in two respects. First, we focus on the first acute health shock the individual experiences, rather than using any new onset, as the first onset is plausibly more unanticipated than possible subsequent ones. Second, rather than adopting parametric methods, we employ semi-parametric matching techniques to remove bias stemming from observable confounders, as in García-Gómez (2011) and other works cited there, leading to estimates that are less model dependant (Ho *et al.*, 2007). Our empirical strategy builds also on a condition-specific literature, developed in health economics, mostly related to the labour supply adjustment of cancer survivors in the US (Bradley *et al.*, 2002, 2005, 2013; Farley Short *et al.*, 2008; Einesen, 2013; Moran *et al.*, 2011)[5]. In these works, the adopted methodologies include semi-parametric matching techniques used to achieve an appropriate balance in confounders between cancer survivors (often observed from register data) and an adequate set of control individuals, selected from population surveys[6]. Our empirical strategy, presented in Section 3, is based on the comparison between workers hit by the first-ever acute health shock, with observationally identical, in terms of previous health risk and labour market outcomes and prospects, workers, never hit by an acute health shock up to the same point in time. Identification relies on a standard conditional independence assumption, while the longitudinal dimension of data allows controlling for time invariant unobservables too. Implementation is performed through a combination of stratification and propensity score matching techniques.

Estimation results are presented, separately by gender, in Section 4. In terms of outcomes, we consider labour market participation, and the number of hours worked. To gain insight on the mechanisms explaining the observed labour market participation adjustments, we also measure the impact of acute health shocks on physical functioning and mental health, indicative of work ability impairment, and on perceived life expectancy, indicative of other factors that might alter the optimal labour supply choice, irrespective of shock-induced impairment. Also, we investigate the demographic, socioeconomic and disability gradient in labour supply responses. Evidence of heterogeneity across different European countries, and an analysis of the driving institutional differences, are then offered, before conclusions are drawn in section 5.

2. Data

The ELSA and SHARE surveys, both modelled after the US Health and Retirement Study, present extensive similarities with respect to survey design, longitudinal dimension, interview target population, and topics coverage (Taylor et al., 2003; Börsch-Supan and Jürges, 2005). Since 2002, the ELSA collects panel data from a representative sample of the English population aged 50 or older, and younger partners. The ELSA sample

[5] While these studies consider heterogeneous age groups and assess the behavioural response adopting different time frames, spanning from 2 months to 7 years after diagnosis, they generally find a significant reduction in labour supply, both along the intensive and extensive margin. The only exception is Bradley (2002) who found an increase in hours worked and earnings for breast cancer survivors who remain in employment.

[6] Such as the Health and Retirement Study, the Current Population Survey or the Panel Study of Income Dynamics.

is drawn from respondents to the Health Survey for England and covers about 12,000 men and women, interviewed every other year. Since 2004, the SHARE collects cross-national panel data from representative samples of the older population in 17 European countries[7] covering different areas, ranging from Scandinavia (Sweden and Denmark), through Central Europe (Germany, the Netherlands, Belgium, France, Switzerland, Austria) to Mediterranean countries (Italy, Spain, Greece and Portugal) and Eastern European ones (the Czech Republic, Poland, Estonia, Hungary and Slovenia). The sample involves about 85,000 men and women aged 50 or older (and again their younger partners), with interviews again carried out every other year. Table 1 summarises the timing of each survey respective fieldwork: the ELSA currently offers six waves of data collection, spanning from 2002 to 2013, while the SHARE currently offers five waves of data collection, spanning from 2004 to 2013.

Table 1. ELSA and SHARE fieldwork periods and corresponding panel waves

Data collection years	ELSA	SHARE
2002/3	Wave 1	
2004/5	Wave 2	Wave 1
2006/7	Wave 3	Wave 2
2008/9	Wave 4	Wave 3
2010/11	Wave 5	Wave 4
2012/13	Wave 6	Wave 5

In terms of subject areas, both surveys are multidisciplinary in nature and cover, among others, socio-demographic characteristics, housing, physical and mental health, healthcare, cognitive abilities, social networks, formal and informal care, labour market participation, income and assets, expectations, as well as previous life history information. The questionnaires are designed to be broadly comparable, also in terms of questions wording, so that consistent indicators can be built from the two surveys. The combination of generous sample size, ample coverage of different subject areas, detailed set of health and health history information, together with the panel structure, and the similarity of the two surveys, make the ELSA and SHARE uniquely tailored to our research needs and to the implementation of the empirical strategy detailed in the following section.

For our analysis, we use all available waves, with the only exception of the SHARE wave 3, as that collected life history information, with questions on current health and labour market activity being limited with respect to the standard questionnaire administered in other waves[8]. Also, the selection of SHARE countries is limited to those who participated in the survey for at least two waves. Most SHARE countries took

[7] Israel also takes part in the survey. The list refers to all the countries that ever participated in SHARE since 2004, although not all of them took part in each wave.

[8] In the ELSA, life history information was collected in wave 2, on top of the regular current questionnaire. In the following analysis, we do not exploit information collected through the life history interview as that would have entailed a dramatic reduction in sample size, particularly in the case of SHARE.

part in all of waves 1, 2, 4 and 5, with the exception of Greece (only waves 1 and 2), the Czech Republic (only waves 2, 4 and 5), Poland (only waves 2 and 4), Estonia and Slovenia (only waves 4 and 5). The countries covered in the analysis then are England, Sweden, Denmark, the Netherlands, Germany, Belgium, France, Switzerland, Austria, Italy, Spain, Greece, the Czech Republic, Poland, Estonia and Slovenia.

The sample for analysis is restricted to individuals observed for at least two consecutive waves[9], labour market active when observed in the first one, and who have never experienced an acute health shock in life, up to that point in time. Because the outcome concerns labour market activity, the sample is further restricted to individuals aged below the country-specific statutory retirement age when interviewed in the second wave. Overall, these restrictions lead to a sample of 29,870 older workers (of which 11,375 observed in ELSA and 18,495 observed in SHARE) who have never experienced an acute health shock up to the first time interviewed.

The labour market participation indicator is built combining information on whether the individual has been working in the past four weeks (in SHARE) or in the last month (in ELSA)[10] with the self-reported occupational status (including both employed and self-employed). This aims at including as labour market active those individuals who do have a job, despite not having worked in recent weeks, for example because of being on sickness leave. As to the acute health shock life history information, in both surveys, when interviewed for the first time, respondents are asked about past diagnoses of specific conditions, including major health shocks such as cancer, stroke and myocardial infarction. At any following waves, respondents are asked whether any new diagnosis (for the same set of conditions) arose since the previous interview, so that the full lifetime history of onsets can be reconstructed. Differently from ELSA, in SHARE, when first asking about past diagnoses, the answer category for myocardial infarction includes also other heart conditions, such as coronary thrombosis and congestive heart failure. However, follow-up questions that are administered at the subsequent wave are specific to myocardial infarction[11]; this allows disentangling the previous onset of this particular condition from that of the other heart conditions, so that full consistency with the ELSA myocardial infarction indicator is achieved.

Tables 3 and 4 provide details on how comparable indicators have been derived from the two surveys, covering outcome and conditioning variables respectively. The list of conditioning variables includes also gender, age, and time and country dummies, which are not reported in Table 4 because not posing particular comparability issues. Specific adjustments were needed when constructing indicators for limitations in mobility, in Activities of Daily Living (ADL) and in Instrumental Activities of Daily Living (IADL): only the

[9] Except in the case of SHARE, where we consider wave 2 and wave 4 as consecutive waves, because wave 3 entailed a different life history questionnaire.

[10] A question about whether the respondent has a job despite not having been working in the past month, and the reason for that, is only available in ELSA. A comparison of this information with the self-reported occupational status reveals that the vast majority of individuals having a job despite not having been working in the past month do report themselves as labour market active under the question on self-reported occupational status.

[11] SHARE questions PH067_, PH068_, PH072_ and PH073_ ask the respondent if he/she was diagnosed myocardial infarction since the last interview and/or before then.

types of limitation recorded in both surveys, and consistently across waves, have been considered. Also, adjustments were needed when constructing the poor mental health measure, because the list of relevant depressive symptoms[12] collected in the two surveys differs. In ELSA it corresponds to the 8-item Centre of Epidemiological Studies Depression (CES-D) scale (Rasloff, 1977), in SHARE to the 12 items EURO-D (Prince *et al.*, 1999) scale. Most other variables have been derived from identical, up to translation in national languages, or very similar, questions.

