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**Working Paper**

## Health, Cognition and Work Capacity Beyond the Age of 50

GLO Discussion Paper, No. 295

**Provided in Cooperation with:**

Global Labor Organization (GLO)

*Suggested Citation:* Vandenberghe, Vincent (2019) : Health, Cognition and Work Capacity Beyond the Age of 50, GLO Discussion Paper, No. 295, Global Labor Organization (GLO), Maastricht

This Version is available at:

<https://hdl.handle.net/10419/190974>

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# Health, Cognition and Work Capacity Beyond the Age of 50

International Evidence on the Extensive and Intensive Margin of Work

V. Vandenberghe<sup>§</sup>

## Abstract

The rising cost of old-age dependency in Europe and elsewhere invariably leads to reforms aimed at raising the effective age or retirement. But do older individuals have the health/cognitive capacity to work longer? Following Cutler et al. (2012), this paper asks how much older individuals *could* work if they worked as much as their younger (50-54) counterparts in similar health/with equal cognitive performance. Contrary to existing papers, this one uses international, European, comparable panel evidence available in the Survey of Health, Ageing and Retirement in Europe (SHARE). It considers both physical health and cognition; and health consists of subjective and objective measures. Also, it examines the extensive and intensive margins of work (employment and hours): existing papers only consider the former. Results are essentially fivefold. First, declines in health significantly affect employment. Second, the impact on hours is statistical significant but of much smaller magnitude. People suffering from ill health rarely adjust hours; they rather stop working altogether. Third, cognition is not fundamentally affected by ageing, and it adds little to our capacity to predict how work capacity evolves with age. Fourth, identification issues exist and must be addressed. They comprise unobserved heterogeneity across respondents, justification bias or proxying/measurement errors regarding health. Finally, declining health/cognition explain at most 31% of the actual labour supply reduction between 50 and 70. This confirms the existence of a, currently largely underused, work capacity among older individuals.

JEL Classification: J22, I10, J26

Keywords: Ageing, Health, Cognition, Labour Supply, Work Capacity.

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## Introduction

The increase in life expectancy is arguably the most remarkable by-product of economic growth and medical progress. Since the end of the 19<sup>th</sup> century, advanced economies have been gaining roughly 2.4 years of longevity every decade. But this trend — in combination with lower fertility — translates into population ageing. And this has far-reaching economic and socio-political consequences. *Ceteris paribus*, population aging will cause declining labour forces and rising old-age dependency. This may hurt economic growth and the overall quality of life if governments need to divert public spending from education or infrastructure investment to fund elderly-related obligations.

Different things could adjust to combat secular stagnation<sup>1</sup> (i.e. compensate for the contraction of the working age population and the rise of old-age dependency) and have been explored theoretically and empirically (Cutler et al., 1990; Acemoglu, 2010; Vandenberghe, 2017). But the most obvious adjustment is to raise the age of effective retirement. Researchers at the OECD (Oliveira Martins et. al., 2005) have shown that indexing it on (rising) life expectancy could stabilise old-age dependency ratios around their current levels, preventing dramatic tax increments to finance pay-as-you-go (PAYG) pensions, or a general reduction of the level of pensions.

Stricter retirement policies have been shown to be effective at increasing employment rates (Atalay & Barrett, 2015). However, one concern often raised is whether such policies are fair, given that some individuals may be too unhealthy, or lack the cognitive skills, to continue working for any longer while waiting to receive their pension. It is important, therefore, to investigate the extent to which ill health and/or poor cognition limit the ability of older people to work. In more policy terms, the question is: if eligibility ages for public pension keeps rising, would more people stay in employment, or would more people instead be out of work and classified as disabled?

Evidence abounds to indicate that when people get older they tend, on average, to be less healthy and to work less. But this alone is not sufficient to draw conclusions, since there are many other factors that also affect the labour force participation of older age groups. Instead, we need to understand how much health/cognition affect individuals' work capacity — with may remain

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<sup>1</sup> The expression was coined by Alvin Hansen in his famous 1938 presidential address to the American Economic Association (Hansen, 1939).

significantly larger than what older employment and labour supply patterns suggest. By focusing here on health and cognition our objective is not to diminish the importance of other factors, nor to draw conclusions about how much people *should* work — many individuals will prefer to retire, regardless of their health/cognitive performances —, but rather to suggest how much they could work given their health/cognition.

Building on an estimation strategy suggested by Cutler et al. (2011), we measure the (unused) work capacity as the difference between *i*) the observed labour supply of older people and *ii*) that of similarly endowed (in terms of health/cognition) younger people, observed at the same point in time. A strength of this approach, given the availability of micro panel dataset like SHARE<sup>2</sup> used here, is that we can include a rich set of indicators of health/cognition that may impact on work capacity. This includes self-reported/subjective evaluation of respondents' general health, but also numerous and detailed, doctor-diagnosed, health conditions (diabetes, blood pressure problems, arthritis...), difficulties with mobility and activities of daily living, grip strength.... SHARE is also rich in items like memory or math/numeracy test scores, that can be used to compute a cognition index.

The key results of this paper are essentially fivefold.

- First, as most observers would expect, our analysis shows that the health of the older group is on average worse than that of those in their early fifties. There is less evidence in support of cognitive decline with age. The cross-sectional evidence on cognition points as a negative relationship with age. But the negative gradient disappears when resorting to the longitudinal dimension of our panel data, where identification of the age/cognition relationship rests exclusively on individuals' change of cognition as they grow older.

- Second, ill health significantly and negatively impacts employment (i.e. the extensive margin of the supply of labour) beyond the age of 50-54. This result aligns with those already published by economists (Cutler et al., 2013; Banks et al., 2016; Coile et al., 2016; Blundell et al. 2017). A novelty of our paper is to simultaneously examine the impact of declining health on hours worked (known as the intensive margin in labour economics). We find evidence that the latter impact is also negative and statistically significant. But it is of much smaller magnitude. This suggests that

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<sup>2</sup> Survey of Health, Ageing and Retirement in Europe (Börsch-Supan et al., 2013).

people suffering from ill health rarely adjust labour supply at the extensive margin but rather stop working altogether.

- Third, cognition is not fundamentally affected by ageing, and thus logically adds little explanatory power to health when it comes to predicting the evolution of labour supply. This result aligns with what Blundell et al. (2017) found about cognition for the US and the UK.

- Fourth, properly measuring the impact of health on labour supply (even when focusing of the age group 50-54 for which there are *a priori* not too many confounding factors) is not trivial from an econometric point of view. We show in this paper that OLS/cross-section results are likely to *i*) overestimate the degree of decline of cognition with age, and consequently its contribution to the reduction of work capacity, and also *ii*) underestimate the impact of health when the latter is assessed via self-reported/subjective general description of people's health. We show that resorting to econometric methods based on individual fixed effects (FE) and instruments<sup>3</sup> (IV) matters for identification.

- Fifth, and most importantly, this paper shows that, declines in health/cognition explain at most 31% of the observed labour supply reduction between the age of 50 and 70 — and smaller percentages if we consider slightly younger categories of older workers. Our results support the idea that many old individuals in Europe have the capacity to work up to the age of 65 or 70. This result echoes the conclusion of Culter et al., 2013; Banks et al., 2016; Coile et al., 2016; Blundell et al. 2017 for the UK, the US or Canada.

The rest of the paper is organized as follows. In Section 1, we expose and discuss the existing literature on work capacity. Section 2 presents the Cutler et al. (2011) two-stage estimation of work capacity, the key identification problems and the way we deal with them. Section 3 presents the SHARE microdata on labour supply, health and cognition used in the paper. Results are presented in detail in Section 4, while Section 5 concludes.

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<sup>3</sup> Objective measures of physical health used to instrument subjective health indexes.

## 1. Literature

This paper contributes to the literature on ageing and employment, and more precisely the barriers to employment at older ages. The focus is on the supply side of the labour market, and on the role of (presumably) declining health and/or cognition in limiting people's capacity to supply labour.

As stated above, rapid population ageing in many advanced economies leads to reforms that consist of explicitly or implicitly indexing the age of retirement on life expectancy.<sup>4</sup> But lifting the age of retirement, however relevant in a context of rapid population ageing, is bound to prove challenging. Across Europe, millions of individuals continue leaving the labour market before the legal/reference age of retirement; most likely due to the presence of several supply- and demand-side barriers to elderly employment. Many of these barriers have been studied by economists.

On the demand side of the employment relationship, Hutchens (1986, 2010) pioneered the study the determinants of older workers' [limited] employment opportunities. Others, like Dorn & Sousa-Poza (2010), document the importance of involuntary early retirement. In the early 1990s in Europe, involuntary early retirement is the rule rather than the exception in several countries. In Germany, Portugal, and Hungary, more than half of all early retirements were, reportedly, not by choice. Other economists have examined the relationship between age, productivity and labour cost at the level of the firm and have concluded at a risk of low employability beyond the age of 50. The employability handicap has its roots either in a fall of productivity with age, or a rise of total labour cost that is not matched by a rise of productivity (Dostie, 2011; Skirbekk, 2004, 2008; van Ours & Stoeldraijer, 2011; Vandenberghe 2013, Vandenberghe et al. 2013, Vandenberghe 2011a, 2011b). A related issue is the rise of labour costs per hour in the presence of quasi-fixed labour costs<sup>5</sup> and reduced working hours that many older workers aspire to (Delmez & Vandenberghe, 2018).<sup>6</sup>

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<sup>4</sup> A more macroeconomic literature also examined the question of total factor productivity growth as possible response to population ageing (Culter et al. 1990; Vandenberghe, 2017)

<sup>5</sup> Quasi-fixed labour costs reflect the propensity of a worker's compensation to be not strictly indexed on the hours of work delivered. They comprise the lump-sum part of pay, non-proportional taxes or social security contributions, fixed insurance premia, indivisible perks like a company car, and also recruitment/ training or redundancy/firing costs.

<sup>6</sup> For instance, in the context of pension reforms aimed at extending people's careers, a corollary if very often part-time/flexitime work arrangements most older individuals aspire to. But these, in the presence of quasi-fixed costs translate into higher hourly labour cost that employers seem to be reluctant to endorse (Pencavel, 2016).

On the supply side of the labour market, a lot of attention has been given to the role of early-pension schemes and other welfare regimes in enticing people to withdraw early from the labour force. In Europe, evidence abounds to suggest that easy access and high replacement rates played a significant role in the drop in the employment rate among older individuals from the 1960s to the mid-1990s (Blöndal & Scarpetta, 1999; Jousten et al., 2010). Lastly, still on the the supply side, there is the role of health and cognitive performance decline with age, on wich this paper focuses.

The macro evidence about health and age points at a regular compression of morbidity towards the end of life. World Health Organisation (WHO) data show, over the past 200 years, a systematic rise of the healthy life expectancy, and even a rise of the share of healthy life expectancy. Consequently, Börsch-Supan (2014) concludes it is probably not true that most workers are too sick to continue work until 65,70 or even beyond those ages. The aim of this paper is to put the latter claim to the test, using individual-level panel data to assess the causal impact of ill health — but also poor cognition — on labour supply beyond the age of 50. In doing so we add to a burgeoning literature on working capacity that started with Culter et al. (2013) and was followed by Jousten & Lefèvre (2016), Mulligan et al. (2016) or Banks et al. (2016).

To be precise, we focus on the Culter et al. (2013) method. It measures underused work capacity as the gap between the *i*) actual employment rate of older people and *ii*) that of similarly healthy younger people observed at the same point in time.<sup>7</sup> The method implies estimating a ‘counterfactual’ employment rate for currently-older people. This counterfactual is intended to demonstrate the level of employment that would be seen among the older group if health were the only factor affecting their employment rate. It is constructed using employment rates seen among another group of people who are in similar health observed in the same year, but at a younger age<sup>8</sup> — typically in their 50's; an age where health issues are likely to be already affecting a sizeable number of individuals, but where retirement benefits are not yet accessible.

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<sup>7</sup> The alternative approach (Banks et al. 2016) -- that we do not implement here -- compares employment rates of currently older people to the employment rates of people deemed to have the same level of health in an earlier year. If the former is lower than the latter, we conclude that there is ‘additional work capacity’ among the currently older population. The measure of ‘health’ used in this approach is the one-year mortality rate for people of a given age and sex. The strength of this measure of health is that it is readily available and defined in the same way for long time periods. A weakness is that this health measure (life vs death) may not be a particularly relevant one for determining whether someone is able to do paid work. It also assumes that the impact of health on work capacity has not varied over time.

<sup>8</sup> Or in the case of Banks et al. (2016) those observed in earlier years at the same age.

A clear strength of this approach is that it allows for the inclusion of a rich set of indicators of health that may impact on work capacity. The datasets used typically comprise doctor diagnoses of numerous health conditions, difficulties with mobility and activities of daily living, body mass index... The method *assumes any impacts of health on work capacity do not vary by age*: the negative impact of ill health observed among individuals aged 50-54 is assumed to be a valid predictor of what would be the impact of the same ill health on individuals aged 70-74. What is more, it is also assumed that *work itself (and its accumulation) has no effect on health*. This is a potentially important concern, investigated by some economists — see Caroli & Bassanini (2015) for a review of the (rather mixed) evidence. The results discussed below should be interpreted with these limitations in mind.

## 2. Methods

### 2.1. Overall presentation

In what follows, we implement and improve on the method proposed by Culter et al. (2013). That method comprises two stages. Stage one consists of estimating the relationship between health and/or cognition and employment (*EMPL*). We depart from Culter et al. as we consider the different dimensions of labour supply: employment (*EMPL*), hours worked in case of employment participation (*HOURS*), plus what we call the overall labour supply (*LSUP*). It consists of the expected number hours, where the extensive (*HOURS*) and intensive (*EMPL*) margins are combined. To our knowledge this is an innovation. So far, the papers implementing Cutler et al. (2011) only consider the extensive margin of labour supply.

