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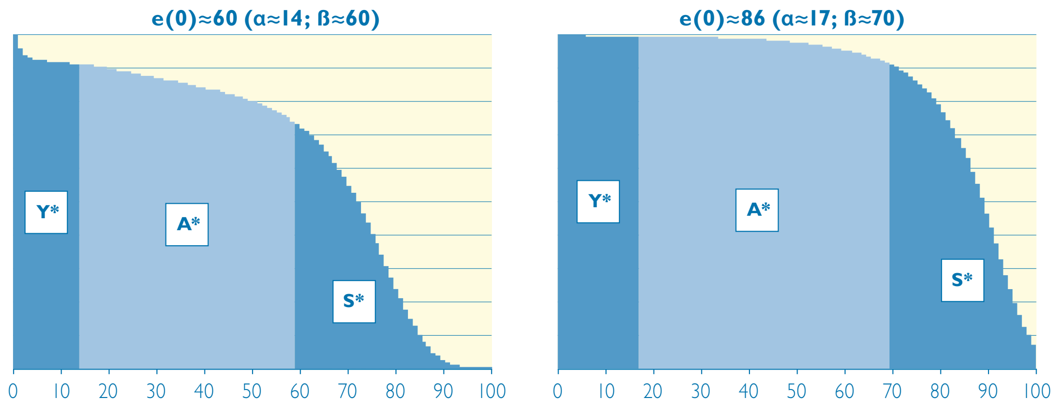

Reference age structures (with e0 ≈ 60 and 86, respectively) when Y = 20% and S* = 20%, the proportions spent in young respectively senior condition (illustrative policy choices)*

Source: Gustavo De Santis, this volume

Health, education and retirement over the prolonged life cycle

Guest Editors: Michael Kuhn, Alexia Prskawetz and Uwe Sunde

Vienna Institute of Demography

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Guest editors:
Michael Kuhn, Alexia Prskawetz and Uwe Sunde

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Health, education, and retirement over the prolonged life cycle: a selective survey of recent research

*Michael Kuhn, Alexia Prskawetz and Uwe Sunde**

1 Introduction

This issue of the Vienna Yearbook of Population Research contains a selection of papers that were presented at the conference 'Health, Education, and Retirement over the Prolonged Life Cycle', which was organised by the Vienna Institute of Demography of the Austrian Academy of Sciences and held in Vienna in November 2013. The conference was devoted to the socio-economic causes and consequences at both the individual and the societal level of the unprecedented increase in life expectancy over the past few decades. At the micro level, a better understanding is needed regarding the extent to which the increase in human life expectancy has been shaped by individual health behaviour, rather than by other socio-economic influences, and through which channels this happened. Conversely, it is important to understand better how the prolongation of the life cycle will shape individual behaviour. The conference focused on behaviour relating to health, education, and the supply of labour.

Although generally perceived as a positive development, the increase in life expectancy also poses policy challenges for social security and the cohesion of society, given that different social groups benefit from rising longevity to varying degrees. Important questions have been raised about the macro consequences of the prolongation of the individual life cycle, not least because having an understanding of the underlying mechanisms will be crucial for assessing the extent to which retirement, health, and educational policies need to be reformed. The recognition that the design of reforms should be guided by an awareness of the potential effects

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of policies on individual life-cycle behaviour closes the circle of topics addressed in this volume.

The remainder of this introduction sets the scene for the articles contained within this volume by presenting the editors' (subjective and selective) take on the state of research regarding the link between longevity and individual life-cycle behaviour relating to health, education, and retirement.

2 Health, health behaviour, and the prolonged life cycle

This sub-section presents a brief review of some of the recent debates on the role of health in the extension of the life course. After providing an overview of the debate on the extent to which reductions in mortality are accompanied by reductions in morbidity, we highlight the roles of health behaviours, education and social context in shaping health and longevity.

2.1 The debate on healthy life expectancy: demographic and economic perspectives

Since the 1980s there has been a heated debate among demographers and epidemiologists about the relationship between life expectancy and morbidity, and the implications of this relationship for the quality of life experienced by ageing populations. Central to this debate are the following questions: Is increasing life expectancy accompanied by a compression of morbidity, and thus by a more than proportional increase in healthy life expectancy (Fries 1980)? Alternatively, is mortality accompanied by an expansion of morbidity (Gruenberg 1977)? Moreover, is it possible that morbidity and mortality are jointly determined by physiological processes that govern both the incidence and severity of disease (Manton 1982)? This debate is on-going (see, e.g. the survey by Crimmins and Beltran-Sanchez (2010)). While recent studies based on aggregated data provide evidence that healthy life expectancy has been increasing (e.g. Cai and Lubitz 2007), a much more complex picture emerges when the different dimensions of health are considered (e.g. Crimmins 2004, Crimmins and Beltran-Sanchez 2010). Generally, it appears that while the prevalence of chronic conditions among the elderly has increased, the extent to which these conditions lead to disability has declined (Freedman et al. 2007). Recent evidence also shows that the trend in the increase in healthy life expectancy may have recently started to reverse, at least in the US. One prime suspect in this context is the increased prevalence of obesity (Lakdawalla et al. 2004; Martin et al. 2009, 2010). At the same time, there is clear evidence of a widening educational gap in longevity gains in the US (Meara et al. 2008; Baker et al. 2011; Montez et al. 2011, 2012; Brown et al. 2012), with the longevity gains concentrated among those with the highest levels of education.

Cutler et al. (2006) surveyed the historical and the current mechanisms behind the longevity expansion in both developed and developing countries. As the main drivers they identified a complex nexus of pathways, including access to health care and medical progress, the provision of public health infrastructure and education, behavioural factors, family and social background reaching back into early childhood, and social structures. Specific sources of longevity expansion can be identified at the disease level. Ford et al. (2007), for instance, showed that about 47% of the reduction in US mortality from coronary disease between 1980 and 2000 was explained by changes in treatments, while 44% of the decline was attributable to changes in medical and behavioural risk factors.

Focusing on behaviour, economists have conceptualised the relationship between health and longevity as being the (joint) outcome of a life-cycle decision problem in which individuals are able to influence their health and their survival by consuming health care and adopting lifestyles conducive or detrimental to health. Refining the seminal model by Grossman (1972), economists have endogenised life expectancy (Ehrlich and Chuma 1990) and mortality (e.g. Ehrlich 2000, Kuhn et al. 2011, 2015), making them functions of deliberate health investments. While models in the tradition of Grossman (1972) have assumed that health investments contribute to an increase in the stock of health (Ehrlich and Chuma 1990) or to a reduction in the rate of health decline (Kuhn et al. 2015), Dalgaard and Strulik (2014) and Strulik (2015) have recently modelled the 'reverse' process through which individuals invest in factors that delay the accumulation of deficits linked to frailty and a higher risk of mortality (Rockwood and Mitnitski 2007).

2.2 Health behaviour along the prolonged life course

Generally, the willingness to spend more resources to improve the chances of survival is measured as the (statistical) value of life, a metric of the (monetary) value assigned to the stream of utility and income over the remaining life course (e.g. Shepard and Zeckhauser 1984, Ehrlich and Chuma 1990, Ehrlich 2000, Murphy and Topel 2006, Becker 2007, Hall and Jones 2007, Birchenall and Soares 2009, Kuhn et al. 2010, 2011, 2015). The value of life is generally assumed to increase with the length of the remaining life time; with the quality of the remaining life, as measured by the benefits from consumption, leisure, and health; and with the value assigned to descendants. Murphy and Topel (2006) have made the important case that medical advances that have led to a reduction in mortality from causes such as coronary heart disease have also increased the willingness of people to pay for a reduction in competing mortality risks, such as cancer (see also Dow et al. 1999, Becker 2007). A similar complementarity exists between treatments aimed at extending the 'quantity of life' and those aimed at improving the quality of life (e.g. treatment of Alzheimer's disease). The concept of complementarities along the life course extends to investments in education (Becker 2007): i.e. avoiding the loss of human capital or the capacity to benefit from it due to morbidity or premature mortality constitutes a return on health investments, whereas health and longevity boost the returns on education.

Surprisingly, there are very few empirical studies based on individual-level data, as van Baal et al. (2013) pointed out in a survey on the relationship between health expenditure and longevity.[1] Among this handful of studies is an analysis by Cutler (2007). His examination of the impact of cardiac revascularisation on individual survival showed that revascularisation raises a patient's remaining life expectancy by about one year at a cost of USD 40,000.

In contrast, there is a large body of literature on the relationship between health behaviour—or 'lifestyle', as it is often called—and health outcomes, including morbidity. Referring readers to the recent surveys by Strauss and Thomas (2007) and Cawley and Ruhm (2011), we focus on a few selected studies to illustrate recent developments in research on this topic. While the positive association between health, longevity, and socio-economic status (SES) is widely accepted, it is notoriously difficult to establish causal relationships within the nexus of income, education, and health; as these characteristics tend to be jointly determined (Adams et al. 2003). A life-cycle perspective is helpful in a number of ways: conceptually, life-cycle models make transparent how health outcomes and income, as well as the underlying stocks of 'health capital' and assets, develop jointly over the life cycle as a consequence of prior choices related to health, education, and saving. In principle, these models then allow us to determine how the life-cycle allocation is shaped by the initial endowment of wealth, health, and ability, including genetic disposition and, depending on the focus, (early) childhood experience. Empirically, the panel structure of individual life-cycle data facilitates an identification of the causal effects in this context.

Adams et al. (2003) used the US Asset and Health Dynamics of the Oldest Old (AHEAD) panel to test for the absence of causal links between SES and health changes and mortality. They found that among the elderly population, who are typically covered by Medicare health insurance, there is no direct causal link between SES on the one hand and mortality and acute health conditions on the other, once initial health is taken into account. It is, however, possible that there is a causal link between SES and conditions with a gradual onset, such as mental conditions and some degenerative and chronic conditions. Applying dynamic panel methods to British Household Panel data, Contoyannis et al. (2004) established the presence of a strong positive state dependency for health and unobserved permanent heterogeneity, which accounts for around 30% of the unexplained variation. Based on these findings, they argued that mean income, as a measure of permanent income, has a stronger impact on health than transitory fluctuations in current income. Using data from the British Health and Lifestyle Survey, Balia and Jones (2008) estimated a recursive model of mortality, morbidity, and lifestyles. They found that

[1] Studies at macro level typically identify a weak yet significant impact (e.g. Cremieux et al. 1999, Lichtenberg 2004, Hall and Jones 2007, Martin et al. 2008, Baltagi et al. 2012).

behaviour, and particularly behaviour related to smoking and sleeping patterns, has a significant impact on predicted mortality; whereas SES measures play a reduced role. Rosa Dias (2010) used data from the UK's National Child Development Study to estimate how initial circumstances, which are beyond the control of the individual, determine health outcomes by affecting the individual's lifestyle 'effort'.[2] While social development during childhood and educational opportunities strongly shape the lifestyle of adults, the analysis also showed that unobserved heterogeneity drives both lifestyle choices and health outcomes. These results corroborate the assumption that parental and early childhood circumstances are important determinants of adult health behaviour and outcomes. Examining the impact of smoking on mortality, Adda and Lechene (2013) provided support for the notion that an individual's willingness to invest in health is governed by his or her survival chances: the analysis showed that individuals who are in relatively poor baseline health are more likely to start smoking and to smoke heavily. Finally, Fichera and Sutton (2011) and Cobb-Clark et al. (2014) provided evidence that health behaviours are shaped by both health policy and personality traits, such as self-control.

A large body of empirical literature in demography and epidemiology has documented a positive association between education and health (Grossman 2008). Recent research has sought to identify the causal pathways of this association (Meara et al. 2008; Baker et al. 2011; Kunst et al. 2010; Montez et al. 2011, 2012; Brown et al. 2012). Indeed, we would expect to observe that education has a positive impact on health because of both the high marginal benefit associated with the life-cycle complementarity between health and education, and the low marginal cost of investing in health care for the highly educated.[3] Using exogenous variation in education, recent studies have generated mixed support for a causal role of education in driving health and health behaviours: while Lleras-Muney (2005) found a strong negative impact of education on mortality in the US, a similar effect was not confirmed for France (Albouy and Lequien 2008) or for the UK (Clark and Royer 2013). However, using European data from the Survey of Health and Retirement (SHARE) in Europe, Brunello et al. (2015) found a positive impact of education on self-reported health. Cutler and Lleras-Muney (2010) identified a strong educational gradient in a large set of health-related behaviours for the US; a result that is in line with earlier US findings on smoking (Currie and Moretti 2003, Kenkel et al. 2006, De Walque 2007, Grimard and Parent 2007), but not on obesity (Kenkel et al. 2006). While variations in exogenous measures of education do not appear to explain health behaviours in a number of European settings (Reinhold and Jürges 2009, Braakman

[2] The study ties in with a larger literature on the role of equality in opportunity in health care (e.g. Rosa Dias 2009; Trannoy et al. 2010; Balia and Jones 2011; Jusot et al. 2013; Garcia-Gomez et al. 2014; Jones et al. 2014).

[3] Glied and Lleras-Muney (2008), for instance, found that the educated tend to benefit disproportionately from mortality-reducing medical innovations. Presumably this is because, compared to people with less education, highly educated people have better information, which in turn reduces the cost of accessing these technologies.

2011, Kemptner et al. 2011, Clark and Royer 2013), Brunello et al. (2015) identified significant behavioural effects when decomposing the impact of education on self-reported health.

According to findings by Cutler and Lleras-Muney (2010) and Conti and Hansman (2013), cognition and personality during childhood play important roles in determining the extent to which education feeds into health and health behaviours. These findings are in many ways consistent with the results from a Danish twin study, which found that the education-health gradient is not causal, but is instead related to the children's social and genetic endowment (Behrman et al. 2011). In a similar vein, Auld and Sidhu (2005) studied the impact of schooling on health, conditional on the level of schooling and cognitive ability; and found that schooling has a causal effect on health only among individuals with low levels of schooling and ability. Indeed, as Montez and Friedman (2015) argued in their introduction to a special edition of Social Science and Medicine (Vol. 127) on educational attainment and health, the education-health gradient is context dependent: for instance, the gradient is more pronounced when education and knowledge are more relevant because of the prevailing social and (advanced) technological conditions (e.g. Hayward et al. 2015), in disadvantaged contexts, and at the bottom end of the education distribution (e.g. Gathmann et al. 2015, Hayward et al. 2015).

2.3 Health and ageing within social networks

Individuals are embedded in social networks of family, friends, colleagues, and neighbours; and these networks affect health and health behaviour through social influence, the provision of social support and social capital, and the transmission of both diseases and information (see Luke and Harris 2007 and Smith and Christakis 2008 for surveys). The analysis of network effects is not typically conducted within a life-cycle setting, although life-cycle effects should clearly be expected. First, peer effects during childhood and adolescence determine health behaviours over long periods of an individual's life course (Harris 2010), and particularly addictive or habitual behaviours, such as smoking, drinking, and eating habits (e.g. Auld 2005, Powell et al. 2005, Clark and Loheac 2007, Nakajima 2007, Harris and Lopez-Valcarcel 2008, Trogdon et al. 2008, Fletcher 2012, Mora and Gil 2013). To the extent that an individual enters into and remains within a (homophilous) network of like-minded peers and family (e.g. Clark and Etile 2006, 2011), these habits may persist over the life course. Second, the selection into certain networks is likely to determine the level of support an individual receives when his or her health deteriorates. Thus, for example, marriage has been shown to have a protective effect (e.g. Grundy and Sloggett 2003, Gardner and Oswald 2004, Murphy et al. 2007). Finally, the networks an individual belongs to are prone to change over the life course (e.g. Wenger et al. 2000, Ajrouch et al. 2005), which implies that individuals tend to be exposed to age-specific social influences on their health and their health behaviour. These considerations suggest that an integration of the elements of network and life-cycle analysis is needed.

3 Human capital, education, and the prolonged life cycle

This subsection provides a brief review of the recent debate on the implications of the prolonged life cycle for education and human capital acquisition. We end by pointing to some implications for long-run development.

3.1 The conventional view of life expectancy and education

Education and, more broadly, the acquisition of human capital are investment activities that can involve immediate costs for the individual. Education-related expenses include opportunity costs with respect to labour market participation, as well as resource costs such as tuition. The benefits of education, which typically come in the form of increased productivity and returns on the labour market, do not accrue to the individual until after the completion of education. As with any investment, the total expected return depends on the length of the amortisation period, which in the context of education hinges on the length of life. The earliest formal treatments of this insight go back at least to Mincer (1958), who pointed out the crucial role of the length of the work life in making an optimal decision about the amount of time spent in education and training. In a reduced form, similar arguments were made by Gary Becker, who noted that "the influence of life span on the rate of return [to human capital] and thus the incentive to invest is important (. . .) the longer is the expected life span and the larger is the fraction of a lifetime that can be spent at any activity". (Becker 1964[1993], p. 86). Ben Porath (1967) developed a formal model of the optimal allocation of education decisions over the life cycle and the corresponding earnings path that used a deterministic time horizon. In this model, the length of life was considered the crucial determinant of any investment in human capital. It was thus long seen as a truism that the increase in longevity over the past two centuries was a central force behind the massive increase in educational attainment observed over the same period.

A direct implication of this view is that the prolongation of life and the associated increase in educational attainment had important consequences for (human capital-driven) growth and development (see, e.g. de la Croix and Licandro 1999, Kalemli-Ozcan et al. 2000, Boucekkine et al. 2003, Lagerlöf 2003, Soares 2005, and Cervellati and Sunde 2005, 2015a).

3.2 The debate on longevity, life-time labour supply, and education

The argument that the increase in life expectancy played a central role in the sharp rise in educational attainment has been debated recently. This debate began with the work by Hazan (2009), who argued that in the Ben Porath model, a necessary condition for the prolongation of life to cause a higher investment in education is an increase in life-time labour supply. He then showed that life expectancy and educational attainment had increased across consecutive cohorts of American men born between 1840 and 1970, and for American individuals born between 1890 and 1970; but that life-time labour supply had actually decreased along both the extensive and the intensive margins, which arguably violates this necessary condition. This contradiction of the conventional wisdom sparked a debate about the role of life expectancy in educational attainment at the macro level. Hansen and Lonstrup (2012a) showed that these empirical patterns can be reconciled using a model with imperfect financial markets in which an increase in life expectancy can lead to both an increase in the amount of time spent in education and a reduction in life-time labour supply, because individuals can afford to retire earlier as a result of their higher life-time earnings and savings. Complementary work by d'Albis et al. (2012) suggested that the incentives for earlier retirement might also depend on whether the mortality decline that causes life expectancy to increase affects people at younger or older ages.

Cervellati and Sunde (2013) studied a generalised Ben Porath model with a realistic survival law, and demonstrated that, in general, an increase in life-time labour supply is neither a necessary nor a sufficient condition for an increase in life expectancy to cause an increase in educational attainment. In fact, in this model the life-time labour supply is the central factor in the marginal benefits of education. However, a reduction in benefits does not necessarily mean that the optimal educational level cannot be higher, because the marginal costs might also have fallen with life expectancy. Using the same data as Hazan, they found that the progressive rectangularisation of the survival curve, which was responsible for the prolongation of life over the past 150 years, led to changes in both marginal benefits and marginal costs. Overall, their evidence does not call into question the assumption made in a generalised Ben Porath model that longer life expectancy is a necessary condition of increased educational attainment. Recent work by Bonneuil and Boucekkine (2014) has suggested that the relationship between longevity and the optimal length of education might depend on the age distribution of mortality rates. Sanchez-Romero et al. (2015) provided conditions under which a decrease in mortality leads to a longer period of education and an earlier retirement, which can be decomposed into a Ben Porath mechanism; i.e. a wealth effect and a years-to-consume effect.

3.3 Longevity and schooling: macro-level evidence

Empirical evidence at the macro level supports the view that the effect of life expectancy on education might not be homogeneous. Hazan (2012) found that increases in life expectancy at birth between 1960 and 1990 were positively correlated with the increase in educational attainment across the world, whereas the increase in life expectancy at age five exhibited only a weak relationship with schooling. A potential reason for this apparent contradiction is heterogeneity in the decline of age-specific mortality that underlies the increases in life expectancy affected, as some of the theoretical contributions mentioned above have suggested. Moreover, the incentives to invest in education might depend on the demographic development of a country. In particular, the demographic transition constitutes a turning point for population dynamics, as the fertility decline in the later phases of the demographic transition frees up resources that households can devote to education. Hence, improvements in life expectancy are likely to deliver more pronounced increases in educational attainment after the fertility transition has commenced, and as long as the decline in mortality rates affects individuals of working ages. Using cross-country panel data from the international epidemiological transition of the 20th century to identify the causal effects of life expectancy on education and population dynamics, Cervellati and Sunde (2015b) found evidence that supports the hypothesis of a heterogeneous effect. This finding is complemented by evidence reported by Hansen (2013), who examined data from medical breakthroughs in the 1940s and 1950s. His findings indicate that the rise in life expectancy, and in particular the improvement in childhood health, was responsible for a significant part of the increase in human capital over the second half of the 20th century. Using a calibration exercise, Sanchez-Romero et al. (2015) showed that a combination of a Ben Porath mechanism and a wealth/years-to-consume effect can account for the dynamics among the Swedish birth cohorts between 1865 and 2000.