Table 3: Outcome variables

Variables	ELSA		SHARE	
	Source question/survey derived variable	Description	Source question/survey derived variable	Description
Worker	WPACT	This variable takes value 1 if: a) the respondent reports to be employee or self-employed and/or, b) declares to have worked in the last month	EP005_ & EP002_	This variable takes value 1 if: a) the respondent reports to be employee or self-employed and/or, b) declares to have worked in the last four weeks
Hours	WPHJOB	Number of hours worked per week	EP013_	Number of hours worked per week
Subjective life expectancy	EXLO80	Reported probability of living up to a specific (age-dependent) threshold age	EX009_	Reported probability to live up to a specific (age-dependent) threshold age
Mobility limitations (#)	HEADLA	Count of 10 reported mobility limitations, including: - walking 100 yards - sitting 2 hours - getting up from chair after sitting long periods - climbing several flights stairs without resting - climbing one flight stairs without resting - stooping kneeling or crouching - reaching or extending arms above shoulder level - pulling or pushing large objects - lifting or carrying weights over 10 pounds - picking up 5p coin from table	PH048_	Count of 10 reported mobility limitations, including: - walking 100 metres - sitting 2 hours - getting up from chair after sitting long periods - climbing several flights stairs without resting - climbing one flight stairs without resting - stooping kneeling or crouching - reaching or extending arms above shoulder level - pulling or pushing large objects - lifting or carrying weights over 10 pounds/5 kilos - picking up a small coin from a table
(poor) Mental health	PSCEDA-PSCEDH	Count of reported depressive symptoms, ranging from 0 to 8 (CES-D scale).	EUROD	Count of reported depressive symptoms, rescaled to range from 0 to 8 to be harmonized with ELSA, as SHARE collects the 12 items EURO-D scale.

[12] Covering emotional experiences such as depression, effort, loss of sleep, happiness, enjoyment, loneliness, sadness and lack of motivation.

Table 4: Conditioning variables

Variables	ELSA		SHARE	
	Source question/survey derived variable	Description	Source question/survey derived variable	Description
Education	EDQUAL	Highest educational qualification, recoded to the 1997 International Standard Classification of Education (ISCED) scale, ranging from 0 (None) to 6 (Tertiary education)	ISCED_R	Highest educational qualification, coded on the basis of the 1997-ISCED scale, ranging from 0 (No education) to 6 (Tertiary education)
Household size	NPEOPLE	Number of household components	HHSIZE	Number of household components
Number of children	NSIBS	Number of children	CH001_	Number of children
Income	TOTINC_BU_S	Couple (or single person) monthly income, equivalised (pounds)	HGTINCV	Couple (or single person) monthly income, equivalised (PPP adjusted Euros)
Home owner	HOTENU	Dummy taking value 1 if the respondent owns outright his/her residence	HO002_, HO013_	Dummy taking value 1 if the respondent owns outright his/her residence
Health related limitations	HEILL, HELIM	Takes value 0 in case of no long standing illnesses, 1 if non-limiting long standing illnesses, 2 if limiting long standing illnesses	PH004_, PH005_	Takes value 0 in case of no long standing illnesses, 1 if non-limiting long standing illnesses, 2 if limiting long standing illnesses
Self-assessed health	HEHELF, HEGENH	Dummy taking value 1 if the respondent reports fair or poor health	SPHUS	Dummy taking value 1 if the respondent reports fair or poor health
Mother dead	MALIVE	Dummy taking value 1 if respondent's mother is dead	DN026_1	Dummy taking value 1 if respondent's mother is dead
Father dead	FALIVE	Dummy taking value 1 if respondent's father is dead	DN026_2	Dummy taking value 1 if respondent's father is dead
High blood pressure	HEDIM	Dummy taking value 1 if ever diagnosed with high blood pressure	PH006_	Dummy taking value 1 if ever diagnosed with high blood pressure
Smoker	HESKA	Dummy taking value 1 if current smoker	BR002_, BR022_	Dummy taking value 1 if current smoker
# of ADL limitations	HEADLB	Count of up to 6 ADL limitations[a]	PH049_	Count of up to 6 ADL limitations[a]
# of IADL limitations	HEADLB	Count of up to 3 IADL limitations[b]	PH049_	Count of up to 3 IADL limitations[b]
Earnings	EMPINC_R_S, SEINC_R_S	Income from employment and self-employment (pounds per month)	YDIPV, YINDV	Income from employment and self-employment (PPP adjusted monthly Euros)
Expects early retirement due to health	EXHLIM	Dummy taking value 1 if the reported probability of retiring before statutory age retirement age because of health problem is higher than 50%	EP037_	Dummy taking value 1 if the reported probability of retiring before statutory age retirement age because of health problem is higher than 50%

Notes: The full set of explanatory variables includes also lagged outcome variables (see Table 3 for detail on those).

[a] The set of ADL limitatations includes: dressing, bathing or showering, eating such as cutting up food, getting in and out of bed, walking across a room and using the toilet.

[b] The set of IADL limitatations includes: using a map, doing work around the house/garden and managing money, such as paying bills and keeping track of expenses.

3. Empirical strategy

3.1 Design

The identification strategy exploits innovations in health induced by the first onset of an acute health shock, namely the first onset of cancer, myocardial infarction or stroke. This is regarded as unanticipated in the sense that uncertainty arises, conditionally on one own health risk, both with respect to the actual occurrence of the health shock, and with respect to the timing of occurrence. In the sample for analysis, N individuals, indexed by i, are observed for two subsequent points in time, t-1 and t. The acute health shock status is denoted by the binary indicator S_i^t, where $S_i^t=0$ if i has never experienced an acute health shock up to time t, and $S_i^t=1$ if i has experienced the first acute health shock by t. The onset of an acute health shock is measured by individuals' entry into the $S_i^t=1$state.

In order to remove avoidable bias stemming from observed confounders, denoted by the vector X_i^{t-1}, that is variables affecting both the acute health shock risk and labour market behaviour (such as prior health conditions and labour market outcomes, behavioural risk factors, demographic and socioeconomic characteristics) we adopt a *selection on observables* identification approach. As in a dynamic treatment assignment setting (Sianesi, 2004), at any point in time t, we compare

- the $T \in N$ subset of individuals', indexed by j, just hit by a first acute health shock, regarded as the treatment group: $T=(j \in N: S_j^{t-1}=0, S_j^t=1)$
- a $C \in N$ subset of individuals, appropriately selected from the subset $K \in N$ of those who have not been hit by the acute health shock up to then, regarded as the potential controls: $K=(k \in N: S_k^{t-1}=0, S_k^t=0)$

The selection of an appropriate subset $C \in K$ aims at limiting the comparison to individuals observationally identical to those observed in T. This adjustment removes the potential endogeneity bias stemming from compositional differences between T and K, for example the upward bias that would result in the plausible case individuals in T displayed weaker labour market attachment since before the shock. This identification approach relies on the standard, yet untestable, conditional independence assumption (CIA) that conditioning on observed confounders is enough to regard as random the chance of experiencing (or not) an acute health shock at the particular point in time t. Denoting the outcome of interest with O^t:

$$O^t \perp S^t \mid X^{t-1}.$$

Undoubtedly, the soundness of CIA rests crucially on the available set of information on potential confounders. Given the wide scope of comparable socio-demographic, health and labour market information available in ELSA and SHARE, CIA does not seem implausible in our setting. In more detail, we have the chance of selecting the set C with respect to country, demographic characteristics (age, gender, household size,

the number of children, partnership status), socio-economic status (education, equivalent income, homeownership), labour market variables (hours worked per week, earnings), and a generous battery of health risk indicators. These capture not only underlying health trajectories (self-assessed health, whether the individual reports limitations in activities because of health, specific counts of mobility, ADL and IADL limitations) but also genetic (whether the father and the mother are dead), behavioural (smoking) and other risk factors (high blood pressure). Finally, an indicator of whether the individual expects to retire before the statutory age because of health allows capturing further potential unobserved health conditions/trends. Besides, time invariant unobservables, which reasonably affect both current and lagged outcomes, can be controlled for through the inclusion of lagged outcomes in the set of conditioning variables (Wooldridge, 2000). Other yet uncovered time-varying confounders are accounted to the extent they are correlated with observed confounders: this for example could be the case for unobserved time preferences captured by correlated information on smoking behaviour (Peretti-Watel *et al.*, 2013.).

Under CIA, the Average Treatment effect on the Treated (ATT) can be estimated by integrating, over the X_j^{t-1} distribution

$$ATT = E(O_j^t - O_k^t \mid X_j^{t-1}=x, X_k^{t-1}=x)$$

In the case of the labour market participation outcome, given the sample restriction to those labour market active in *t-1*, this actually corresponds to a difference in difference estimator.