Stage one involves only individuals that are still relatively young. We have opted for those aged 50-54. Algebraically, we regress — separately for each country present in SHARE — different dimensions of labour supply ( $Z=EMPL, HOURS, LSUP$ ) on health and/or cognition:

$$Z^{50-54}_{it} = \beta^z_0 + \beta^z_h HEALTH^{50-54}_{it} + \beta^z_c COGN^{50-54}_{it} + \beta^z_i + \varepsilon^z_{it} \quad [1.]$$

with  $Z= EMPL, HOURS, LSUP$

At stage one, there are many identification issues that are discussed extensively here after in Section 2.2. What matters for the moment is to remember that the vector of coefficients  $\widehat{\beta}^z_0; \widehat{\beta}^z_h; \widehat{\beta}^z_c$  is retrieved from the estimation of [1.]. Note that the model contains individual/respondent fixed effects



$\beta^z_i$ . Thus, in practice, the estimated intercept  $\beta^z_0$  will correspond to the average fixed effect, capturing the contribution of unobserved individual heterogeneity specific to the age group 50-54.<sup>9</sup>

At stage two, we apply  $\widehat{\beta^z_0}$ ;  $\widehat{\beta^z_h}$ ;  $\widehat{\beta^z_c}$  to the health and cognition variables characterizing individuals aged  $a=50, \dots, 70, \dots, 75$  — thus also those older than 50-54, that inform about the evolution of health/cognition with age. This delivers their expected labour supply:

$$\hat{Z}^a_{it} = \widehat{\beta^z_0} + \widehat{\beta^z_h} HEALTH^a_{it} + \widehat{\beta^z_c} COGN^a_{it} \quad [2.]$$

with  $Z = EMPL, HOURS, LSUP$

The expected values in [2] can then be used to compute various synthetic indicators of health/cognition-driven decline of labour supply, both in absolute and relative terms. Following French (2005) and Blundell & al. (2017), we will focus on the cumulative impact over 20 years, by comparing results for individuals aged 50 to those for individuals aged 70. We will typically compare the [average] predicted values to those observed<sup>10</sup>, and compute the percentage  $\delta$  of the actual labour supply change that can be ascribed to health/cognition decline, say between the age of 50 and 70,<sup>11</sup>

$$\delta^{Z,50-70} = \frac{\hat{Z}^{70} - Z^{50}}{Z^{70} - Z^{50}} \quad [3.]$$

The  $\delta$ 's above can be computed as the ratio of two age-70-dummy coefficients ( $\theta^{70}, \pi^{70}$ ) delivered by the regression of (respectively) predicted vs observed labour supply on age dummies (50 being the reference age, corresponding to the intercepts).

$$\hat{Z}^{70}_{it} = \theta^{50} + \theta^{70} AGE_{it}^{70} + v^z_{it} \quad [4.]$$

$$Z^{70}_{it} = \pi^{50} + \pi^{75} AGE_{it}^{70} + \mu^z_{it} \quad [5.]$$

$$\delta^{Z,70-50} = \frac{\hat{\theta}^{75}}{\hat{\pi}^{75}} \quad [6.]$$

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<sup>9</sup> Intercepts in models with fixed effects correspond to the average value of the fixed effects. <https://www.stata.com/support/faqs/statistics/intercept-in-fixed-effects-model>.

<sup>11</sup> The age of 70 is purely illustrative here.

with  $Z = EMPL, HOURS, LSUP$

Finally, note that intercepts  $\widehat{\beta}^Z_0$  in [2] are retrieved from stage one and used to make predictions. As explained above, with fixed effect estimation (FE), intercepts correspond to the average individual fixed effects characterizing the reference group i.e. individuals aged 50-54. Implicitly thus, when computing predictions [2] for individuals older than 54, we assume that their unobserved (and fixed) characteristics are the same as those of respondents aged 50-54. Compositional differences across cohorts participating to SHARE (in terms of gender and/or educational attainment ...) are thus neutralised. This is rather welcome in the context of this analysis, as one aims at delivering estimates of work capacity that are primarily driven by the [age-driven] evolution of health/cognition.

But the issue of cohort heterogeneity is more complex than it seems. Indeed, when using observed labour supply of individuals older than 54 to compute the denominator of the  $\delta$ 's in [3.], [6.] — but also when using the health/cognition data to compute the numerator —, one would also want to "neutralise" the effects of likely compositional changes. Older cohorts are typically less educated or could display a different gender mix than individuals aged 50-54.<sup>12</sup> Observed labour supply of individuals that are currently older than 54 may slightly underestimate that of individuals aged 50-54 when they grow older. The same reasoning applies the distribution and the incidence of medical conditions used to predict labour supply. The health and cognition outcomes observed in SHARE among older cohorts may underestimate that of younger cohorts when they reach those age.

We propose neutralizing the effect of compositional differences via inverse propensity score weighing. This consists of computing for everyone in the 50-74 age band, given his/her characteristics  $X^{50-74}_i$  (gender, education...), the probability that he/she belongs to the 50-54 age group. In other words, we estimate

$$Prob(d^{5054}=1) = f(\eta_0 + \eta_1 X_i) \quad [7.]$$

We then use the estimated coefficients to compute the odd ratio of individual  $i$  belong to the 50-54 age group (vs not).

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<sup>12</sup> Due to different mortality rates for instance.

$$w_i = pr_i / (1 - pr_i) \quad [8.]$$

where  $pr_i = f(\hat{\eta}_0 + \hat{\eta}_1 X_i)$

In turn, the odd ratio  $w_i$  is used to weight observations. This amounts to giving more(less) weight to individuals older than 54 who — given their characteristics  $X_i$  — are more(less) likely to belong the 50-54 age group. Technically, this is achieved by estimating both the numerator and the denominator of [7],[8],[9] using WLS. This weighting strategy is like the one underpinning the use of propensity score in the treatment evaluation literature. Weights are regularly used to try to make two groups (here individuals aged 55-75 vs those aged 50-54) as similar as possible in terms of background characteristics  $X$ .

## 2.2. Properly identifying the health/cognition labour supply stage one relationship

Key in the methodology exposed above is the estimation of the relationship between health/cognition and labour supply. Despite a growing literature on this question, there is still no agreement on the magnitude of the negative impact of ill health on labour supply; and/or [but to a lesser extent as less attention has been dedicated to it] poor cognition.<sup>13</sup> This reflects the heterogeneity of empirical approaches and data sources. An important source of differences has to do with the way health is measured. As explained by Blundell et al. (2017), ideally one would want a summary measure of individuals' stock of health/cognition that is relevant to work capacity ( $H$ ,  $C$ ). Even rich datasets like SHARE (and many others) do not include all the variables determining stocks  $H$ ,  $C$ ; and those that are included may suffer from measurement errors and other sources of biases. The paper by Blundell et al. (2017) contains an excellent review of these biases. Hereafter, we will focus on two broadly-defined categories of biases causing endogeneity. First unobserved (but fixed in time) individual factors. These are likely to affect both the measurement of the impact of age on health/cognition, and that of age-driven health/cognition decline on labour supply. For example, an apparent decline of cognition with age in cross-sectional data might be driven by older cohorts with lower educational attainment. Also, and more in relation to the estimation of the impact of health/cognition on labour supply, individuals from poor backgrounds may have missed on critical investments fostering good health. At the same time, it is likely that they have

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<sup>13</sup> Most if not all authors focus on employment.

underachieved in terms of educational attainment and other types of skills valorised by the labour market. Failure to control for skills in general will confound estimates of the employment effect of health. To address these risks will we resort to fixed effects (FE) estimation, exploiting the panel dimension of SHARE. Thus, in what will amount to our preferred model here below, identification of age and labour supply effects will exclusively rest on "within" individual variation of health/cognition over time.

The second source of biases we try to address has its roots in two rather distinct problems: *i*) measurement errors/proxying i.e. measures of health  $H^j$   $C^j$  — where  $j$  refer to a particular dimension of health/cognition — imperfectly proxying the actual  $H$ ,  $C$  and *ii*) justification bias i.e. the fact that individuals report values of  $H^j$   $C^j$  that are (partially driven) by their status on the labour market: with unemployed individuals who tend to report lower level of health to justify their absence of employment (Baker et al., 2004). In econometric terms, measurement errors can cause strong attenuation biases (i.e. underestimation of the true impact of ill health/poor cognition on labour supply). By contrast, justification biases push the estimates in the other direction: they are source of overestimation. So far, the literature remains inconclusive about the relative importance of these two problems. O'Donnell et al. (2015) suggest that justification bias dominates, resulting in an upward biased estimate of  $\widehat{\beta}_h^z$ ;  $\widehat{\beta}_c^z$ . However, Stern (1989) and Dwyer & Mitchell (1999) do not find that justification bias dominates. Our approach, hereafter will consist of using instrumental variables (IV) that we combine with the above fixed effects (FE) to deliver what will be our preferred econometric model (IV-FE). We have many potential instruments to choose from. Following Blundell et al. (2017) we prioritize objective health measures provided by SHARE i.e. doctor diagnosed conditions, plus some results to physical/dexterity tests implemented by the SHARE investigators (Table 3).

### 3. Data

This paper uses waves 1 to 6 of SHARE survey; a total of 230,000 individuals  $\times$  waves (Table 1). All individuals in SHARE are 50 or older when interviewed for the first time. Data limitations or different sorts (missing values, absence of repeated observation as the country has participated only to one wave...) explain that we retain 14 among the 18 participating countries (AUT, BEL, CHE, CZE, DEU, DNK, ESP, EST, FRA, ITA, LUX, PRT, SVN, SWE).

SHARE contains a rich set of items describing people's labour supply (hours of work<sup>14</sup> and employment status<sup>15</sup>) but also their health status and their cognitive performance. We consider health variables in two broad categories, subjective (Table 2) and objective (Table 3). Most items are self-reported/subjective (Table 2) but many also explicitly refer to conditions diagnosed by health professionals (heart attack, hyper-tension, cholesterol, stroke, diabetes, lung disease, cancer...) or measured by the SHARE investigators (Table 3) like the maximum grip strength of respondents. Items used to assess cognitive performance are reported in Table 4 and include memory test scores or numeracy/math test scores.

In what follows, we will make extensive use of subjective health and cognition *indexes*. These are computed as first principal components of items listed in (respectively) Table 2 and Table 4. When resorting to IV or IV-FE estimation, we use items listed in Table 3 to instrument the subjective health index that appears in the last column of Table 2.

Table 1 — SHARE data. Observation by country (lines) and wave<sup>b</sup> (col.)

	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5	Wave 6	Spells <sup>a</sup> (total)	Spells per respondent
AUT	1,520	1,179	991	5,108	4,302	3,371	16,471	3.26
BEL	3,660	3,126	2,826	5,179	5,538	5,720	26,049	3.81
CHE	926	1,452	1,292	3,671	2,990	2,778	13,109	3.68
CZE	.	2,649	1,816	5,399	5,555	4,811	20,230	3.02
DEU	2,911	2,581	1,904	1,612	5,585	4,349	18,942	3.12
DNK	1,595	2,538	2,101	2,229	4,064	3,666	16,193	3.83
ESP	2,261	2,379	2,246	3,657	6,588	5,603	22,734	3.48
EST	.	.	.	6,727	5,710	5,576	18,013	2.64
FRA	2,962	2,877	2,461	5,649	4,434	3,873	22,256	3.61
ITA	2,491	2,918	2,499	3,533	4,673	5,235	21,349	3.73
LUX	.	.	.	.	1,590	1,544	3,134	1.70
PRT	.	.	.	1,953	.	1,665	3,618	1.81
SVN	.	.	.	2,703	2,915	4,196	9,814	2.26
SWE	2,983	2,761	1,951	1,973	4,522	3,937	18,127	3.75
Total	21,309	24,460	20,087	49,393	58,466	56,324	230,039	3.26

Source: SHARE 2004-2015

<sup>a</sup>: yearXrespondents

<sup>b</sup>: wave 1 [2004], wave 2 [2007], wave 3 [2009], wave 4 [2011], wave 5 [2013], wave 6 [2015]

<sup>14</sup> Total hours usually working per week.

<sup>15</sup> Dummy variable ( $EMPL=1$  if individuals report positive hours;  $EMPL=0$  otherwise).

Table 2 — Subjective health (all ages pooled)

Country	Poor general health <sup>a</sup>	Self-perceived bad health (US scale) <sup>a</sup>	Long-term illness <sup>b</sup>	Limited in activities   because of health <sup>c</sup>	#limitations with activities of daily living <sup>d</sup>	#limitations with instrumental activities of daily living <sup>e</sup>	Subjective poor health index <sup>f</sup>
AUT	3.00	3.00	3.07	2.36	0.24	0.45	-0.11
BEL	3.00	2.98	3.11	2.37	0.29	0.47	-0.10
CHE	2.68	2.68	3.59	2.59	0.10	0.18	-0.44
CZE	3.39	3.39	2.80	2.26	0.25	0.43	0.14
DEU	3.25	3.24	2.59	2.30	0.23	0.33	0.06
DNK	2.54	2.55	2.96	2.51	0.18	0.34	-0.39
ESP	3.38	3.38	2.91	2.52	0.38	0.68	0.10
EST	3.87	3.87	2.05	2.12	0.36	0.60	0.52
FRA	3.22	3.20	3.10	2.40	0.25	0.41	-0.02
ITA	3.27	3.27	3.32	2.44	0.28	0.46	-0.02
LUX	3.04	3.04	3.13	2.38	0.23	0.39	-0.11
PRT	3.74	3.74	2.85	2.26	0.46	0.65	0.36
SVN	3.33	3.33	3.00	2.35	0.25	0.44	0.06
SWE	2.75	2.72	2.85	2.43	0.18	0.31	-0.26
TOTAL	3.18	3.16	2.93	2.38	0.26	0.44	-0.01

Source: SHARE 2004-2015

<sup>a</sup>: 1-5 scale (1. Excellent 2. Very good 3. Good 4. Fair 5. Poor)

<sup>b</sup>: 1 yes, 5 no

<sup>c</sup>: 1. Severely limited, 2. Limited, but not severely, 3. Not limited

<sup>d</sup>: 0, 1, 2,.....6

<sup>e</sup>: 0, 1, 2,.....9

<sup>f</sup>: first principal component all previous subjective health items (the higher, the worse people' perceive health). Principal component analysis carried with all countries pooled. Displayed values correspond to the predicted score values divided by standard deviation.