3.4 Longevity and schooling: micro-level evidence

The aggregate evidence suggesting that life expectancy and health play important roles in educational outcomes is consistent with recent micro evidence. Using data from the hookworm eradication in the US south around 1910, Bleakley (2007) found that the substantial and immediate reduction in disease prevalence led to substantial increases in school enrolment, school attendance, and literacy. Jayachandran and Lleras-Muney (2009) examined the effects of the reduction in maternal mortality in Sri Lanka between 1946 and 1953, which led to a significant increase in life expectancy among school-age girls. They found that female literacy and years of education increased as a result of this rise in life expectancy. Recent work by Oster, Shoulson, and Dorsey (2013) has suggested that the expected length of life appears to influence decisions about education. They used variation across individuals who have ex-ante identical risks of the outbreak of Huntington disease, an inherited neurological disorder, but who differed in terms of whether they were actually affected by the disease and thus expected to have a shortened life span. They found that the individuals with the mutation that leads to the outbreak of the diseases completed less education and job training.

3.5 Interactions with other margins: fertility, labour force participation, and health feedbacks

The shift in decisions regarding education caused by a prolongation of life also interacts with behaviour in other domains. As we discussed above, the mortality decline in the early stages of the demographic transition was followed by a decline in fertility and a slow-down in population growth, which was in turn accompanied by increased participation in schooling. Using micro evidence from Brazil, Soares (2006) found that higher longevity is systematically associated with higher educational outcomes and lower fertility. Similarly, Bleakley and Lange (2009), also using data on the hookworm eradication in the US south around 1910, found that the ensuing increase in educational attainment was accompanied by a significant decline in fertility. Soares and Falcao (2008) suggested that, through changes in educational incentives and fertility, the prolongation of life might have changed female labour force participation and narrowed the gender wage gap.

Another important implication of increased schooling is the feedback to health and life expectancy. This feedback might have been an important factor in the transition from stagnation to growth (Cervellati and Sunde 2005, 2015a). The evidence discussed above shows that changes in education resulting from compulsory schooling legislation and other factors had causal effects on health behaviour and mortality decline.

4 Retirement and the prolonged life cycle

In parallel with the sharp increase in life expectancy, the labour supply at both young and old ages has been declining since the 1960s in most of the OECD countries. The decline in the labour supply at younger ages was related to the extension of education and the corresponding later entry into the labour market, while the decline in labour supply at higher ages was related to a trend towards early retirement. The average retirement age in the OECD countries was 68 in 1970, and had declined to age 64 by 2010 (OECD 2009).

In an effort to reconcile these findings with economic theory, a number of authors have pointed out that increases in life expectancy were accompanied by rising income. Since consumption and leisure are both normal goods, an increase in income may also be associated with an increase in the demand for leisure; i.e. retirement (Costa 1998). However, many other factors affect the labour supply as well, and the final question boils down to whether the value of leisure becomes higher than the value of work when life expectancy increases (Lazear 1986).

In a series of papers, Gruber and Wise (1998, 2004) studied the role social security programs play in early retirement. They showed that the present value of social security benefits declines with the retirement age, and that the implicit tax rate on wage income at old age is quite high, which tends to push workers out of the labour market once they have reached the age of pension eligibility. In most European countries the wage adjustments associated with early retirement are not actuarially fair. Moreover, social programs like unemployment and disability insurance support retirement at ages below the normal retirement age. Consistent with this view, Eichhorst (2011) showed that the core factors that drive the cross-national diversity in retirement behaviour are differences in both institutional arrangements and social and labour market policies. Various studies have indicated that limiting the incentives for early retirement, increasing the statutory retirement age, reducing the generosity of unemployment benefits, and lowering income taxes and non-labour wage costs can foster employment among older workers.

In addition to these institutional factors, Phillipson and Smith (2005) have argued that poor health, disability, and work-related stress may lead individuals to exit the labour market early. Measures that can help keep people in the work force as they age include providing older workers with on-going training and skills development, as well as with flexibility in terms of their work schedules and responsibilities.

The reduction in the retirement age has also been attributed to changes in technology, and to age-specific differences in productivity. The lower productivity of older workers may lead firms to lay off employees before they reach the normal retirement age. Ferreira and Pessoa (2007) have argued that the retirement age may fall further as longevity increases, because older workers may become obsolete in periods of rapid innovation.

Theoretical models that aim to reconcile the observed increase in life expectancy and the parallel decrease in the retirement age have offered various alternative explanations. One central argument, put forth by Kalemli-Ozcan and Weil (2010), is that uncertainty about the date of death plays a role in the decision about how to balance labour supply and leisure. Increases in life expectancy are accompanied by less uncertainty about the date of death, which may be expected to induce individuals to save for retirement and to avoid working until they die. Based on work by Gruber and Wise (2004), Heijdra and Romp (2009) have shown that in an OLG model with realistic mortality patterns, the effect of greater longevity on optimal endogenous retirement age is ambiguous, and will depend on the prevailing fiscal and pension system. Bloom et al. (2003) argued that the effect of increases in life expectancy on retirement may be less than proportional, and pointed out that an increase in longevity accompanied by reductions in morbidity may also induce people to work longer. Recently, several authors have shown that the age pattern of the mortality decline may play a decisive role in whether the retirement age decreases or increases with longevity. In particular, it has been shown that mortality declines during adulthood may cause earlier retirement, while reductions in mortality at older ages may lead to delayed retirement (d'Albis et al. 2012, and Strulik and Werner, 2012). The trend towards earlier retirement caused by a decline in adult mortality may be explained by the increase in the expected life-time human wealth effect when mortality at working ages decreases. Hansen and Lonstrup (2012b) offered another complementary theory to explain the relationship between life expectancy and the fall and rise in the retirement age. For low levels of life expectancy, they supported the uncertainty effect of increased longevity laid out in Kalemli-Oczan and Weil (2001). They argued that when levels of life expectancy rise, fewer unintended bequests are transferred to the succeeding generations, who in turn have lower incomes and are less able to save. Consequently, these generations may be expected to retire later. Like the model of Kalemli-Ozcan and Weil (2010), their model lacks an annuity market. While most of the existing theoretical models have studied partial equilibrium effects, Prettner and Canning (2014) examined the interdependencies between savings, interest rates, and optimal retirement decisions; and how these decisions respond to both increases in longevity and changes in technological progress. Since longevity increases saving rates, interest rates also decline; thus, the effect on retirement is ambiguous. While decreasing interest rates may induce individuals to work longer, the lower compound interest rates on their life-time labour income may lead them to retire earlier. In addition to these two indirect effects, the authors identified two direct effects: higher life expectancy may reduce incentives to work, and working longer may imply higher life-time consumption. By fostering economic growth, technological progress will boost life-time income and hence the demand for leisure. At the same time, however, higher wages may induce older workers to retire later. Prettner and Canning concluded by showing that the parameter restrictions of the model that implies that the retirement age will increase as a consequence of longevity are fulfilled in Europe. However, these results will hold only as long as public pension systems do not introduce incentives for early retirement.

In addition to these changes at the extensive margin of labour supply, increases in longevity may affect the intensive margin by influencing the number of hours worked. Restuccia and Vandenbroucke (2013) showed that increases in wages and life expectancy account for 88% of the decline in the number of hours worked between the 1870 and 1970 birth cohorts in the US. However, life expectancy alone accounts only for 3% of the decrease in working hours. Restuccia and Vandenbroucke (2014) also demonstrated that the decline with rising income in the number of hours worked is more pronounced in poor countries.

5 Structure of the Vienna Yearbook 2014

The present issue of the VYPR contains seven original articles that are closely related to and extend the literature surveyed above. The first two chapters contribute to the literature on health and health behaviour and to the literature on retirement, and establish interesting links between these two fields of study.

The first chapter, authored by Heather Booth, Pilar Rioseco and Heather Crawford, deals with the role of demographic differences in the association between social networks (SN), social support (SS), and self-rated health (SRH) among the elderly population. The authors argue that demography is likely to shape this relationship in at least three dimensions: first, the family status of an individual delineates his or her social networks of kin and friends; second, these networks evolve and change with demographic events (marriage, widowhood, etc.) over the life cycle, which implies that the networks of the elderly depend on earlier life course events; third, the impact of the SN and the SS structures on self-rated health is prone to vary across (demographic) subgroups of the population. Using survey data from Australia, the authors explore the extent to which a positive association between social networks and self-related health is driven by reverse causation, and how the causal and reverse-causal effects vary across demographic subgroups. Starting with the full sample, they study the association across distinct 'healthy' and 'unhealthy' subgroups, assuming that reverse causation (i.e. restricted access to social networks due to ill health) should not matter for the healthy. Their findings suggest that reverse causation tends to play a large role overall, as it explains most of the association between social networks and self-reported health among the unhealthy; while the positive relationship among the healthy varies with the demographic context. Based on their exploratory evidence, the authors highlight potential channels through which the SN/SS–SRH relationship is expressed among the different sub-groups.

In the second chapter, Lucia Coppola and Daniele Spizzichino use EU-SILC data for Italy to study the impact of retirement on self-reported health. Focusing on the role of gender, they argue that in light of the persistence of traditional family role models (male breadwinner, female housewife, and second earner) in Italy, the effects may differ considerably across male and female retirees: i.e. while retirement may lead to a worsening of self-reported health due to the stress associated with the reorganisation of lifestyles and family roles after retirement, the opposite may be the case for women who were previously struggling to reconcile work and family roles. Applying propensity score matching methods for identification, the authors find that while retirement has a negative short-term impact on male health, it has no significant effects on female health. This result may be viewed as partial confirmation of their hypothesis. Their findings suggest that recent reforms of the Italian pension system, which have predominantly affected women's retirement, should not have a strong offsetting effect on health expenditures. However, the authors conclude by noting that further research is needed to determine the long-run impact of retirement on health and to investigate in greater depth the effects of pension reforms on the health-retirement nexus.

The three chapters that follow are related to the literature on the link between ageing, labour supply, and retirement. These chapters highlight the changing roles of leisure, socio-economic status, education, and social networks for labour supply and retirement. The third chapter authored by Haodong Qui, presents new estimates on the relationship between labour supply and wage dynamics in Sweden for the time period 1985–2003. As population ageing will require an extension of the labour supply among the working-age population, it is important that we gain a better understanding of how the age-specific labour supply reacts to changes in the wage structure. According to the inter-temporal substitution hypothesis (ISH), labour supply and wages should be positively correlated over the life cycle. However, empirical estimates at the micro and the macro levels are so far not conclusive. The innovation by Haodong Qui is to apply recent data from the National Transfer Accounts to yield age-specific values for the ISH at the macro level. While the values he estimates are, in aggregate, quite close to those found in the literature, he shows that the variation across ages is quite high. Qui therefore argues that calibrations of overlapping generation economies need to take into account the life-cycle patterns of the labour supply elasticities.

The fourth chapter, contributed by Madelin Gómez-León and Pau Miret-Gamundi, investigates the role of socio-economic determinants for early retirement in Spain during the period 1999–2012 based on data from the Spanish Labour Force survey. As Spain has one of the oldest populations in Europe and one of the lowest labour force participation rates among the elderly, it is important that we gain a better understanding of the socio-economic characteristics that are associated with early labour market exit in Spain. The study focuses on the role of family arrangements in early retirement. The results clearly indicate that there is a strong gender division in the Spanish labour market, with men being more active than women. In terms of family structure, women are more likely to retire if they live with dependants (e.g. parents), while men are more likely to retire if they have a partner. The trend towards early exit from the labour market appears to be slowing among women but accelerating among men. Since education is positively correlated with working longer, investing in training and qualifications for adults may help to keep them in the work force longer.

In the fifth chapter, Linda Kridhal investigates the role of leisure activities for retirement using Swedish longitudinal data over the period 1981–2010. Since engaging in leisure activities is associated with having an active and healthy life, postponing retirement may be expected to have detrimental effects on retirees' activity and health levels. If period is not controlled for there is a clear association between engagement in specific leisure activities (e.g. cultural activities, gardening) and early retirement. However, once a period effect (representing labour market or pension policies) is controlled for, the empirical estimates indicate that those who are more engaged in leisure activities before retirement are not entering retirement significantly earlier. The author notes that future research may examine whether retirement timing is related to whether the leisure activities are physical, social, or intellectual. The results also show that leisure activities before and after retirement are quite similar.

The final two chapters link the literature on labour supply and retirement to institutional aspects and highlight broader implications of a prolonged life cycle for society. In the sixth chapter, Gustavo de Santis examines the properties of so-called Almost Ideal Pension Systems (AIPS), which are pay-as-you-go schemes for which the relevant policy parameters are set in relative rather than in absolute terms. The relative policy variables include, in particular, the relative shares of the life course spent working and in retirement, the standard of living afforded to children and pensioners relative to that of the working-age population, and the weight attached to actuarial fairness as opposed to intra-generational redistribution. The author shows how the design of these schemes renders the AIPS resilient to demographic and economic change. Using numerical exercises, he illustrates how AIPS compare with more conventional pension schemes (defined contribution, defined benefit, and risk-sharing) in terms of cross-sectional relative welfare, intergenerational equity, and contribution rates. The author finds that the AIPS outperform the conventional schemes in most respects. While these findings are subject to the stylised nature of the analysis, they help to identify in a structured way some of the weaknesses of real-world pension schemes.

In the final chapter of this volume, Josh Goldstein and Ronald Lee relate the on-going process of population ageing to the inequality of wealth in a society. The authors study three channels through which population ageing may affect inequality of income and of net worth: the increase in capital intensity under a slowdown of population growth; the shift in the age structure towards older and typically more unequal cohorts; and the impact of a longer life cycle on earnings and on the accumulation of capital. Employing US data, they find that a slowdown in population growth by one percentage point is expected to raise the income share of the top decile from 50 per cent to about 55 per cent—which represents a considerable increase in income inequality—merely through the increase in capital intensity. While the other two channels give rise to weaker effects, the authors conclude that, overall, the process of population ageing is likely to be accompanied by a sizeable increase in economic inequality.

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What can reverse causation tell us about demographic differences in the social network and social support determinants of self-rated health in later life?

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Abstract

Few studies of the association between social networks (SN), social support (SS), and self-rated health (SRH) address the role of demography in determining that association. Yet demography defines social-structural context, differentiates family from friend networks, and influences network structures. This study examines the SN-SRH association through cross-cutting analyses of four demographically defined groups (Males, Females, Partnered, Unpartnered) and three networks (Family, Friend, Group). By distinguishing between 'healthy' and 'unhealthy' samples, the underlying causal mechanisms are explored. The positive causal effect of SN on SRH is almost entirely confined to the healthy. In this sample, Friend SN is operational among Females and the Partnered, and Group SN is operational among Males. In the unhealthy sample, reverse causation accounts for all but a weak positive effect of Group SN on the SRH of the Partnered, while worse SRH among Females has the causal effect of greater emotional SS through confiding in friends. Among the Unpartnered, only the effect of SRH on confiding in family members is significant. The findings call into question the validity of studies which assume only positive causation, and underline the importance of demographic differentiation of both population and networks for understanding the SN-SRH association.

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1 Introduction

It is widely recognised that social networks play an important role in determining health, well-being, and survival at older ages (Bowling and Grundy 1998; Berkman et al. 2000; Litwin and Shiovitz-Ezra 2011; Fiori and Jager 2012). Most research on this topic focuses on social interactions between the ego and network members and/or the function of the network in providing social support. Different bodies of work refer to different outcomes, use different social network variables, and variously focus on the type of network, on family or friends, on differences by sex, or on narrowly specified populations; leading to a large body of findings that are difficult to assimilate. Clarity is not assisted by a failure in some studies to distinguish between the social network and social support. The extent to which the findings are context-specific often cannot be determined. The fact that most studies rely on cross-sectional data to examine this complex association makes it difficult to establish causation. Distinguishing between causation (social activity begets health) and reverse causation (health begets social activity) in the positive association is further complicated by the likelihood that a negative association will arise from reverse causation (worse health begets more social support and health-related activity). These three causal mechanisms are likely to coexist in any population.

In most studies on this topic, the role of demography is largely ignored. While demographic variables appear in statistical models, they usually serve as controls: their role is to allow an overarching relationship between social networks and health to be revealed. Yet social networks are formed primarily along demographic lines (Kalmijn and Vermunt 2007), and health is differentiated by demographic characteristics (Gjonca et al. 2005; Murphy et al. 2007). It can therefore be expected that demographic variables play an important role in determining the relationship between social networks and health, and that the nature of this relationship might differ among demographic groups.

This exploratory study uses cross-cutting demographic differentiation to further examine and explain the association between social networks and health among older people. It employs a structured analysis of the association by considering, on the one hand, different social contexts through demographically defined groups; and, on the other, different social networks bounded by notions of kith and kin and structured by demographic processes and characteristics. By design, the study seeks to distinguish between the three causal mechanisms in order to further illuminate the demographic differences in the overall association. To our knowledge, the study is unique in distinguishing the causal mechanisms underlying the association between social networks and health.

The data are drawn from a national survey which focuses on the social activity levels and well-being of Australian seniors (Booth et al. 2013). The outcome variable is self-rated health (SRH), a widely used, reliable, and strong predictor of survival which is, however, relatively little understood (Lundberg and

Manderbacka 1996; Idler and Benyamini 1997; Sargent-Cox et al. 2008; Jylhä 2009). Thus, it is important to seek new insights into the determinants of SRH.

The paper is organised as follows. Section 2 contains background material, including the definitions of and the distinctions between social networks (SN) and social support (SS), a review of previous findings on the SN-SRH association, and a discussion of demography in relation to social networks and the SN-SRH association. The term SN-SRH is used in this paper to refer to the overall association between social networks and self-rated health encompassing social support effects. Section 3 presents the study design, including its aims and scope, a conceptual framework for the study of the SN-SRH association, and a clarification of the causal mechanisms underlying the association. Section 4 describes the data, measures, and statistical methods used. The results are presented in Section 5, and a discussion of the results follows in Section 6.

2 Background

2.1 Social networks and social support

The notion of the social network (SN) has been credited to Barnes (1954). Social network theory views social communication in terms of network members (nodes) and their relationships (ties), rather than the characteristics of individual agents, and views social behaviour as shaped by the patterns and the quality of relationships (Kadushin 2012). Social networks are defined in terms of network structure and the characteristics of network ties. Network structure includes size (number of members), density (ties per member), boundedness (definition by a particular characteristic, such as family membership), homogeneity (of members with respect to a particular characteristic, such as sex or age), proximity (physical distances among network members), and reachability (ease of access to other network members). The characteristics of ties include the frequency of face-to-face and non-face-to-face contact and of group participation, duration (the length of time two members have known each other), the degree of closeness or intimacy, multiplexity (the number of types of functions a tie serves), and reciprocity (the extent to which functional exchanges are reciprocal) (Scott 2000). Social relationships govern the interpersonal flow of resources, including material goods, feelings, assistance, and information; and thereby shape individual behavioural and emotional responses. The social network perspective thus has relevance for understanding how social relationships relate to personal health and well-being (Smith and Christakis 2008).

Most studies of the SN-SRH association among older people focus on a single network function: social support. (Other functions include social influence, social engagement and attachment, and access to resources and material goods.) Social support (SS) refers to the flow of assistance or resources to the older person from his or her social network which is typically treated as singular and egocentric (see Smith and Christakis (2008) for a discussion of network analyses involving more complex, supradyadic effects), and may be instrumental, financial, informational, appraisal, or emotional. Most studies refer to perceived social support (e.g. Ashida and Heaney 2008), but a few use actual support (e.g. Litwin 2006).

The distinction between the social network and social support is rarely maintained in the literature (Smith and Christakis 2008). A multiplicity of terms have been employed, which often span and conflate these two concepts (examples include social engagement, social capital, social connectedness, social interaction, and social environment). Some studies of the SN-SRH association focus entirely on network functions (e.g. Cheng and Chan 2006), while others focus on the network without regard to function (e.g. Ferlander and Mäkinen 2009). Most studies take no particular account of social-structural conditions, which remain implicit.

2.2 Findings on the SN-SRH association

This brief review of the main literature on the SN-SRH association among older people first divides the findings into the effect of the social network and the effect of social support, based on the actual measures used. The review then considers studies involving different types of networks and partially differentiated networks, as distinct from multiple exclusive sub-networks. Finally, the social-structural context is considered, as distinct from model covariates. Almost all of the findings in the literature are based on cross-sectional data. Only three of the studies cited employ longitudinal data (as noted below).

Most existing research regarding the role of the social network has indicated that having more social contact is associated with better SRH (e.g. Litwin 2006; Cherry et al. 2013), while having a poor relationship with one's children or seeing one's family or friends less often is associated with worse SRH (Zunzunegui et al. 2004; Garcia et al. 2005). Participation in group activities has also been found to be associated with better SRH (Norstrand et al. 2012), but not in all populations (Pollack and von dem Knesebeck 2004; Nummela et al. 2008). There is little evidence that network size has an effect on SRH.