3.2 Implementation

Table 5 reports, for each survey and pair of observational points (waves), the size of T and K. Overall, 637 individuals experience a first-ever acute health shock between the two observational points. Among them, about half experience the first onset of cancer, while about 30% and 20% experience the first onset of myocardial infarction and stroke respectively. Women hit by a first acute health shock appear relatively more likely to experience cancer (66%) than cardio vascular diseases (CVD)(33%), while the opposite occurs for men (37% versus 63% respectively). The limited number of treated individuals, reflecting the relatively low incidence of acute health shocks in the observed population, is not out of line with previous studies. The very rich set of potential controls appears promising with respect to the chance of achieving a good balance in the distribution of potential confounders: on average, for each treated individual, about 50 potential control individuals are available.

Descriptive statistics for observed confounders are reported in Table 6. One the one hand, the overlap in variables distribution between treated and potential control individuals is indicative of common support, a necessary requirement for the success of the outlined empirical strategy. On the other hand, non ignorable

differences in sample means emerge under both surveys, calling for appropriate distributional adjustments of the comparison group.

Table 5. Sample numbers: treated and potential control individuals

ELSA				SHARE			
t-1	*t*	# T	# K	*t-1*	*t*	# T	# K
wave 1	wave 2	44	2,600	wave 1	wave 2	101	4,561
wave 2	wave 3	25	1,922	wave 2	wave 4	134	4,185
wave 3	wave 4	37	2,280	wave 4	wave 5	207	9,307
wave 4	wave 5	52	2,546				
wave 5	wave 6	37	1,832				
		195	11,180			442	18,053

Source: ELSA, waves 1-6; SHARE, waves 1, 2, 4, 5.

Table 6. Sample descriptive statistics (unweighted) for conditioning covariates

	ELSA				SHARE			
	T		K		T		K	
	Mean	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*
Age (t-1)	58.03	3.43	56.71	3.76	59.20	4.32	57.70	4.07
Male	0.66	0.47	0.55	0.50	0.58	0.49	0.48	0.50
Education	5.44	1.68	5.82	1.83	6.77	2.17	6.78	2.23
Household size (t-1)	2.54	0.96	2.56	1.04	2.38	1.09	2.58	1.12
Number of children (t-1)	2.36	2.26	2.17	1.86	1.98	1.27	2.10	1.21
Income (t-1)	1,853	2,038	1,861	1,449	2,723	2,620	2,825	3,002
Home owner (t-1)	0.45	0.50	0.39	0.49	0.30	0.46	0.38	0.48
Health-related limitations (t-1)	0.76	0.83	0.54	0.76	0.74	0.87	0.52	0.79
Self assesses bad health (t-1)	0.03	0.18	0.02	0.12	0.03	0.18	0.02	0.13
Mother dead (t-1)	0.62	0.48	0.53	0.50	0.57	0.50	0.49	0.50
Father dead (t-1)	0.86	0.33	0.75	0.43	0.79	0.40	0.75	0.43
High blood pressure (t-1)	0.39	0.49	0.27	0.44	0.26	0.44	0.21	0.41
Smoker (t-1)	0.24	0.43	0.18	0.38	0.41	0.49	0.25	0.43
(Poor) Mental health (t-1)	1.23	1.69	1.13	1.71	1.25	1.24	1.26	1.41
# of Mobility limitations (t-1)	1.06	1.74	0.69	0.135	0.70	1.43	0.57	1.21
# of IADL limitations (t-1)	0.06	0.24	0.05	0.23	0.07	0.30	0.04	0.22
# of ADL limitations (t-1)	0.16	0.51	0.08	0.42	0.05	0.36	0.04	0.29
Hours (t-1)	36.56	15.28	36.21	14.07	37.90	13.55	36.91	13.86
Earnings (t-1)	1,298	1,157	1,359	1393	1,703	2,140	1,735	2,018
Exp. early ret. due to health(t-1)	0.28	0.45	0.25	0.43	0.30	0.46	0.26	0.44

Source: ELSA, waves 1-6; SHARE, waves 1, 2, 4, 5.

Implementation of the adjustment is based on semi-parametric matching methods, namely stratification combined with propensity score matching (Rosenbaum and Rubin, 1983). In a first step, we stratify the sample based on survey, in order to account for possible remaining specificities in variables definition, and on gender, in order to account for gender specific health risk (Vlassoff, 2007). In the case of SHARE, the sample number allows a finer stratification by time of first observational point (i.e. *t-1* corresponding to wave 1, 2 or 4), while in ELSA, due to the lower sample size, this is not possible and time is controlled for in the following step. The resulting strata, and their sizes, are reported in the first two columns of Table 7.

Table 7: Observed confounders adjustments

Strata	Size	Stratum specific additional[a] covariates used in propensity score estimation	Additional exact matching variables
1 ELSA, women, all waves	5,794	wave	education, wave
2 ELSA, men, all waves	5,912	wave	education, wave
3 SHARE, women, wave 1 as *t-1*	2.111	country	education, country
4 SHARE, men, wave 1 as *t-1*	2,285	country	education, country
5 SHARE, women, wave 2 as *t-1*	2,054	country	education, country
6 SHARE, men, wave 2 as *t-1*	1,924	country	education, country
7 SHARE, women, wave 4 as *t-1*	4,425	country	education, country
8 SHARE, men, wave 5 as *t-1*	4, 068	country	education, country

Source: ELSA, waves 1-6; SHARE, waves 1, 2, 4, 5.

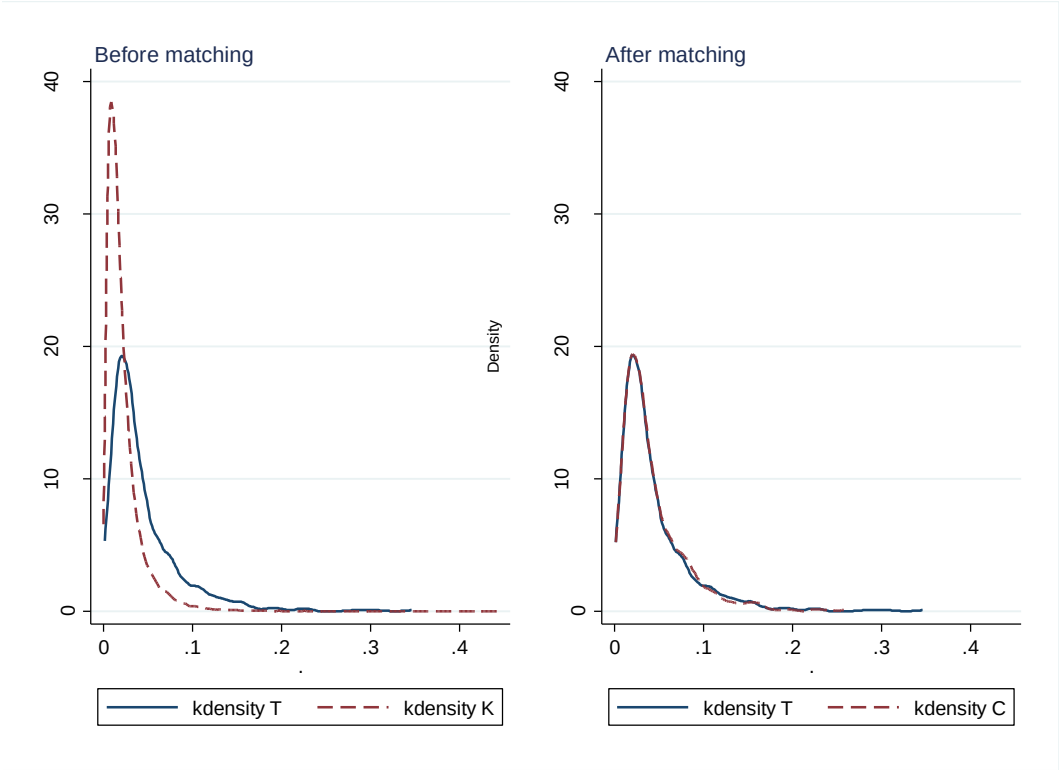
Notes: Covariates used in each stratum Propensity Score estimation include also all those listed in Table 6.

Within each stratum we then estimate the propensity score, i.e. the conditional probability of experiencing a first acute health shock between the two observational points, to be then used a balancing score. Estimation is based on a probit specification, with covariates including, on top of all the variables listed in Table 6, also a few stratum-specific variables, as indicated in the third column of Table 7. Time-varying covariates are measured as of the first (pre-shock) observational point. Estimation results generally point at age, self-assessed health, health-related limitations, father's and mother's longevity, high blood pressure and smoking as the most important predictors of the first acute health shock onset.