Table 3 — Objective health (all ages pooled): doctor-diagnosed conditions or surveyor measurement

Country	Hart attack	Hyper-tension	Choles-terol	Stroke	Diabetes	Lung disease	Cancer	Ulcer	Parkinson	Cataract	Hip fracture	Other fractures	Alzheimer's disease, dementia, senility	Arthritis	Mobility, arm function and fine motor limitations <sup>a</sup>	Max. of grip strength measure <sup>b</sup>
AUT	0.12	0.40	0.21	0.05	0.12	0.06	0.04	0.04	0.01	0.09	0.02	0.24	0.16	0.07	1.43	34.33
BEL	0.11	0.34	0.30	0.03	0.11	0.06	0.05	0.06	0.01	0.07	0.02	0.21	0.14	0.06	1.49	34.63
CHE	0.07	0.30	0.15	0.02	0.07	0.04	0.05	0.02	0.00	0.07	0.01	0.34	0.13	0.04	0.77	34.62
CZE	0.14	0.49	0.24	0.05	0.18	0.07	0.05	0.05	0.01	0.10	0.02	0.18	0.17	0.07	1.53	34.21
DEU	0.11	0.42	0.19	0.04	0.13	0.08	0.07	0.03	0.01	0.09	0.02	0.22	0.17	0.07	1.34	36.00
DNK	0.09	0.34	0.23	0.04	0.08	0.07	0.05	0.03	0.01	0.08	0.01	0.26	0.18	0.05	0.95	36.50
ESP	0.11	0.39	0.28	0.03	0.17	0.06	0.04	0.04	0.01	0.09	0.02	0.19	0.21	0.05	1.64	29.10
EST	0.20	0.49	0.20	0.06	0.13	0.07	0.06	0.09	0.01	0.10	0.02	0.18	0.15	0.08	2.02	33.12
FRA	0.13	0.32	0.24	0.03	0.11	0.06	0.05	0.03	0.01	0.07	0.02	0.23	0.13	0.04	1.42	32.72
ITA	0.10	0.41	0.23	0.03	0.12	0.06	0.04	0.04	0.01	0.06	0.02	0.25	0.13	0.04	1.44	32.59
LUX	0.10	0.34	0.33	0.03	0.12	0.08	0.08	0.07	0.01	0.10	0.03	0.18	0.14	0.15	1.33	34.43
PRT	0.11	0.46	0.40	0.05	0.20	0.07	0.06	0.08	0.01	0.10	0.03	0.15	0.18	0.07	2.23	29.55
SVN	0.13	0.45	0.24	0.04	0.13	0.05	0.05	0.06	0.01	0.08	0.02	0.23	0.15	0.07	1.82	34.17
SWE	0.12	0.37	0.16	0.05	0.10	0.04	0.06	0.03	0.01	0.11	0.03	0.26	0.20	0.04	1.03	35.25

Source: SHARE 2004-2015

a: number of limitations (measured by surveyor)

b: 0-100 (measured by surveyor)

Table 4 — Cognition (all ages pooled)

Country	Numeracy <sup>a</sup>	Numerary2 <sup>b</sup>	Orientation <sup>c</sup>	Memory <sup>d</sup>	Memory2 <sup>e</sup>	Poor cognition index <sup>f</sup>
AUT	3.69	4.37	3.81	5.71	4.47	-0.31
BEL	3.36	4.32	3.78	5.46	4.15	-0.17
CHE	3.81	4.51	3.89	5.82	4.72	-0.44
CZE	3.47	4.29	3.79	5.46	3.86	-0.11
DEU	3.62	4.42	3.84	5.60	4.33	-0.25
DNK	3.60	4.38	3.81	5.76	4.60	-0.39
ESP	2.52	2.68	3.60	4.20	2.78	0.76
EST	3.23	4.14	3.80	5.22	3.74	0.03
FRA	3.14	3.83	3.75	5.17	3.94	0.09
ITA	2.98	3.72	3.79	4.76	3.24	0.17
LUX	3.42	4.27	3.81	5.43	4.44	-0.16
PRT	2.72	3.05	3.75	4.35	3.02	0.58
SVN	3.16	4.02	3.80	4.98	3.30	0.18
SWE	3.63	4.34	3.84	5.35	4.24	-0.23
Total	3.31	4.03	3.79	5.24	3.89	0.00

Source: SHARE 2004-2015

<sup>a</sup>: Numeracy score - mathematical performance [percentage] (1:bad, 5:good)

<sup>b</sup>: Numeracy score mathematical performance [subtraction] (0: bad, 5 good)

<sup>c</sup>: Orientation to date, month, year and day of week (0: bad, 4 good)

<sup>d</sup>: Ten words list learning first trial (total)

<sup>e</sup>: Ten words list learning delayed recall (total)

<sup>f</sup>: first principal component all previous cognition items (the higher, the worse people' cognitive performance (1). Principal component analysis carried with all countries pooled. Displayed values correspond to the predicted score values divided by standard deviation.

## 4. Results

### 4.1. Physical health and cognitive performance deteriorates with age

Data from SHARE show that (subjective/broadly defined) physical health deteriorates regularly with age, across all countries. The same holds for cognitive performance, although much wider confidence intervals point at a weaker relationship. Remember that our health index<sup>16</sup> measures poor health: the higher the index on display on Figure 1-A.B., the more respondents declare suffering from ill health. Figure 1-A. depicts the situation of individuals aged 50 to 75, whereas panel B. does it for a larger group that include those aged 76-80. Similarly, for our cognition index<sup>17</sup>: the higher the index on Figure 2 the more people perform poorly to the memory and numeracy tests underpinning the index.

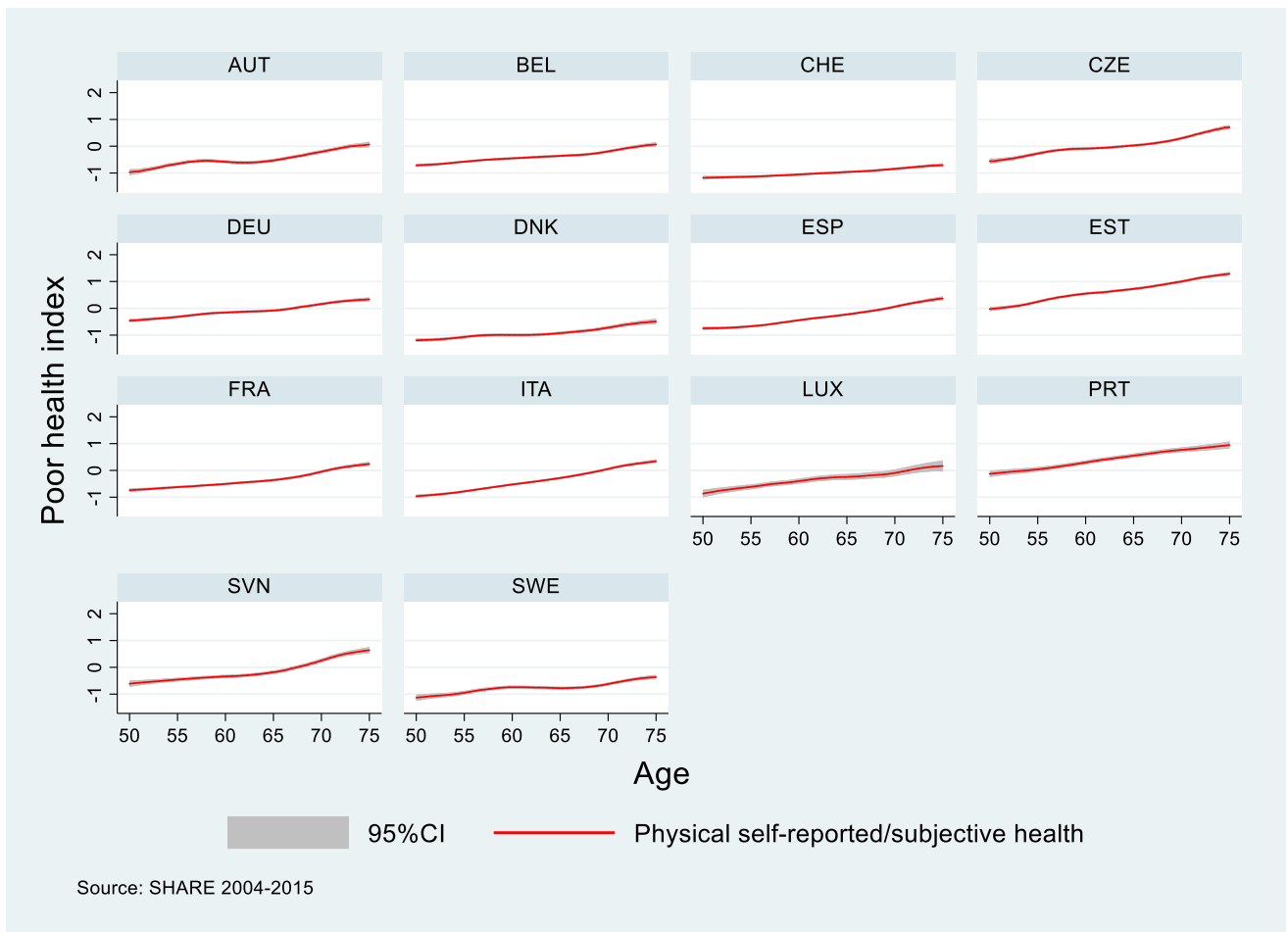
<sup>16</sup> These correspond to the first principal component all subjective and general health items reported in Table 2.

<sup>17</sup> The first principal component all items reported in Table 4.

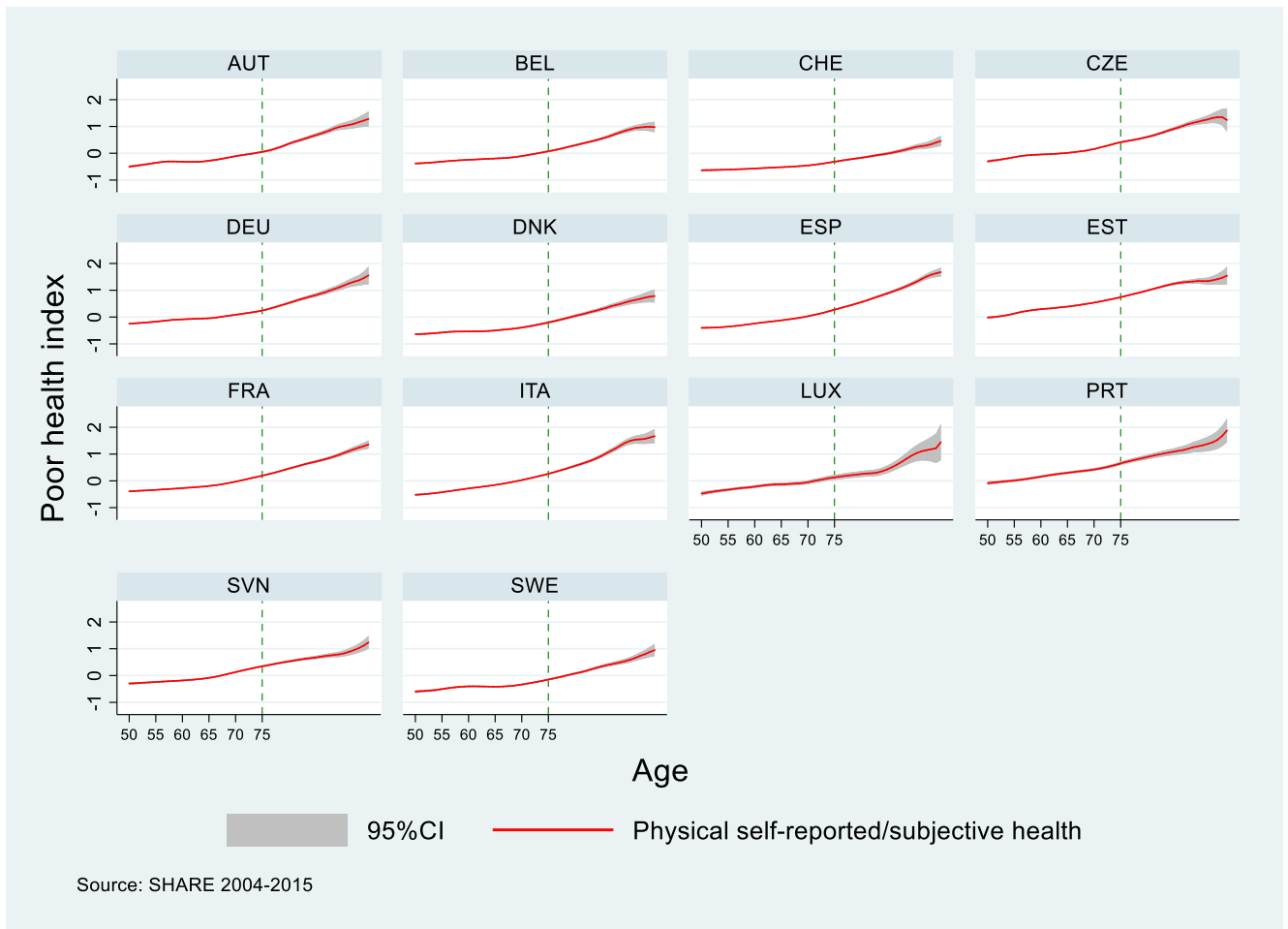


Figure 1 — Age and poor physical health

A. Individuals aged 50-75

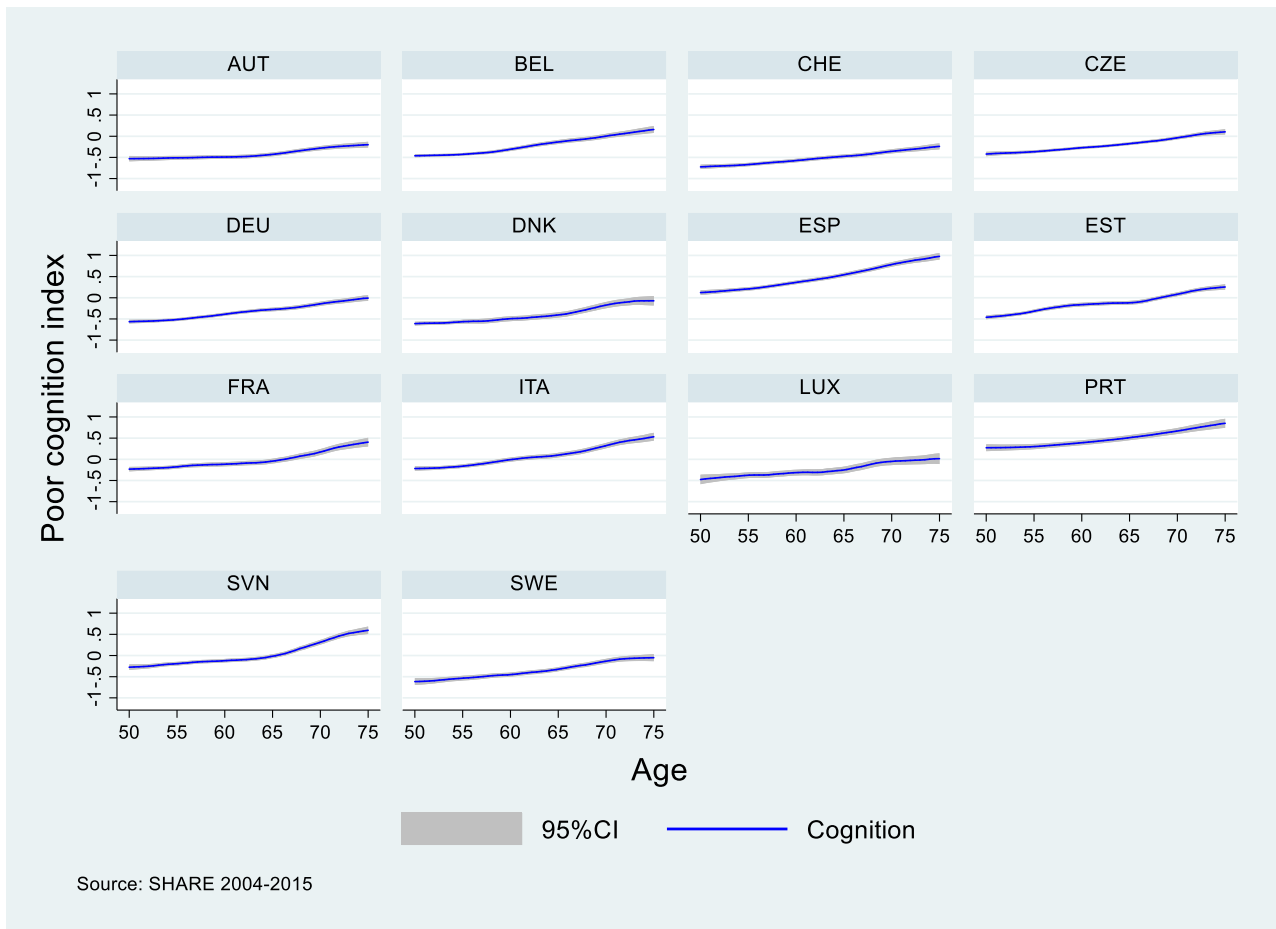


B. Individuals aged 50-95



Note: The physical health index displayed here is the first principal component from list of subjective health variables described in Table 2. Plotted values are the result of a kernel-weighted local polynomial regression of health index on age.