The findings regarding the role of social support in the SN-SRH association are mixed. Having greater actual support from adult children and the residential proximity of children have been found to be associated with worse SRH (Litwin 2006). Other studies have shown that having greater perceived social support is associated with better SRH (Dupertuis et al. 2001; Melchior et al. 2003 *based on longitudinal data*; White et al. 2009; Burke et al. 2012; Gilmour 2012). Analyses by sex of perceived non-instrumental support found no association with SRH in a Chinese sample (Cheng and Chan 2006), but a positive association among women in England (Grundy and Sloggett 2003) and among Japanese men (Okamoto and Tanaka 2004). It is possible that these differences have a cultural basis.

Some studies approach the analysis of the SN-SRH association through the concept of network type, whereby ego's overall network is first classified into one of several data-derived types which then form the basis of association with SRH. Several robust types have been identified across studies: 'friend-focused' networks are associated with better SRH, and 'restricted' (referring to low levels of receiving and giving support) networks with worse SRH (Fiori and Jager 2012 *based on longitudinal data*). Other studies partially differentiate between sub-networks (e.g. network structures are differentiated but network functions are not). Litwin (2006) found that contact with friends had a positive effect on SRH, whereas contact with neighbours had no effect, concluding that 'the autonomy and control that are expressed in the selection of friends seem to contribute to better self-rated health' (p. 351). The voluntariness of friendship has been similarly cited in explaining why social activities with friends have a more positive effect on subjective well-being than social activities with family members (Huxhold et al. 2013 *based on longitudinal data*). Few studies have considered ego's network as a series of exclusive sub-networks, despite the early and ongoing recognition of the need to distinguish between family and friends (Antonucci and Akiyama 1987a; Lennartsson 1999). Zunzunegui et al. (2004) considered friends, extended family, and children, and found that while a stronger network was associated with better SRH for all three sub-networks, the association was attenuated in the presence of disability only for the network of friends.

While this variation in findings by population points to the importance of the social-structural context in the SN-SRH association, it has so far received little attention (Berkman et al. 2000). The existing contextual comparisons include studies of different countries (Pollack and von dem Knesebeck 2004) and of different ethnic or geographic populations within a country (Zunzunegui et al. 2004; Litwin 2006; Nummela et al. 2008). Kavanagh et al. (2006) used the social characteristics of the local environment as a social-structural context. While several studies have compared the sexes, often finding differences between men and women in the SN-SRH association (e.g. Ferlander and Mäkinen 2009), few have treated gender as explicitly contextual (Kavanagh et al. 2006).

2.3 Demography and the SN-SRH association

Demography features in three distinct but interrelated ways in the discussion of social networks. First, demography delineates family (kin) and friend (kith) sub-networks, and their exclusivity allows for contrasts to be drawn in the SN-SRH association. Family and friend networks exhibit different degrees of closeness to ego, and play different roles in the provision of social support (Antonucci and Akiyama 1987a; Seeman and Berkman 1988). Second, demography plays a key role in defining network structures, including those of the family, which is traditionally the most influential social network in human society. Demographic processes are the basis of the family, shaping family network size and other structural characteristics (Wolf 1994). The demographic life course events, such as entering and leaving a partnership and family formation, of both ego and his or her family members are instrumental in shaping ego's kinship networks in later life (Antonucci and Akiyama 1987a; Wenger et al. 2000). Demographic and life course factors also feature strongly as dimensions along which friend networks are formed. Studies of the non-kin social networks of adult egos show considerable homogeneity of network members with respect to sex, partnership status, and age; and of their interactions (McPherson et al. 2001; Kalmijn and Vermunt 2007). Group networks may also be homogeneous with respect to demographic variables. For example, certain interests may be gendered, and certain day-time activities may be accessed primarily by retirees (most of whom are older).

Third, demography is an important source of variation within the population. Different demographic groups tend to have networks with different characteristics, resulting from different stages or trajectories in the life course or from different social and cultural norms and values, including different degrees of volition in determining who counts as kin (Finch and Mason 1993). In line with demographic homophily (the tendency of individuals to associate with others of the same kind), differences are found in the network characteristics of men and women (Antonucci and Akiyama 1987b; Ajrouch et al. 2005; McLaughlin et al. 2010), and of groups defined by marital status and by age (Kalmijn and Vermunt 2005). Clearly, social sub-network characteristics and demographic groups are inter-related through demographic boundedness and homophily. These inter-relationships also extend to the characteristics of ties and to social support.

Sex and partnership status (and their interaction) are important determinants of social networks and social support. Sex (or gender) has been extensively cited as a distinguishing factor: women's networks are larger, more supportive, and more multifaceted; and involve more friends, more confidants, and greater intimacy and disclosure; while men's networks emphasize sociability, instrumentality, and activity, and involve few intimate relationships (Antonucci and Akiyama 1987b; Shye et al. 1995). Antonucci et al. (1998) found that among older married couples with children, women reported having more close relationships than men. Partnership status has received less attention (Adams et al. 2011), though it is influential in shaping social networks, especially through childbearing, in sex-specific ways (Wenger et al. 2000).

Age also influences social networks through the stage in the life course (Ajrouch et al. 2005). Age (or birth cohort) may also reflect historical changes in social behaviour and attitudes. Importantly, older people's social networks generally become smaller over time (Bowling and Grundy 1998). This accords with socio-emotional selectivity theory (Carstensen 1995): a greater sense of limited remaining life expectancy results in greater selectivity in favour of emotionally rewarding relationships. The voluntariness of friendship would allow for greater selectivity in friend networks than in family networks. Though the family network remains the main source of support (Antonucci and Akiyama 1987a), the reduced friend network is also important in terms of social activity and emotional support (Huxhold et al. 2013).

Given its role in shaping social networks, and hence social support, demography can be expected to have a significant effect on the relationship between social networks and outcomes such as health. It is therefore important to give full recognition to demographic factors in examining the SN-SRH association. A distinction must be clearly drawn here between separately considering complementary populations (such as males and females) and relegating the distinguishing variable (i.e. sex of ego) to the status of covariate. Most (if not all) studies include covariates in their models to take account of confounding influences. However, the inclusion of demographic variables as covariates does not give sufficient recognition to, and thus cannot adequately illuminate the context. Only by comparing different populations or complementary groups within a population can the influence of different demographic or social-structural contexts be understood. Treatment as a covariate (sex of ego) removes the effect, whereas treatment as a context definition (male vs. female) focuses on the effect. To fully take account of demographic influences, it is necessary to focus on demographic groups. The importance of independent analyses for demographic groups has been previously recognised (Antonucci and Akiyama 1987a; Berkman et al. 2000; Fiori and Jager 2012).

3 Study design

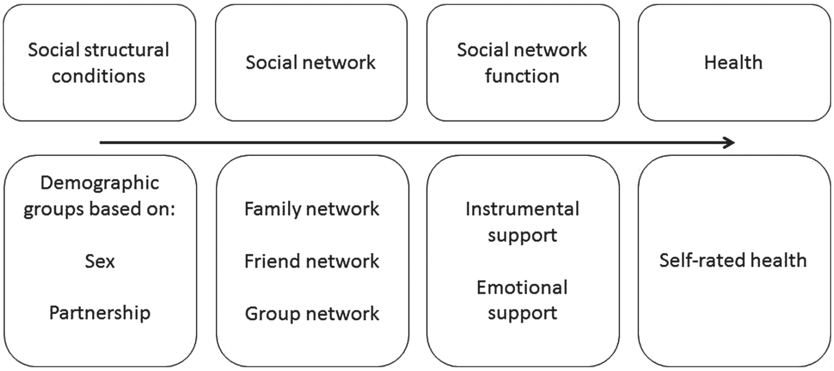
3.1 Aims and scope

The aim of this exploratory study is the illumination of the SN-SRH association in a national sample of Australian adults aged 50–89. This is done through demographically cross-cutting comparative analyses of the SN-SRH association, while also accounting as far as possible for three underlying causal mechanisms. Thus, three different dimensions are addressed. Specifically, the analysis explores social-structural differences due to sex and partnership status in the underlying causal mechanisms of the association between SRH and three exclusive social networks (family, friend, and group) providing two social support functions (instrumental and emotional).

3.2 Conceptual framework

In a landmark paper, (Berkman et al. 2000) proposed a comprehensive conceptual framework detailing how social networks influence health. In this framework, social networks are situated within the social-structural conditions of the macro-environment, which include culture, socio-economic conditions, politics, and social change. These factors condition the nature of social networks, which are defined in terms of network structure and the characteristics of ties. Social networks provide opportunities for five network functions: social support, social influence, social

Figure 1:
Conceptual framework linking social networks and health



Source: Adapted from Berkman et al. (2000).

engagement, person-to-person (close) contact, and access to resources. These in turn operate to influence health through three pathways: health behaviour, psychology, and physiology. Further details are listed under each aspect of each component.

In this study, we (initially) adopt a conceptual framework (Figure 1) based on the first three components of the Berkman–Glass–Brissette–Seeman (BGBS) framework (pathways are not considered) and the availability of variables. The BGBS framework naturally accommodates demographic factors in both the first and the second components: i.e. the social-structural conditions and the social network. Demographically defined groups can be viewed as representing social-structural conditions within the wider conditions of the relevant society. We individually model four demographic groups in Australian society: Males, Females, Partnered, Unpartnered, and Total.

The social network is also largely demographically defined through network boundedness and demographic homophily. Three exclusive sub-networks are considered: Family, Friend, and Group. These sub-networks are modelled simultaneously, enabling us to determine the net effects of each sub-network and to compare and contrast them. The social networks are egocentric and described in terms of network structure and ties. For the Family and Friend networks, we combine a structural dimension indicating size with tie characteristics indicating the frequency of face-to-face contact; whereas for the Group networks only the frequency of face-to-face contact is used. Two social network functions feature in the framework: Instrumental and Emotional support. These refer to support provided specifically by the Family and Friend networks; thus, network functions are also bounded.

By incorporating demographic variables in the first and second components, cross-cutting demographic differentiation is incorporated in the analytical design:

the multi-network model is estimated for each of four pairwise-complementary demographic groups. Making comparisons between and within these models can be expected to enhance our understanding of the SN-SRH association.

3.3 Causal mechanisms

A defining feature of the BGBS framework is the direction of flow. The components are labelled as 'upstream' and 'downstream' in relation to the social network/function (Berkman et al. 2000). The association is depicted as positive and causal: i.e. a stronger SN begets better health. It is, however, possible that the positive association is due to reverse causation: i.e. better health begets a stronger SN. Moreover, there may also be a negative association, which is logically confined to reverse causation: i.e. being in worse health begets a stronger SN because the individual has a greater need for and is the recipient of SS (whereas being in better health begets a weaker SN through the lack of need for support). (Causation is considered illogical: stronger (weaker) SS is unlikely to lead to worse (better) health.) Disentangling the precise effects of these three causal mechanisms is difficult, and can only be done through a longitudinal study design.

In this study, two strategies are used to isolate, to the extent possible, one or more causal mechanisms of the SN-SRH association. The intent is to allow more meaningful interpretations of this association, and facilitate comparisons across demographic groups and sub-networks. The first strategy follows the structure of the analytical design: clear distinctions are maintained between the social network and social support, between instrumental support and emotional support, and between the three sub-networks. Symmetry of cross-cutting differentiation is also maintained, both between the Family and Friend networks and among demographic groups. This structured analytical design, shown in Tables 3–5, is intended to assist interpretation.

The second strategy is the elimination of one or more mechanisms through sub-sample selection. We take advantage of the logical selectivity of causal mechanism offered by the variable 'frequency (degree) of social activity restriction due to own (poor) health or disability' (hereafter, 'SN restriction'; see Section 4.2.4). The sample was divided into an 'Unrestricted SN' sample and a 'Restricted SN' sample according to whether the respondent's social activity was never or ever restricted.

By definition, the Unrestricted SN sample does not experience positive reverse causation (health begets SN), as the frequency of the SN restriction is 'never' (see Discussion). Further, because these respondents are not in need of disability-related visits/activities or instrumental support, the strength of their social networks or Instrumental SS is not attributable to negative reverse causation. However, having stronger Emotional SS may stem from having worse health of a form that does not restrict social activity. The logical causal mechanisms for this sample are therefore positive causation, as embodied in the BGBS framework, and negative reverse causation related to Emotional SS. The applicability of causal mechanisms in the SN-SRH association is shown in Table 1.

Table 1:
Causal mechanisms underlying the SN-SRH association in the Unrestricted SN and Restricted SN samples

Causal mechanism	Description	Unrestricted SN sample	Restricted SN sample
Positive causation SN/SS → SRH	Stronger SN/SS begets better SRH Weaker SN/SS begets worse SRH	✓	✓
Positive reverse causation SRH → SN/SS	Better SRH begets (facilitates) stronger SN/SS Poorer SRH begets weaker (restricts) SN/SS	X	✓
Negative reverse causation SRH → SN/SS	Poorer SRH begets stronger SN and stronger SS (Instrumental or Emotional)	SN : X Instrumental SS: X Emotional SS: ✓	✓

Note: SN = social network; SS = social support; SRH = self-rated health. The Unrestricted SN and Restricted SN samples include respondents whose social activities are 'never' and 'ever' restricted by their health or disability, respectively.

In contrast, all three causal mechanisms are likely to operate in the Restricted SN sample (see Table 1) Among those with some degree of social restriction due to their own health or disability, a stronger SN is likely to beget better health (positive causation), while worse health is likely to beget both a weaker SN (positive reverse causation) and a stronger SN, through disability-related visits/activities and stronger Instrumental and Emotional SS (negative reverse causation). However, the variable used to divide the total sample can also be used to take account of the degree of social activity restriction due to health or disability in the Restricted SN sample: in other words, reverse causation can be (largely) taken into account. As in the Unrestricted SN sample, the only reverse causation that then logically remains applicable is negative reverse causation due to stronger Emotional SS stemming from worse health (after the level of health/disability has been accounted for by the variable SN restriction).

3.4 Health, SRH, and SN restriction

It is important to make distinctions between health, SRH and the degree of SN restriction due to health. The three causal mechanisms underlying the SN-SRH association refer to health in the general sense of the term. SRH is the *indicator* of health used as the dependent variable in the analyses. The meaning of SRH is the subject of ongoing research but it is clear that it is not synonymous with medical notions of health (Duncan and Frankenberg 2000; Benyamini et al. 2003; Manderbacka 2013). Rather, SRH is an assessment of health made on the basis of multifarious conditions in the context of possible age, social and temporal comparisons (Sargent-Cox et al. 2008).

In the context of the present study, a positive association between social networks and health, whether due to causation or reverse causation, is more readily appreciated in terms of SRH. In comparison, a negative association, which would arise from reverse causation (worse health begets stronger SS and a stronger SN), is more easily envisaged in terms of physical health and instrumental support. To some extent, causation and reverse causation are likely to be addressing different concepts of health.

The frequency of social activity restriction due to ego's health or disability (SN restriction) is the second indicator of health available to the study. SN restriction differs from SRH in two important respects. First, SN restriction is highly likely to be viewed by respondents in terms of physical health, especially given the reference to disability. It is thus much less comprehensive than SRH, omitting health conditions that do not restrict social activity, and ignoring the broader scope of SRH. Second, SN restriction refers to the frequency of restriction due to health/disability rather than to the state of health *per se*. In the total sample, the correlation between SN restriction and the five-category SRH is 0.53, indicating only moderate correspondence.

The distinction between SN restriction and SRH is important for understanding the SN-SRH association (See Section 6.5). Greater social restriction due to ego's health/disability implies that ego's social network is increasingly reliant on others. Rather than acting as his or her own social agent, the disabled ego is often a more passive social 'recipient'. This interpretation is consistent with Litwin's observation that network choice and independence are important for (SRH 2006).

4 Data and methods

4.1 Data

The data are from the 2010/11 national survey of the Social Networks and Ageing Project (SNAP), which was designed to investigate the role of social networks in successful ageing (Booth et al. 2013). Participants were drawn from the membership of National Seniors Australia (NSA), a broad-based Australia-wide older persons' interest group (http://nationalseniors.com.au/). More than half of the group's members reported joining NSA 'to be informed about over 50s issues' (personal communication, NSA). The sampling frame comprised two exclusive membership sub-lists which the NSA uses to maintain contact with its members (by email or by post). Each sub-list was stratified by sex and ten-year age group (50 to 89). To avoid sampling both partners of couples, an age-sex-matched substitute was selected. To overcome potential gender bias within couples (arising from the NSA membership numbering system), the initial invitee was asked to assign the invitation to the partner (of the couple) with the more recent birthday (Salmon and Nichols 1983). The postal questionnaire was sent to 2,500 members, and a further 10,000 members were sent an email invitation to complete the questionnaire online. All of the invitees had the option of completing the questionnaire using the alternative method. Overall, the response rate was 17.0%, with approximate (due to uncertain denominators) response rates of 39.4% for the postal method and 11.4% for the online method. The final sample of 2,122 Australians comprised 46% who completed the postal questionnaire and 54% who responded online. An effect-size metric (Lindenberger et al. 2002) was used to compare the postal sample with the online sample on study variables. Generally, small effect sizes (< 0.20 SD units) indicated no substantial differences between respondents according to mode of completion. Educational differences were somewhat greater (0.30 SD units). Item response rates were high: dependent variable > 99%, covariates > 97%, and independent variables 78%–96%.

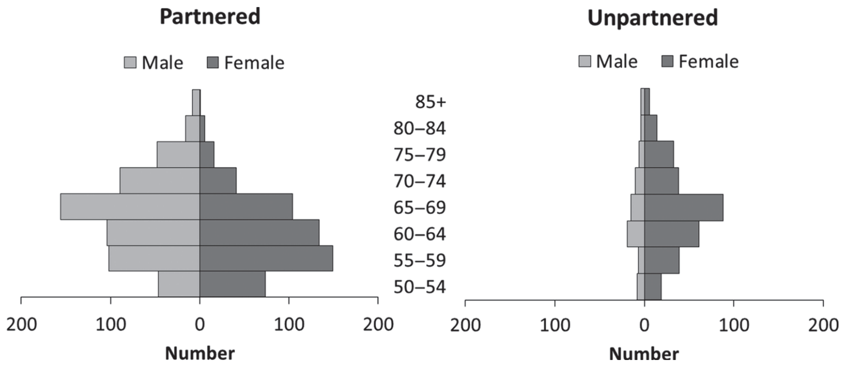
Compared with the 2011 Australian population (Australian Bureau of Statistics, 2011), the sample under-represents the age groups 50–54 (because NSA membership eligibility starts at age 50) and 80–89 (due to membership attrition and possible age-related non-response), and over-represents the age group 65–69. The sample is, on average, more educated than the general population. Unweighted data are used, since age and education are taken into account in the analysis. The age, sex, and partnership status distribution of the total analytical sample (n = 1522) is shown in Figure 2. The group sample sizes are shown in Table 2.

The division of the sample into Unrestricted SN and Restricted SN samples yielded sample sizes of 800 and 722, respectively. The group sample sizes within these samples are shown in Tables 4 and 5, respectively.

4.2 Measures

The dependent variable, SRH, is a multidimensional evaluation of the ego's current state of health. At its core is objective health and functioning, but more subjective and contextual factors are also involved (Jylhä 2009). In this study, we employ 'global' SRH, based on the question *'In general, would you say your health is ...?'* 1 'Excellent', 2 'Very good', 3 'Good', 4 'Fair', 5 'Poor'. For this study, responses were coded 0 'Excellent/very good/good' and 1 'Fair/poor' for the total sample and the Restricted SN sample, and 0 'Excellent/very good' and 1 'Good/fair/poor' for the Unrestricted SN sample. This distinction was necessary because in the case of the Unrestricted SN sample, the number of respondents with fair/poor SRH in the analytical sample was too small (n = 17) for reliable estimation; in fact, no respondents in the Unrestricted SN sample reported having poor health. As the two

Figure 2:
Age, sex and partnership status distribution of the analytical sample



samples are not directly compared, this was considered the optimum solution. The alternative was to model good/fair/poor SRH throughout; this was rejected on the grounds that fair/poor SRH is the main focus in the literature.

The independent variables include social network and social support characteristics referring to the previous four weeks, taken as representing the respondent's usual experience of his or her 'effective' network. Social support is thus actual, rather than perceived. In all cases, the term 'persons' refers to adults aged 18 or older, and the term 'family' refers to adult family members not living in the same household as the respondent. Personal socio-demographic characteristics are included as covariates.

4.2.1 Social network

Family network and friend network. Network strength is a continuous variable constructed as the average of three variables: network size, occasions and duration. Network size refers to the number of persons (family or friends) with whom the respondent had been in face-to-face contact, measured on a scale from 1 to 5; coded 1 '1', 2 '2 or 3', 3 '4 to 6', 4 '7 to 10', and 5 '11 or more'. Occasions on which the respondent spent time with these family/friends was coded 1 'Once', 2 '2 or 3', 3 '4 to 6', 4 '7 to 10', and 5 '11 or more'. Duration or time spent on these occasions was coded 1 'Less than an hour', 2 '1 hour to less than 5 hours', 3 '5 hours to less than 10 hours', 4 '10 hours to less than 20 hours', and 5 '20 hours or more'. Respondents who had not been in face-to-face contact with any family/friend were coded 0 on all three variables.

Group network. Time spent in group activities ranges from 1 'Less than one hour', to 2 '1 to 5 hours', 3 '5 to 10 hours', 4 '10 to 20 hours', and 5 '21 hours or more'.

Examples of group activities are committee meetings, gym class, and choir practice. This variable is treated as continuous.