After propensity score estimation, we apply a nearest neighbour matching algorithm. The algorithm selects, for each treated individual, the closest control, i.e. the one that minimizes the absolute distance in estimated propensity scores. The choice of the nearest neighbour is bounded so that each matched pair of individuals belongs not only to the same stratum, but is also identical with respect to a few confounders, on which exact matching is performed. These are wave (in ELSA only, where wave wasn't used as stratification variable in the first step), country (in SHARE only, for the same reason), and a further dummy variable indicating whether the educational qualification is above the country-specific median. In this way, the overall algorithm allows exact matching on country (to account for institutional and cultural differences), time (to

account for the economic cycle, given the relatively long time period covered), gender and education (to account for remarkable gender and educational differences in labour market attachment and trajectories[13]) to take precedence over the propensity score distance minimization. Matching is performed with replacement, meaning that the same potential control individual could serve as a nearest neighbour matched control for more than a single treated individual. However, replacement involves only the 3.6% of matched pairs.

Figure 1. Estimated propensity scores distributions, treated and controls



Source: ELSA, waves 1-6; SHARE, waves 1, 2, 4, 5.

The generous set of available potential controls makes it possible to achieve a satisfactory balancing of conditioning covariates. To gauge the success of adjustment, Figure 1 displays the distributions of estimated propensity scores for treated (continuous line) and potential control (dashed line) individuals before matching (in the left panel), and that achieved after matching for treated (continuous line) and matched control (dashed line) individuals. While some overlap in distributions is visible since before matching, post-matching distributions display a remarkable overlap, which holds when considering different country, gender and educational groups (corresponding graphs are reported in Appendix Figures A1 and A2). Variable-specific balancing results are reported in Table 8. T-test results point in favour of not rejecting the null hypothesis of no difference in means between treated and matched controls for each conditioning variable, while the size of

[13] In our sample, LMP rates are 71% for men and 63% for women. LMP is strongly affected also by education. The labour market participation rate for low educated women is 57% and rises to 74% in the case of high educated women; the corresponding figures for men are 66% for the low educated and 77% for high educated men.

variable-specific standardised percentage bias is generally minor[14]. Treated and matched control individuals appear reassuringly similar in the perceived chance of retiring before the statutory age because of health, as reported in the year prior to the potential shock occurrence. In other words, once potential confounders are controlled for, no statistically significant difference is registered in the expectations of those who will be soon after hit by a severe health shock and those who won't. The corresponding standardised percentage bias is trivial, and remains so when balance is assessed on gender specific subgroups[15], supporting success of the adjustment procedure in removing the bias stemming from potential confounders. Additional evidence on the achieved balance is reported in the Appendix Figure A3.

Table 8. Achieved balancing of conditioning variables

Variable	Mean:		% bias	P-value
	Treated	Matched controls		
Age	58.8	58.7	2.5	0.658
Education (ISCED)	3.2	3.1	4.7	0.405
Household size (t-1)	2.4	2.5	-1.9	0.734
Number of children (t-1)	2.1	2.1	1.2	0.829
Income (t-1)	22,806	23,162	-1.2	0.826
Home owner (t-1)	0.345	0.325	4.3	0.441
Health-related limitations (t-1)	0.733	0.698	4.1	0.47
Self assesses bad health (t-1)	0.034	0.02	8.6	0.123
Mother dead (t-1)	0.585	0.584	0.3	0.955
Father dead (t-1)	0.812	0.793	4.7	0.399
High Blood Pressure (t-1)	0.306	0.297	2.1	0.714
Smoker (t-1)	0.363	0.37	-1.6	0.771
(Poor) Mental health (t-1)	1.248	1.2	4.7	0.405
# of Mobility limitations (t-1)	0.815	0.7	8	0.156
# of IADL (t-1)	0.067	0.053	5.4	0.333
# of ADL (t-1)	0.085	0.053	8.5	0.127
Hours (t-1)	37.6	37.9	-2.7	0.634
Earnings (t-1)	1,320.60	1,343.60	-1.3	0.819
Exp. early ret. due to health (t-1)	0.3	0.29	2.1	0.713

Source: ELSA, waves 1-6; SHARE, waves 1, 2, 4, 5.
Notes: The standardised % bias is measured as the difference of the sample means in the treated and non-treated (full or matched) sub-samples as a percentage of the square root of the average of the sample variances in the treated and potential controls groups.

[14] Given the limited sample size, the standardized percent bias might be regarded as a more suited indicator of the achieved balance than the t-test, which looses power in small samples.
[15] The P-values computed separately for men and women are .859 and .677 respectively; and the standardised percentage bias amounts to 1.2 and 3.2 respectively for men and women.

5. Results

Given the remarkable gender difference observed in labour market attachment and trajectories at older ages (see e.g. Aaberge *et al.* 1999), we present results separately for men and women. Table 8 reports the estimated ATT for labour market participation (LMP) and hours worked conditional on working. The onset of a first acute health shock results in a significant reduction in the LMP of older European workers. Consistently with findings from previous studies, the behavioural response is similar in size across genders, or slightly higher for women (10 and 13 percentage points for men and women respectively). In relative terms, this broadly corresponds to doubling the baseline labour market exit risk (i.e. 10.2% and 10.6% respectively).

Table 8. Labour market participation and conditional hours worked (per week)

	MEN				WOMEN			
	Obs.	ATT	S.E.	P-val.	Obs.	ATT	S.E.	P-val.
LMP	376	-0.101	0.026	0.000	261	-0.130	0.031	0.000
C. HOURS	233	4.075	1.272	0.001	149	0.974	1.732	0.575

Source: ELSA, waves 1-6; SHARE, waves 1, 2, 4, 5.

A significant difference across genders does arise though along the intensive margin. Men who experience an acute health shock appear to increase hours worked, by almost one additional hour per working day. On the contrary, no change in conditional hours is registered for women. Men's increase in hours[16] could reflect a selection mechanism, as the effect on hours is measured only on those who remain in work. The increase in hours could indicate that it is the men more attached to the labour market, and motivated to catch up after the health shock, who keep on working. This hypothesis appears supported when computing the ATT separately on men who worked full- time before the shock and on the presumably less labour market attached ones who worked part-time before the shock. The average increase in men's working hours reported in Table 8 results entirely driven by full-timers. Full-timers' ATT amounts to 8.3 hours more worked per week; on the contrary, men previously working part-time register a significant reduction in hours, amounting to 7.7 hours per week[17].

[16] An increase in working hours was also found by Bradley et al. (2002), based on HRS data, for female breast cancer's survivors aged 51 to 61. The authors tested for possible underlying explanatory selection mechanisms but did not find evidence in support of selection bias driving the results, and concluded in favor of a causal positive impact of health shocks on hours worked, possibly explained by health insurance funding needs.

[17] The corresponding P-values are .0004 for the ATT on full-timers and .0213 for that on part-timers.

Table 9. Heterogeneity in LMP responses

	MEN			WOMEN		
	Obs.	ATT	P-val.	Obs.	ATT	P-val.
Marital status						
No partner	75	-0.187	0.002	63	-0.190	0.006
Has a partner	301	-0.080	0.005	198	-0.112	0.002
Household size						
Single component	47	-0.191	0.001	40	-0.150	0.110
Household size >1	329	-0.088	0.001	221	-0.127	0.000
Mobility limitations						
No increase after shock	263	-0.068	0.022	160	-0.119	0.003
Increase after shock	113	-0.177	0.000	101	-0.148	0.003
Education						
Low EDU	231	-0.117	0.000	157	-0.115	0.006
High EDU	145	-0.076	0.048	104	-0.154	0.000
Household income						
Above median	190	-0.100	0.004	125	-0.176	0.000
Below median	186	-0.102	0.007	136	-0.088	0.051
Occupational status						
Managerial	116	-0.086	0.049	61	-0.197	0.002
Intermediate	72	-0.028	0.658	80	-0.137	0.021
Routine	162	-0.136	0.000	101	-0.079	0.117

Source: ELSA, waves 1-6; SHARE, waves 1, 2, 4, 5.
Notes: Descriptive statistics for heterogeneity variables not included in Table 6 are reported in Appendix Table A1.

Table 9 reports ATT in LMP computed on specific subgroups[18]. First, we consider household composition. Those living with a partner before the shock onset display smaller LMP reductions than single individuals; a qualitatively similar picture emerges when considering individuals living with other household members, as opposed to those living in single-person households. Such differences, although not statistically significant under the available sample size, point against a substitution in household members' labour supply. Rather, they seems suggestive of partners/household members representing a source of additional financial need that discourages labour market exit, and/or possibly acting as providers of the kind of support that allows remaining in the labour market.