Figure 2 — Age and poor cognition (individuals aged 50-75)



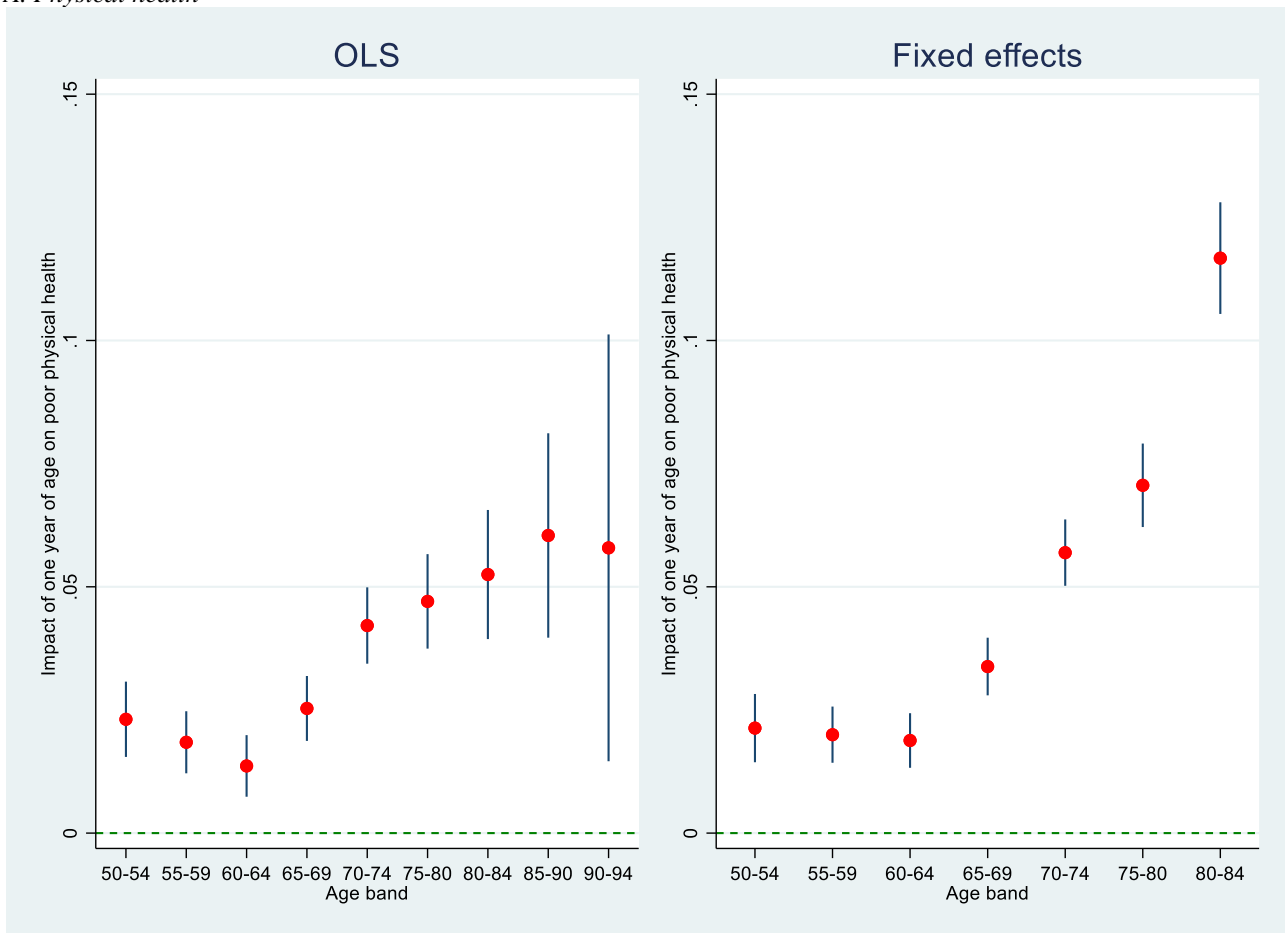
Source: SHARE 2004-2015

Note: The cognitive index displayed here is the first principal component of variables described in Table 4. Plotted values are the result of a kernel-weighted local polynomial regression of health index on age.

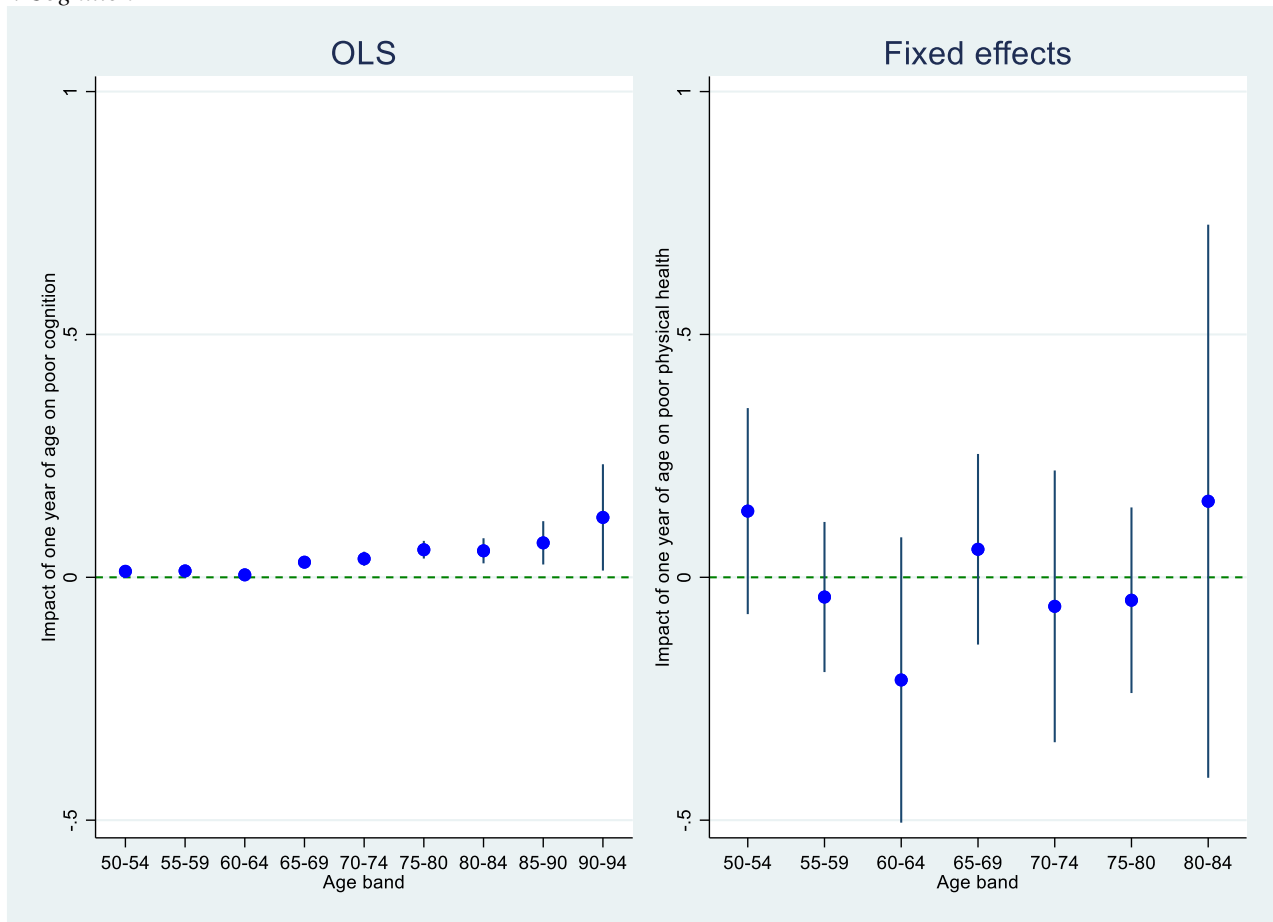
What is visible in Figures 1 & 2 is confirmed by a simple econometric analysis aimed at capturing the impact of an additional year of age on poor health and cognition (Figure 3, and Table A.1 in Appendix). The results reported in Figure 3 are point estimates, calculated separately for each age band of 5 years. All countries are pooled but the regression equations contain country fixed effects, but also gender  $\times$  educational attainment fixed effects. A coefficient of 0.05 for instance means that an additional year of age leads to rise of 5 % of one standard deviation of our poor physical health index. Quite logically, Figure 3- panel A. suggests that the impact of an additional year of age on [ill] health is higher when people turn 70, and even more when they turn 80.... It is worth nothing that results from regressions that comprise respondent fixed effects (FE) — thus solely based within/ over time variations — largely align with those obtained with OLS. However, this is not the case for cognition (Figure 3-panel B.). For the latter, FE results point at the absence of real impact of an additional year of age. The positive correlations visible in Figure 2 are, thus, probably spurious. In SHARE, older individuals have lower cognition not because of their age, but because they were born into older cohorts with lower cognition over their entire life.

Figure 4 — The relationship between age and poor physical health or cognition<sup>a,b</sup>

A. Physical health



B. Cognition



<sup>a</sup>: plotted coefficients report the impact of one extra year of age [within each age band displayed on the x-axis] as a fraction of one standard deviation of the cognition index. Vertical bars represent 95% confidence intervals. All countries are pooled but the regression equations contain country fixed effects, but also gender X educational attainment fixed effects.

<sup>b</sup>: due to a lack of repeated observations for age bands 85-90 & 90-94, we are unable to report FE point estimates.

#### 4. 2. Assessing the impact of health on labour supply beyond the age of 50

In this section, we focus on the impact of poor health and/or cognition on the labour supply of older individuals. The latter consists of the employment rate (*EMPL*) (the extensive margin), and the weekly number of hours of work (*HOURS*) for those who work (the intensive margin). We also consider the impact on total labour supply (*LSUP*), measured as the number of hours workers for all individuals.

As explained in Section 2, the analysis consists of two stages. At stage one, we only consider individuals aged 50-54, and we examine how ill health and/or poor cognition affect their labour supply (*EMPL*, *HOURS*, *LSUP*). We store the estimated coefficients, considering that they reflect the causal impact of poor health and/or cognition of the capacity of individuals to work. We then

move to the second stage of the analysis. As explained early, stage two essentially consists in a prediction/counterfactual exercise. The stage-one coefficients are applied to the health/cognitive variables characterising respondents older than 50-54. The result informs on the [expected] evolution/decline of labour supply, were health and cognition be the only determinants of labour supply as individuals grow older.

We first present stage-one results (Table 5) when using [A.] only physical (but subjectively assessed) health, [B.] only cognitive health, [C.] physical health and cognition together. We also control for the risk of endogeneity and its determinants exposed and discussed in Section 2. This is done [D.] by resorting to IV where subjective physical health is instrumented by objective indicators of ill health. Our preferred model [E.] combines instrumental variables and respondent fixed effects (IV-FE). Stage-two results (based exclusively on our preferred IV- FE stage one estimates) are reported in Table 6 and used in Figure 5 to plot the expected evolution of labour supply/older people's work capacity.

Table 5 starts with the exposition of the OLS results, when only our physical health index is used. Results show a small negative effect of poor health among respondents aged 50-54 on the number of hours they usually work during a week. Except for Portugal (PRT) and Austria (AUT), all countries display a negative, statistically significant, coefficient. By contrast, the effect on the extensive margin (employment) is always negative and statistically significant. It is also much larger. Consider the case of Sweden (SWE): a 1 standard-deviation drop of the value of the physical health index is associated with a reduction of 2.7 hours of work [average is 39.6 hours], but a 14-percentage points reduction of the employment rate [average among respondents aged 50-54 is 93 percentage points]. The last line of Table 5.A. reports (in terms of hours of work) the combined effect of the intensive and extensive margin. If we focus again on Sweden, the estimated impact of 1 standard-deviation drop of physical health amounts to -7.25 hours of work (average is 36.8 hours).

Table 5.B. exposes the results for cognition. It is immediate to see that the association between poor cognition and labour supply is weaker. In many countries, the correlation between poor cognition at the age of 50-54 and the number hours worked (intensive margin) is not statistically significant. If we turn to the effect on employment, again for Sweden (SWE), we now have that 1 standard-deviation drop is associated with a 7 percentage points decline of the employment rate.

Table 5.C contains OLS results when physical health and cognition are included in the model. They suggest that poor physical health is the main driver of the reduction of labour supply. The results also confirm that the adjustment to ill health primarily takes the form an interruption of work, rather than a reduction of the number of hours of work. This hints at the predominant role of the extensive margin regarding how workers and employers cope with health problems.

Table 5.D. contains the results of the model where the subjective physical health index has been instrumented by the objective health variables listed in Table 3. We get the confirmation that the extensive margin is the main adjustment channel to ill health. More importantly, if we focus of the magnitude of the (negative) employment effect of ill health, we see that it is larger than with OLS. Referring to the methodological discussion in Section 2, this suggests that the attenuation bias (due to proxying/measurement errors) is stronger than the justification bias (Baker et al., 2010).

