Chapter 1
Introduction
There is a strong and widespread agreement among governments and intergovernmental organizations that actions have to be taken to incite workers to delay their retirement (Keese 2006; University of Warwick 2006; Zaidi 2013). Two global trends set the stage for this situation to materialize in economically developed countries. The first one is population aging (Lutz et al. 2008; United Nations 2017). This phenomenon has been long foreseen and little can be done to reverse or attenuate it. Therefore, it should continue to exercise a downward pressure on the ratio of workers to retirees inside of most populations. The second trend concerns the decline in the average effective retirement age that took place from the late 1970s until the middle of the 1990s (Costa 1998; Herbertsson and Orszag 2003). As we will see below, this phenomenon is more malleable. By raising the official retirement ages and by reducing access to early retirement options, governments hope to incite the aging workers to extend their careers and work beyond the current ages. In fact, actions seem to already have started to bear fruit as an upward trend in the effective age at retirement is being observed since a bit more than a decade in many countries (Loichinger and Weber 2016).

Despite the efforts being made to underline its positive aspects (WHO 2001; Foster and Walker 2014), aging remains a process that is accompanied by a decrease in physical capacities and growing frailty (Rowe 1987; Verbrugge and Jette 1994). Worse health goes together with lower labor force attainment and earlier retirement (Van Rijn et al. 2014). As longer careers are being expected by older workers, one natural question that arises is to which extent the fact that health deteriorates with age is likely to form a hurdle towards longer working lives.

The present chapter provides the background that led to this question and reviews the scientific literature that aimed at providing answers to it. The first section discusses the political and social context that is creating more pressure on the aging workers to extend their career, and shows some trends in the average effective retirement age. The second section shows how health deteriorates with age and reviews past research that investigated the impact of poor health on retirement. The third section discusses the concepts of work ability and capacity to work and reviews the literature that aimed at measuring the number of years that people are physically and mentally able to work. The fourth section presents an outline of this dissertation and briefly summarizes the contribution of each chapter.

**CONTEXT**

In 2010 the size of the population of ages 15 to 64—also referred to as the working population—started to decline for the first time in history in the group of countries that the United Nations label as “More developed regions” (United Nations 2017). At the same time, the size of the population aged 65 and older started growing at an unprecedented rate. Between 2010 and 2050, the working age population is projected to decrease by 10 per cent while the population aged 65 and over will grow by about 75 per cent. The support ratio (the number of people aged 15 to 64 for one person aged 65 and older) was 4.2 in 2010. It will almost be cut in half in the interval comprised between 2010 and 2050, hovering around 2.2 by the end of it (United Nations 2017).

The support ratio only gives a rough approximation of the number of working people to the number of older, non-working people (see Sanderson and Scherbov 2015 for alternate measures). Still, in all economically developed countries, people past a certain age are more

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1 This promise could not be better crystallized than by the 2006 OECD report titled “Live longer, Work longer”.

2 This group of countries comprises all European countries, Canada, the United States, Australia, New Zealand and Japan.
often economically dependent (Fürnkranz-Prskawetz and Sambt 2014). The economic dependency of older people expresses itself in part through transfers that take place as part of retirement systems. Most retirement systems rely at least partially on a defined benefit (pay-as-you-go) system, meaning that employed people finance the retirement of older people through payment of contributions. Supposing that the retirement age is stable over time, population aging puts a growing burden on employed people because fewer of them must finance the retirement of a growing number of older people.

The normal retirement age is usually the age at which older workers are entitled to retirement benefits from the government. Such a retirement age is set by law; however, people do not always retire at that age. They often retire before and rely on personal savings or governmental programs that provide early retirement or disability benefits to people who qualify. People also sometimes retire after that age, and a growing number of countries allow older workers to defer the receipt of pension benefits (OECD 2015). To keep track of trends in retirement behaviors, different intergovernmental institutions are gathering statistics on the effective retirement age. The average effective retirement age is the age at which an average worker is observed effectively retiring under certain assumptions (OECD data 2018). A downward trend in the effective retirement age has been observed in all north American and European countries from the 1970s or before, up until the 1990s. Research showed that such a downward trend was mostly attributable to the greater accessibility and generosity of early retirement programs (Blöndal and Scarpetta 1999; Coile and Gruber 2007).