4.2.2 Social support

Actual social support characteristics apply to the family/friend networks. Instrumental support was measured by the question: 'How many family/friends assisted you to do something practical?' Emotional support was measured by the question: 'How many family/friends did you confide in?' Both variables are coded 1 '0', '2', 3 '2', 4 '3', 5 '4', 6 '5-6', and 7 '7+', and are treated as continuous.

4.2.3 Covariates

Several covariates are included in the models. Sex and partnership status are taken into account as being relevant within each demographic group. Sex is coded 1 'Male', 2 'Female'. Partnership status is coded 1 'Partnered' if the person was living with a spouse or a de facto partner (or was in a relationship but not living together); and otherwise 0 'Unpartnered'. Age is measured in single years. Other covariates include education and comfortable with standard of living (Kennedy et al. 1998; Mirowsky and Ross 2008). Highest educational qualification is coded 1 'No secondary school qualification', 2 'School certificate/intermediate certificate', 3 'Higher school certificate/trade apprenticeship', 4 'Certificate/diploma', and 5 'University degree or higher'. The respondent's agreement with the statement 'I am comfortable with my standard of living' (on a scale from 1 'Strongly disagree' to 5 'Strongly agree') is used as a proxy measure for socio-economic status. Education and comfortable with living standard are treated as continuous.

4.2.4 Frequency of social activity restriction due to health or disability

The survey questionnaire included a question asking: 'How often are your social activities with adult family members (who do not live with you) restricted by your health or disability?' The same question was asked regarding friends. The questions do not refer to a specific time period. Responses range from 1 'Never' to 5 'Always'. Frequency of social activity restriction due to health or disability (SN restriction) is the sum of these two variables, with a score ranging from 2 'Social activities never restricted' to 10 'Social activities always restricted'. As noted in Section 3.3, SN restriction is used to divide the sample into an Unrestricted SN sub-sample (a score of 2, or never restricted) and a Restricted SN sub-sample (a score of 3 to 10, or ever restricted). This variable is also used in modelling SRH in the Restricted SN sub-sample, where it is included to take account of reverse causation. SN restriction provides a direct measure of positive reverse causation and serves as an indicator of negative reverse causation, and is thus the key variable in 'isolating' the underlying causal mechanisms in the SN-SRH association.

4.3 Method

Logistic regression is used to identify the predictors of worse SRH, using STATA 12. The models are estimated separately for each demographic group, across which the variables are identical, facilitating the comparison of groups. Two models are estimated (as appropriate). Model 1 includes the covariates and independent SN and SS variables. This model is estimated for the total sample and for the Unrestricted SN and Restricted SN samples. Model 2 also includes SN restriction, and is estimated for the Restricted SN sample.

As the purpose of the analysis is to compare the nature of associations among demographic groups and sub-networks, the reporting of regression results is limited to the statistical significance of variables. Thus, in presenting these models in Tables 3–5, '+' indicates that weaker SN or SS is associated with worse SRH (or, equally, stronger SN or SS is associated with better SRH), equivalent to a positive SN-SRH association. Similarly, '−' indicates that stronger SN or SS is associated with worse SRH; in other words, a negative SN-SRH association applies, logically, as negative reverse causation.

5 Results

The distributions and the means of the study variables by demographic group are shown in Table 2. In the analytical sample, 14% rated their health as fair/poor. Associations with sex and with partnership status were found to be non-significant. Logistic regression models (Tables 3–5) show that the SN-SRH association (Model 1) differs according to both sub-network and demographic group. For the Total sample, there are no Family SN or Friend SN effects, but Group SN is highly significant. The two significant SS effects are both Emotional (Family and Friend), but they are in opposite directions.

When comparing demographic groups, the most striking result is that for three of the four groups, Group SN is positively related to SRH. The absence of a significant Group SN effect for the Unpartnered is in stark contrast to the highly significant effect for the Partnered. Among the Unpartnered, there is only one effect, the marginal benefit of Friend SN for SRH. This marginal effect also occurs among Females. Among Males, Group SN is the only effect, while among the Partnered Family Emotional SS is positively associated with SRH. These positive effects are consistent with the BGBS framework, although there is no indication of causal direction in the positive SN-SRH association.

Several significant negative effects are indicated for Friend Emotional SS and Family Instrumental SS. Together these negative effects suggest that the BGBS

Table 2:
Study variables by demographic group: means for continuous variables and distributions for categorical variables

Variable	Total	Males		Females	Partnered		Unpartnered
Sample size	1522	665		857	1141		381
SRH (% Fair/poor)	14.5	14.7		14.2	13.5		17.3
Age	64.5	65.6	***	63.7	63.8	***	66.7
Sex (% female)	56.3	—		—	48.1	***	80.8
Partnership status (% partnered)	75.0	89.0	***	64.1	—		—
Level of education	3.47	3.55	*	3.40	3.46		3.48
Comfortable with living standard	1.92	1.92		1.92	1.86	***	2.07
Disability limits social activities	3.22	3.16		3.26	3.12	***	3.52
Family network							
Network strength[a]	2.54	2.36	***	2.67	2.57		2.44
Family instrumental support[a]	2.42	2.29	**	2.53	2.40		2.48
Family emotional support[a]	2.18	2.06	**	2.27	2.14	*	2.30
Friend network							
Network strength[a]	2.57	2.33	***	2.76	2.48	***	2.86
Friends instrumental support[a]	2.26	2.16	**	2.35	2.20	**	2.45
Friends emotional support[a]	2.03	1.77	***	2.23	1.95	***	2.28
Group network							
Time spent in group activities[a]	3.01	2.96		3.05	2.95	*	3.19

Note: Group differences were tested using chi-squared for categorical variables and Student's t for continuous variables. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$; [a]Refers to previous 4 weeks.

framework may not be entirely appropriate. Rather than stronger SS resulting in better health through positive causation, these negative effects indicate that the dominant causal mechanism is negative reverse causation whereby being in worse health begets stronger SS. These causal mechanisms are confounded in the model.

We explore these opposing mechanisms by dividing the sample into respondents who reported no restrictions on their social activity due to their own health or disability (Unrestricted SN) and those who reported some restrictions (Restricted SN). By doing so, we effectively eliminate in the Unrestricted SN model the effects of positive reverse causation of SN and negative reverse causation of Instrumental SS, leaving positive causation and weak negative reverse causation of Emotional SS as possible mechanisms (see Section 3.3). It can be seen in Table 4 that the dominant pattern in the Unrestricted SN sample is indeed positive association, logically attributed to positive causation. This occurs for both Friend SN and Group SN, the sub-networks that can be expected to contribute most to SRH in a socially unrestricted sample; whereas there are no such effects for Family SN.

It can also be seen in Table 4 that the positive effects of Friend SN and Group SN are again absent among the Unpartnered. For this group, the only effect is a

Table 3:
Associations with SRH, total sample by demographic group

Variable	Total	Males	Females	Partnered	Un-partnered
Age	—	—	–	—	–
Sex					
Partnership					
Education		++			
Comfortable with living standard	+++	+++	+++	+++	++
Family SN					
Family Instrumental SS				[–]	
Family Emotional SS	[+]			[+]	
Friend SN			[+]		[+]
Friend Instrumental SS					
Friend Emotional SS	–		–	–	
Group SN	+++	++	++	+++	
Sample size	1522	665	857	1141	381
Pseudo R^2	.070	.101	.072	.080	.075

Note: Based on logistic regression of Fair/poor SRH (Model 1). + positive (beneficial) effect on SRH; − negative (detrimental) effect on SRH; [ ] $p < 0.10$; $^{+}$ $p < 0.05$; $^{++}$ $p < 0.01$; $^{+++}$ $p < 0.001$.

Table 4:
Associations with SRH, Unrestricted SN sample[a] by demographic group

Variable	Total	Males	Females	Partnered	Un-partnered
Age					
Sex	+				+
Partnership					
Education	+++	+	++	+++	
Comfortable with living standard	++		++	+	
Family SN					
Family Instrumental SS					
Family Emotional SS					–
Friend SN	+		++	+	
Friend Instrumental SS					
Friend Emotional SS					
Group SN	++	++		+	
Sample size	800	365	435	615	185
Pseudo R^2	.063	.058	.083	.061	.122

Note: Based on logistic regression of Good/fair/poor SRH (Model 1). [a] Includes respondents whose social activities are never restricted by their health or disability. + positive (beneficial) effect on SRH; − negative (detrimental) effect on SRH. [ ] $p < 0.10$; $^{+}$ $p < 0.05$; $^{++}$ $p < 0.01$; $^{+++}$ $p < 0.001$.

negative effect of Family Emotional SS due to reverse causation: i.e. worse SRH begets greater Emotional SS from family members. The fact that this occurs only among the Unpartnered may be attributable to the absence of a partner which may result in family members serving as confidants in situations of stress or ill health. Thus, the effect of Family Emotional SS differs between the Unpartnered and the Partnered, as the latter can be expected to confide in their partner (the relevant variable was not available).

In the comparison of Males and Females, two highly significant causal effects are contrasted: among Females better SRH stems from having a stronger Friend SN, whereas among Males better SRH stems from having a stronger Group SN. This difference is in line with theories regarding gendered styles of communication, which assert that women are more likely than men to prefer having close and emotionally satisfying relationships (Cross and Madson 1997).

The models for the Restricted SN sample are shown in Table 5. For this sample, all three causal mechanisms are applicable. Model 1 shows a positive SN-SRH association for Group SN for Females and the Partnered, as well as for the Total (the model for the Unpartnered is non-significant). It is not possible to distinguish between positive causation and positive reverse causation. For these groups, there is also evidence of a negative SN-SRH association in relation to Friend Emotional SS, which suggests that ill health may be the subject of confidential disclosure (negative reverse causation).

The applicability of the causal mechanisms is likely to be related to the degree of SN restriction. Thus for the Restricted SN sample, further analysis was undertaken to take the frequency of SN restriction into account (Model 2), thereby essentially accounting for reverse causation in the positive association. It is expected that due to the inclusion of SN restriction, the positive SN-SRH association will be weakened.

Table 5 (Model 2) shows that this is indeed the case. The frequency of SN restriction is very highly significant for all demographic groups, which indicates that reverse causation contributes substantially to the positive SN-SRH association across the sample. The previously strongly positive Group SN-SRH association is reduced to a weak association found only among the Partnered. In other words, the positive association between Group SN and SRH is accounted for by the degree of SN restriction due to the ego's health or disability, or his or her ability to physically access group activities. Comparing Model 1 with Model 2, only one effect persists: the negative association of Friend Emotional SS with SRH for Females. The addition of interaction terms (not shown) did not change these results appreciably. Thus, it would appear that once reverse causation has been accounted for in the BGBS framework, only the model for Females shows a significant SN-SRH association in the form of negative reverse causation for Friend Emotional SS. Females in worse health confide in more friends.

Table 5:
Associations with SRH, Restricted SN sample[a] by demographic group

	Model 1					Model 2				
Variable	**T**	**M**	**F**	**P**	**U**	**T**	**M**	**F**	**P**	**U**
Age	—	–	–	—		–	–	[–]	–	
Sex										
Partnership										
Education		++					[+]			
Comfortable with living standard	+++	++	++	+++		++	[+]	[+]	++	
SN restriction						—	—	—	—	—
Family SN										
Family Instrumental SS										
Family Emotional SS				[+]						
Friend SN									[–]	
Friend Instrumental SS										
Friend Emotional SS	–		–	–				–		
Group SN	++		+	++					[+]	
Sample size	722	300	422	526		722	300	422	526	196
Pseudo R^2	.050	.074	.055	.073		.208	.240	.201	.242	.188

Note: Based on logistic regression of Fair/poor SRH. [a] Includes respondents whose social activities are to some extent restricted by their health or disability. Model 1 for Unpartnered (U) is non-significant. + positive (beneficial) effect on SRH; − negative (detrimental) effect on SRH. [ ] $p < 0.10$; $^{+}$ $p < 0.05$; $^{++}$ $p < 0.01$; $^{+++}$ $p < 0.001$.

6 Discussion

This study sought to identify differences in the SN-SRH association among complementary population groups and exclusive social sub-networks, with both delineated by demographic characteristics. Apparently plausible findings were obtained, including a highly significant positive Group SN-SRH association and a negative association between Friend Emotional SS and SRH. These findings may be directly compared with many of those in the literature, and are in some cases consistent.

However, the analyses also involved the consideration of three causal mechanisms underlying the observed associations: positive causation, positive reverse causation, and negative reverse causation. After identifying as far as possible the competing mechanisms in the total sample, the sample was divided into two sub-samples according to the frequency with which the respondent's social activity was restricted by his or her own health or disability. This enabled some causal effects to be estimated, changing the interpretation of the initial findings.

6.1 Unrestricted and Restricted social networks

The findings for the Unrestricted SN and Restricted SN samples differ in important respects. In the Unrestricted SN sample, for which there is logically no positive reverse causation (health does not restrict social activity) and no negative reverse causation between either SN or Instrumental SS and SRH (healthy people do not need disability-related activity or support), positive effects were identified, indicating a causal SN-SRH association: i.e. stronger social networks beget better SRH. These effects were confined to the Friend SN and Group SN among the Total, Males, Females, and the Partnered. Among the Unpartnered, a negative causal effect was found for Family Emotional SS, indicating that unpartnered people in worse health confide in more family members (see Section 6.3). For this healthy sub-sample, there were no effects of Family SN or of Friend Instrumental or Emotional SS. The inapplicability of Instrumental SS is confirmed in the model estimates.

In the Restricted SN sample, a different story emerges. Model 1 shows that both positive and negative associations exist. Again, Group SN is positively associated with SRH among several groups (Total, Females, and Partnered), but for the same three groups Friend Emotional SS is negatively associated with SRH, indicating that people in worse health confide in more friends. However, when the frequency of SN restriction is included (Model 2), accounting for positive reverse causation, the positive Group SN-SRH association is no longer significant, except weakly so among the Partnered; while the negative Friend Emotional SS-SRH association remains only for Females. In other words, the two initial effects, which also feature in the total sample, are largely explained in the Restricted SN sample by the degree of SN restriction. Very few significant effects remain.

The finding of negative reverse causation in the Friend Emotional SS-SRH association among Females (i.e. that those in worse health confide in more friends) is consistent with socio-emotional selectivity theory (Carstensen 1995), which predicts that a greater sense of limited remaining life expectancy (assumed here to stem from worse SRH) results in greater selectivity in favour of emotionally rewarding relationships; or, in other words, a negative association with Emotional SS. There is no evidence that this selectivity reduces network size to the extent that a positive effect of Friend SN on SRH occurs. In this model, this is to be expected because the inclusion of SN restriction essentially takes account of any positive network size effect (due to reverse causation) arising from this corollary of the theory. An indication of a weak *negative* effect of Friend SN among the Partnered (negative reverse causation) suggests that more friends visit partnered people in worse health more frequently.

The findings for the two samples have implications for the applicability of the BGBS framework for the study of the SN-SRH association. The final models for the Unrestricted SN sample indicate that for the 'healthy', if not for the Unpartnered, the BGBS framework of positive causation is applicable. However, the models for the Restricted SN sample show that there is no positive causal effect of SN on SRH, except marginally among the Partnered. For this 'unhealthy' sample, the BGBS framework does not apply. This is problematic because research on the SN-SRH association is more concerned more the unhealthy than the healthy, or at least with the comparison of these groups. The validity of much of the published literature on the SN-SRH association based on cross-sectional data may also be called into question. It is likely that the findings of such studies are a weighted average of the effects of the three causal mechanisms demonstrated here; evidence for this can be seen in comparing Tables 3–5.

6.2 Males and Females

The models for Males and Females differ in both the Unrestricted SN and the Restricted SN samples. In the Unrestricted SN sample, the positive SN-SRH association derives from the Group SN for Males and from the Friend SN for Females. In the Restricted SN sample, Friend Emotional SS is significant for Females but not for Males. These sex differences can be attributed to gender. Research on gendered relationship preferences has suggested that men generally do not seek to extend their network of friends (often not beyond their spouse), whereas women maintain larger and more multifaceted networks (Antonucci and Akiyama 1987b). It has also been previously reported that men derive greater health benefits from group activities than women (Caetano et al. 2013). This may be because the non-group social networks of men are more likely than those of women to be classified as ‘low exchange’ or ‘restricted’ (calculated from Fiori and Jager 2012 Table 1). Gendered socialisation leads to differences in the meaning of relationships, with men’s relationships tending to be more practical, instrumental, and informational; and female relationships being more relational and emotional (Olson and Shultz 1994; Cross and Madson 1997).

When the degree of SN restriction is taken into account (Model 2 for the Restricted SN sample), no effects are found among Males, but the negative association between Friend Emotional SS and SRH persists among Females. The finding that this effect occurs only among Females can be attributed to the preference among women for emotionally satisfying relationships (Cross and Madson 1997). Stemming logically from negative reverse causation, this effect indicates that whatever their level of SN restriction due to their own health or disability, Females reporting worse SRH confide in more friends.

These findings suggest that friendship, rather than the family, plays an important role in women’s health, and that women place considerable value on emotional support from friends. The results also indicate that men can benefit from less emotional relationships (through group activities), but that men in ill health gain little or no benefit from social networks or social support, which would suggest that men have a certain degree of social vulnerability.

6.3 Partnered and Unpartnered

Substantial differences also exist between the Partnered and the Unpartnered. In the Unrestricted SN sample, Family Emotional SS is negatively associated with SRH among the Unpartnered, and is this group's only effect, indicating that those with worse SRH confide in more family members. Among the Partnered in the Unrestricted SN sample, both Friend SN and Group SN show positive effects: i.e. having stronger social networks begets better SRH. In the Restricted SN sample, Model 2 shows that there are no effects among the Unpartnered and only weak effects among the Partnered, with the latter finding indicating that Group SN maintains some level of positive causal (beneficial) effect on SRH, while having worse SRH results in a stronger Friend SN based on disability-related visits.

These findings can be attributed in part to structural differences in the social networks of partnered and unpartnered older people. Different life course experiences play a fundamental role. The social networks of partnered people tend to be family-oriented; the partner and children are the main sources of support. Furthermore, the partner, where present, is not only the main source of instrumental support (especially in disability), but for males in particular is often the only source of emotional support (Antonucci and Akiyama 1987b). Our data do not capture the role of the partner (or of other co-resident family members). This may explain why we find no effects for social support among the Partnered.

The social reliance of partnered people on their partner and family may help to explain why Friend SN and Group SN are positively associated with SRH among the Partnered in the Unrestricted SN sample. Group networks in particular, but also friend networks, generally differ from the family networks of partnered people, offering the opportunity for different types of social relationships with a greater diversity of people. Moreover, participation in group networks is voluntary, involves fewer responsibilities and obligations, takes place outside the home, and may involve exercise and outdoor activities; factors which are associated with better SRH or physical health (Berkman et al. 2000; Litwin 2006; Cherry et al. 2013). Partnered people who rely less on their partner and family network, and maintain stronger friend and group networks can be expected to benefit in terms of better health.

In the Restricted sample, after taking account of the degree of SN restriction, the positive effect of Group SN on SRH is weakly maintained. However, the association between Friend SN and SRH is weakly negative, which (as already noted) indicates that more friends visit partnered people in worse health more frequently. That these effects occur only among the Partnered may be an artefact of sample size, but it is also likely that some partnered people in ill health benefit from the presence of the partner as a facilitator of both participation in group activities and visits by friends.

Previous research has found that for people without partners, networks tend to be relatively friend-oriented, and that friends can play an important role as sources of support (Seeman and Berkman 1988; Cornwell et al. 2008). Our finding for the total sample (Table 3) that Friend SN is weakly positively associated with SRH among the Unpartnered is consistent with these existing findings. However, in the Unrestricted SN sample, having worse SRH (of a form that does not restrict social activity) leads to the Unpartnered confiding in more family members, rather than in friends. This finding may be due to the fact that 81% of the Unpartnered in this sub-sample have previously been partnered, which suggests that most have children in whom they may confide. The small sample size precluded meaningful analysis of the Unpartnered group in Restricted SN sample.

These findings suggest that for the healthy and partnered, one key to better SRH is the strength of friend and group social networks. Maintaining these networks while in ill health is also beneficial. In the case of the friend social network, the net effect is negative, i.e. having worse SRH begets a stronger Friend SN. However, having friends is a prerequisite for having visits from friends. There are no positive effects for the Unpartnered, which may suggest a degree of social vulnerability.

6.4 Family, Friend, and Group networks

Among the three networks, positive causal effects on SRH are found for the Friend and Group networks, but not for the Family network (which is itself noteworthy). In the Unrestricted SN sample, having a stronger Friend SN and Group SN both contribute to better health, while in the Restricted SN sample the contribution of Group SN is also present. The voluntary nature of friendship (Litwin 2006; Huxhold et al. 2013) and group activities may help to explain these findings; Litwin (2006) also found a beneficial effect for frequency of contact with friends.

The positive effects of Group SN and Friend SN are consistent with the Cherry et al. (2013) finding that time spent outside the home in social activities (including through club/organisation membership) was more important than social support in predicting self-reported physical health (though, perhaps more informatively, this study also found club membership to be ‘predictive’ of objective health). We find that the Group SN and Friend SN effects are almost entirely confined to the Unrestricted SN sample. In the Restricted SN sample, Model 2 shows only a marginal effect of Group SN among the Partnered, indicating that the positive association of Group SN with SRH (Model 1) is due to reverse causation. Thus, the positive Group SN-SRH association would appear to be explained almost entirely by the degree of SN restriction due to ego’s health or disability, in other words, by the ability to physically access group activities.