Table 5.E contains the results of our preferred model where IV is combined to FE. Results confirm the importance of ill health over that of cognition when it comes to predicting older labour supply. They also confirm the pre-eminence of the extensive over the intensive margin in the presence of health issues. What is more, the double correction for endogeneity (IV+FE) suggests that OLS underestimates the impact of ill health on labour supply. In the case of Sweden, a drop of 1 standard-deviation along the health index causes a reduction of the employment rate of 19 percentage points (14 points with OLS). The other countries display similar magnitudes [always higher than with OLS], ranging from -13 percentages points for Italy (ITA) to -25 percentage points for Austria (AUT).

Table 6 displays the stage-two results. These are based on stage-one coefficients obtained with IV-FE (Table 5.E) i.e. the estimates we consider as the most robust one from an econometric viewpoint. Note that in Table A.2 in the Appendix, we report the outcome of the comparison of the predicted total labour supply (*LSUP*) decline using OLS vs IV-FE. For all countries, we find that IV-FE predicts a *larger* decline than OLS; and for most of them the difference is statistically significant. In Table A.3, we report the results of a similar comparison, between two specifications of the IV-FE model. One with physical health only, vs one with physical health *and* cognition. We find no strong evidence in support of the richer specification that includes cognition. We interpret the absence of statistically significant difference in terms of predicted *LSUP*, as additional evidence that cognition does not matter much when it comes the evolution of work capacity.

The results displayed in Table 6 consist mostly of *predictions* as to what labour supply should be, were health and cognition be its only determinants. We have chosen the age of 70 to compute the reported results (and age 50 as the reference). In panel A., for instance for Sweden, we see that the employment rate should drop by 7 percentage points. And the overall labour supply should decline by 3.17 hours. Panel B. reports the same computations but in relative terms. Perhaps more interestingly, panel C. presents our estimates of  $\delta^{Z,50-70}$  (eq. [3.],[6.] in Section 2), that is to say the share of the observed labour supply decline that can be ascribed to the deterioration of health and/or cognition. For Sweden (SWE) health/cognition decline only accounts for 3 percentage points of the observed decline of weekly hours. And bootstrapped standard errors suggest that this share is not statistically different from zero. As to employment, health/cognition explain 9 percentage points of the observed decline; a share that is statistically significant. And considering the overall labour supply, we also get a health/cognition-related share of about 9 percentage points. Turning to the other countries, we see that shares explained by health/cognition decline are always statistically significant for the extensive margin (i.e. the employment rate). Also, these shares can rise to 31% in the case of Spain (ESP). Switzerland (CHE) is the only country for which we find a share that is not statistically different than zero. Such a result derives primarily from the very low propensity of health in Switzerland to decline between 50 and 70.<sup>18</sup>

Figure 5 visualises and extends the results of Table 6- panel A, B, as it displays the predicted labour supply for all possible ages between 50 and 75. Panel A. focuses on individuals aged 50-75 and suggests sizeable labour supply reductions. Panel B. adds the very old individuals, aged 76 to 95 and tentatively highlights the uneven pace of health decline. The pattern that emerges — and more so it seems if relatively rich countries like Austria (AUT), Switzerland (CHE), Germany (DEU), Denmark (DNK) or Sweden (SWE) — is that of a relatively limited decline until individuals turn 70, followed by an acceleration after that, which logically translates into much lower labour supply. Our model is capable to predict reductions of 50 percentage points of the level of labour supply observed at 50, but for individuals that are much older than 70, or even 75. This hints at the presence of a largely underused work capacity, and that for all the countries examined here.

Figures 6, 7 & 8 are the graphical extensions of Table 6, panel C. They confront our labour supply predictions to the actual labour supply observed among individuals older than 50. They invariably illustrate, country by country, the existence of an important gap between work capacity (as

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<sup>18</sup> On Figure 1, Switzerland is the country displaying the flatter age/ill-health profile.



predicted by the evolution of health/cognition) and the actual level of labour supply. In Sweden, for instance, (Figure 6, last graph), we predict a reduction of the overall labour supply (*LSUP*) from 36.8 to 32.1 hours, between the age of 50 and the age of 75. By contrast, the actual labour supply at that age is zero. The gap is less dramatic if we consider individuals aged 65, but still quite important; suggesting that even at that age the unused work capacity is important. It is only below the age of 60 that we get some (visual) alignment between the health/cognition- driven prediction and the observed level of labour supply. Figure 6 also reveals the heterogeneity across countries regarding the moment a significant gap opens between the estimated work capacity and the actual supply of labour. Sweden is in fact the country where it opens the latest; reflecting the well-publicized performance of the country when it comes to maintaining its older citizens in employment (OCDE, 2006).

Table 5 — Stage one results: impact of physical health & cognition on labour supply of individuals aged 50-54  
(point estimates of the effect of a one standard deviation increment of the index on hours [a], employment [b] and total labour supply [c]<sup>£</sup>)

A. [OLS] *Poor physical health index*

Outcome	AUT	BEL	CHE	CZE	DEU	DNK	ESP	EST	FRA	ITA	LUX	PRT	SVN	SWE
<i>HOURS</i>	-0.57 (0.153)	-1.30*** (0.000)	-1.04*** (0.001)	-1.70** (0.002)	-1.31** (0.010)	-2.11*** (0.000)	-2.36** (0.008)	-0.55 (0.086)	-1.16* (0.041)	-1.49* (0.026)	-1.98* (0.011)	3.80* (0.024)	-1.40* (0.012)	-2.70*** (0.000)
<i>EMPL</i>	-0.19*** (0.000)	-0.17*** (0.000)	-0.11*** (0.000)	-0.20*** (0.000)	-0.15*** (0.000)	-0.17*** (0.000)	-0.15*** (0.000)	-0.17*** (0.000)	-0.14*** (0.000)	-0.08*** (0.000)	-0.06** (0.008)	-0.12*** (0.000)	-0.14*** (0.000)	-0.14*** (0.000)
<i>LSUP<sup>£</sup></i>	-7.58*** (0.000)	-6.78*** (0.000)	-4.61*** (0.000)	-9.15*** (0.000)	-6.20*** (0.000)	-7.64*** (0.000)	-6.94*** (0.000)	-7.17*** (0.000)	-5.85*** (0.000)	-4.03*** (0.000)	-3.13*** (0.000)	-2.54*** (0.000)	-6.41*** (0.000)	-7.25*** (0.000)
<i>N</i>	1,490	3,505	1,395	1,733	2,325	2,328	1,804	2,010	2,308	1,929	431	371	1,068	998

<sup>£</sup>: The combination of hours (*HOURS*) and employment (*EMPL*)

B. [OLS] *Poor cognition index*

Outcome	AUT	BEL	CHE	CZE	DEU	DNK	ESP	EST	FRA	ITA	LUX	PRT	SVN	SWE
<i>HOURS</i>	-0.49 (0.375)	-0.19 (0.754)	0.07 (0.936)	0.37 (0.326)	0.33 (0.718)	-0.31 (0.569)	-1.40 (0.057)	-1.09** (0.001)	-0.62 (0.167)	-1.86*** (0.000)	-1.05 (0.115)	-0.17 (0.957)	-0.85* (0.030)	-0.98 (0.404)
<i>EMPL</i>	-0.03* (0.037)	-0.11*** (0.000)	-0.08* (0.020)	-0.11*** (0.000)	-0.10*** (0.000)	-0.08*** (0.000)	-0.11*** (0.000)	-0.08** (0.004)	-0.08** (0.001)	-0.09*** (0.000)	-0.04 (0.323)	-0.07** (0.004)	-0.09** (0.001)	-0.07* (0.043)
<i>LSUP<sup>£</sup></i>	-1.21** (0.002)	-3.89*** (0.000)	-2.47 (0.073)	-4.19*** (0.000)	-3.18** (0.002)	-3.22*** (0.000)	-5.14*** (0.000)	-4.01*** (0.001)	-3.54*** (0.001)	-4.59*** (0.000)	-2.20 (0.095)	-1.88* (0.034)	-4.11*** (0.000)	-3.43** (0.005)
<i>N</i>	1,490	3,505	1,395	1,733	2,325	2,328	1,804	2,010	2,308	1,929	431	371	1,068	998

<sup>£</sup>: The combination of hours (*HOURS*) and employment (*EMPL*)

## C. [OLS]

## Poor physical health and poor cognition

Outcome	AUT	BEL	CHE	CZE	DEU	DNK	ESP	EST	FRA	ITA	LUX	PRT	SVN	SWE
<i>Physical health index</i>														
<i>HOURS</i>	-1.14 (0.413)	-1.69* (0.024)	-1.67*** (0.000)	-1.77* (0.028)	-2.22** (0.003)	-2.48*** (0.000)	-2.51 (0.081)	-0.59 (0.140)	-2.10*** (0.000)	-1.13 (0.096)	-3.06*** (0.001)	3.72* (0.035)	-2.15*** (0.001)	-1.56 (0.078)
<i>EMPL</i>	-0.19*** (0.000)	-0.16*** (0.000)	-0.12*** (0.000)	-0.20*** (0.000)	-0.16*** (0.000)	-0.19*** (0.000)	-0.11*** (0.000)	-0.18*** (0.000)	-0.16*** (0.000)	-0.10** (0.001)	-0.13*** (0.000)	-0.12*** (0.000)	-0.14*** (0.000)	-0.14*** (0.000)
<i>LSUP<sup>£</sup></i>	-7.70*** (0.000)	-6.91*** (0.000)	-5.56*** (0.000)	-9.32*** (0.000)	-7.17*** (0.000)	-8.62*** (0.000)	-5.64*** (0.000)	-7.63*** (0.000)	-6.96*** (0.000)	-4.18*** (0.000)	-6.59*** (0.000)	-2.37*** (0.000)	-6.97*** (0.000)	-6.68*** (0.000)
<i>Cognition index</i>														
<i>HOURS</i>	0.24 (0.732)	-0.07 (0.903)	1.55 (0.178)	0.43 (0.266)	0.31 (0.700)	-0.43 (0.391)	-0.65 (0.457)	-0.73*** (0.000)	-0.82 (0.203)	-1.72*** (0.000)	-0.27 (0.776)	1.12 (0.759)	-1.35*** (0.001)	-0.37 (0.726)
<i>EMPL</i>	-0.02 (0.215)	-0.10*** (0.000)	-0.05* (0.045)	-0.09*** (0.000)	-0.09*** (0.000)	-0.06*** (0.000)	-0.13*** (0.000)	-0.07** (0.006)	-0.06* (0.012)	-0.15** (0.000)	-0.03 (0.525)	-0.07*** (0.001)	-0.13*** (0.000)	-0.06* (0.022)
<i>LSUP<sup>£</sup></i>	-0.47 (0.456)	-3.70*** (0.000)	-0.53 (0.636)	-3.33*** (0.000)	-2.67*** (0.001)	-2.48** (0.005)	-5.57*** (0.000)	-3.31** (0.002)	-2.69* (0.014)	-6.64*** (0.000)	-1.15 (0.320)	-1.64 (0.058)	-5.74*** (0.000)	-2.55* (0.042)
<i>N</i>	723	1,748	569	780	1,072	960	822	1,399	1,048	1,044	328	320	720	295

£: The combination of hours (*HOURS*) and employment (*EMPL*)

D. [IV<sup>§</sup>]

## Poor physical health and cognition

Outcome	AUT	BEL	CHE	CZE	DEU	DNK	ESP	EST	FRA	ITA	LUX	PRT	SVN	SWE
<i>Physical health index</i>														
<i>HOURS</i>	-0.78 (0.680)	-2.84** (0.005)	-1.41 (0.358)	-2.42** (0.005)	-1.28 (0.215)	-3.11** (0.002)	-1.70 (0.519)	-1.05 (0.167)	-2.53*** (0.001)	-0.88 (0.410)	-4.82** (0.007)	4.85* (0.039)	-2.68* (0.023)	-3.02 (0.106)
<i>EMPL</i>	-0.24*** (0.000)	-0.23*** (0.000)	-0.12*** (0.000)	-0.23*** (0.000)	-0.17*** (0.000)	-0.19*** (0.000)	-0.17*** (0.000)	-0.21*** (0.000)	-0.19*** (0.000)	-0.16*** (0.000)	-0.24** (0.002)	-0.18*** (0.001)	-0.25*** (0.000)	-0.18*** (0.000)
<i>LSUP<sup>£</sup></i>	-9.76*** (0.000)	-10.12*** (0.000)	-6.59*** (0.000)	-11.17*** (0.000)	-8.88*** (0.000)	-10.10*** (0.000)	-8.01*** (0.000)	-9.40*** (0.000)	-8.77*** (0.000)	-7.14*** (0.000)	-13.51*** (0.000)	-5.83** (0.004)	-11.85*** (0.000)	-10.46*** (0.000)
<i>Cognition index</i>														
<i>HOURS</i>	-1.92* (0.016)	-1.23*** (0.000)	-2.89*** (0.000)	-0.55 (0.072)	-1.10*** (0.000)	-1.01* (0.046)	-0.57 (0.541)	-0.26 (0.305)	-0.81 (0.054)	-1.32** (0.002)	-1.12 (0.257)	-0.60 (0.584)	-0.32 (0.581)	-0.26 (0.713)
<i>EMPL</i>	-0.03 (0.063)	-0.03* (0.027)	-0.03** (0.004)	-0.04* (0.021)	-0.02 (0.242)	-0.02 (0.126)	-0.09*** (0.000)	-0.02 (0.092)	-0.00 (0.812)	-0.05** (0.004)	0.06 (0.068)	-0.01 (0.795)	0.00 (0.892)	0.00 (0.762)
<i>LSUP<sup>£</sup></i>	-2.30** (0.003)	-1.82*** (0.000)	-3.31*** (0.000)	-1.96** (0.003)	-1.02* (0.019)	-1.18* (0.026)	-3.51*** (0.000)	-0.59 (0.171)	-0.84 (0.225)	-2.55** (0.002)	0.85 (0.534)	0.19 (0.827)	-0.12 (0.913)	0.36 (0.476)
<i>N</i>	723	1,748	569	780	1,072	960	822	1,399	1,048	1,044	328	320	720	295

§: physical/subjective health index instrumented by objective variables listed in Table 3.