The problems associated to such low effective retirement ages became apparent in the 1990s. Then it became clear that the pension arrangements of the time could not be sustained when the larger cohorts born during the baby boom would reach old age. This problem was only made worse by the continued increases in life expectancy at age 65, meaning that retired people would benefit of pension income for a increased number of years.

Few options are available to decision makers to make pension arrangements compatible with the changes in the age composition of populations. Actions have been taken and since 2005 documented in a series of biannual reports from the Organisation for economic co-operation and development (OECD) (OECD 2005; OECD 2007; OECD 2009; OECD 2011b; OECD 2013; OECD 2015; OECD 2017). The changes have been numerous; in fact, all countries surveyed in the OECD reports made at some point changes to their pension system to make it more financially sustainable. The changes are difficult to summarize because of their different natures and because of the different contexts in which they have been taking place. Usually, they aim at improving the financial sustainability of the system while still providing a decent income to retirees and prevent poverty among the less favoured. Many changes concern the financial aspects of retirement systems. For example, governments have changed the level of contribution that employees or employers pay, or they adjusted the amount of benefits that pensioners receive. In some instances, systems have been modified to include a defined contribution component, meaning that the amount of benefits that pensioners receive can vary according to the number of contributors and beneficiaries or according to the performance of the financial market. Another area of change concerns the fiscal treatment of pension income (OECD 2013; OECD 2015). While these changes may have important implications for the financial sustainability of the systems, their implications for when individuals will retire are less obvious.

Another set of changes is having a more significant impact on people’s timing to retirement. They concern the availability and generosity of programs that grant retirement benefits to older workers. In the 1990s and 2000s, in many countries, programs that allow workers to receive benefits before the normal retirement age have been either made less financially attractive, less accessible or simply discontinued. To name a few examples, the amount of benefits that an
American worker can earn if he or she retires early (age 62) was gradually reduced between 2000 and 2006, and another reduction in such benefits is planned to take place between 2015 and 2021 (Svahn and Ross 1983). In the Netherlands, the early retirement program was discontinued in 2004 (OECD 2015). In many countries (Denmark, Netherlands, Spain, United Kingdom, United States), the rules of admissibility to disability pension were made more stringent (OECD 2010). In other countries (France, Italy), the minimum number of contribution years to be entitled to retirement benefits was raised (OECD 2011b).

Figure 1.1 Legal retirement age, past and projected (dashes) and effective retirement age (full lines) in six OECD countries. Source OECD (2018).

The downward trend in the average effective retirement age has been inverted in most European and North American countries since the end of the 1990s or the beginning of the 2000s (Loichinger and Weber 2016). Figure 1.1 shows how the effective retirement age has been increasing in six selected countries since 2000. The changes described above undoubtly played a role in inducing this upward trend, although the extent of their role varies across countries (Gruber and Wise 2002; Blau and Goodstein 2010). Also, other forces such as the higher education of the younger cohorts and the higher labor force participation of women have played an important role (Schirle 2008). Yet, there is general agreement that more has to be done to insure the long-term sustainability of pension systems (OASDI 2015; European Commission 2012). Increases in the normal retirement age were or are presently being phased in in many countries (OECD 2015; OECD 2017). The increases can be seen in Figure 1.1. Such increases provide a strong incentive to people to retire later because they make early retirement more costly. Besides that, the official retirement age contributes to setting the norm concerning when it is socially acceptable to retire. Also, it is often accompanied by rules and laws regarding the rights of the aging worker. As of 2017, half of the OECD countries are planning higher normal
retirement ages in the future and many more are debating a such measure (OECD 2017). Six countries (Denmark, Finland, Italy, the Netherlands, Portugal and the Slovak Republic) have linked increases in the normal retirement age with future changes in life expectancy (OECD 2017). This should contribute offsetting the negative effect of longer lives on the sustainability of pension schemes.