Consistently with findings from Coile (2004), the extent to which acute health shocks result in physical impairment, measured by increases in the number of reported mobility difficulties, appears relevant to labour

[18] The available sample size severely limits the chance of running the same heterogeneity analysis on conditional hours worked.

supply adjustments, particularly in the case of men. The size of ATT computed on men who experience an increase in mobility limitations after the shock is almost three times larger than for those who don't, while more nuanced differences between the two groups arise in the case of women.

Gender differences again emerge when considering heterogeneity by socio-economic (SES) characteristics. Low educated (i.e. those whose highest qualification is below or equal to the country specific median) men appear more likely than high educated (i.e. those whose highest qualification is above the country specific median) men to exit the labour market after an acute health shock. A similar educational gradient has been previously found for cancer survivors in Scandinavian countries by Heinesen *et al.* (2013) and Taskila-Abrandt *et al.*, (2004) and appears coherent with predictions from standard life-cycle models. Low educated (or low skilled) workers typically exit earlier from the labour market because of a higher disutility of work and because generally employed in more physically demanding or `hazardous or arduous' jobs that can more hardly be adapted to accommodate impairments (Krause *et al.*, 1997 and Blekesaune and Solem, 2005). However, an inverse educational gradient is observed for women: in their case, the high educated display a larger reduction, with respect to the low educated, in LMP[19]. While generally older labour market active women constitute quite a selected group, their LMP is often a household level decision, with women representing the second earner and displaying a more elastic labour supply (Heckmann and Macurdy, 1980; Blundell and Walker, 1986). High educated women are more likely found in higher income households; for this reason, they plausibly face lower financial constraints than low educated women, for which financial need might limit labour market exit. This interpretation seems confirmed when considering heterogeneity by income level: results suggest that women's response reflects a preferred reduction in LMP that become apparent under favourable financial resources. A broadly consistent gender difference emerges when considering LMP responses by type of occupation. Larger LMP adjustments are found for men in routine occupations; however, in the case of women, the largest response in LMP is found for those on managerial, followed by intermediate occupations.

We next consider the effect of acute health shocks on other outcomes, which might be indicative of the underlying mechanisms of adjustment and of the extent to which these may differ between genders. Results are reported in Table 10. First, we investigate whether the first acute health shock experienced affects perceived life expectancy. A reduction in perceived life expectancy could in fact lead to a desired reduction in labour supply irrespective of the possible shock-induced impairment acting as a barrier to work. Indeed, a significant contraction in subjective survival probability, amounting to about 12% of its baseline value, is observed for both men and women, with the only exception of women who do not experience an increase in physical limitations after the shock occurs.

[19] As will become evident in Table 10, the largest LMP adjustment found for high educated women is not explained by them experiencing more severe shocks.

Table 10. ATT, other outcome variables

	MEN			WOMEN		
	Obs.	ATT	P-val.	Obs.	ATT	P-val.
Life expectancy	275	-7.960	0.000	187	-8.566	0.001
Life expectancy, by mobility limitations						
No increase after shock	200	-5.400	0.018	123	-2.634	0.349
Increase after shock	75	-14.787	0.001	64	-19.969	0.000
Impairment						
# mobility limitations	376	0.689	0.000	260	0.692	0.000
(Poor) Mental health	363	0.541	0.000	255	0.684	0.000
Impairment, by education:						
# of mobility limitations						
Low EDU	231	0.710	0.000	157	1.064	0.000
High EDU	145	0.655	0.000	103	0.126	0.259
(Bad) Mental health						
Low EDU	223	0.614	0.000	153	0.795	0.000
High EDU	140	0.424	0.004	102	0.516	0.035

Source: ELSA, waves 1-6; SHARE, waves 1, 2, 4, 5.

Second, we compute the ATT for indicators of impairment potentially limiting the ability to work. As the standard 'ability to work' variable might be more exposed to justification bias, we consider as alternative indicators the number of mobility-related limitations and poor mental health, which has been shown to play a role in explaining labour market participation (Frijters et al., 2010). On average, acute health shocks cause significant reductions in both physical mobility and mental health, similar in size across genders. This evidence seems against the possibility that gender differences in LMP adjustments are driven by gender differential severity in shock-induced impairments.

For both genders, the low educated appear more severely impaired by the health shock onset, with respect to the high educated, both in terms of mobility limitations and mental health. These results complement those on the opposite educational gradient in LMP found for men and women in Table 9. The negative educational gradient observed for men in both LMP response and impairment onset suggests that impairment might act as the primary mechanisms explaining men's labour supply adjustment after an acute health shock. On the contrary, the evidence that low educated women display a lower LMP response than high educated women, despite experiencing stronger impairments, hints again at women's response being driven more by a desired reduction in labour supply, which emerges under non-binding financial constraints,

than by impairments hampering return to work. Indeed, low educated older women are often employed in clerical occupations, rather than in physically demanding ones.

The fact that stronger reductions in subjective life expectancy are observed for those who experience shock-induced physical impairment, with respect to those who don't, limits the possibility of disentangling the role of impairment-related barriers to a desired return to work, from that of modified optimal decisions (that could be driven, among other factors, by a perceived reduction in life expectancy). However, further insight can be gained analysing how the 'disability gap' in LMP response varies by individuals' characteristics deemed indicative of preferences and financial constraints. The 'disability gap', denoted by $\Delta^D ATT$, is defined as the difference in ATT for LMP computed on those who experience an increase in physical limitations after the shock onset and the ATT computed on those who don't. A higher disability gap can be regarded as indicative of the relative importance of shock-induced impairment in limiting return to work even under no desire for reducing labour supply. Results are reported in Table 11.

Table 11. Disability gap in labour market participation, by demographic and socio-economic characteristics

	MEN			WOMEN		
	Obs.	$\Delta^D ATT$	P-val.	Obs.	$\Delta^D ATT$	P-val.
All	376	0.109	0.050	261	0.029	0.650
Marital status						
No partner	75	0.068	0.587	63	-0.006	0.965
Has partner	301	0.113	0.062	198	0.029	0.693
Household size						
Single component	47	0.089	0.596	40	0.200	0.281
Household size >1	329	0.109	0.065	221	-0.006	0.930
Education						
Low EDU	231	0.129	0.077	157	0.077	0.357
High EDU	145	0.068	0.426	104	-0.035	0.734
Occupational status						
Managerial	116	-0.026	0.794	61	-0.056	0.674
Intermediate	72	0.221	0.103	80	0.008	0.948
Routine	162	0.147	0.070	101	0.094	0.350
Household income						
Above median	190	0.119	0.122	125	-0.086	0.367
Below median	186	0.098	0.228	136	0.153	0.089

Source: ELSA, waves 1-6; SHARE, waves 1, 2, 4, 5. Notes: P-values refer to the t-test on the equality of ATT computed on the shock-impaired versus that computed on the non shock-impaired.

Significant disability gaps are more likely found for men than for women, suggesting again that men's observed adjustments are more likely driven by impairment hampering a desired return to work, than women's. In more detail, significant disability gaps in LMP response arise for men living with a cohabiting partner and those living with other household members (both of which, in Table 8, display lower LMP reductions than single/single-person-household men). This could hint at the existence of impairment-related

barriers clashing with their stronger labour market attachment, possibly motivated by higher financial needs stemming from the presence of other household members. Significant disability gaps arise also for low educated men and men working in routine occupation, both presumably employed in more physically demanding jobs. Women's LMP adjustment to the onset of acute health shocks seem less responsive to shock-induced impairment, supporting the idea that preferences for leisure and financial constraints might play a bigger role in women's adjustments. The only significant disability gap is registered for women living in lower income households, for which the financial need to keep on working might clash with physical limitations impeding to do so.

5.1 The role of institutions

Beyond the heterogeneities analysed so far, institutions might play a role in shaping older workers' adjustments to acute health shocks. For example, previous work by Garcìa-Gomez (2011) shows how cross-country differences in labour supply responses partly reflect the emphasis that each European country places on the potentially conflicting targets of protecting disabled individuals' income and providing incentives to their labour market inclusion. Also in our setting, the large set of countries covered allows to investigate international differences in LMP adjustments, although the available sample size does not permit to produce reliable country specific estimates. Still, the sixteen countries we consider can be grouped into meaningful 'institutional' or 'regimes-based' aggregates (e.g. as in Attanasio et al., 2014), broadly reflecting within-group homogeneity in cultural attitudes, social environment, and labour and welfare institutions, in particular those regarded as most relevant to older workers' labour supply in Europe. We consider five groups of countries: the Nordic (Sweden, Denmark and the Netherlands), England (representative of the Anglo-Saxon model), the Continental (Austria, Germany, France, Switzerland and Belgium), the Mediterranean (Spain, Italy and Greece) and the Eastern European (the Czech Republic, Poland, Slovenia and Estonia) ones.