£: The combination of hours (*HOURS*) and employment (*EMPL*)

Outcome	AUT	BEL	CHE	CZE	DEU	DNK	ESP	EST	FRA	ITA	LUX	PRT	SVN	SWE
<i>Physical health index</i>														
<i>HOURS</i>	-2.12 (0.389)	-3.49** (0.007)	-3.57*** (0.000)	-3.64*** (0.000)	-3.36** (0.002)	-3.70** (0.003)	-4.11 (0.069)	-0.76 (0.326)	-4.37*** (0.000)	-3.43* (0.032)	-7.29*** (0.000)	3.50 (0.474)	-4.38** (0.002)	-1.99 (0.059)
<i>EMPL</i>	-0.25*** (0.000)	-0.21*** (0.000)	-0.15** (0.001)	-0.27*** (0.000)	-0.21*** (0.000)	-0.22*** (0.000)	-0.20*** (0.000)	-0.22*** (0.000)	-0.18*** (0.000)	-0.13** (0.002)	-0.19*** (0.000)	-0.16** (0.001)	-0.22*** (0.000)	-0.19*** (0.000)
<i>LSUP<sup>‡</sup></i>	-10.82*** (0.000)	-9.32*** (0.000)	-7.82*** (0.000)	-13.13*** (0.000)	-9.47*** (0.000)	-10.36*** (0.000)	-9.44*** (0.000)	-9.35*** (0.000)	-8.72*** (0.000)	-6.48*** (0.000)	-11.61*** (0.000)	-3.87* (0.035)	-10.74*** (0.000)	-8.47*** (0.000)
<i>Cognition index</i>														
<i>HOURS</i>	-0.41 (0.645)	0.21 (0.698)	1.48 (0.297)	0.83* (0.029)	0.61 (0.470)	-0.35 (0.509)	-0.73 (0.447)	-0.72*** (0.000)	-0.34 (0.616)	-1.73** (0.005)	0.56 (0.607)	1.28 (0.765)	-0.90 (0.108)	-0.25 (0.827)
<i>EMPL</i>	-0.04 (0.192)	-0.08*** (0.000)	-0.05 (0.081)	-0.06*** (0.000)	-0.06*** (0.000)	-0.05** (0.003)	-0.12*** (0.000)	-0.07** (0.007)	-0.06** (0.009)	-0.16*** (0.000)	0.01 (0.871)	-0.06* (0.010)	-0.10*** (0.000)	-0.04 (0.130)
<i>LSUP<sup>‡</sup></i>	-1.68 (0.161)	-2.80*** (0.000)	-0.40 (0.704)	-1.78** (0.002)	-1.58 (0.053)	-1.97* (0.027)	-5.04*** (0.000)	-3.38** (0.003)	-2.38* (0.036)	-6.81*** (0.000)	0.28 (0.831)	-1.13 (0.322)	-4.43*** (0.000)	-1.87 (0.172)
<i>N</i>	667	1,684	555	739	1,036	950	794	1,343	1,007	975	309	302	675	291

*p*-values in parentheses

Source: SHARE 2004-2015

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

<sup>‡</sup>: The combination of hours and employment

\$: physical/subjective health index instrumented by objective variables listed in Table 3.

Table 6 — Stage-two results: labour supply reduction among 70 year olds (ref. 50 year-olds) explained by poor physical health and/or cognition.  
(Estimates based on stage one IV-FE health/cognition to labour supply relationship- see Table 5.E.)

	AUT <sup>n</sup>	BEL	CHE	CZE	DEU	DNK	ESP	EST	FRA	ITA	LUX	PRT	SVN	SWE
<i>A. Level of reduction explained (0= 50-54 level)</i>														
<i>HOURS</i>	-0.84 (0.258)	-0.94* (0.014)	0.22 (0.724)	-1.62* (0.030)	-1.04 (0.082)	-1.02* (0.038)	-2.34** (0.008)	-0.80 (0.091)	-1.31*** (0.001)	-2.47** (0.001)	-2.69** (0.003)	2.26 (0.311)	-2.91*** (0.000)	-0.66 (0.268)
<i>EMPL</i>	-0.10*** (0.000)	-0.10*** (0.000)	-0.04*** (0.001)	-0.18*** (0.000)	-0.12*** (0.000)	-0.07*** (0.000)	-0.17*** (0.000)	-0.16*** (0.000)	-0.07*** (0.000)	-0.13*** (0.000)	-0.08** (0.008)	-0.10*** (0.000)	-0.18*** (0.000)	-0.07*** (0.000)
<i>LSUP<sup>ℓ</sup></i>	-4.21*** (0.000)	-4.22*** (0.000)	-1.16 (0.080)	-8.09*** (0.000)	-4.89*** (0.000)	-3.30*** (0.001)	-7.67*** (0.000)	-6.96*** (0.000)	-3.22*** (0.000)	-6.01*** (0.000)	-4.57*** (0.000)	-2.34* (0.012)	-8.61*** (0.000)	-3.17*** (0.000)
<i>B. Relative reduction explained (1= 50-54 level)</i>														
<i>HOURS</i>	-0.02 (0.261)	-0.03* (0.015)	0.01 (0.726)	-0.04* (0.032)	-0.03 (0.084)	-0.03* (0.039)	-0.06** (0.009)	-0.02 (0.093)	-0.04*** (0.001)	-0.07** (0.001)	-0.07** (0.003)	0.08 (0.292)	-0.07*** (0.000)	-0.02 (0.272)
<i>EMPL</i>	-0.13*** (0.000)	-0.13*** (0.000)	-0.05*** (0.000)	-0.22*** (0.000)	-0.15*** (0.000)	-0.08*** (0.000)	-0.24*** (0.000)	-0.21*** (0.000)	-0.09*** (0.000)	-0.18*** (0.000)	-0.10** (0.009)	-0.24*** (0.000)	-0.24*** (0.000)	-0.08*** (0.000)
<i>LSUP<sup>ℓ</sup></i>	-0.15*** (0.000)	-0.14*** (0.000)	-0.04 (0.078)	-0.24*** (0.000)	-0.16*** (0.000)	-0.10*** (0.001)	-0.28*** (0.000)	-0.23*** (0.000)	-0.11*** (0.000)	-0.22*** (0.000)	-0.16*** (0.000)	-0.19* (0.017)	-0.29*** (0.000)	-0.09*** (0.000)
<i>C. Share of observed labour supply reduction explained by health and/or cognition decline (1=100%), <math>\delta^{Z,50-70}</math>. a,b</i>														
<i>HOURS</i>	0.05 (0.266)	0.08* (0.027)	-0.01 (0.722)	0.08* (0.028)	0.06 (0.087)	0.05* (0.043)	0.52 (0.783)	0.09 (0.100)	0.09** (0.003)	0.51 (0.847)	0.12* (0.020)	1.10 (0.750)	0.14*** (0.001)	0.03 (0.273)
<i>EMPL</i>	0.14*** (0.000)	0.14*** (0.000)	0.06*** (0.000)	0.25*** (0.000)	0.17*** (0.000)	0.10*** (0.000)	0.26*** (0.000)	0.25*** (0.000)	0.09*** (0.000)	0.20*** (0.000)	0.10** (0.009)	0.23*** (0.000)	0.25*** (0.000)	0.09*** (0.000)
<i>LSUP<sup>ℓ</sup></i>	0.15*** (0.000)	0.16*** (0.000)	0.04 (0.077)	0.26*** (0.000)	0.18*** (0.000)	0.11*** (0.001)	0.31*** (0.000)	0.25*** (0.000)	0.11*** (0.000)	0.25*** (0.000)	0.17*** (0.000)	0.17* (0.015)	0.29*** (0.000)	0.09*** (0.000)
<i>N</i>	15,224	22,487	11,634	18,057	16,710	13,927	15,374	17,369	16,865	17,574	3,048	3,297	9,321	15,616

*p*-values in parentheses

Source: SHARE 2004-2015

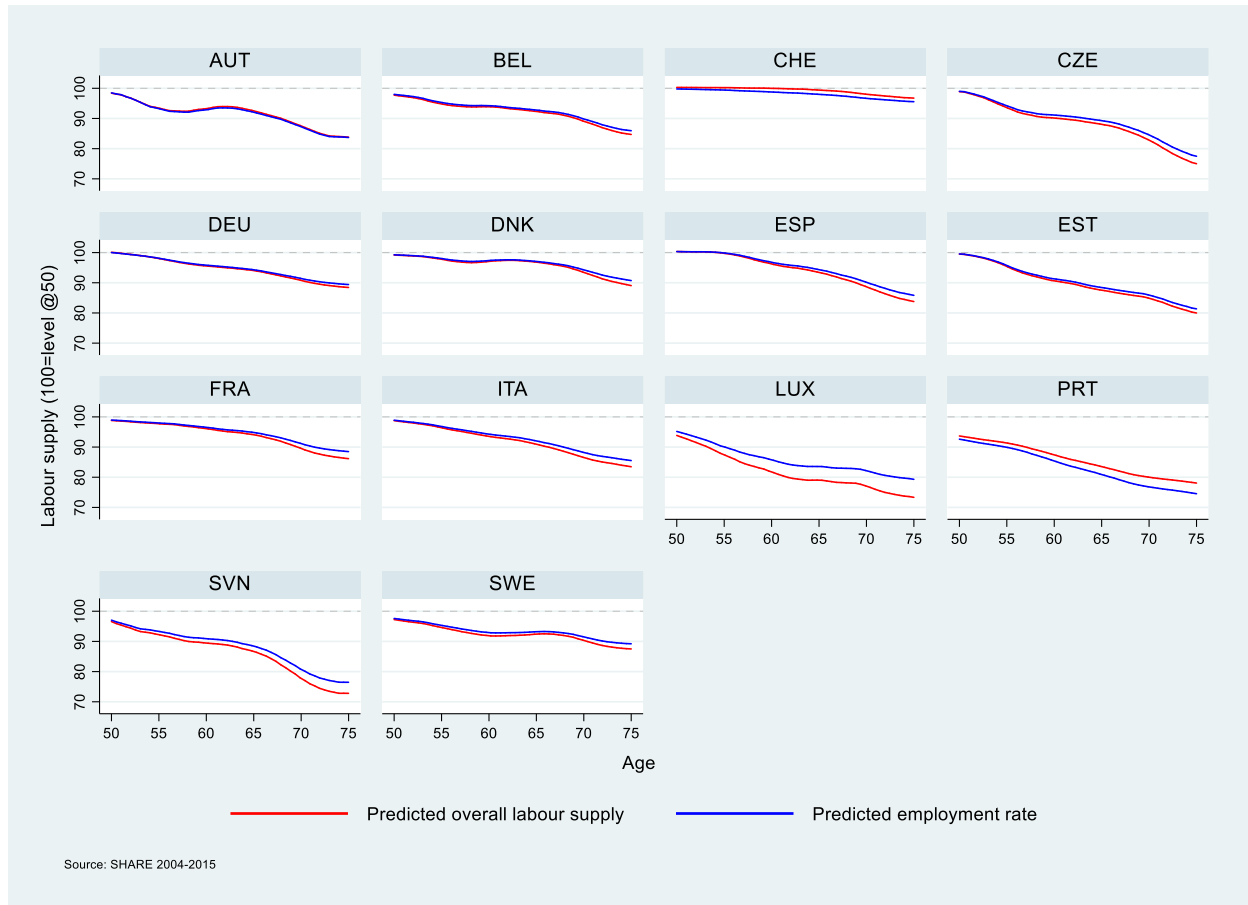
\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

<sup>a</sup>: corresponding to eq. [3.] and [6.] in Section 2.

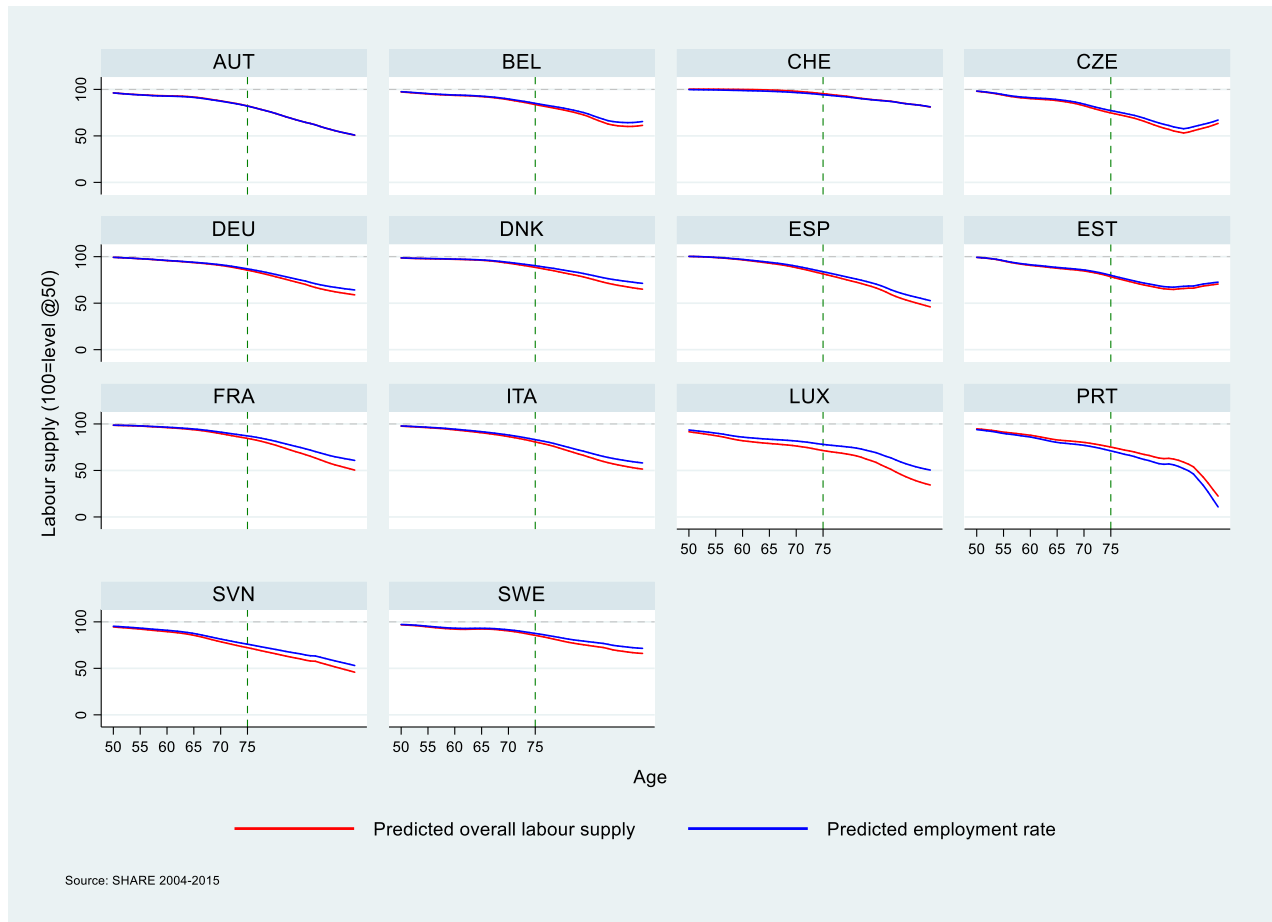
<sup>b</sup>: The effect of cross-cohort compositional differences has been neutralised via inverse propensity score weighing, for a set of background characteristics that comprise and education (ISCED, 6 levels of attainment classification).