Changes in the normal retirement age are likely to play an important role in determining when people will retire in the future. At the same time, it is a restrictive measure that may lead to inequalities if not carefully implemented. An important concern is whether older people will be capable of staying on the labor market until they reach such higher retirement ages. As we will show in the next section, health deteriorates with age. At the same time, poor health often pushes workers to retire early. Therefore, will older workers have longer careers, as expected by governments and intergovernental institutions, or will they instead be forced to retire early due to poor health?

THE RELATIONSHIP BETWEEN HEALTH AND RETIREMENT

The fact that health deteriorates with age and that poor health is associated with earlier retirement ages are seen as potential hurdles towards higher effective retirement ages in the future. This section examines these two points. First, change in health according to age is documented using micro-data recently collected in different European countries. Second, the scientific literature that showed how health induces early retirement is reviewed.

![](image)

**Figure 1.2** Age-related decline in physical health as measured by grip strength and peak flow. The lines were smoothed using loess regression. The grey area shows the 95% confidence bounds. Source: author’s computations with SHARE and ELSA data.

Mean values of health between ages 50 and 80 is shown according to six measures that cover a broad range of health outcomes (Figures 1.2 to 1.4). The data come from the Survey of Health and Retirement in Europe (SHARE) (Börsch-Supan et al. 2013) and from the English Longitudinal Study of Ageing (ELSA) (Marmot et al. 2016). The SHARE data cover 12 European countries. Both datasets contain data ranging from 2004 to 2015. The trends are adjusted for individual level of education, year of birth and body mass index.

Figure 1.2 shows how physical health declines with age according to two objective measures of physical health, grip strength and peak expiratory flow. Grip strength is obtained by asking survey respondents to grasp a dynamometer as firmly as they can. The result is given in kilograms. It is a good indicator of general muscular vitality and it has been shown to predict
other health outcomes, including self-rated health and subsequent mortality (Bohannon 2008; Sanderson and Scherbov 2014b). The peak expiratory flow is obtained by asking respondents to expulse air out of their lungs as strong as they can in a peak flow meter and is measured in liters per second. It is a good indicator of many respiratory illnesses and is also a predictor of more general health outcomes such as subsequent death (Cook et al. 1991). Because they are collected using standardized devices and protocols, they lend themselves very well to comparisons across populations (Sanderson and Scherbov 2014b).

The age-related decline in these two measures provides an indication of the decline in health that people go through when aging. This biological decline can also be observed by measuring how the risk of onset of illnesses varies according to age. Figure 1.3 shows how the risk of spending a night at the hospital and the proportion of people with a long term condition (such as diabetes, arthritis and certain forms of cancer) grows with age.

![Figure 1.3 Age-related change in the proportion of people with at least one hospital overnight stay in the previous year and average number of chronic diseases. Source: author’s computations with SHARE data.](image)

Papers in the field of occupational health studied the impact of health on retirement distinguishing between different early retirement transitions (via disability pension, unemployment, or early retirement programs) and late or “normal” retirement (Van Rijn et al. 2014). Health is usually measured prior to the transition of interest and is based on the number of chronic conditions, musculo-skeletal problems, mental health, or self-rated health or limitations. Besides socio-demographic variables, control variables usually include some work characteristics, such as control over one’s job or self-assessed job demands (Van Rijn et al. 2014; Leijten et al. 2015; Palmer and Goodson 2015; Robroeck et al. 2015; Kouwenhoven-Pasmooij et al. 2016; Leinonen et al. 2016). These papers consistently found that poor self-perceived health is associated with a higher probability of making a transition from work to disability pension. They also usually find that poor mental health and the presence of chronic diseases or musculo-skeletal complaints are also associated with such transitions. Poor health outcomes are also associated with transitions into unemployment or early retirement, although these associations were not always significant, especially after controlling for job characteristics.