This aggregation also reflects relative homogeneity in three summary measures of relevant institutional features: namely the generosity of disability programs, the existence of in-job protection and labour market tightness. These institutional features capture contrasting forces: the generosity of disability programs might encourage labour market exit after an acute health shock. On the other hand, in-job protection regulations are expected to help retaining disabled workers in their jobs, while tight labour markets might favour disabled workers' reallocation to more appropriate jobs, via higher job mobility. Country-specific figures for these institutional indicators are reported in Table 12. The generosity of disability programs is measured in terms of accessibility, i.e. the disability recipients' rate. In-job protection is measured by the existence of regulations for mandatory quota (i.e., obligations for firms to employ a quota of disabled workers). Labour market tightness is measured by the hiring rate in the age group 55-64, defined as the ratio of employees aged 55-64 with a job tenure of less than one year, over the total number of employees aged 54-63 a year before.

Table 12 Institutional variables

Country	Hiring rate age 55-64[1]	Disability recipients rate[2]	Mandatory quotas on hiring[3]
England	7.0	4.9	No
Nordic			
Sweden	6.6	9.9	No
Netherlands	2.5	8.7	Yes
Denmark	10.2	7.9	No
Continental			
Austria	5.0	5.9	Yes
Germany	4.9	4.4	Yes
France	3.9	3.8	Yes
Switzerland	4.2	-	No
Belgium	2.9	5.6	Yes
Mediterranean			
Spain	7.2	3.8	Yes
Italy	3.8	5.5	Yes
Greece	4.9	2.2	Yes
Eastern			
Czech Republic	7.6	6.9	Yes
Poland	8.5	5.6	Yes
Slovenia	3.0	4.7	Yes
Estonia	7.8	6.8	No

Note: (1) Hiring rate: Employees aged 55-64 with job tenure of less than one year as a percentage of total employees aged 54-63 a year before in 2007. *Source*: OECD estimations from national labour force surveys, EU-LFS, from the *OECD Earnings Distribution database* and the *OECD Education database.* (2) Disability recipient's rate: Recipients of disability-related benefits aged 25-64 as a percentage of total population aged 25-64 in 2005. Source: "Study of compilation of disability statistical data from the administrative registers of the member states", Aplica & Cesep & European Centre, 2007. (3) Mandatory quotas on hiring: Obligations to employ a quota of disable workers. Source: EU, Compendium – Good practise in employment of people with disabilities 1999; Fuchs M. (2014) Quota system for disabled persons: Parameters, Aspects, Effectivity. European Centre Policy Brief.

Based on these indicators, four combinations of institutional features can be identified. England is characterized by a tight labour market (i.e. high hiring rate and non-existence of mandatory quota) and a relatively low disability recipients' rate. Also the Nordic countries present tight labour markets, (with the only exception of the Netherlands) but they all exhibit very generous disability programs. Continental and Mediterranean countries are quite similar: both groups present rigid labour markets displaying low hiring rates[20] and the existence of mandatory quotas, combined with low disability recipients rates. Finally, Eastern countries combine relatively high job hiring rates with generous disability programs, as the Nordic countries,

[20] The high hiring rate in Spain is presumably due more to the large use of temporary contracts than to high job mobility (Horwitz and Myant, 2015).

but present widespread provision for mandatory quota. Table 13 reports the LMP ATT computed on these different country aggregates.

Table 13. ATT by country groupings, population weighed

	ALL			MEN			WOMEN		
	Obs.	ATT	P-val.	Obs.	ATT	P-val.	Obs.	ATT	P-val.
ENGLAND	360	-0.119	0.008	228	-0.109	0.051	132	-0.139	0.062
NORDIC	326	-0.142	0.010	180	-0.098	0.061	146	-0.208	0.052
CONTINENTAL	326	-0.066	0.433	176	0.095	0.438	150	-0.181	0.087
MEDITERRANEAN	104	-0.057	0.577	70	0.043	0.390	34	-0.339	0.167
EASTERN	124	-0.595	0.000	84	-0.635	0.000	20	-	-

Source: ELSA, waves 1-6; SHARE, waves 1, 2, 4, 5.

While in all areas the LMP reduction is stronger for women than for men, striking differences arise across country aggregates. The Eastern countries display the largest[21] reduction in LMP (59%, corresponding to about 6 times the baseline exit rate), followed by the Nordic countries (14%, corresponding to about 1.5 times the baseline exit rate) and England (12%, corresponding to about doubling the baseline exit rate). On the contrary, no significant reduction in labour market participation is registered in Continental and Mediterranean countries. These heterogeneous effects appear consistent with cross-countries differences in labour market and welfare arrangements. In Nordic countries, the combination of very generous of disability programs, labour market flexibility and absence of in-job protection facilitates labour market exits. In England the effect of labour market tightness is attenuated by provision for less generous disability benefit. Continental and Mediterranean countries offer a combination of low hiring rates, low disability recipients rates and in-job protections, all of which favour the LMP of workers after an acute health shock. In Eastern countries, the effect of wide disability programs accessibility is enhanced by the relatively high hiring rate, seemingly overcoming the retention effect of mandatory quotas. Still, the dramatic reduction in LMP registered in these countries, calls for particular policy attention.

While cross-countries heterogeneities that have emerged so far appear generally plausible with respect to the role of institutions (at the least in terms of the institutional indicators considered here), the next step of analysis entails an attempt to disentangle the particular contribution of each institutional aspect. To this end we run, on the sample of treated and matched controls, a LMP probit regression on the three institutional

[21] The dramatic increase in exit registered in Easter European countries though, is mostly driven by Poland. Excluding this country, the reduction in LMP in Eastern countries amounts to -.245.

variables, the treatment dummy, plus interactions between the treatment dummy and institutional variables. Table 14 presents the probit marginal effects for the interaction terms, capturing the role of each institutional feature in explaining the adjustment of individuals hit by a first acute health shock. We consider different model specifications, including each institutional variable in turn (columns 1 to 3), and then all of them (column 4). When considered in turn, each institutional indicator displays a significant marginal effect, of the expected sign. Higher hiring rates and higher disability receipt rates reduce the probability of remaining in employment, while the existence of mandatory quotas increases it. However, when including all three institutional indicators, disability program generosity remains the only one that retains significance, hinting at a prominent role played by replacement incomes accessibility in explaining observed cross-country differences.

Table 14. The role of Institutions: probit marginal effects

	(1)		(2)		(3)		(4)	
	Marginal effect	S.E.	Marginal effect	S.E	Marginal effect	S.E	Marginal effect	S.E
T*Hiring rate age 55-64	-0.021**	0.010					-0.021	0.015
T*Disability recipients rate			-0.022*	0.011			-0.023**	0.011
T*Quota vs no quota					0.070*	0.034	0.013	0.060

Source: ELSA, waves 1-6; SHARE, waves 1, 2, 4, 5.
Notes: Switzerland not included, due to lack of comparable data on disability benefit receipt rate; * 10% significance; ** 5% significance.

6. Conclusions

The current European social security reform agenda aims at fostering older and disabled workers' inclusion in the labour market. In this respect, rigorous evidence on how older workers respond to health deteriorations, and on the mechanisms lying behind the observed adjustments, is required if effective policy interventions are to be devised. Although the issue of labour supply responses to health deteriorations represents a previously studied subject, so far up to date and cross-country comparable evidence for older workers in Europe was lacking. This paper has offered a response to such research needs, providing novel evidence on workers observed over the past decade, including more than five years before the onset of the Great Recession, and five years after, in a set of 16 European countries. The analysis has built on the availability of two comparable panel surveys of the older population in Europe, ELSA and SHARE, which offer an extremely rich set of health and health history information. As a few previous authors, we've exploited the onset of acute health conditions, less subject to justification and recall biases, as a source of unanticipated variation in health. With respect to those works, which covered mostly the US, we've improved the empirical strategy by focussing on the first health shock onset, less exposed to endogeneity bias than the following ones, and adopting semi-

parametric methods which reduce the scope for model-dependent estimates. Also, we've deepened the investigation of explanatory mechanisms, relevant to effective policy design, by studying heterogeneities in observed adjustments and considering other meaningful outcomes, such as perceived life expectancy and physical and mental impairment.

Still, the analysis presents a few potential limitations. First, since we do not observe individuals who die as a consequence of the acute health shock, and also those who quit the panel surveys because of an health deterioration, our results might be biased by differential mortality and attrition. However, the survivors and non-attritors we observed can plausibly be considered as in better health conditions, with respect to the deceased and the health-related attritors that we do not observe. Hence our results can be regarded as a lower bound to the effect, and our estimates as conservative, presenting, if anything, a downward bias. A second limitation concerns the short time horizon we consider when estimating the impact of acute health shocks, motivated by the sample size reduction that panel attrition would have entailed, had we further extended the time frame. However, previous research (Smith, 2005) found the bulk of adjustment to acute health shock to be immediate, and broadly persisting afterwards. Finally, the focus on the three major health conditions we cover, while functional to the identification strategy, comes at a the cost of a possible lack of generalizability of our results to other types of health deteriorations experienced by older workers.