Figure 5 — Age, predicted employment rate (*EMPL*) & overall labour supply(*LSUP*)<sup>a,b</sup>

A. Individuals aged 50-75



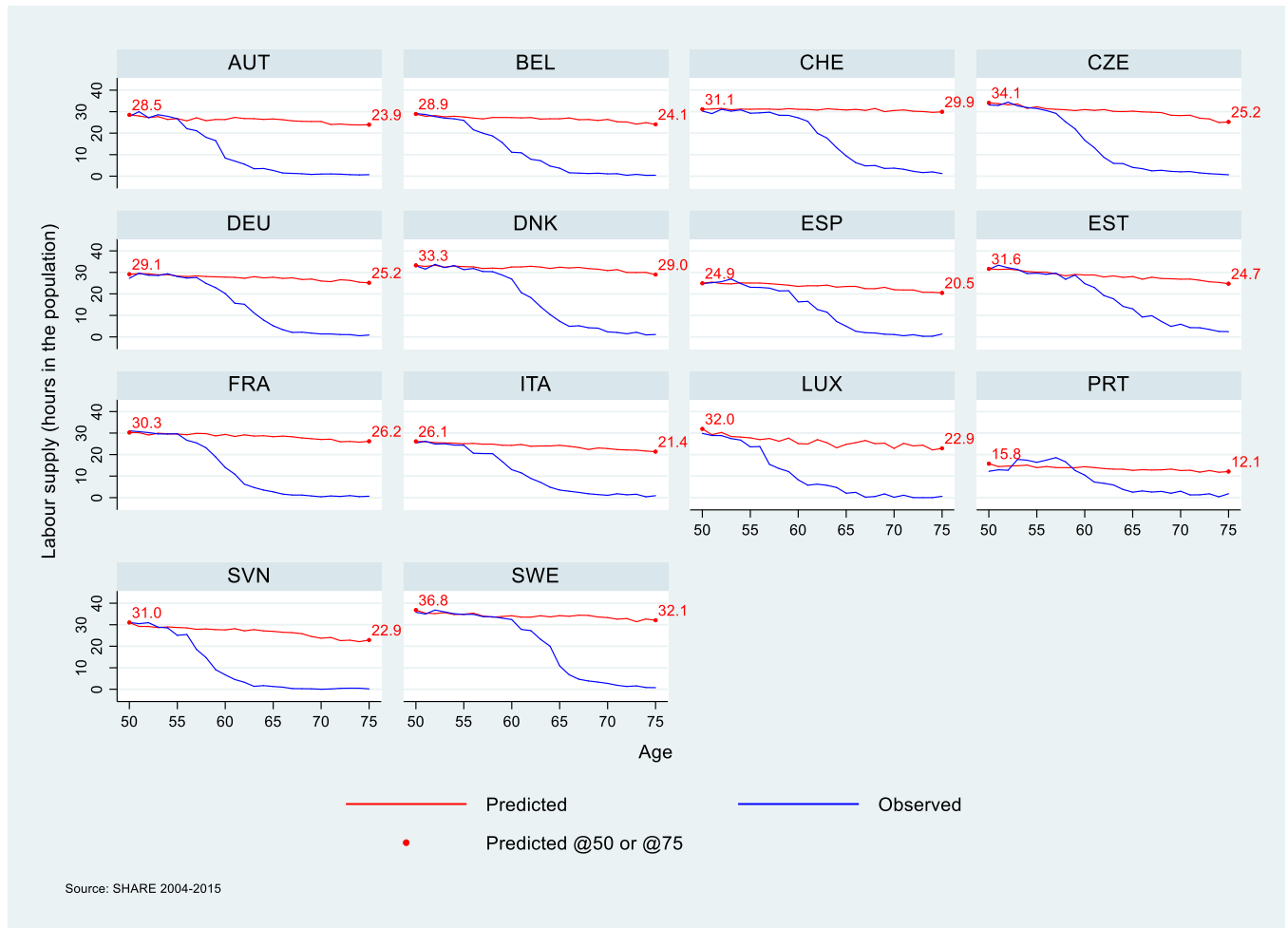
B. Individuals aged 50-95



<sup>a</sup>: the predicted evolution of hours corresponds to the difference between total labour supply and employment

<sup>b</sup>: the effect of cross-cohort compositional differences has been neutralised via inverse propensity score weighing, for a set of background characteristics that comprise and education (ISCED, 6 levels of attainment classification).

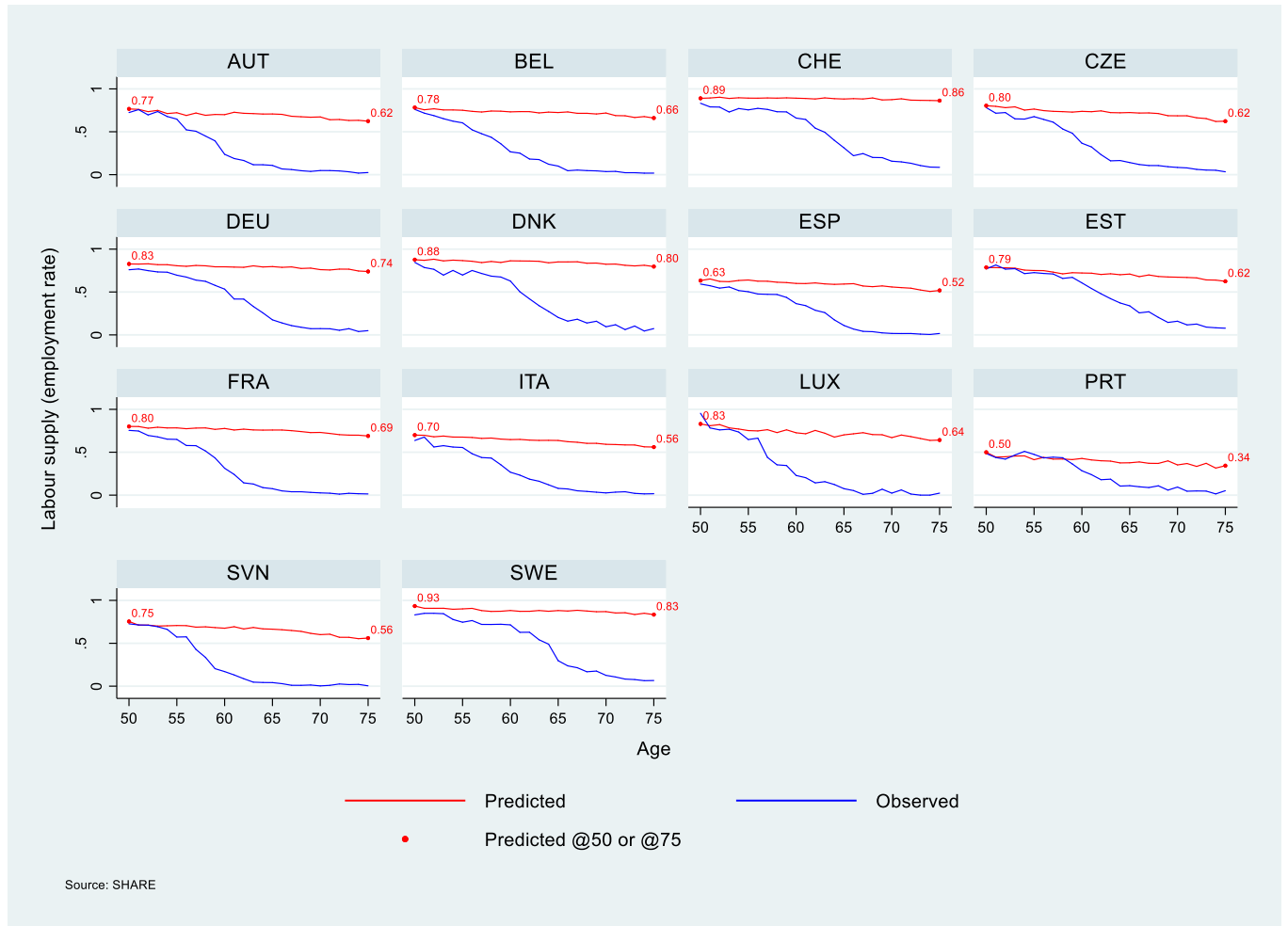
Figure 6 — Age, predicted vs observed<sup>S</sup> overall labour supply (*LSUP*)



<sup>S</sup>: The effect of cross-cohort compositional differences has been neutralised via inverse propensity score weighing, for a set of background characteristics that comprise and education (ISCED, 6 levels of attainment classification).

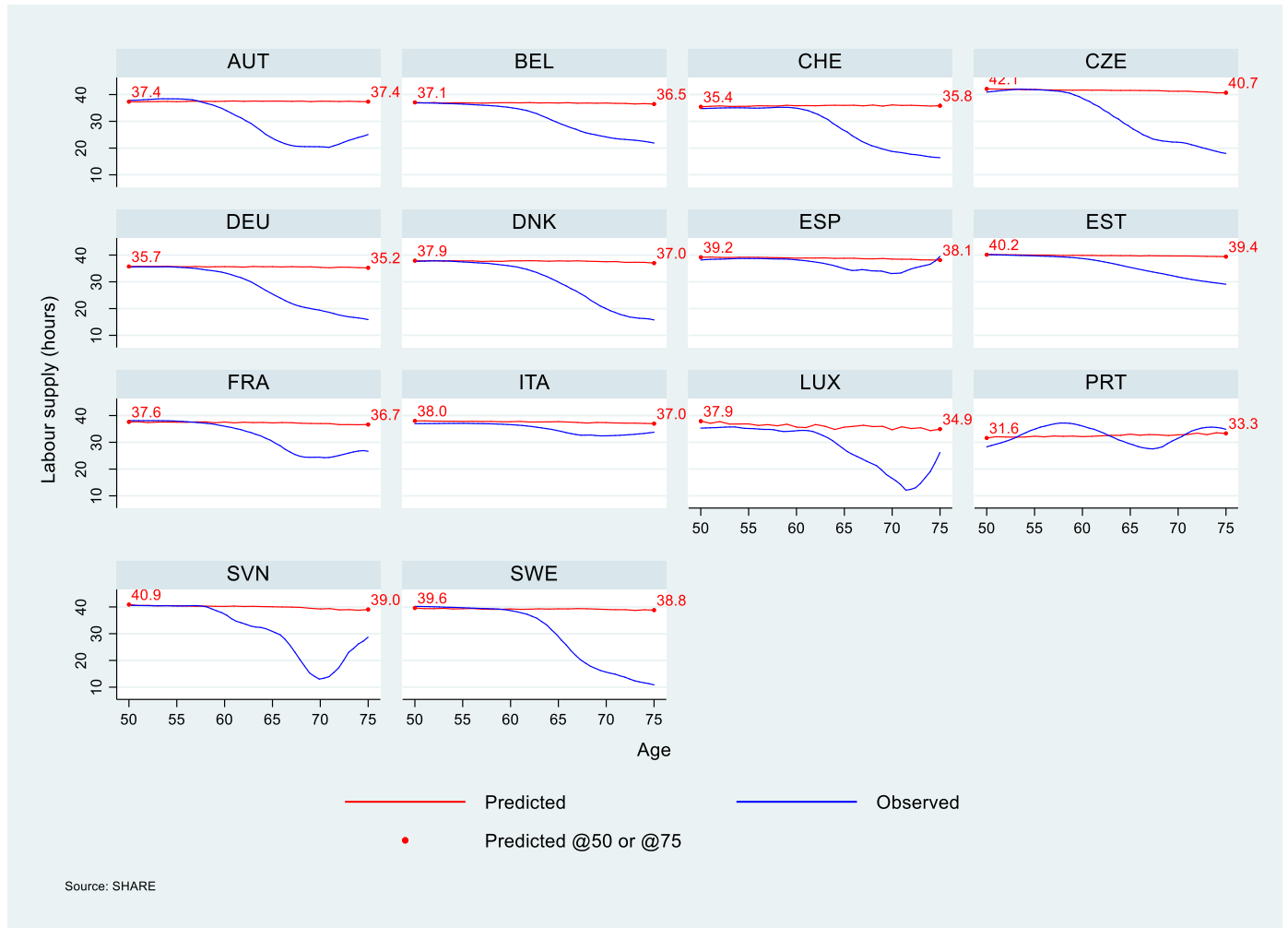


Figure 7 — Age, predicted vs observed<sup>§</sup> employment rate (EMPL)



<sup>§</sup>: The effect of cross-cohort compositional differences has been neutralised via inverse propensity score weighing, for a set of background characteristics that comprise and education (ISCED, 6 levels of attainment classification).

Figure 8 — Age, predicted vs observed<sup>s</sup> working hours (*HOURS*)



<sup>s</sup>: The effect of cross-cohort compositional differences has been neutralised via inverse propensity score weighing, for a set of background characteristics that comprise and education (ISCED, 6 levels of attainment classification).

## 5. Concluding remarks

The rise of old-age dependency in Europe and elsewhere explains the proliferation of reforms aimed at lifting the effective age of retirement. In countries like Japan, Netherlands or Denmark<sup>19</sup> legislation has been enacted that explicitly index retirement on life expectancy. Other countries do the same implicitly. A recurrent question however, is whether, in these countries, older individuals have the health/cognitive capacity to work longer. Following the seminal work of Cutler et al. (2013), this paper explores this question by asking how much older individuals *could* work were they animated by the same propensity to work as their younger (50-54) peers, in similar health or in possession of the same cognitive skills.

Contrary to most existing papers, this one quantifies work capacity simultaneously for 14 European countries (AUT, BEL, CHE, CZE, DEU, DNK, ESP, EST, FRA, ITA, LUX, PRT, SVN, SWE). It uses comparable/harmonized panel microdata, amassed via the Survey of Health, Ageing and Retirement in Europe (SHARE). Another strength of the paper is that it considers physical health, but also cognition — a dimension that has so far received less attention.<sup>20</sup> What is more, health consists of subjective and objective measures. Also, — and to our knowledge this is the first time — the paper examines the extensive (employment) and the intensive margin of work (duration of work): existing papers only consider the decision to work, and do not look at the relationship between ill health and/or poor cognition and the number of hours worked.