There exist more general measures that allow to keep track of the change in health that accompanies aging. Figure 1.4 shows change in self-rated health with age. Self-rated health is a general measure of health for which respondents are asked to rate their health on a scale ranging from 1 to 5. It is a measure that is used extensively due to its simplicity, reliability and ease of collection (Idler and Benyamini 1997; Jylha 2009). Finally, Figure 1.4 also shows
variation according to age in the proportion of people with at least one limitation in activities of daily living. This measure is obtained by asking the ease with which participants perform different activities of daily living such as walking a certain distance or climbing up a flight of stairs (Katz 1983).

The field of economics also provided an important contribution to the question of how health impacts retirement. We identified two main questions that researchers tried to answer. The first one asks whether change in health between two points in time is more likely to induce early retirement than health measured at baseline (Disney 2006; Jones et al. 2010; Erdogan-Cifti et al. 2008; Riphahn 1999; Bound et al. 1999). Although there is no complete agreement, most papers found a significant effect of both baseline health and change in health. The other important question is whether financial incentives or poor health is more likely to induce retirement among aging individuals (Disney et al 2006; Bound and Waidmann 2007; Kalwij and Vermeulen 2008; Lindeboom and Kerkhofs 2009). If health proves to be more important, then efforts made towards encouraging higher effective retirement ages will have little effect and workers will take up disability pension instead of continuing work until the official retirement age. To answer this question properly, health and financial incentives must be modelled adequately. Subjective measures of health are imperfect measures of health in this context because they are arguably correlated with other non-observed variables that also influence the retirement decision, such as preference for leisure. Furthermore, subjectively measured health and the retirement decision can be endogenous. One hypothesis states that early retirees make a more pessimistic assessment of their health to justify the fact that they are economically inactive, known as the justification hypothesis (Chirikos and Nestel 1984).

These problems can be solved by using objective measures of health. Most of the early attempts were based on subsequent mortality as a measure of health (Parsons 1982; Anderson and Burkhauser 1985; Bound 1989). While this measure is clearly objective and free of bias, it has the drawback that it is only available many years after most people retire. Furthermore, some argued that mortality is a poor proxy for actual work ability (Bound 1989). More recent work used grip-strength as an objective measure of health (Kalwij and Vermeulen 2008). Another way of correcting for the error induced by the self-assessment of health is to use self-rated health before and after retirement (Bazzoli 1985). Big discrepancies can be found in early work concerning the extent of the effect of health on the retirement decision, ranging from much smaller (Parsons 1982; Anderson and Burkhauser 1985; Bazzoli 1985) to bigger than that of financial incentives (Quinn 1977; Dwyer and Mitchell 1999). More recent work however seems

![Figure 1.4 Age-related decline in self-rated health and change in the proportion with at least one limitation in activities of daily living. Source: author’s computations with SHARE data.](image)
to agree that although health does play an important role, it clearly plays a lesser one than economic incentives (Disney et al. 2006; Bound and Waidmann 2007; Lindeboom and Kerkhofs 2009).

HOW MANY YEARS ARE PEOPLE CAPABLE OF WORKING?

The literature reviewed above has provided important insights into the correlates of early retirement, but little is known about until which age people are actually capable to work. This section reviews the literature that addressed this question. Authors used distinct but semantically similar expressions to refer to measures that allow to answer this question. These include work ability (Crimmins et al. 1999; Reynolds and Crimmins 2010), work capacity, capacity to work (Milligan and Wise 2015), capability to work (Wubulihasimu et al. 2015) and capacity for work (Rehkopf et al. 2017). We will refer in the remaining of this dissertation to two expressions: work ability and capacity to work. We will use each expression to refer to two distinct concepts. Work ability will be used to refer to the ability to work of individuals; capacity to work will be used to refer to the capacity of a population to work longer. We first introduce the concept of work ability and then move on to the concept of capacity to work.