Thus the positive effect of Group SN, which features so strongly in the models for the total sample (Table 3), is almost entirely confined to the Unrestricted SN sample; in other words, to the healthy. If the benefits of group activities, demonstrated by the positive causal relationship found in the healthy, are to be extended to the unhealthy, better physical access is required. This interpretation is supported by the indication that access may be facilitated by the presence of a partner (Section 6.3).

6.5 The role of SN restriction in the models

This study has underlined the importance of reverse causation in understanding the SN-SRH association at older ages. Through the use of the variable measuring SN restriction, we have been able to identify three causal mechanisms (Table 1): positive causation, positive reverse causation, and negative reverse causation.

There are, of course, more blurred distinctions between causation and reverse causation than those represented in these models. Here it is important to recall that SRH is a much broader and more multifaceted construct than the restriction of social activity due to health or disability, and that SRH is imperfectly related to objective health (Idler et al. 1999); moreover, unmeasured variables are also likely to contribute to blurred distinctions. Though positive reverse causation has been eliminated or taken into account in terms of SN restriction in the models, a degree of reverse causation stemming from the broader construct is likely to exert an influence. Positive causation and positive reverse causation are reinforcing: to this extent the models are likely to overestimate the role of positive causation in the SN-SRH association.

Furthermore, positive reverse causation and negative reverse causation are counterbalancing: the estimated effects of SRH on SN/SS are net effects. Whenever negative reverse causation is present, the strength of the SN-SRH association is underestimated. Thus, any statistical evidence of negative reverse causation is likely to be substantially underestimated, as it must significantly outweigh both positive causation and positive reverse causation. Friend Emotional SS among Females is a case in point.

Longitudinal data would be needed to accurately quantify these separate effects. This study has highlighted the existence of the contribution of positive reverse causation and negative reverse causation to the SN-SRH association in a sample for which this is possible.

6.6 Limitations, strengths, and future research

A main limitation of the study is the sample on which it is based. The study population, members of National Seniors Australia, is unlikely to be entirely representative of the wider Australian population. Thus, though we have taken account of known sources of potential bias (age and education), the extent to which the results can be generalised is limited. This limitation is, however, of reduced importance in this study, because we compare only the significance patterns among models for demographic groups.

Limitations in the comparability of models for the Partnered and the Unpartnered arise from the lack of availability of variables concerning the partner's role in the social network and social support of partnered respondents. This is likely the reason why the Unpartnered exhibit unique patterns of significance. Future research might usefully consider the inclusion of the partner and other co-resident family members in the family network.

The major strength of the study is our ability to address causation. This was possible through a direct measure of the degree to which own health or disability restricts social activity. By dividing the sample on this continuum, thereby logically eliminating competing mechanisms and by taking the degree of SN restriction into account, it was possible to identify causal and reverse causal effects. To our knowledge, the analysis is unique.

Finally, the findings for the Unrestricted SN and the Restricted SN samples differ considerably. Notably, positive causal effects of SN on SRH are confined to the 'healthy' Unrestricted SN sample, while no such effects are found for the 'unhealthy' Restricted SN sample (with one weakly significant exception). This calls into question the validity of analyses that do not take positive and negative reverse causation into account in the SN-SRH association, and may explain some of the confusion among the extant findings. Furthermore, differences between complementary demographic groups have been shown to be masked in the Total sample. This suggests that analyses that treat demographic variables purely as covariates routinely ignore important differences deriving from the demographic social-structural conditions. Differences between sub-networks are also found to be substantial in this study, which suggests that the widespread tendency to conflate family and friends is not appropriate. These differences underline the importance of demography in defining the context and the boundaries of the SN-SRH association, and in understanding that association. The findings of this study have considerable relevance for future research.

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The effect of retirement on self-reported health: a gender comparison in Italy

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Abstract

The effect of retirement on health has been widely investigated in the literature, but the evidence on this issue is conflicting, and the debate surrounding it still open. This topic is of particular interest when expenditures for pensions and health care systems, and their potential interrelationship, are primary concerns for policy-makers. This is the case in ageing countries like Italy, where the recent pension reform, which included an increase in the minimum pension age, makes gaining an understanding of the potential consequences of retirement postponement for health even more relevant. Using EU-SILC longitudinal data, we investigate the effect of retirement on self-reported health in Italy from a gender perspective. We apply logistic regressions and propensity score matching to estimate the net effect of retirement on health after potential endogeneity is controlled for. The main results show that the self-reported health of men worsens shortly after retirement, while the self-reported health of women does not change.

1 Introduction

In an era characterised by the ageing of the population, two central concerns for policy-makers are (i) the burden on the pension system, and (ii) the burden on the health care system. Policies aimed at reducing costs in either of these two sectors should take into account the well-known retirement-health nexus. If retiring is expected to enhance the health of certain individuals, such as of people who have

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physically demanding jobs (Sickles and Taubman 1986), postponing retirement may decrease the costs associated with providing pensions, but it may increase the costs associated with providing health care. Conversely, if retirement has a negative effect on individual health—by, for example, reducing mental activity or depriving individuals of the economic and social roles they are used to—postponing retirement may reduce costs for both pension and health care systems.

The relationship between retirement and health status has been widely investigated in the literature, but the debate about the effect of retirement on subsequent health outcomes is still open. Some studies have shown that retirement has a negative effect on health (Dave et al. 2008; Szinovacz and Davey 2004), while others have found either no evidence of such a negative effect (Ekerd 1987; Ekerdt and Bosse 1982; Van Solinge 2007; Coe and Lindeboom 2008) or even a positive effect (Bound and Waidmann 2007; Midanik et al. 1995; Kremer 1985).

Many scholars have pointed out the difficulties which can arise when attempting to distinguish between correlation and causality in the health-retirement link. Health and retirement decisions may affect each other, as poor health conditions may lead individuals to retire earlier (Dwyer and Mitchell 1999). These decisions may also be affected by individual observed and unobserved characteristics (Bound and Waidmann 2007; Anderson and Burkhauser 1985). If this is the case, unbiased estimates of the net effect of each experience on the other cannot be achieved unless the issue of the endogeneity of the two experiences is explicitly taken into account.

In this paper we investigate the effect of retirement on self-reported health in Italy, a country in which the ageing process is occurring at a faster pace than in most of the other EU countries (European Commission 2006). Moreover, Italy has recently undergone a pension system reform aimed at raising the minimum pension age and narrowing gender differences (European Commission 2013). In this context, therefore, gaining an understanding of the potential effect of retirement on subsequent health—and of gender differences in how this effect plays out—has even greater relevance. In particular, we ask whether the experience of retirement leads to an improvement in—or, conversely, a worsening of—self-reported health, and whether the effect differs between men and women. Retirement is associated with important changes in the life-styles and social roles of individuals (Aldwin 1990; Eisdorfer and Wilkie 1997). In a country characterised by gendered relationships (Pasqua 2002; Di Giulio and Pinnelli 2003), we expect to find that retirement represents the loss of an important social role for the male breadwinner, and thus has negative repercussions on the self-reported health of men. By contrast, women tend to be intensively engaged in family-related tasks throughout their life, even when they are working, and may therefore find it easier than men to adapt to a new life-style. We thus expect to find that the self-reported health of women does not worsen after retirement, and may even improve.

In Italy, relatively little research has so far been done on this issue. An earlier study which focused on the effect of health on retirement examined Italy, but in conjunction with other European countries (Hagan et al. 2009). Furthermore, to our knowledge, our paper represents a novelty in terms of the data and the methodological approach used.

Our analysis uses EU-SILC longitudinal data, which contain information on both occupational and health conditions and transitions, as well as on other relevant household and individual characteristics. First, we apply a logistic regression to provide a description of the relationship between different individual characteristics, including retirement, and self-reported health. We then use propensity score matching estimators of the average effect of retirement on retirees' health (Rosenbaum and Rubin 1983; Heckman et al. 1997), which, combined with the longitudinal information on changes in self-reported health, allow us to control for potential endogeneity.

The paper proceeds as follows: in Section 2 the general theoretical framework is reviewed, in Section 3 the data and the methods are described, in Section 4 the main results are presented, and in Section 5 we offer some concluding remarks.

2 The health-retirement nexus

When studying the relationship between retirement and health, an unbiased estimate of the real effect of each experience on the other can be achieved only if the interdependence of the two experiences is explicitly taken into account. In addition to affecting each other, retirement and health may also be simultaneously affected by other factors.

A large body of literature has been devoted to investigating the effect of health on the decision to retire and the timing of retirement, and the results of these studies clearly show that being in poor health can induce individuals to retire earlier (McGarry 2004; Hagan et al. 2009; Disney et al. 2006).

Less attention has been paid to the effect of retirement on subsequent health, and the existing evidence on this question has so far been mixed. On the one hand, some studies have shown that after people retire, their health worsens. One possible explanation for this effect is that retirement can be a stressful event (Rosow 1974), and it is indeed often listed on stress inventories (Aldwin 1990). Retirement stress has been linked to elevated suicide rates (Miller 1979), a diminished sense of wellbeing, and lowered morale (George and Maddox 1977). Furthermore, retirement often implies a weakening of the social networks the individual formed in the workplace, and is thus often associated with the loss of an important social role. Finally, work itself may be rewarding. In all such cases, continued employment would tend to have a positive effect on a person's mental or physical health (Bound and Waidmann 2007).

On the other hand, retirement may represent an escape from a stressful working life. After retirement, an individual's health might improve as he or she adopts a healthier lifestyle, which may, for example, include engaging in regular exercise (Midanik et al. 1995) or quitting smoking (Lange et al. 2007).

The conflicting evidence on this issue may be due in part to the heterogeneity of retirees in different countries: for example, cultural factors and institutionalised breadwinning expectations may contribute to the diffusion of more or less gender-equal roles (Yodanis and Lauer 2007), and may affect the social and economic opportunities/costs of entry into retirement.

Another potential reason for the conflicting findings is that the methodological approaches used to investigate the possible selection of individuals into retirement differ. Most studies either apply instrumental variables or control for confounding variables. The former tend to find a positive effect of retirement on health (Hessel 2012; Coe and Zamarro 2008; Bound and Waidmann 2007), whereas studies which control for confounding variables, such as regressions or matching estimators, tend to find negative effects (Dave et al. 2008). Notably, Behncke (2012) found evidence of a negative effect of retirement on health using both non-parametric instrumental variables and matching estimators; this suggests that the conflicting results may be due to population-specific heterogeneity rather than to the method of analysis.

In this paper, we first employ a logistic regression to provide an overview of the household and the individual characteristics associated with a change in health, and then apply matching estimators to assess the net effect of retirement on health, once the possible self-selection of individuals into retirement is controlled for. We disregard the IV approach because finding a valid instrument is not easy: the instrumental variable has to determine the decision to retire, it should not affect health, and it has to be uncorrelated with any other variable affecting the outcome of interest. In other words, because a valid instrument has to affect health only by affecting the decision to retire, the causal effect is identified through variation in the instrument (Caliendo and Hujier 2005). Moreover, if a valid instrument is available, we expect that our results will be consistent with those of the other methods implemented (Benhcke 2012).

As our health indicator we use self-reported health, a widely used global indicator of health status. The results of previous studies based on both quantitative and qualitative strategies confirm the reliability of overall perceived health as an indicator of an individual's health status (Lundberg and Manderbacka 1996), even after controlling for the individual's objective health. A large number of factors are important for self-perceived health. The strongest association has been found for physical, functional, and mental health; but socio-demographic, life-style, and behavioural factors also have an impact on subjective health (Bjorner et al. 1996).

2.1 The Italian framework and research hypotheses

The population of Italy is ageing rapidly, and at an even faster pace than elsewhere in Europe (European Commission 2006). According to recent projections, individuals aged 65 and over are expected to make up around the 32%–33% of the total population in 2056, up from 20% today (ISTAT 2011). Meanwhile, the working-age population (ages 15–64) is expected to decrease from 66% currently to 54% in 2056.

This description of the demographic context illustrates why policy-makers are concerned about covering pension and health care costs. Relative to today, in the future more retirees are expected to collect old-age pensions and benefits and for longer periods of time, and more elderly people are expected to need health care and long-term care services (European Commission 2006).

In this framework, understanding the relationship between retirement and health is of particular interest, because policies aimed at reducing the burden on the pension system may in turn affect the burden on the health care system. If retirement improves the health of the elderly, then an increase in the minimum pension age may reduce the potential gains from lower health care expenditures. If, however, retirement is associated with worse health, postponing it to a later age may simultaneously reduce both pension- and health care-related expenditures.

To reduce the economic burden on the pension system, Italy has recently implemented a pension reform aimed at increasing the minimum retirement age for both men and women, with a narrowing of the existing gender differences. From 2012 onwards the minimum retirement age for men is 66 years and three months. For women the retirement threshold depends on the sector of employment: in the civil service it is the same as the age for men, while in the private and self-employment sectors it is lower (62 years and three months and 63 years and nine months, respectively). The retirement age is set to increase gradually, reaching 66 in 2018 (European Commission 2013). Although the aim of the reform is to achieve greater gender equality in terms of old-age pensions and benefit rights, it is likely to have considerable repercussions for women. In Italy, men and women have different social and economic roles: men are expected to focus on earning an income and providing for the family, while women are expected to focus on family-related activities and care, even if they also have a job (Pasqua 2002; Di Giulio and Pinnelli 2003). Although these gender roles are becoming less rigid among the younger generations, they are still enforced among the older generations.

Because life expectancy, pension benefits, and socio-economic roles are highly gender-specific in Italy, we believe it is necessary to take a gender perspective when studying the potential effect of retirement on subjective health. Thus, our research hypotheses are formulated separately for men and for women, and our empirical analyses are performed separately by gender. As we have noted, a man is expected to be a traditional breadwinner, while an employed women is expected to reconcile her job commitments with caring for her family (Naldini and Saraceno 2011). Thus, we expect to find that retirement is a shock for men, who have to re-arrange their life-style and social roles after leaving the labour market; and a relief for women, who benefit from having more time and resources to devote to other activities.

Hypotheses 1: Among men, retirement could lead to a worsening of self-reported health in the short term, as it is a stressful event which requires men to re-organise their life-style and their roles.

Hypotheses 2: Retirement could lead to an improvement in women's self-reported health in the short term, as it provides women with more time and other individual resources.

If this is the case, the increase in the minimum pension age, as established by the pension reform, may lead to additional burdens being placed on the health care system by women, but not by men.

3 Data and methods

3.1 Data, sample selection, and health outcomes

Since 2004, the European Union Statistics on Income and Living Conditions (EU-SILC) survey has been collecting cross-sectional and longitudinal microdata on different dimensions of household and individual living conditions in Europe.[1] Although the main purpose of the EU-SILC is to provide comparable structural indicators to monitor poverty and social exclusion in the EU,[2] it also provides information on individual self-reported health and employment careers. This allows us to analyse the effect of retirement on health, controlling for other relevant household and individual characteristics, such as the presence of a long-standing illness or physical limitations in activities resulting from health problems,[3] marital status, educational level, job characteristics, household composition, and disposable income.

In most of the countries where it is conducted the survey relies on a rotational sample design based on four groups. Each year, the longitudinal release provides data on sampled individuals belonging to three independent panels (who are interviewed two, three, or four times). So far, five longitudinal releases are available (from 2004–2007 to 2008–2011). In each release, specific weights are provided to allow for estimates on two-year transitions, based on the pooling of three panels: i.e. as is shown in Figure 2, the transitions between t and $t + 1$ are based on the data in panels 1, 2, and 3 (Eurostat 2013).

To achieve a higher number of observations we have selected the last two years of each longitudinal release, and pooled together data belonging to the available

[1] The project was informally launched in 2003 in seven countries, but it started in Italy in 2004.

[2] The Europe 2020 strategy, which aims to reduce the number of people who are living in poverty and are socially excluded by 20 million by 2020, relies on EU-SILC data.

[3] Questions corresponding to self-reported health, long-standing illness, and limitations in activities due to health problems are part of the so-called minimum European health module (MEHM).

Figure 1:
EU-SILC sample design and longitudinal release

	t–2	t–1	t	t+1
Panel 3			Wave 1	Wave 2
Panel 2		Wave 1	Wave 2	Wave 3
Panel 1	Wave 1	Wave 2	Wave 3	Wave 4

Table 1:
Transitions from employment between two consecutive years. Individuals between 55 and 74 years old, by years of transitions: sample size (*N*) and percentage (%)

	2006–2007		2007–2008		2008–2009		2009–2010		2010–2011		Pooled	
	N	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
Still empl.	1412	81.7	1392	82.4	1361	79.9	1428	83.7	1119	75.0	6712	80.7
Retired	224	13.0	210	12.4	241	14.1	171	10.0	255	17.1	1101	13.2
Inactive	92	5.3	87	5.2	102	6.0	107	6.3	118	7.9	506	6.1
Total	1728	100.0	1689	100.0	1704	100.0	1706	100.0	1492	100.0	8319	100.0

releases. The analyses are based on employed individuals (according to their self-reported activity status) between the ages of 55 and 74 at time t, which is the age range when most Italians enter retirement. The transition to retirement is measured by comparing the self-declared activity status at t and $t + 1$. Employed individuals at t may still be employed at $t + 1$, or have retired, or have become unemployed or inactive for any reason. No information is available about the reason for retiring (e.g. eligibility to collect an old-age or a disability insurance pension). In the selected sample, about 13% of the workers retire between t and $t + 1$, while 6% become inactive for other reasons, but with some variability across the years under study (Table 1).

3.2 Health change: an overview through logistic regression

Self-reported health status is measured by asking respondents to rate their overall health as ‘very good’, ‘good’, ‘fair’, ‘bad’, or ‘very bad’ (according to a scale ranging from one for ‘very good’ to five for ‘very bad’[4]). Individuals are classified

[4] The wording of the question is suggested by the World Health Organization (WHO): ‘How is your health in general?’.

according to the change in their health status between t and $t + 1$ as the same, better, or worse. This specific analysis focuses on the short-term effects of retirement, as it compares the self-reported health status between two points in time within which the retirement event is observed. The observed effects may be expected to fade with time, as individuals adjust their life-styles to their new social and family roles.

In order to provide a picture of the household and individual characteristics associated with changes in self-reported health, logistic regressions are estimated. Individuals who report that their health improved or worsened between t and $t + 1$ are compared to individuals who report no change.

In particular:

(i) Individuals who report being in worse health in $t + 1$ compared to t are regressed against those who report no change (in this case, only individuals at risk of a deterioration in their health are selected; i.e. those who say they are in ‘very bad’ health in t are excluded because they cannot have worse health at $t + 1$);

(ii) Individuals who claim their health improved in $t + 1$ compared to t are regressed against those who report no change (only individuals at risk of improving their health are selected, i.e. those who said they are in ‘very good’ health in t are excluded because they cannot have better health at $t + 1$).

We are therefore considering whether an individual’s health has worsened or improved, but not the extent of the deterioration/improvement.

Clearly, our main focus is on the retirement effect, which is picked up through the transition from employment, either to retirement or to another inactivity status between t and $t + 1$.

The other control variables selected for the model estimates are as follows: age, being in a union (either marriage or consensual union), education, self-reported health at t, long-standing illness and limitations in activities due to health problems (and relative changes between t and $t + 1$), household size, region of residence, and equivalent disposable income at t. Job-related characteristics were tested but have not been included in the final models, as they were not shown to be significantly associated with changes in health. Eventually, the years of transition (i.e. the longitudinal release sample the units belong to) are controlled for.

Although several individual and household characteristics are controlled for, logistic regression may still provide a biased estimation of the retirement effect on health change because both the decision to retire and the change in health may be simultaneously affected by other factors which are not accounted for. In the next section, we explain the strategy used to estimate the net effect of retirement on health, once selection bias, due to observed and unobserved characteristics, is controlled for.

3.3 Retirement effect with propensity score matching estimators

Different strategies of analysis, each of which has its own pros and cons, may be implemented when investigating the relationship between potentially endogenous phenomena (see Caliendo and Hujer (2005) for a detailed review). In this paper, we use propensity score matching on longitudinal data. This method allows us to control for bias due to both observed and (time-invariant) unobserved characteristics. When non-experimental data are available, propensity score matching simulates an experimental context in which a specific 'treatment' effect on an 'outcome' of interest can be estimated (see Caliendo and Kopeing (2005) for a detailed guidance). In our case, retirement is the treatment, and the change in health status (improvement/worsening) is the outcome. In principle, we would be interested in comparing the change in the retirees' health status with the change in health they would have experienced if they were still employed. This is clearly not possible. However, we cannot simply compare the change in health of the retirees with that of the still-employed, because the two population groups may be different: i.e. retirees may have characteristics which make them more or less likely to experience a change in health (selection bias). Broadly, the matching strategy overcomes this problem by comparing the outcome observed on the treated group to the outcome observed on a 'control group'. The control group is selected among the untreated and is composed of the individuals who are the most similar to those in the treated group. The treatment includes any kind of reason for retirement (e.g. eligibility to collect an old-age or a disability insurance pension). The control group is given by those still employed at time $t + 1$. The control group selection is made according to a set of characteristics observed before the treatment. In our case, the change in health observed among retirees is compared to that observed among the 'most similar' workers. If the control group is properly selected, the two groups are 'equivalent' and any difference in the outcomes they experience can be attributed to the treatment.