The results gathered in this paper are essentially fivefold. First, there is evidence that people aged 50-54 with health issues significantly reduce their participation to employment. Second, for that group the negative impact of ill health on the number of hours worked is also significant from a statistical viewpoint but is of much smaller magnitude. This suggests — at least in the context of the 14 European countries considered here — that people suffering from ill health rarely adjust labour supply at the intensive margin; they rather stop working altogether. That

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<sup>19</sup> In 2006 the Danish government enacted a welfare reform, increasing the pension age from 65 to 67 between 2024 and 2027. Furthermore, from 2025, the age limits in the retirement system will be indexed to the mean life expectancy of 60 year olds.

<sup>20</sup> A notable exception is Blundell et al. (2017). Other authors have examined the relationship with earnings (Anger & Heineck, 2010).

raises questions about the interest of reduced hours/flexitime to address the needs of older workers with health problems. These work arrangements are usually considered of the highest importance when it comes to supporting an ageing workforce. At the very least, our results indicate that, during the 2000s in Europe, they were far from being common practice. Third, cognitive performance is not fundamentally driven by age. It varies a lot across individuals aged 50+ but does not decline markedly due to age. Consequently, it adds little explanatory power when it comes to predicting work capacity. This result aligns with the recent findings of Blundell et al. (2017) for the UK and the US. Fourth, when it comes to health, cognition and labour supply, identification issues exist and must be properly addressed. They comprise unobserved heterogeneity across respondents, that call for the use of panel data and fixed effects estimation (FE). There is also the problem of the justification bias (i.e. the propensity of unemployed people to "justify" their lack of employment by health issues). Finally, there is the problem of proxying/measurement errors inherent to the absence of proper measure of the total "stock" of health and/or cognition. Most health items available in datasets are self-reported/subjective or consists of proxies of the actual stock of health. We find here that the use of objective measures of health to instrument (IV) subjective health indexes makes a difference, as it leads to *larger* estimates of ill health/labour supply elasticity. Finally, we find that work capacity remains very high for many older adults, certainly up to the age of 70. Declines in health/cognition explain at most 31% of the observed labour supply reduction between the age of 50 and 70. These results come as a confirmation of the existence of a currently underused work capacity among older individuals, and that across a relatively large and diverse group of European countries.

Our results show that there is significant work capacity at older ages, including in countries with, by European standards, lower income per head (Estonia, Slovenia, Czech Republic, Portugal). For many individuals, the lack of employment at older ages does not appear to be a consequence of ill health or age-driven poor cognition. Therefore, policymakers wanting to increase employment rates of older people should, in priority, focus on the other barriers to old employment. They comprise supply-side barriers like a preference for leisure, the fact that spouses' retirement decisions tend to be correlated, caretaking obligations or still — despite many pension reforms — financial disincentives to postpone retirement. More on the demand side, older individuals' capacity to work may be seriously hampered by rampant age discrimination

(Neumark et al. 2015), or an employability handicap driven by a low productivity/labour cost ratio (Vandenberghe, 2013; Dostie, 2011).

Also, it is important to repeat that the conclusion of the paper is not to say that all those whose health/cognition means that they *could* work *should* necessary work. Some individuals may well prefer to choose to retire early and receive a smaller pension. And some countries could afford, or would be willing, to pay for retirement before work capacity declines markedly.

Finally, it is useful to recall that the methods and results presented in this paper address the work capacity of the population overall. Even if, as amply shown by this paper, the health/cognition of most individuals is sufficiently good to work beyond 50, 60 or even 70, there are many individuals that are too sick/disable to work. Already some (relatively) young individuals aged 50-54 are prevented from working due to their bad health condition.<sup>21</sup> Thus, as already stated by Culter et al. (2013), it is crucial that decision makers consider the needs of such individuals and, for instance, provide well-designed disability insurance and active labour market programmes that can reliably assess the absence or limited capacity to work.

## Acknowledgment

This paper uses data from SHARE Waves 1, 2, 3 (SHARELIFE), 4, 5 and 6 (DOIs: [10.6103/SHARE.w1.611](https://doi.org/10.6103/SHARE.w1.611), [10.6103/SHARE.w2.611](https://doi.org/10.6103/SHARE.w2.611), [10.6103/SHARE.w3.611](https://doi.org/10.6103/SHARE.w3.611), [10.6103/SHARE.w4.611](https://doi.org/10.6103/SHARE.w4.611), [10.6103/SHARE.w5.611](https://doi.org/10.6103/SHARE.w5.611), [10.6103/SHARE.w6.611](https://doi.org/10.6103/SHARE.w6.611)), see Börsch-Supan et al. (2013) for methodological details. The SHARE data collection has been primarily funded by the European Commission through FP5 (QLK6-CT-2001-00360), FP6 (SHARE-I3: RII-CT-2006-062193, COMPARE: CIT5-CT-2005-028857, SHARELIFE: CIT4-CT-2006-028812) and FP7 (SHARE-PREP: N°211909, SHARE-LEAP: N°227822, SHARE M4: N°261982). Additional funding from the German Ministry of Education and Research, the Max Planck Society for the Advancement of Science, 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, OGHA\_04-064, HHSN271201300071C) and from various national funding sources is gratefully acknowledged (see [www.share-project.org](http://www.share-project.org)).

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<sup>21</sup> Otherwise, we would not be able to estimate the relation between health and labour supply, and compute estimates of work capacity.

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## Appendix

Table A.1 — Correlation<sup>a</sup> between age and poor physical health or [poor] cognition

### a. Poor physical health

#### a.1 OLS results:

	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	90-95
Age	0.023*** (0.004)	0.018*** (0.003)	0.014*** (0.003)	0.025*** (0.003)	0.042*** (0.004)	0.047*** (0.005)	0.052*** (0.007)	0.060*** (0.011)	0.058** (0.022)
Control	Gender X education(ISCED), country FE								
Rsq	23,695	31,983	33,493	31,090	25,593	19,397	12,857	6,249	1,907
R <sup>2</sup>	0.0621	0.0691	0.0651	0.0776	0.0820	0.0821	0.0734	0.0726	0.0487

#### a.2 Fixed effects (within individuals) results:

	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	90-95
Age	0.021*** (0.004)	0.020*** (0.003)	0.019*** (0.003)	0.034*** (0.003)	0.057*** (0.003)	0.071*** (0.004)	0.117*** (0.006)	0.153*** (0.010)	0.235*** (0.022)
Nobs	24,513	33,170	34,916	32,651	27,298	21,269	14,505	7,131	2,197
R <sup>2</sup> (within)	0.0058	0.0050	0.0043	0.0130	0.0323	0.0410	0.0886	0.1173	0.1759

### b. Poor cognition

#### b.1. OLS results

	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	90-95
Age	0.012* (0.005)	0.013* (0.005)	0.005 (0.006)	0.031*** (0.006)	0.038*** (0.007)	0.057*** (0.009)	0.055*** (0.013)	0.071** (0.023)	0.123* (0.056)
Controls	Gender X education(ISCED), country FE								
Nobs	11,504	9,638	9,338	7,948	6,403	4,625	2,845	1,280	312
R <sup>2</sup>	0.1753	0.1814	0.1869	0.2024	0.1915	0.1927	0.1568	0.1687	0.1210

#### b.2 Fixed effects (within individuals) results:

	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	90-95
Age	0.136 (0.096)	-0.041 (0.075)	-0.211 (0.139)	0.058 (0.091)	-0.060 (0.124)	-0.047 (0.088)	0.157 (0.205)	0.013 (0.397)	0.000 (.)
Nobs	11,838	9,919	9,631	8,281	6,804	5,069	3,256	1,484	368
R <sup>2</sup> (within)	0.1539	0.0106	0.1195	0.0301	0.0253	0.0215	0.1272	0.0011	.

Standard errors in parentheses

Source: SHARE

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

<sup>a</sup> As captured by regression coefficients. Within each age band, the capture the impact of additional year of age on the physical health/cognition index. A coefficient of 0.05 for instance means that an additional year of age leads to rise of 5 % of one standard deviation of our poor physical health/cognition index

Table A.2 — Stage one results: impact of physical health & cognition on total labour supply (*LSUP*) of individuals aged 50-54  
Comparison: OLS vs IV<sup>S</sup>-FE

	AUT	BEL	CHE	CZE	DEU	DNK	ESP	EST	FRA	ITA	LUX	PRT	SVN	SWE
<i>Model 1: OLS</i>														
Coef. (ph)	-7.70*** (0.000)	-6.91*** (0.000)	-5.56*** (0.000)	-9.32*** (0.000)	-7.17*** (0.000)	-8.62*** (0.000)	-5.64*** (0.000)	-7.63*** (0.000)	-6.96*** (0.000)	-4.18*** (0.000)	-6.59*** (0.000)	-2.37 (0.067)	-6.97*** (0.000)	-6.68*** (0.000)
Coef. (co)	-0.47 (0.518)	-3.70*** (0.000)	-0.53 (0.682)	-3.33*** (0.000)	-2.67*** (0.000)	-2.48*** (0.000)	-5.57*** (0.000)	-3.31*** (0.000)	-2.69*** (0.001)	-6.64*** (0.000)	-1.15 (0.238)	-1.64 (0.279)	-5.74*** (0.000)	-2.55* (0.020)
Decline [A]	-3.17*** (0.000)	-4.23*** (0.000)	-1.01 (0.063)	-6.63*** (0.000)	-3.95*** (0.000)	-3.75*** (0.000)	-7.57*** (0.000)	-6.66*** (0.000)	-3.69*** (0.000)	-6.93*** (0.000)	-3.45*** (0.000)	-2.20** (0.002)	-7.99*** (0.000)	-3.31*** (0.000)
<i>Model 2: IV-FE</i>														
Coef. (ph)	-10.82*** (0.000)	-9.32*** (0.000)	-7.82*** (0.000)	-13.13*** (0.000)	-9.47*** (0.000)	-10.36*** (0.000)	-9.44*** (0.000)	-9.35*** (0.000)	-8.72*** (0.000)	-6.48*** (0.000)	-11.61*** (0.000)	-3.87** (0.003)	-10.74*** (0.000)	-8.47*** (0.000)
Coef. (co)	-1.68 (0.154)	-2.80** (0.002)	-0.40 (0.731)	-1.78** (0.008)	-1.58* (0.021)	-1.97*** (0.000)	-5.04*** (0.000)	-3.38*** (0.000)	-2.38** (0.007)	-6.81*** (0.000)	0.28 (0.711)	-1.13 (0.517)	-4.43*** (0.000)	-1.87 (0.093)
Decline [B]	-4.753*** (0.000)	-4.532*** (0.000)	-1.260* (0.039)	-7.915*** (0.000)	-4.198*** (0.000)	-3.967*** (0.000)	-9.003*** (0.000)	-7.732*** (0.000)	-4.111*** (0.000)	-8.569*** (0.000)	-5.117*** (0.001)	-2.684** (0.002)	-9.014*** (0.000)	-3.457*** (0.000)
<i>Comparison Model 1 &amp; 2</i>														
[B]-[A]	-1.58*** (0.000)	-0.30 (0.119)	-0.25 (0.408)	-1.29** (0.006)	-0.25 (0.226)	-0.22 (0.161)	-1.43* (0.017)	-1.07** (0.004)	-0.42* (0.045)	-1.64** (0.008)	-1.67* (0.034)	-0.49 (0.533)	-1.03* (0.024)	-0.15 (0.579)
<i>N OLS</i>	1,490	3,505	1,395	1,733	2,325	2,328	1,804	2,010	2,308	1,929	431	371	1,068	998
<i>N IV-FE</i>	667	1,684	555	739	1,036	950	794	1,343	1,007	975	309	302	675	291

*p*-values in parentheses

Source: SHARE

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

S: physical/subjective health index instrumented by objective variables listed in Table 3

Standard errors for [A],[B] and [B]-[A] have been bootstrapped with 200 repetitions

Table A.3 — Stage one results: impact of physical health & cognition on total labour supply (*LSUP*) of individuals aged 50-54Comparison : IV<sup>\$</sup>- FE : physical health only vs physical health + cognition

	AUT	BEL	CHE	CZE	DEU	DNK	ESP	EST	FRA	ITA	LUX	PRT	SVN	SWE
	<i>Model 1: Physical health only</i>													
Coef.	-9.94***	-10.39***	-7.73***	-12.29***	-8.98***	-10.59***	-10.27***	-9.55***	-9.51***	-8.29***	-11.81***	-4.54***	-11.82***	-9.96***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Decline [A]	-4.15***	-3.45***	-1.80***	-6.35***	-3.46***	-3.39**	-5.29***	-5.71***	-4.18**	-5.18**	-6.03***	-2.99**	-6.62***	-3.08***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)	(0.000)
	<i>Model 2: Physical health + cognition</i>													
Coef. (ph)	-7.70***	-6.91***	-5.56***	-9.32***	-7.17***	-8.62***	-5.64***	-7.63***	-6.96***	-4.18***	-6.59***	-2.37	-6.97***	-6.68***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.067)	(0.000)	(0.000)
Coef. (co)	-0.47	-3.70***	-0.53	-3.33***	-2.67***	-2.48**	-5.57***	-3.31***	-2.69***	-6.64***	-1.15	-1.64	-5.74***	-2.55*
	(0.518)	(0.000)	(0.682)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.238)	(0.279)	(0.000)	(0.020)
Decline [B]	-3.17***	-4.23***	-1.01	-6.63***	-3.95***	-3.75***	-7.57***	-6.66***	-3.69***	-6.93***	-3.45***	-2.20**	-7.99***	-3.31***
	(0.000)	(0.000)	(0.063)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)	(0.000)
	<i>Comparison Model 1 &amp; 2</i>													
[B]-[A]	0.98	-0.77	0.80	-0.28	-0.48	-0.36	-2.28**	-0.95*	0.49	-1.75	2.59*	0.79	-1.37	-0.23
	(0.057)	(0.098)	(0.100)	(0.664)	(0.090)	(0.456)	(0.002)	(0.015)	(0.363)	(0.137)	(0.018)	(0.442)	(0.095)	(0.740)
<i>N</i>	667	1,684	555	739	1,036	950	794	1,343	1,007	975	309	302	675	291

*p*-values in parentheses

Source: SHARE

\* *p* < 0.05, \*\* *p* < 0.01, \*\*\* *p* < 0.001

\$: physical/subjective health index instrumented by objective variables listed in Table 3

Standard errors for [A],[B] and [B]-[A] have been bootstrapped with 200 repetitions