Figure 1.5 The concept of work ability, “a process of human resources in relation to work”. Source: Ilmarinen 2001 p. 549.

Work ability is a well known concept in the field of occupational health (Ilmarinen 2009). As displayed in Figure 1.5, this concept opposes two forces: human resources and work. Human resources are the resources that are tapped into in order to perform work. These include physical and mental health, but also education and competences, motivation, values, etc. On the right hand side, Figure 1.5 shows the work characteristics that make a job more or less demanding. These include the physical and mental demands and the environment in which work is performed. Ability to work is the result of the interaction between these two forces.

Capacity to work, on the other hand, has not yet been formally defined and has been used inconsistently in the literature. It is convenient to define it in reference to work ability. It can be seen as the proportion of people in the population that has sufficient human resources for the amount of work demands that they face. Alternatively, it can be measured as the average number of years that workers are able to work before their resources become insufficient to
perform their work. A population can for example have a capacity to work of 17 years from age 50 onwards; that is, the work demands surpass the human resources in average at age 67.

Capacity to work is in practice difficult to measure because most people retire before they become incapable to work. Also, work ability is by definition a dynamic process since it captures the interaction between human resources and work. Therefore, it may evolve in a non-monotonous fashion. For example, a worker with a physically demanding job may quit his or her work at age 55 due to back problems, but be able to work another ten years on a job that is less physically demanding. Still, some attempts of measuring capacity to work can be found in the scientific literature. Research in occupational health has established the work ability index (de Zwart et al. 2002). The index is a score between 7 and 49 that is based on seven questions about the self-assessed health and ability to perform work. By averaging the score of people from a population and displaying it for each year of age, a measure of capacity to work can be obtained. For example, Ilmarinen and Ilmarinen (2015) find that for Finnish workers, work ability is in average good or excellent until about age 60, after which it becomes moderate. However, there exists important inter-individual variation in the values of the index. Although it is a useful tool for identifying the determinants of early labor market exits, the index cannot be used to assess how longer people could be able to work since it is based on the actual experience of workers.

Crimmins et al. (1999) and Reynolds and Crimmins (2010) measured capacity to work using a similar but simpler approach. They investigated whether there was any change between different cohorts of older American workers in the way that they answered to the question “Are you limited in the kind or amount of work that you can perform due to a long lasting sickness or injury?”. The data was collected among people age 55 to 69 years old, without consideration for whether they were employed or not at the moment of the interview. Results show that younger cohorts make a more positive assessment of their ability to work, which is in part explained by their higher level of education. However, trends in obesity partially offset this positive trend. Although aggregating these data over the whole population can provide a good approximation of the total capacity to work of a population, the reliability of the assessment of a person who has not been working for many years may be questioned.

More research relied on the statistical relationship between work and health to estimate, under certain assumptions, what the capacity to work of a population is. Following Coile et al. (2017a), we consider to this end two distinct approaches. The first approach is based on mortality as a proxy for work ability and is called the Milligan-Wise (MW) approach (Milligan and Wise 2015). This approach consists in asking what is the proportion of men who would work in a year of interest if, for the level of mortality at each given age, men would work as much as in a reference year. For example, in their 2015 paper (Milligan and Wise 2015), the authors identify among American men the level of mortality that is specific to each year of age between ages 55 and 69 in 2007. Then, they ask what were the employment rates of men with the same mortality rates in 1977. The employment rates for the same levels of mortality are considerably higher in 1977 than in 2007. This is first due to the fact that the corresponding men with same mortality in 1977 are younger as mortality decreased substantially in the interval. This is further due to the fact that older men used to work more in the 1970s than in the 2000s. The authors then compute a measure of “unused capacity to work” by integrating the difference between the two sets of employment rates over the whole age range. Results show that if men in 2007 would work as much as men in 1977 with the same mortality rates, men in 2007 would work 3.8 years longer between ages 55 and 69. Obviously, different conditions must be met for this measure to be a valid measure of capacity to work. First, all men who are able to work in the reference year must actually work. Second, change in mortality must capture perfectly change in capacity to work over time. These conditions are clearly not
met. However, the method provides interesting insights because it shows how much longer men that correspond to a specific measure of health (i.e. mortality) used to work in comparison to now. It shows that at present, there is likely a considerable amount of retired men who would be capable to work. Unfortunately, this method is not applicable to women since only a small share of older women used to work in the 1970’s or 1980’s.