Let D = 0 and D = 1 denote the untreated and the treated, respectively; and Y(0) and Y(1) denote the outcomes observed in the absence and in the presence of the treatment, respectively. The parameter of interest is the so-called average treatment effect on the treated (ATT), and is defined as:

$$T_{ATT} = E(T|D = 1) = E[Y(1)|D = 1] - E[Y(0)|D = 1] \tag{1}$$

where the treatment average effect on the treated is defined as the difference between the average outcome observed on the treated after the treatment (E[Y(1)|D = 1]) and the average outcome which would have been observed on the treated if they had not been treated (E[Y(0)|D = 1]). In our case, the outcomes represent the change in the individuals' health status after retirement and the change in the individuals' health status if they had not retired. The latter (E[Y(0)|D = 1]) is not observed and cannot be replaced by the outcome observed on the untreated (E[Y(0)|D = 0]) because the treated and the untreated are likely to differ even in the absence of treatment.

From (1) follows:

$$E[Y(1)|D = 1] - E[Y(0)|D = 0] = T_{ATT} + E[Y(0)|D = 1] - E[Y(0)|D = 0] \quad (2)$$

the difference between $E[Y(1)|D = 1] - E[Y(0)|D = 0]$ and T_{ATT} is the so-called 'selection bias'. Thus, T_{ATT} is identified only if $E[Y(0)|D = 1] - E[Y(0)|D = 0] = 0$; i.e. if the average outcome observed on the treated and the untreated is the same in absence of treatment. The conditional independence assumption (CIA) allows us to show (2) that given a vector of covariates X not affected by the treatment, the potential outcomes are independent of the treatment assignment. The CIA implies that selection bias is based on observed characteristics (X), and that all of the characteristics which may affect the treatment assignment and the outcome are observed. Since conditioning on numerous covariates may not be feasible, a balancing score is usually used (Rosenbaum and Rubin 1983). The propensity score (PS) is a possible balancing score which represents the probability that an individual will participate in a treatment, given the observed characteristics:

$$PS = P(D = 1|X) = P(X) \quad (3)$$

Eventually, the common support (CS) is required, according to which individuals with the same characteristics X have a positive probability of being treated and untreated (Heckman et al. 1999).

$$0 < P(D = 1|X) < 1 \quad (4)$$

Assuming the CIA and the CS, the propensity score matching estimator of the treatment effect on the treated is the mean difference in the outcome over the common support, weighted by the PS distribution of the treated:

$$T_{ATT\,(PSM)} = E_{P(X)|D=1}\{E[Y(1)|D = 1, P(X)] - E[Y(0)|D = 0, P(X)]\} \quad (5)$$

If longitudinal data are used and the outcome of interest measures a change which occurred among the same individuals, selection based on unobserved characteristics is also controlled for. Formally:

$$[Y(1)|D = 1] = [Y(1)_{t+1} - Y(0)_t|D = 1] \quad (6)$$

$$[Y(0)|D = 0] = [Y(0)_{t+1} - Y(0)_t|D = 0] \quad (7)$$

Let the outcome for an individual at time *t* be $Y_t = \pi_t + D_t^* Y(1)_t + (1 - D_t)^* Y(0)_t$ where π_t represents unobserved characteristics. If selection on the unobservable is time-invariant ($\pi_t = \pi_{t+1}$), the differences due to the unobservable are implicitly netted out in both (6) and (7). Thus, when the propensity score is combined with the longitudinal data, the selection bias due to both observed and (time-constant) unobserved characteristics is controlled for.

In estimating the propensity score, both the model and the covariates have to be properly selected. When the treatment is binary—that is the probability of being either treated or not treated has to be estimated—logit or probit models are chosen, and usually provide similar results. Both models have been tested, and generate almost the same results. The logit regression estimates are presented.

In choosing the covariates, it is important to note that the covariates have to affect both the treatment participation and the outcome; and that, according to the CIA, the outcome has to be independent of the treatment given the covariates. Moreover, because the covariates have to be unaffected by the treatment participation, they are measured before the treatment, and it is assumed that they will not be influenced by the anticipation of the participation. In our study, the propensity score matching is estimated separately for men and women, and several individual characteristics have been tested. In principle, we tried to select a parsimonious model, because over-parametrisation may increase the common support problem, and the inclusion of non-significant variables may increase the variance in the estimates (Caliendo and Kopeinig, 2005). Thus, we first select only the significant variables: (i) for a man these covariates are age (in five-year age bands), level of education, labour income, whether he is self-employed, whether his job is full- or part-time, and the years in which he made transitions (i.e. the longitudinal release the sampled individual belongs to); (ii) for a woman, the same covariates are used with the exception of education and work schedule, because these factors are non-significantly related to the probability of being treated. Although non-significant, self-reported health, long-standing illness, and limitations in activities due to health problems before retirement are also included as being of primary interest in our analysis. The risks of including covariates non-significantly related to the propensity for experiencing the outcome of interest after treatment are that more individuals may fall outside of the common support, and that the final estimator may have a higher variance. Estimates achieved by including or not including health-related variables are discussed to show that this is not the case. In both cases, all of the selected covariates show similar distributions between the treated and the matched untreated individuals.

Multiple matching algorithms have been tested, and we show the three which provide the best performance and the most similar results[5] (see section 4.2). In particular, radius matching allows us to impose a threshold for the maximum propensity score distance between each of the treated and the matched untreated, increasing the matching quality by avoiding bad matches (i.e. those among the treated and the untreated individuals with very different propensity scores). We set the threshold at 0.1 (i.e. the maximum distance between the treated and the untreated matched PS has to be lower than 0.1). Kernel and local linear regressions are also applied. These algorithms are non-parametric estimators which use the weighted averages of all of the individuals in the control group to construct the counterfactual outcome.

[5] Among the tested methods, the nearest neighbor, with and without replacement, has be disregarded because its performance is below that of the others, it provides less consistent estimates, and it has a higher variance.

4 Results

4.1 An overview of the household and the individual characteristics associated with self-reported health change

Logistic regressions are estimated separately for men and women. Table 2 shows the coefficients of worsening (model 1) and improving health between t and $t + 1$ (model 2) for men. Table 3 shows the same estimates for women.

As expected, men employed at time t, and who retire before $t + 1$, have a higher risk of a deterioration in self-reported health than men who are still employed at time $t + 1$. In fact, compared to workers at $t + 1$, retired men have a 80% higher risk of assessing a health deterioration at $t + 1$.[6]

Interestingly, this result does not hold for women. When individuals leave the labour market, their job loses its centrality in their daily life, and they have to reallocate the time they previously spent in paid employment to alternative activities. This seems to have a negative impact on men but not on women. Possibly because women are traditionally engaged in other family-related tasks, they appear to be able devote their time and energy to other activities after leaving their job.

Retirement is not significantly related to an improvement in self-reported health for men, and contrary to our expectations, it is also not associated with an improvement in health for women.

The analysis shows that the control variable of long-standing illness is strongly associated with a worsening of self-rated health among men. Compared with men with no long-standing illness at time t and $t + 1$, men who report having a long-standing illness at time $t + 1$ are more likely to report a worsening of their subjective health at $t + 1$ compared to time t. Similarly, a higher risk of reporting worsening health is observed among those who report having a long-standing illness at time $t + 1$. A worsening of self-reported health is also observed among those who claim their long-standing illness disappeared over the analysed period. This could be due to the lingering effects of the previous illness. Similar results have been found for limitations in activities due to health problems. A worsening in self-reported health is generally observed when individuals report having limitations in activities due to health problems, or having developed limitations between t and $t + 1$. Chronic conditions and a lack of functional self-sufficiency contribute significantly to perceptions of health. Furthermore, as changes in health are likely to depend on the initial health status, self-reported health at t is also controlled for: individuals in better health are more likely to report a worsening of self-reported health, while individuals in worse health are more likely to report an improvement.

Individual socio-economic status is positively associated with self-reported health. People who are relatively wealthy and highly educated are protected against a deterioration in health. Highly educated people may be inclined to seek out correct

[6] The risk is computed as exp (coef.), in this case exp (0.592) = 1.80.

Table 2:
Worsening and improvement in health among men. Logistic regression coefficients, standard errors and significance levels

	Model 1 Worse			Model 2 Better		
Variable (reference value)	**Coef.**	**s.e.**	**Sig.**	**Coef.**	**s.e.**	**Sig.**
Intercept	−3.216	0.730	***	0.775	0.758	
Change in the employment condition (employed-employed)						
Employed – retired	0.592	0.130	***	−0.140	0.154	
Employed – other condition	0.552	0.170	**	−0.285	0.221	
Age	−0.009	0.011		−0.009	0.012	
Union (in union – legal or consensual)						
Not in union	−0.037	0.144		−0.157	0.157	
Education (lower secondary education or less)						
Secondary education	−0.409	0.103	***	0.116	0.109	
Tertiary education	−0.730	0.140	***	0.464	0.140	**
Change in long-standing illness (no-no)						
Yes-yes	1.355	0.177	***	−0.687	0.187	***
Yes-no	0.473	0.202	*	0.146	0.159	
No-yes	1.432	0.141	***	−0.743	0.203	***
Change in limitations in activities (no-no)						
Yes-yes	1.509	0.195	***	−1.950	0.207	***
Yes-no	0.297	0.229		−0.320	0.152	*
No-yes	1.754	0.140	***	−1.702	0.215	***
Self-reported health (fair)						
Very good	4.599	0.212	***			
Good	2.329	0.162	***			
Bad	−0.458	0.317				
Self-reported health (fair)						
Good				−2.892	0.116	***
Bad				2.109	0.222	***
Very bad				3.897	0.572	***
Household size	−0.064	0.045		−0.027	0.048	
Geographical region (north)						
Centre	0.191	0.119		−0.106	0.124	
South	0.311	0.105	**	0.019	0.111	
Equivalised disposable income	−0.010	0.004	*	−0.005	0.005	
Equivalised disposable income – square	0.000	0.000		0.000	0.000	
Years of transitions 2006–2007						
2007–2008	0.063	0.136		0.132	0.139	
2008–2009	−0.015	0.139		0.139	0.139	
2009–2010	−0.383	0.146	**	−0.104	0.143	
2010–2011	0.454	0.139	***	0.809	0.152	***

Note: Sig.: ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$.

Table 3:
Worsening and improvement in health among women. Logistic regression coefficients, standard errors and significance levels

	Model 1 Worse			Model 2 Better		
Variable (reference value)	**Coef.**	**s.e.**	**Sig.**	**Coef.**	**s.e.**	**Sig.**
Intercept	−3.645	1.139	**	0.881	1.170	
Change in the employment condition (employed-employed)						
Employed – retired	0.055	0.182		−0.370	0.194	
Employed – other condition	0.405	0.238		−0.240	0.249	
Age	0.007	0.018		−0.012	0.019	
Union (in union – legal or consensual)						
Not in union	0.123	0.163		−0.140	0.162	
Education (lower secondary education or less)						
Secondary education	−0.524	0.153	**	0.405	0.151	*
Tertiary education	−0.649	0.188	**	0.327	0.185	
Change in long-standing illness (no-no)						
Yes-yes	0.701	0.253	**	−1.317	0.248	***
Yes-no	0.433	0.276		0.210	0.201	
No-yes	1.253	0.202	***	−0.454	0.255	
Change in limitations in activities (no-no)						
Yes-yes	1.559	0.257	***	−1.405	0.250	***
Yes-no	0.334	0.283		0.033	0.201	
No-yes	1.746	0.199	***	−1.299	0.251	***
Self-reported health (fair)						
Very good	4.552	0.298	***			
Good	1.958	0.217	***			
Bad	−1.119	0.512	*			
Self-reported health (fair)						
Good				−2.883	0.161	***
Bad				1.568	0.283	***
Very bad				2.065	0.712	**
Household size	−0.040	0.067		−0.030	0.066	
Geographical region (north)						
Centre	0.032	0.163		0.078	0.158	
South	0.482	0.155	**	0.050	0.155	
Equivalised disposable income	−0.021	0.009	*	0.001	0.008	
Equivalised disposable income – square	0.000	0.000	*	0.000	0.000	
Years of transitions (2006–2007)						
2007–2008	−0.088	0.204		−0.353	0.198	
2008–2009	−0.120	0.206		−0.188	0.188	
2009–2010	−0.222	0.209		−0.171	0.192	
2010–2011	0.112	0.202		0.382	0.195	*

Note: Sig.: ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$.

information about prevention, while people who are wealthy may find it relatively easy to access health care, including care provided by expensive private services.

For the improvement in self-reported health (model 2), the coefficients estimates are in line with those observed for the deterioration in self-reported health. Men with better objective health and higher social status had more chances to improve their subjective health between t and $t + 1$.

For women (Table 3), most of the variables associated with a worsening or an improvement in self-reported health are the same as they are for men.

These results confirm our hypotheses for men but not for women. However, as was previously noted, the effect of the relationship between retirement and the change in health status may be biased if unobserved characteristics simultaneously affect the decision to retire and the change in the health status. The average treatment effect on the treated estimators will help to shed light on the association.

4.2 The effect of retirement on changes in self-reported health

For the sake of comparability with the logistic regression approach, propensity score matching[7] is carried out by gender, and separately for (i) individuals reporting the same or worse health at $t + 1$ compared to t, and (ii) individuals reporting the same or better health at $t + 1$ compared to t. The average treatment effect on the treated represents whether retirement led to a deterioration or an improvement in health among the two groups of retirees, respectively.

Table 4 shows the estimates of the propensity score to retire among individuals who report they have the same or worse health (Model 1) or the same or better health (Model 2), and among men and women, according to two sets of covariates: set A includes only significant variables (Model 1A and Model 2A, respectively, for men and women), and set B includes both significant and health-related variables (Model 1B and Model 2B).

The conditional independence assumption (CIA) requires that the outcome (worsening/improvement in health) is independent of the treatment assignment (retirement) given a set of covariates (Table 4) not affected by the treatment, and that all of the characteristics which affect the treatment assignment are observed. In our case, the selected covariates cannot be affected by the treatment because they are measured before retirement. The assumption that they are not affected by an anticipation of the treatment also seems reasonable because they are associated with decisions usually taken before retirement, such as decisions regarding investments in education and job characteristics. Most of the covariates are related to both outcomes (worsening/improvement in health, as in Tables 2 and 3) and the treatment (retirement, as in Table 4). The finding that health variables are not significantly related to the propensity to retire may be quite surprising, because the literature has

[7] Psmatch2 STATA module is used.

Table 4:
Propensity score to retire among individuals reporting worse/same health conditions at time $t + 1$ compared to t (Model 1), and among individuals reporting better/same health conditions at time $t + 1$ compared to t (Model 2), by gender and two sets of covariates (A and B). Logistic regression coefficients, standard errors, and levels of significance

Men	Model 1							Model 2					
	Worse/Same							Better/Same					
	Model 1A			Model 1B				Model 2A			Model 2B		
Variable (ref. value)	Coef.	s.e.	sign.	Coef.	s.e.	sign.	Variable (ref. value)	Coef.	s.e.	sign.	Coef.	s.e.	sign.
Intercept	−2.39	0.157	***	−2.21	0.337	***	Intercept	−2.58	0.166	***	−2.11	0.341	***
Age (55–59)							Age (55–59)						
60–64	0.78	0.112	***	0.76	0.113	***	60–64	0.73	0.119	***	0.73	0.119	***
65–69	1.77	0.141	***	1.75	0.142	***	65–69	1.70	0.149	***	1.70	0.150	***
70–74	1.66	0.220	***	1.64	0.220	***	70–74	1.65	0.231	***	1.62	0.232	***
Education (lower secondary education or less)							Education (lower secondary education or less)						
Secondary education	−0.32	0.111	**	−0.30	0.112	**	Secondary education	−0.20	0.115		−0.19	0.116	
Tertiary education	−0.72	0.164	***	−0.69	0.165	***	Tertiary education	−0.68	0.172	***	−0.67	0.173	***
Labour income	−0.01	0.003	**	−0.01	0.003	**	Labour income	−0.01	0.003	**	−0.01	0.003	**
Self-employed							Self-employed						
Employee	0.48	0.104	***	0.47	0.104	***	Employee	0.45	0.110	***	0.45	0.111	***
Full-time							Full-time						
Part-time	0.87	0.190	***	0.86	0.191	***	Part-time	0.81	0.201	***	0.78	0.203	***
Years of transitions 2006–2007							Years of transitions 2006–2007						
2007–2008	−0.02	0.147		0.00	0.148		2007–2008	0.09	0.155		0.10	0.155	
2008–2009	0.15	0.144		0.17	0.145		2008–2009	0.20	0.152		0.20	0.153	
2009–2010	−0.15	0.160		−0.13	0.161		2009–2010	0.00	0.164		0.00	0.166	
2010–2011	0.41	0.153	**	0.44	0.154		2010–2011	0.54	0.163	**	0.55	0.164	**
Self-reported health (fair)							Self-reported health (fair)						
Very good				−0.32	0.206		Good				−0.09	0.115	
Good				−0.19	0.121		Bad				−0.18	0.236	
Bad				−0.10	0.306		Very bad				0.08	0.526	
Long-standing illness (no)							Long-standing illness (no)						
Yes				−0.06	0.144		Yes				−0.14	0.145	
Limitations in activities (no)							Limitations in activities (no)						
Yes				0.04	0.148		Yes				−0.10	0.145	

Table 4:
Continued

Women	Model 1							Model 2					
	Worse/Same							Better/Same					
	Model 1A			Model 1B				Model 2A			Model 2B		
Variable (ref. value)	Coef.	s.e.	sign.	Coef.	s.e.	sign.	Variable (ref. value)	Coef.	s.e.	sign.	Coef.	s.e.	sign.
Intercept	−2.04	0.201	***	−1.47	0.403	***	Intercept	−2.19	0.201	***	−1.66	0.398	***
Age (55–59)							Age (55–59)						
60–64	1.34	0.136	***	1.36	0.137	***	60–64	1.21	0.139	***	1.20	0.140	***
65–69	1.28	0.232	***	1.33	0.234	***	65–69	1.02	0.246	***	1.03	0.247	***
70–74	1.37	0.334	***	1.32	0.336	***	70–74	1.53	0.351	***	1.51	0.353	***
Labour income	−0.03	0.006	***	−0.02	0.006	***	Labour income	−0.02	0.006	**	−0.02	0.006	**
Self-employed							Self-employed						
Employee	0.33	0.142	*	0.33	0.143	*	Employee	0.40	0.148	**	0.41	0.148	**
Years of transitions 2006–2007							Years of transitions 2006–2007						
2007–2008	−0.07	0.195		−0.07	0.197		2007–2008	−0.13	0.197		−0.15	0.199	
2008–2009	0.01	0.191		0.02	0.193		2008–2009	−0.07	0.187		−0.09	0.188	
2009–2010	−0.41	0.203	*	−0.40	0.206		2009–2010	−0.48	0.203	*	−0.50	0.205	**
2010–2011	0.43	0.186	*	0.44	0.189	*	2010–2011	0.41	0.182	*	0.40	0.185	**
Self-reported health (fair)							Self-reported health (fair)						
Very good				−0.15	0.271		Very good				0.10	0.144	
Good				−0.05	0.158		Good				−0.03	0.273	
Bad				−0.88	0.414		Bad				−0.49	0.787	
Long-standing illness (no)							Long-standing illness (no)						
Yes				−0.09	0.178		Yes				−0.05	0.171	
Limitations in activities (no)							Limitations in activities (no)						
Yes				−0.21	0.182		Yes				−0.28	0.172	

Note: Sig.: ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$.

Table 5:
Individuals on and off support among those reporting worse/same health conditions at time $t + 1$ compared to t (Model 1), and those reporting better/same health conditions at time $t + 1$ compared to t (Model 2), by gender, and two sets of matching covariates (A and B)

	On support		Off support		
Men	**Treated**	**Untreated**	**Treated**	**Untreated**	**Total**
Worse – Model 1					
Model 1A	558	3684	1	79	4322
Model 1B	555	3681	4	82	4322
Better – Model 2					
Model 2A	483	3591	4	104	4182
Model 2B	483	3595	4	100	4182
	On support		**Off support**		
Women	**Treated**	**Untreated**	**Treated**	**Untreated**	**Total**
Worse – Model 1					
Model 1A	335	1933	3	57	2328
Model 1B	336	1927	2	63	2328
Better – Model 2					
Model 2A	322	1974	2	15	2313
Model 2B	323	1978	1	11	2313

shown that individuals who are in poor health tend to retire earlier (McGarry 2004; Hagan et al. 2009; Disney et al. 2006). However, here we are modelling the propensity to retire soon after the health status has been observed (i.e. no later than one year). Since the retirement process may last longer than a few months or one year, the time of observation may be too short to catch the possible effects of health on retirement.