With these potential flaws in mind, our results offer informative evidence on how, in the past decade, older workers in Europe have reacted to the onset of major health conditions, particularly salient, in terms of incidence, to that age group. A sizeable reduction in labour market participation, amounting to a doubled risk of labour market exit, have emerged on average, although remarkable differences have arisen across countries, reflecting the extent to which their institutional settings favour workers' LMP or exit after an acute health shock. While the preferred balance between providing incentives and possibilities for these workers to remain in the labour market, and guaranteeing their incomes in case of exit, remains a matter of political judgement, the accessibility of replacement incomes has clearly emerged as a key driver in older workers' response to acute health shocks.

Further policy relevant indications can be drawn from the heterogeneity analysis and the comparison between men and women's adjustments. Once hit by an acute health shock, individuals might change their preferred labour supply, because perceiving a reduced time horizon, relevant to their intertemporal decision making, or because of stronger preferences for leisure, or less patient time preferences. Although we could not directly measure time preferences or preferences for leisure, our results have shown that indeed individuals perceive a reduction in life expectancy, after the onset of an acute health shock. If labour market exit comes as the result of individuals' updated optimal decision-making, given their preferences and financial constraints, policy intervention aimed retaining them in the labour market seem justified only to the extent that fiscal considerations on social security sustainability recommend so. However, a stronger call for policy intervention, presumably of a different type, would arise if individuals, or subgroups of them, preferred remaining in the labour market but impairment-related barriers to work impeded to do so. Indeed, acute health shocks have

been shown to entail a significant deterioration in both physical functioning and mental health, which could clash with a desire to return to work. The presence of impairment-related barriers to work has emerged as a major explanatory channel in the case of men's adjustment after an acute health shock. Men have displayed higher resilience, and exit strongly related to the onset of work ability impairment, hinting at a potentially effective role for re-training and job accommodation policies. On the other hand, evidence on women's adjustment suggest that the interplay of a preferred reduction in labour supply and financial constraints play a major role, hinting at a limited chance for the effectiveness of those same policies. Further research will hopefully contribute to deepen our understanding of older workers' response to acute health shocks, and the chance for policy intervention to support individuals' preferred, if fiscally sustainable, labour market choices.

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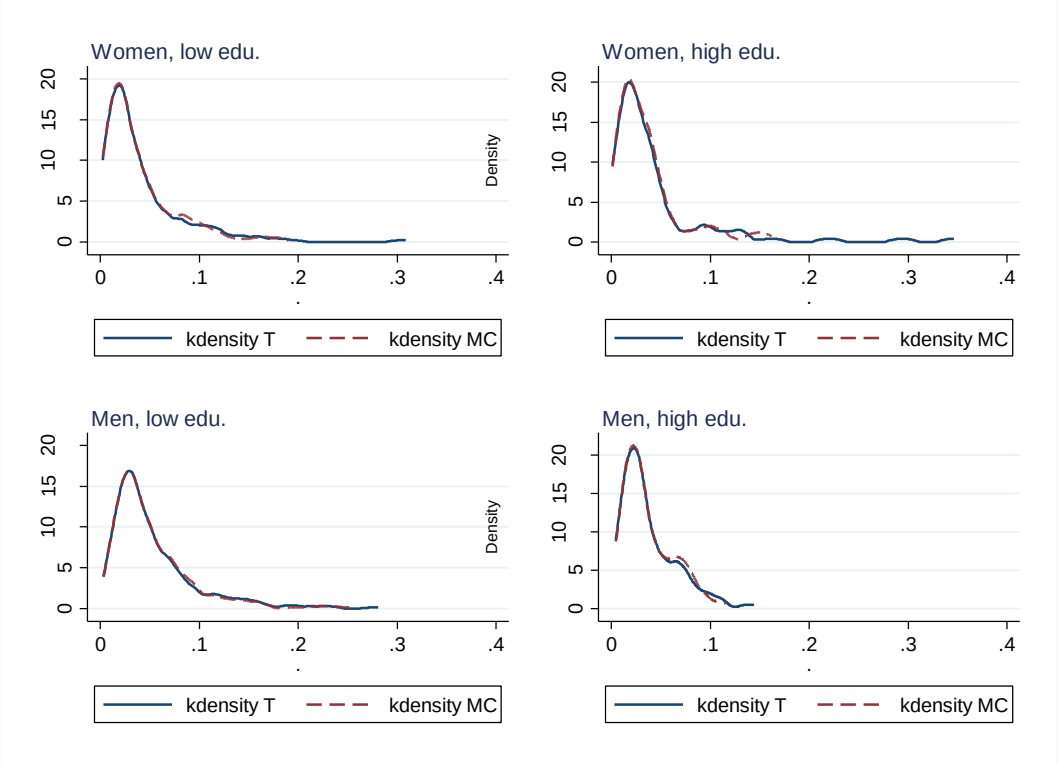
Appendix

Table A.1 Sample descriptive statistics (unweighted) for heterogeneity analysis variables

	ELSA				SHARE			
	T		*K*		*T*		*K*	
	Mean	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*
Has a cohabiting partner	0.79	0.41	0.78	0.41	0.78	0.41	0.83	0.38
Managerial[a] job	0.41	0.49	0.43	0.49	0.27	0.44	0.26	0.44
Intermediate[b] job	0.19	0.40	0.25	0.43	0.26	0.44	0.29	0.45
Routine[c] job	0.40	0.49	0.32	0.47	0.45	0.50	0.43	0.50

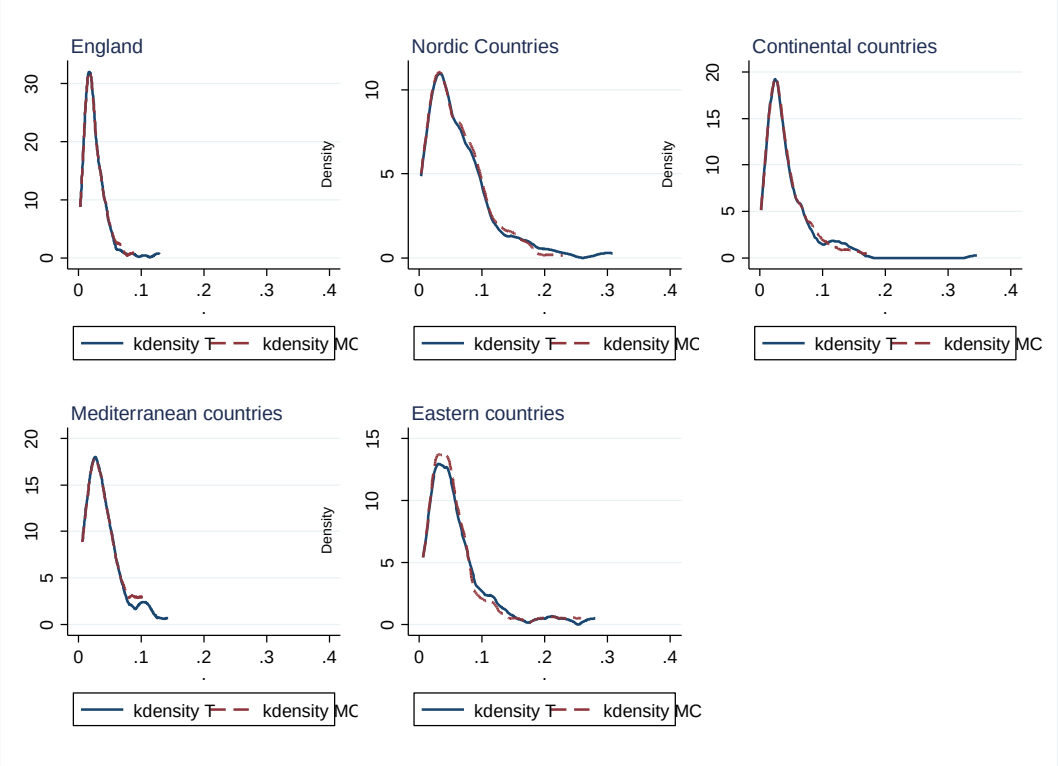
Source: ELSA, waves 1-6; SHARE, waves 1, 2, 4, 5.
Notes: [a] legislator, senior official, manager or professional;
[b] technician, associate professional or clerk;
[c] a manual or routine occupation.