The second approach to capacity to work is the Cutler– Meara– Richards-Shubik (CMR) method (Cutler et al. 2013). This approach features two steps. First, estimates of the relationship between health and employment are obtained at ages before retirement, usually between 50 and 54 years old. Second, the estimated relationship is applied to the older population, up to age 70 or 74. The simulated levels of employment are interpreted as the unused capacity for work supposing that for each level of health, people 55 and older would work as much as people below 55 years old. The 55 years old threshold is taken assuming that below this age, most people who are able to work actually work. The assumption for this measure to be a good approximation of capacity to work is that individual differences in health capture well individual differences in work ability. Health is measured in this context based on a battery of measures, including self-assessed health, a number of self-reported health conditions, limitations in activities of daily living and also some risk factors such as obesity. In their 2013 study, Cutler et al. find a substantial unused capacity for work, but also important differences between people with different education levels.

A similar approach was taken recently by Rehkopf et al (2017). They go beyond the original approach by simulating the number of years that people will be able to work up to the year 2050. By doing this, they take into account changes in the population composition by levels of education and establish scenarios of change over time in levels of disability. Their results suggest that future capacity to work will depend to a large extent on trends in the health of the less educated group. A limitation of their study is however that it does not take into account how work demands might evolve in the future, including lower physical but possibly higher mental demands.

OUTLINE AND CONTRIBUTION OF THIS THESIS

The previous section started by summarizing the research about the ability for individuals to work at older ages, defined as work ability. It then moved on to discuss research that aimed at measuring the capacity to remain employed until higher ages of populations, which we defined as capacity to work. The rest of this dissertation will follow the same scheme. In the second chapter, the impact of individual trajectories of work ability on retirement is investigated. This is done by following American workers between ages 53-54 and 65-66 thereby assigning each respondent to a latent work ability trajectory and to one of different retirement pathways. Although it can be expected that less than optimal work ability trajectories lead to earlier retirement, it is not clear whether different work ability trajectories lead to different forms of retirement. For example, workers with declining work ability can be thought to retire more often gradually, while workers with constantly low work ability can be more often expected to retire abruptly. The dynamic and longitudinal conceptualization of both health and retirement in this chapter are important innovations compared to previous research.

The third chapter proposes a series of visualisations that inform about the form of the link between health, work and age simultaneously. The specific questions that it asks are whether the link between health, work and age varies between countries and over time, and whether it depends on the measure of health that is used. The measures of health (grip-strength, peak expiratory flow, chair stand test and depression scale) used are objective and measured on a
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continuous scale. The countries covered include seven European countries and the United States.

Both the fourth and fifth chapters concentrate on measuring capacity to work, or the average number of years that people can expect to be capable to work. The fourth chapter looks at the future implications of higher retirement ages and the impact of declining physical health with age. More precisely, it asks how many years of work would be lost to retirement due to declining physical health if workers needed to postpone their retirement by six years while the decline in physical health stays constant over time. The analyses are based on fourteen European countries and include a comparison between two groups of countries that differ considerably concerning the link between health and work.

The fifth chapter presents an analysis that is complementary to the MW and CMR methods described above. It follows American workers born between 1936 and 1947 from age 55 until their first retirement. Capacity to work is based on the timing to retirement of people who declare to have retired due to poor health. The advantage of this method compared to the MW and CMR methods are that it reflects more closely the actual experience of older workers concerning work ability, and it allows more easily for group comparisons.