We impose the common support, i.e. individuals with the same characteristics must have a positive probability of being treated and untreated. Individuals who fall outside of the common support are disregarded, and the treatment effect is not estimated for them. Clearly, if there are too many of these individuals, the estimates may not be representative. In our analyses, just a few individuals are outside of the support, and their exclusion is unlikely to affect the representativeness of the results (Table 5).

Finally, the average treatment effect on the treated—that is, the average retirement effect on retirees in terms of worsening or improving health—is estimated. The results achieved if the propensity score is estimated using only significant covariates

Table 6A:
ATT estimate of reporting a worse or a better health status at time $t + 1$, using only significant matching variables (set A)

		Worse			Better		
	PSM algorithms	**est.**	**s.e.**	**sign.**	**est.**	**s.e.**	**sign.**
Men	Radius	0.077	0.020	***	−0.025	0.023	
	Kernel	0.074	0.021	***	−0.028	0.019	
	LLR	0.071	0.023	**	−0.029	0.021	
Women	Radius	0.016	0.024		−0.032	0.027	
	Kernel	0.012	0.027		−0.032	0.027	
	LLR	0.009	0.027		−0.028	0.026	

Note: Sig.: ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$.

are shown in Table 6A, while Table 6B shows the estimates achieved if the health-related characteristics are also used as matching variables[8]. In both cases, the effect of retirement is significant in determining a worsening in self-reported health for men but not for women. In addition, retirement is not associated with any improvement for either gender. When health-related variables are included in the propensity score estimation, the average retirement effect on retirees is stronger and the standard errors are similar. Furthermore, when the health-related variables are included, the increase in individuals who are off support is negligible, and the estimates variance is not bigger. Thus, the propensity score estimates achieved using both significant covariates and health-related characteristics are preferred.

Table 6B shows that retirement increases the risk of reporting a worse health status by about 8% for men. No statistically significant effect is observed in the other cases. These results are in line with the regression analysis, although the effect of retirement on worsening health status for men turns out to be much smaller. This suggests that the logistic regression discussed in the previous section overestimates the negative effect of retirement on health for men.

To assess the matching quality, we compare the mean values of covariates observed among the treated and the matched untreated group (Table 7A and 7B). For the sake of simplicity, the mean values are shown only for the propensity score estimates based on the full set of matching covariates (significant and health-related variables). The matching variables appear to be properly balanced in the two

8 Standard errors are estimated using bootstrapping.

Table 6B:
ATT estimate of reporting a worse or a better health status at time *t* + 1, using significant and health-related matching variables (set B)

		Worse			Better		
	PSM algorithms	**est.**	**s.e.**	**sign.**	**est.**	**s.e.**	**sign.**
Men	Radius	0.084	0.016	***	−0.033	0.019	
	Kernel	0.085	0.023	***	−0.035	0.019	
	LLR	0.085	0.022	***	−0.035	0.020	
Women	Radius	0.015	0.023		−0.031	0.022	
	Kernel	0.010	0.024		−0.028	0.025	
	LLR	0.008	0.026		−0.028	0.025	

Note: Sig.: ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$.

groups, with non-significantly different mean values, regardless of which matching algorithm is used.[9]

A sensitivity analysis is implemented to assess how much a possible unobserved variable may affect the treatment effect estimates (Becker and Caliendo 2007). As we noted in section 3.3, the use of longitudinal data allows us to control for selection due to time-constant unobserved characteristics. However, further bias due to time-varying unobserved characteristics may exist.

Rosenbaum bounds (Rosenbaum 2002) are estimated[10] for significant ATT estimates only (i.e. the effect of retirement on the worsening of health among men) when the full set of matching covariates is used (see Table 6B). Our goal is to assess how big the effect of non-constant unobserved characteristics on the ATT estimates has to be to make the ATT estimates non-significant. Since we have estimated a positive treatment effect, we are interested in the bounds under the assumption that we have overestimated the retirement effect on men's health worsening (i.e. Q_mh+ in Table 8). The LLR estimate becomes non-significant for small values of Γ (say 1.15, 1.2), while radius and Kernel estimates are no longer significant for high levels of Γ (say 1.4); this suggests that the hypothetical bias due to non-constant unobserved characteristics has to be relatively large to make our estimates non-significant.

9 The only significant difference between the treated and the untreated individuals is observed in the first age bound (55–59) when the radius matching algorithm is used. Further age classifications have been tested as single-year age classifications, and in any case the ATT estimates are very similar. We prefer five-year age classification because it provides better PSM estimates, and fewer individuals are off support.

10 Mhbound STATA module is used.

Table 7A:
Health worsening – mean values of matching covariates in the treated and the untreated control group by matching estimator and gender

Man worse	Radius						Kernel						LLR					
	Mean			t-test		V(T)/	Mean			t-test		V(T)/	Mean			t-test		V(T)/
Variable	Treated	Control	% bias	t	p > |t|	V(C)	Treated	Control	% bias	t	p > |t|	V(C)	Treated	Control	% bias	t	p > |t|	V(C)
Age 55–59	0.39	0.46	−15.6	−2.54	0.011	0.96	0.389	0.422	−6.8	−1.11	0.267	0.97	0.389	0.380	1.9	0.31	0.76	1.01
Age 60–64	0.32	0.30	4.7	0.76	0.446	1.04	0.321	0.311	2	0.33	0.741	1.02	0.321	0.357	−8	−1.27	0.21	0.95
Age 65–69	0.22	0.18	11.8	1.73	0.085	1.17	0.220	0.200	5.5	0.79	0.429	1.07	0.220	0.198	6.2	0.89	0.38	1.08
Age 70–74	0.07	0.06	5.9	0.86	0.389	1.2	0.070	0.066	1.9	0.27	0.787	1.06	0.070	0.065	2.5	0.36	0.72	1.08
Lower secondary edu.	0.61	0.57	8.9	1.48	0.14	0.97	0.609	0.601	1.6	0.27	0.79	0.99	0.609	0.629	−4	−0.68	0.50	1.02
Secondary education	0.28	0.30	−4.9	−0.83	0.408	0.96	0.279	0.287	−1.7	−0.3	0.765	0.98	0.279	0.247	7	1.23	0.22	1.08
Tertiary education	0.11	0.13	−5.9	−1.07	0.285	0.86	0.112	0.111	0.1	0.01	0.989	1	0.112	0.124	−3.5	−0.65	0.52	0.91
Labour income	21.30	22.67	−5.6	−1.38	0.166	0.7	21.298	21.324	−0.1	−0.03	0.978	0.88	21.298	20.835	1.9	0.51	0.61	0.95
Self-employed	0.55	0.55	0.5	0.08	0.935	1	0.548	0.552	−0.8	−0.14	0.889	1	0.548	0.559	−2.2	−0.36	0.72	1
Part-time	0.09	0.08	5	0.73	0.465	1.14	0.090	0.090	−0.1	−0.01	0.992	1	0.090	0.094	−1.5	−0.21	0.84	0.97
Years of trans. 06–07	0.21	0.21	−0.1	−0.02	0.984	1	0.207	0.210	−0.7	−0.11	0.912	0.99	0.207	0.220	−3.1	−0.51	0.61	0.96
Years of trans. 07–08	0.21	0.21	−0.8	−0.13	0.897	0.99	0.209	0.211	−0.4	−0.06	0.95	0.99	0.209	0.213	−0.9	−0.15	0.88	0.99
Years of trans. 08–09	0.24	0.23	1.5	0.25	0.8	1.02	0.240	0.241	−0.2	−0.04	0.971	1	0.240	0.245	−1.3	−0.21	0.83	0.98
Years of trans. 09–10	0.15	0.16	−3.6	−0.62	0.535	0.93	0.148	0.149	−0.2	−0.04	0.967	1	0.148	0.126	5.7	1.05	0.30	1.14
Years of trans. 10–11	0.20	0.19	2.8	0.45	0.652	1.04	0.196	0.190	1.6	0.25	0.8	1.02	0.196	0.196	0	0	1.00	1
Very good health	0.07	0.07	−0.6	−0.1	0.923	0.98	0.070	0.066	1.4	0.25	0.801	1.05	0.070	0.077	−2.7	−0.46	0.65	0.91
Good health	0.59	0.62	−5.1	−0.84	0.402	1.02	0.593	0.604	−2.3	−0.37	0.709	1.01	0.593	0.569	4.8	0.79	0.43	0.98
Fair health	0.31	0.28	5.9	0.95	0.344	1.05	0.306	0.297	2.1	0.34	0.735	1.02	0.306	0.315	−2	−0.32	0.75	0.98
Bad health	0.03	0.03	0.1	0.02	0.982	1.01	0.031	0.033	−1.3	−0.2	0.838	0.94	0.031	0.038	−4.4	−0.66	0.51	0.82
Long-standing illness	1.82	1.83	−2.6	−0.42	0.671	1.04	1.816	1.822	−1.6	−0.26	0.793	1.03	1.816	1.807	2.4	0.38	0.70	0.96
Limitations in activities	1.81	1.82	−2.8	−0.45	0.654	1.04	1.807	1.811	−1.1	−0.18	0.861	1.02	1.807	1.800	1.9	0.3	0.76	0.97

Table 7A: Continued

Woman worse	Radius						Kernel						LLR					
	Mean			t-test		V(T)/	Mean			t-test		V(T)/	Mean			t-test		V(T)/
Variable	Treated	Control	% bias	t	p > |t|	V(C)	Treated	Control	% bias	t	p > |t|	V(C)	Treated	Control	% bias	t	p > |t|	V(C)
Age 55–59	0.49	0.54	−10.8	−1.3	0.194	1	0.49	0.50	−4	−0.49	0.627	1	0.49	0.50	−3.2	−0.39	0.70	1
Age 60–64	0.38	0.34	7.7	0.9	0.367	1.04	0.38	0.36	2.8	0.32	0.746	1.01	0.38	0.37	1.4	0.16	0.87	1.01
Age 65–69	0.10	0.08	4.4	0.51	0.61	1.12	0.10	0.09	2.4	0.28	0.781	1.06	0.10	0.08	4.7	0.54	0.59	1.13
Age 70–74	0.04	0.04	3.1	0.35	0.723	1.13	0.04	0.04	0.3	0.03	0.976	1.01	0.04	0.05	−1.7	−0.18	0.85	0.94
Labour income	16.22	16.65	−3.5	−0.56	0.579	0.93	16.22	16.16	0.5	0.08	0.937	1.01	16.22	15.76	3.8	0.63	0.53	1.17
Self-employed	0.70	0.69	0.5	0.07	0.946	1	0.70	0.70	0.1	0.02	0.987	1	0.70	0.69	1.3	0.17	0.87	0.99
Years of trans. 06–07	0.21	0.21	0.3	0.04	0.968	1	0.21	0.21	−1.5	−0.2	0.844	0.98	0.21	0.22	−2.2	−0.28	0.78	0.97
Years of trans. 07–08	0.18	0.19	−1.9	−0.25	0.803	0.97	0.18	0.20	−2.9	−0.38	0.708	0.96	0.18	0.16	6	0.82	0.42	1.12
Years of trans. 08–09	0.21	0.21	−0.5	−0.06	0.951	0.99	0.21	0.21	−1.5	−0.2	0.843	0.98	0.21	0.21	−2.2	−0.28	0.78	0.97
Years of trans. 09–10	0.15	0.17	−5.3	−0.73	0.466	0.9	0.15	0.15	0.4	0.05	0.957	1.01	0.15	0.15	1.5	0.22	0.83	1.03
Years of trans. 10–11	0.25	0.22	7.1	0.88	0.377	1.09	0.25	0.23	5.5	0.68	0.499	1.07	0.25	0.26	−2.9	−0.35	0.72	0.97
Very good health	0.07	0.07	−1.2	−0.16	0.873	0.96	0.07	0.07	−0.8	−0.1	0.92	0.97	0.07	0.07	2.3	0.31	0.76	1.08
Good health	0.61	0.62	−2.5	−0.32	0.752	1.01	0.61	0.62	−1.6	−0.2	0.842	1.01	0.61	0.58	6.8	0.86	0.39	0.97
Fair health	0.29	0.27	3.9	0.49	0.624	1.04	0.29	0.29	1.4	0.18	0.856	1.01	0.29	0.33	−8.7	−1.08	0.28	0.93
Bad health	0.02	0.03	−1.2	−0.17	0.868	0.92	0.02	0.02	1.9	0.28	0.783	1.15	0.02	0.02	0	0	1.00	1
Long-standing illness	1.81	1.81	−1	−0.12	0.902	1.02	1.81	1.81	−0.3	−0.04	0.97	1	1.81	1.80	1.5	0.2	0.85	0.98
Limitations in activities	1.79	1.80	−3.8	−0.48	0.63	1.06	1.79	1.80	−2.9	−0.37	0.713	1.04	1.79	1.79	−2.2	−0.28	0.78	1.03

Table 7B:
Health improvement- mean values of matching covariates in the treated and the untreated control group by matching estimator and gender

	Radius						Kernel						LLR					
Man better	**Mean**			**t-test**		**V(T)/**	**Mean**			**t-test**		**V(T)/**	**Mean**			**t-test**		**V(T)/**
Variable	**Treated**	**Control**	**%bias**	**t**	**p > |t|**	**V(C)**	**Treated**	**Control**	**%bias**	**t**	**p > |t|**	**V(C)**	**Treated**	**Control**	**%bias**	**t**	**p > |t|**	**V(C)**
Age 55–59	0.41	0.49	−16.6	−2.52	0.012	0.97	0.41	0.44	−7.2	−1.09	0.276	0.98	0.41	0.41	−0.9	−0.13	0.90	1
Age 60–64	0.31	0.29	4.2	0.64	0.525	1.04	0.31	0.30	2.4	0.37	0.712	1.02	0.31	0.29	4.2	0.63	0.53	1.04
Age 65–69	0.21	0.16	13.5	1.88	0.061	1.21	0.21	0.19	5.9	0.79	0.428	1.08	0.21	0.22	−2.4	−0.31	0.76	0.97
Age 70–74	0.07	0.06	6.8	0.93	0.355	1.24	0.07	0.07	1.5	0.2	0.84	1.05	0.07	0.08	−2.9	−0.37	0.71	0.93
Lower secondary edu.	0.59	0.55	7.4	1.15	0.248	0.98	0.59	0.58	1.3	0.2	0.84	1	0.59	0.59	−0.8	−0.13	0.90	1
Secondary education	0.30	0.31	−2.8	−0.44	0.657	0.98	0.30	0.31	−1.1	−0.18	0.857	0.99	0.30	0.29	1.8	0.28	0.78	1.02
Tertiary education	0.11	0.14	−6.6	−1.11	0.268	0.85	0.11	0.11	−0.3	−0.05	0.958	0.99	0.11	0.12	−1.2	−0.2	0.84	0.97
Labour income	21.65	23.12	−6	−1.33	0.185	0.7	21.65	21.79	−0.6	−0.13	0.895	0.88	21.65	21.48	0.7	0.18	0.86	1.08
Self-employed	0.55	0.55	−0.8	−0.13	0.898	1	0.55	0.55	−1.4	−0.22	0.822	1	0.55	0.53	2.5	0.39	0.70	1
Part-time	0.08	0.07	7	0.98	0.326	1.23	0.08	0.08	2.1	0.29	0.774	1.06	0.08	0.06	8.7	1.24	0.22	1.3
Years of trans. 06–07	0.21	0.21	−1.1	−0.17	0.868	0.98	0.21	0.21	0	0	0.999	1	0.21	0.22	−3	−0.47	0.64	0.96
Years of trans. 07–08	0.21	0.21	−1.5	−0.24	0.812	0.98	0.21	0.21	−1.3	−0.21	0.837	0.98	0.21	0.20	2.5	0.4	0.69	1.04
Years of trans. 08–09	0.23	0.23	1.7	0.25	0.8	1.02	0.23	0.23	0.4	0.06	0.954	1	0.23	0.23	0.5	0.08	0.94	1.01
Years of trans. 09–10	0.17	0.18	−2.9	−0.47	0.64	0.95	0.17	0.17	−0.6	−0.1	0.918	0.99	0.17	0.16	2.7	0.44	0.66	1.05
Years of trans. 10–11	0.19	0.17	4.1	0.61	0.541	1.07	0.19	0.18	1.7	0.25	0.8	1.03	0.19	0.20	−2.8	−0.41	0.68	0.96
Good health	0.50	0.53	−5.7	−0.88	0.379	1	0.50	0.51	−2.5	−0.39	0.696	1	0.50	0.49	0.4	0.06	0.95	1
Fair health	0.43	0.41	5.1	0.78	0.433	1.02	0.43	0.42	2.5	0.39	0.699	1.01	0.43	0.44	−2.5	−0.39	0.70	0.99
Bad health	0.06	0.06	1.1	0.17	0.868	1.04	0.06	0.06	0.1	0.01	0.989	1	0.06	0.06	1.8	0.27	0.79	1.07
Very bad health	0.01	0.01	1	0.14	0.891	1.09	0.01	0.01	0.1	0.01	0.992	1.01	0.01	0.00	6.8	1.14	0.26	2.48
Long-standing illness	1.77	1.79	−3.4	−0.51	0.608	1.05	1.77	1.78	−1.4	−0.21	0.834	1.02	1.77	1.75	7.2	1.05	0.29	0.92
Limitations in activities	1.76	1.78	−4.3	−0.66	0.511	1.06	1.76	1.77	−2.4	−0.36	0.717	1.03	1.76	1.74	4.5	0.67	0.50	0.95

Table 7B: Continued

Woman better	Radius						Kernel						LLR					
	Mean			t-test		V(T)/	Mean			t-test		V(T)/	Mean			t-test		V(T)/
Variable	Treated	Control	%bias	t	p > |t|	V(C)	Treated	Control	%bias	t	p > |t|	V(C)	Treated	Control	%bias	t	p > |t|	V(C)
Age 55–59	0.52	0.59	−13.7	−1.62	0.105	1.03	0.52	0.54	−4.7	−0.55	0.583	1.01	0.52	0.52	0	0	1	1
Age 60–64	0.35	0.31	9.9	1.15	0.253	1.07	0.35	0.34	3.3	0.38	0.702	1.02	0.35	0.35	0	0	1	1
Age 65–69	0.08	0.07	4.2	0.49	0.621	1.13	0.08	0.07	3.5	0.4	0.686	1.11	0.08	0.07	6.3	0.76	0.45	1.22
Age 70–74	0.04	0.03	6.4	0.72	0.475	1.32	0.04	0.04	−0.7	−0.07	0.941	0.97	0.04	0.06	−9.1	−0.89	0.37	0.75
Labour income	17.05	17.58	−4.2	−0.59	0.558	1.02	17.05	17.00	0.4	0.05	0.956	1.14	17.05	17.31	−2	−0.29	0.77	1.09
Self-employed	0.72	0.71	1.6	0.2	0.842	0.98	0.72	0.72	0.8	0.1	0.918	0.99	0.72	0.68	9	1.12	0.26	0.93
Years of trans. 06–07	0.23	0.23	1.3	0.16	0.87	1.02	0.23	0.24	−0.9	−0.11	0.915	0.99	0.23	0.24	−0.7	−0.09	0.93	0.99
Years of trans. 07–08	0.17	0.17	−1	−0.13	0.894	0.98	0.17	0.17	−0.6	−0.08	0.938	0.99	0.17	0.18	−2.4	−0.31	0.76	0.96
Years of trans. 08–09	0.21	0.21	−0.5	−0.06	0.951	0.99	0.21	0.21	−1.6	−0.2	0.84	0.98	0.21	0.21	−0.8	−0.1	0.92	0.99
Years of trans. 09–10	0.15	0.17	−6.7	−0.91	0.366	0.87	0.15	0.15	−0.9	−0.12	0.904	0.98	0.15	0.13	4	0.57	0.57	1.1
Years of trans. 10–11	0.25	0.22	6.6	0.8	0.427	1.08	0.25	0.23	3.9	0.47	0.64	1.05	0.25	0.25	0	0	1	1
Good health	0.53	0.54	−1.9	−0.24	0.814	1	0.53	0.53	0.1	0.01	0.993	1	0.53	0.49	7.5	0.94	0.35	1
Fair health	0.40	0.39	0.8	0.11	0.916	1	0.40	0.40	−0.5	−0.06	0.951	1	0.40	0.42	−5.1	−0.64	0.52	0.98
Bad health	0.07	0.07	2.4	0.29	0.775	1.08	0.07	0.07	0.9	0.1	0.919	1.03	0.07	0.09	−6.4	−0.73	0.47	0.84
Very bad health	0.01	0.01	−0.7	−0.08	0.935	0.92	0.01	0.01	0	0	0.999	1	0.01	0.00	4	0.58	0.56	1.99
Long-standing illness	1.77	1.78	−1.4	−0.18	0.861	1.02	1.77	1.77	0.7	0.08	0.933	0.99	1.77	1.76	3	0.37	0.71	0.96
Limitations in activities	1.72	1.75	−4.9	−0.61	0.542	1.05	1.72	1.73	−0.3	−0.04	0.966	1	1.72	1.69	7.9	0.95	0.34	0.93

Table 8:
Mantel–Haenszel bounds by matching algorithm for a worsening of health among men