Figure A1: Estimated propensity score distributions, treated and matched controls, by gender and education



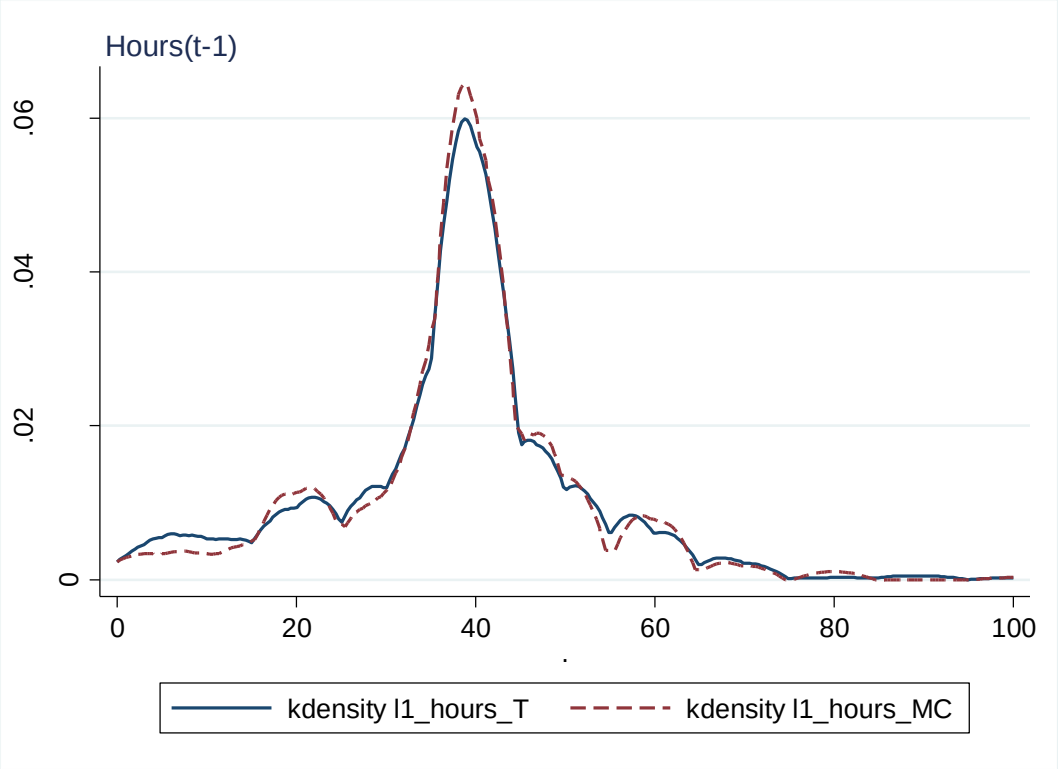
Source: ELSA, waves 1-6; SHARE, waves 1, 2, 4, 5.

Figure A2: Estimated propensity score distributions, treated and matched controls, by geographical area

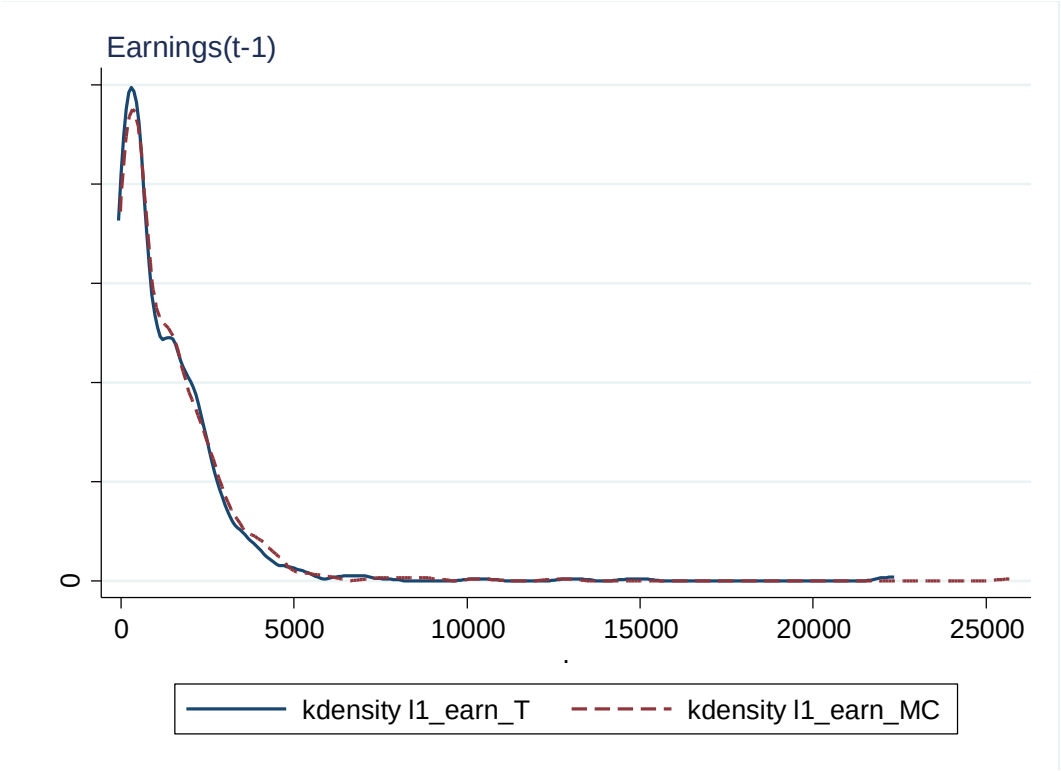


Source: ELSA, waves 1-6; SHARE, waves 1, 2, 4, 5.

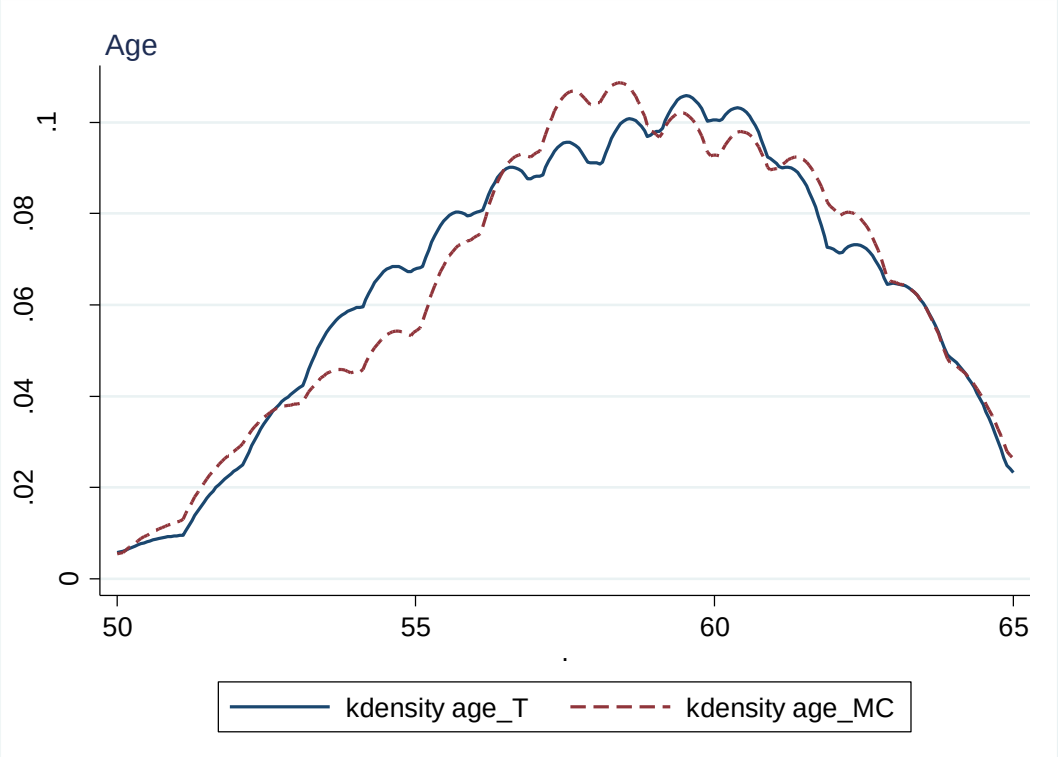
Figure A.3 : Post-matching distributions: hours (t-1), earnings(t-1) and age



Source: ELSA, waves 1-6; SHARE, waves 1, 2, 4, 5.



Source: ELSA, waves 1-6; SHARE, waves 1, 2, 4, 5.



Source: ELSA, waves 1-6; SHARE, waves 1, 2, 4, 5.