	Radius				Kernel				LLR			
Gamma	Q_mh+	Q_mh−	p_mh+	p_ mh−	Q_mh+	Q_mh−	p_mh+	p_mh−	Q_mh+	Q_mh−	p_mh+	p_mh−
1	4.577	4.577	0.000	2.40E-06	4.577	4.577	0.000	2.40E-06	2.554	2.554	0.005	0.005329
1.05	4.083	5.075	0.000	1.90E-07	4.083	5.075	0.000	1.90E-07	2.221	2.890	0.013	0.001927
1.1	3.613	5.551	0.000	1.40E-08	3.613	5.551	0.000	1.40E-08	1.903	3.210	0.029	0.000664
1.15	3.165	6.008	0.001	9.40E-10	3.165	6.008	0.001	9.40E-10	1.599	3.516	0.055	0.000219
1.2	2.737	6.447	0.003	5.70E-11	2.737	6.447	0.003	5.70E-11	1.308	3.810	0.095	0.000069
1.25	2.327	6.871	0.010	3.20E-12	2.327	6.871	0.010	3.20E-12	1.030	4.093	0.151	0.000021
1.3	1.935	7.281	0.027	1.70E-13	1.935	7.281	0.027	1.70E-13	0.763	4.365	0.223	6.30E-06
1.35	1.557	7.677	0.060	8.10E-15	1.557	7.677	0.060	8.10E-15	0.506	4.628	0.307	1.80E-06
1.4	1.194	8.061	0.116	3.30E-16	1.194	8.061	0.116	3.30E-16	0.258	4.882	0.398	5.30E-07
1.45	0.844	8.433	0.199	0	0.844	8.433	0.199	0	0.019	5.127	0.492	1.50E-07
1.5	0.505	8.795	0.307	0	0.505	8.795	0.307	0	0.065	5.365	0.474	4.00E-08
1.55	0.178	9.147	0.429	0	0.178	9.147	0.429	0	0.288	5.596	0.387	1.10E-08
1.6	0.038	9.490	0.485	0	0.038	9.490	0.485	0	0.504	5.820	0.307	2.90E-09
1.65	0.346	9.824	0.365	0	0.346	9.824	0.365	0	0.713	6.037	0.238	7.80E-10
1.7	0.644	10.150	0.260	0	0.644	10.150	0.260	0	0.916	6.249	0.180	2.10E-10
1.75	0.933	10.468	0.175	0	0.933	10.468	0.175	0	1.113	6.455	0.133	5.40E-11
1.8	1.215	10.779	0.112	0	1.215	10.779	0.112	0	1.305	6.656	0.096	1.40E-11
1.85	1.489	11.084	0.068	0	1.489	11.084	0.068	0	1.492	6.852	0.068	3.70E-12
1.9	1.756	11.382	0.040	0	1.756	11.382	0.040	0	1.674	7.043	0.047	9.40E-13
1.95	2.016	11.674	0.022	0	2.016	11.674	0.022	0	1.851	7.230	0.032	2.40E-13
2	2.270	11.960	0.012	0	2.270	11.960	0.012	0	2.024	7.412	0.021	6.20E-14

In sum, the average retirement effect on retirees' estimates partially supports our research hypotheses when the observed and the unobserved heterogeneity between retirees and the still-employed are explicitly taken into account. It is clear that retirement affects men and women differently. Leaving their job is often a shock for men, who report a worsening of their subjective health over the short term. This is generally not the case for women, who are less likely to experience retirement as a negative event, possibly because they are more likely to be fully engaged in other demanding activities, often related to family care. We also expected to find that retirement would be associated with a subjective improvement in health among women, as they gained access to more free time and other individual resources. While this is not shown to be the case, the finding that retirement has no effect on women's self-reported health may suggest that they can more easily re-arrange their life-style in the short term.

5 Conclusions

With the population of Italy ageing rapidly, concerns have been raised about the cost of maintaining the country's pension and health care systems. Recently, following a wide-ranging debate on pension reform, the minimum pension age was increased. The goal of this reform is to reduce the pension burden by requiring people to postpone retirement. The reform affects women in particular, as the minimum retirement age for women is expected to become the same as that for men in the next few years. However, the relationship between retirement and individual health suggests that the changes implemented in the pension system may in turn lead to additional burdens for the health care system: if retirement is associated with improvements in health, then postponing retirement may lead to an increase in health-related expenditures; if, however, retirement is associated with worse health, then the health care system may benefit from the postponement of retirement. For these reasons, understanding the real effect of retirement on health is of primary interest in this context.

Nonetheless, disentangling the real effect of retirement from that of health is challenging, because the two experiences can affect each other: as being in poor health is usually associated with earlier retirement, individuals who retire early may differ systematically from those who retire later (self-selection). Moreover, the decision to retire and a change in health status may be simultaneously determined by the same individual's observed and unobserved characteristics. Different statistical methods can be implemented to identify the net effect of retirement on health, each of which has its own pros and cons. In this paper, we first provided an overview of the household and individual characteristics associated with the change in health status using logistic regression. We then referred to the propensity score matching estimator, which allowed us to estimate the effect of retirement on health.

By comparing health conditions in the two following years, we have been able to capture the short-term effect of retirement, which may be due to an adjustment to new social and economic roles. When individuals leave the labour market, their job loses its centrality in their daily life, and they have to reallocate the time previously spent in paid employment to alternative activities. As Italy is characterised by traditional gender roles, with men being expected to provide for the family, we hypothesised that men's health would worsen after they retired. Meanwhile we expected to find that retirement is less traumatic for women because they are more used to devoting their time to other demanding activities, such as domestic tasks or family care, and they may more easily adapt to the new life-style, by, for example, investing more time in family-related activities. Thus, we posited that women would report better health after retirement, because they would have more time and resources available for their non-work-related tasks and commitments. However, both the regressions and the propensity score matching estimators show that retirement is not associated with an improvement in self-reported health for either men or women. Instead, we find a deterioration in self-reported health for men, but not for women.

We see the gender differences in the retirement effect on self-reported health as being a consequence of the socio-cultural implications retirement has for men and women. However, adjusting to life after retirement may simply require greater effort and more time for men than for women. If this is the case, then the negative effect of retirement on self-reported health may fade away over a longer period of observation for men, as well as for women. Extending the analyses to examine longer term effects (e.g. two or three years) may provide us with some evidence to support this hypothesis. It is worth noting that an extension of the period of observation may affect the reliability of the results by reducing the size of the sample available for the analyses. However, (Sahlgren 2013), taking into account both the effect of retirement and the number of years spent in retirement, has pointed out the short-term impact of retirement on health is somewhat uncertain, while 'the longer-term effects are consistently negative and large'.

Our results suggest that the health care system may benefit if men postpone retirement. Among women, who have been more affected by the recent pension reform, we find no evidence of an improvement in health status after retirement. Thus, it appears that health care expenditures are not affected by these changes in the pension system. However, the recent changes may themselves have affected the retirement-health relationship. Thus, in the near future additional work is needed to re-analyse this association.

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Real wages and labor supply in a quasi life-cycle framework: a macro compression by Swedish National Transfer Accounts (1985–2003)

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Abstract

This paper examines the life-cycle dynamics of real wages and labor supply in Sweden. The descriptive results lend support to the inter-temporal substitution hypothesis (ISH), as the age patterns of real wages and the labor supply are both hump-shaped. However, the age-wage profiles increasingly shift toward older ages over time, whereas the age-employment profiles do not. This leads to an accentuated difference-in-differences of the two variables from prime working age through retirement, which casts doubt on the explanatory power of the ISH for the life-cycle labor supply. Econometric analysis shows that the intra-temporal elasticity outweighs the inter-temporal elasticity of substitution, and thus provides little support for the ISH. The estimated labor supply elasticity also varies considerably across age groups. This suggests that an array of age-specific parameters are needed in calibrating the overlapping generation model (OLG).

1 Introduction

In Sweden, a country at the forefront of best-practice life expectancy trends, life expectancy at birth is expected to reach 100 in about six decades (Oppen and Vaupel 2002). Coupled with the low fertility levels of recent decades, this trend is expected to result in growth in the share of the population who are aged 65+. Holding the mean age at retirement constant, this process implies that the per worker cost of providing a given age vector of per capita benefits will increase (Lee and Edwards 2001). These benefits include health care, elderly care, and other types of old-age social security programs. It might be argued that cutting benefits is one of the

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options for balancing the public budget; however, this simply shifts responsibility from the public to the private sector, and in no way addresses the consequences of population aging. In fact, it is possible that overall economic efficiency would deteriorate if some of the welfare services which are currently provided were shifted to the home, as family members might be forced to leave the labor market to provide care for the elderly.

Alternatively, if these expenditures are financed by national debt, intergenerational equity issues can arise, as future generations are expected to repay the debt. Unless the Ricardian equivalence proposition holds,[1] public debt might crowd out private capital, erode productive investment, and depress economic output. In an open economy, the crowding-out effect may be attenuated by attracting foreign capital (Modigliani 1986), which could mitigate the loss of domestic capital and help to maintain the level of investment. However, as population aging is becoming a global phenomenon, it is unclear whether the inflow of foreign capital can sufficiently offset the crowding out of private capital. Moreover, while external debt can be issued, it still needs to be repaid by future generations; thus, the generational equity issue remains.

In Sweden, the cost of caring for the elderly is largely covered by tax revenues. Therefore, financing higher costs will involve either expanding the tax base or raising tax rates. Since the taxation levels in Sweden are already above the international average, broadening the tax base would appear to be a more reasonable solution. While demographic measures could help to enlarge the tax base, this strategy could create additional problems. For instance, if immigrant workers are poorly integrated into the Swedish labor market, increasing their numbers could place additional burdens on society. Initiatives to increase fertility, on the other hand, would not have positive effects on the size of the working population for at least 25–30 years (Bengtsson and Scott 2011). Hence, a more realistic solution seems to be to increase the labor supply among the existing working-age population who are able to work.

Recent trends in Sweden toward better health among people in their sixties and seventies suggest that working life can be prolonged. However, during the first decade of this century, labor force participation in Sweden among people aged 65+ was low, at around 10 per cent. Meanwhile, youth labor force participation was declining, especially after the recession which began in 2008.[2] These patterns imply that policy measures which encourage early entry into and late exit from the labor market are needed to ensure the expansion of the tax base. This approach is likely to prove effective, because the young and the old together make up a large share of

1 Ricardian equivalence holds if bequests and gifts generate private flows which are large enough to offset changes in government deficit levels; thus, in this scenario there is no impact on short-run and long-run equilibrium (Barro 1974).

2 The data referred to in this discussion come from the Labor Force Statistics in OECD countries. Detailed information on how the statistics from different countries are compiled can be found at: www.oecd.org/els/employmentpoliciesanddata/LFSNOTES.

Sweden's exploitable human resources. More importantly, if these groups remain outside of the workforce, they will place additional burdens on the welfare state.

To assess the long-term impact of population aging, we should consider various scenarios of labor supply. Gaining a thorough understanding of labor supply behavior is a *sine qua non* for formulating meaningful scenarios which would allow us to evaluate viable solutions to potential shortfalls. As the present study contributes to our understanding of the behavior of workers and trends in the labor supply, it has significant policy relevance.

Since the introduction of the inter-temporal substitution hypothesis (hereafter, ISH) by Lucas and Rapping (1969), the issue of labor supply has attracted enormous attention in macroeconomics. The ISH argues that the labor supply and wages should be positively correlated over the life-cycle. This is because the life-cycle wage profile is assumed to be foreseeable for individuals, a phenomenon known as 'evolutionary wage growth'. This wage pattern can generate substitution effects on the labor supply only if it is assumed that rational agents will concentrate their labor supply at ages at which their earning power is relatively high, and enjoy more leisure at ages at which their earning power is relatively low (Macurdy 1981).

So far, economists have been unable to agree upon the magnitude of this elasticity. Labor economists have typically obtained small estimates at the individual level, while macroeconomists have reported mixed evidence. Mankiw et al. (1985) found no statistical evidence supporting the ISH, while Alogoskoufis (1987) obtained higher estimates of intertemporal real wage elasticity than other economists. Lucas and Rapping (1969) have obtained the largest estimate of short-run labor supply elasticity with respect to wages, 1.4. They have claimed that this finding provides supporting evidence for the Keynesian-type assumption of a elastic short-run supply schedule. This paper contributes some new insights on this issue, as well as on some other unresolved questions.

There has been a long tradition of introducing age into macroeconomic models. The overlapping generational model with computable general equilibrium (OLG-CGE) is one such framework. The model was pioneered by Samuelson (1958) and Diamond (1965), and was used by a number of followers in various applications (e.g. Auerbach and Kotlikoff (1987), Miles (1999), and Börsch-Supan (2003)).

All of these models assume that the elasticity of substitution does not vary over the life-cycle. The parameters for calibrating these models are mostly taken from aggregate time series analysis, without taking into account the age differentials. This leads to inconsistencies between the setting in which the empirical evidence is obtained and the setting in which estimated elasticities are applied.

In fact, aggregate estimates of time series data correspond to a model of a single representative agent who lives indefinitely. This differs from the overlapping generation (OLG) environment, where multiple agents have finite lives and coexist with different age groups at each point in time. Such estimated elasticity does not necessarily reflect the actual behavior of the agents at different stages of the life-cycle, which could eliminate the disproportional age-specific responses to macroeconomic change.

For this reason, I use the National Transfer Accounts (NTA) for Sweden with time-varying age profiles of economic activity for the period 1985–2003 to estimate a life-cycle labor supply function. The estimation is theoretically consistent with the overlapping generation framework, and thus allows me to envisage a more realistic life-cycle model with age-separable elasticities of labor supply with respect to wages. This can serve as a new basis for future applications of OLG models.

The remainder of this paper is organized as following. First, I provide some theoretical considerations regarding the life-cycle real wage and labor supply. Next, I introduce various data sources and empirical models. In the following section, I report and discuss the results. Finally, I summarize some key findings in the conclusion.

2 A general theory of real wage and labor supply – a lifecycle perspective

2.1 Age-wage differential

Wage differentials between younger and older workers might be the result of a wage-productivity discrepancy, in which younger workers are underpaid and older workers are overpaid relative to their productivity (Skirbekk 2003). A few theories attempt to explain the existence of wage-productivity discrepancies and age-wage differentials.

The efficiency wage hypothesis argues that firms will be unconstrained by labor market conditions in pursuing their optimal recruitment policy, as long as the labor supply exceeds the demand, and the real wage offers are higher than the reservation wages (Yellen 1984). An extension of this hypothesis, the shirking model, seeks to explain why firms are willing to pay wages above the market rate. According to this model, the piece rate is an inaccurate measure of productivity, and overpaying workers relative to their productivity provides them with incentives not to shirk (Calvo 1979).

Additionally, economists have raised the question of why firms prefer to pay workers less when they are young and more when they are old with respect to their marginal product. This pattern is sometimes attributed to the nature of the optimal wage profile. A contracted pay schedule would lead to Pareto efficiency with mandatory retirement (Lazear 1981). Time spent in the labor market might also affect the wage distribution across age groups. Senior workers earn more on average, even if their perceived productivity is held constant. This is because they have had more time to bid up their wages, and their abilities can be more precisely assessed (Harris and Bengt 1982).

Finally, the age distribution of labor earnings might also be influenced by trade unions. If unions attach greater weight to the wishes of older workers than of younger workers, and if wages and employment are determined by efficient collective bargaining, the wages of older workers will always be higher than the wages of younger workers, regardless of productivity and labor supply (Pissarides 1989).

The time-varying age-wage patterns have rarely been examined in the current empirical literature, partly because yearly age profiles of wages are often unavailable. To the best of my knowledge, the only systematic investigation of the annual variation in the shape of the life-cycle earning profiles is a study for the U.S. which used the Current Population Survey 1962–2003. One of the major findings of that study is that there was a consistent upward trend in the earnings of older men relative to the earnings of younger men, which the authors attributed to the fact that younger workers no longer had an educational advantage over older workers (Lee et al. 2011).

In short, the theoretical literature generally predicts that younger workers tend to be underpaid relative to older workers. Hence, one of the purposes of the present study is to verify whether the age profile of labor income is in line with the theoretical predictions. I also attempt to determine whether in Sweden the earnings of older men have been rising relative to the earnings of younger men over time.

2.2 The substitution and income effects on labor supply

Based on the standard assumption that leisure is a normal good, an increase in real wages may be expected to have two potential effects on labor supply: i.e. substitution effects and income effects.

Based on these two opposite effects, micro-economists have predicted the possible shapes of the individual labor supply curve: i.e. a strictly positive supply curve and a backward-bending supply curve. The former curve suggests that the substitution effects consistently outweigh the income effects; while the latter curve implies that the substitution effects dominate only to a point at which both wages and working hours have reached a relatively high level, and that income effects then kick in and outweigh substitution effects. Accordingly, any further increase after a threshold of real wages and hours worked would induce individuals to reduce their labor to consume more leisure.

These two competing theoretical predictions lead us to ask an important question: Which curve better depicts the labor supply of individuals? So far, the empirical evidence indicates that a mixture of these two curves is needed to answer this question. Although the cross-sectional evidence on the short-run labor supply curve suggests that substitution effects dominate, at least for married women (Cain 1966; Mincer 1962), secular trends consistently provide support for the backward-bending supply curve, particularly in the long run.

2.3 The inter-temporal substitution hypothesis

It is important to note that the preceding discussion on substitution and income effects has been restricted to the static analyses. For a comprehensive life-cycle analysis of labor supply, it is necessary to distinguish between the intra-temporal effect and the inter-temporal effect; specifically, to disentangle the labor supply response to an unanticipated wage shift from the response to anticipated evolutionary wage growth.[3]

There are substantial differences between the two sorts of responses. The unanticipated wage shift can yield not only substitution effects, but also income effects, as was discussed above in the one-period analysis. The evolutionary wage growth, on the other hand, can generate only substitution effects. This is because when the life-cycle wage profile is foreseeable, rational agents will concentrate their labor supply over the ages at which their wages are high, and will demand more leisure over the ages at which their wages are low (Macurdy 1981). Such an assumption implies that the labor supply and the wage rate should be positively correlated over the life-cycle. This is called the inter-temporal substitution hypothesis (hereafter, ISH).

However, the empirical literature on this issue has so far provided inconsistent evidence. Mankiw et al. (1985) found no statistical evidence supporting the ISH using aggregate U.S. data. Alogoskoufis (1987), on the other hand, found substantially higher estimates of inter-temporal real wage and interest rate elasticities than others.

Such inconsistencies may be due to the measurement of the labor supply. Mankiw et al. (1985) used the aggregate man hours, which has been criticized as being the least important component by Heckman (1993). Alogoskoufis (1987) rather found strong inter-temporal elasticity when using numbers of employees and employment rates, but weak estimates when using total employee hours. This is not surprising, as in daily working life hours are not as flexible as is theoretically assumed. The pattern of hours worked over the life-cycle generally appears to be sticky, at least for male workers over the prime working ages. As a result, the responsiveness of the labor supply (measured by hours worked) to wage changes tends to be weak and insignificant. At an aggregate level, most of the variation in total man hours comes from variation in employment, not from hours worked per head (Coleman 1984). In addition, Heckman (1993) asserted that the strongest empirical effects of wages and non-labor income on labor supply are at the extensive margin, where the elasticity is unequivocally not zero.

[3] A fuller discussion on this distinction is given in Macurdy (1981).

2.4 Labor supply elasticity in an overlapping generation setting

Labor supply elasticities are important not only for understanding individual behavior, but also for addressing broader policy issues. For instance, in evaluating the financial stability of a pension system or experimenting with the welfare consequences of potential reforms, one common practice is to calibrate the estimated elasticities into an overlapping generation model with computable general equilibrium (OLG-CGE); e.g. Auerbach and Kotlikoff (1987); Börsch-Supan (2003); Miles (1999), etc. Two major issues arise when conducting this type of analysis.

The first issue is the decision about which parameter values to use, as estimated elasticities can vary depending on the source, and there is little consensus on their magnitude and representativeness. Prescott and Wallenius (2011) noted that aggregate elasticities are typically found to be larger than individual elasticities. This appears to support the argument that parameters should not be estimated in one setting and then applied to another. We can therefore assume that, OLG-CGE, as an abstracted macro model, should be calibrated by elasticities estimated at the aggregate level.

This leads us to the second issue: namely, that aggregate estimates of time series data may correspond to a single agent model with infinite life. This is not necessarily equivalent to the OLG setting, where multiple agents at different ages co-live at each point in time with a finite life span. Such estimated elasticities could eliminate the disproportionate impact of macroeconomic changes on various agents who are co-existing in the stylized environment at a given point in time. For example, the empirical evidence discussed earlier shows that young people were hit particularly hard during the recent recession (OECD 2011). Such unevenly distributed responses to business cycles cannot be reflected in OLG simulations if we assume that elasticities are constant over ages, and calibrate on the basis of estimates from aggregate data in the national accounts.

To the best of my knowledge, none of the existing OLG models have incorporated age-specific parameters governing inter- and intra-temporal decisions into the calibration. Furthermore, there have been very few macroeconomic studies which have empirically estimated age-specific elasticities.

Fair (1971) examined the relationship between wages, the money illusion, and labor force participation using quarterly data for the U.S. for the period 1956–1970. The variables used were age- and gender-specific. The study did not find any consistent labor supply responses to wages by different demographic groups, or any substantive differences between the wage and the money effects. One drawback of Fair's analysis is the lack of a theoretical foundation, both in terms of the variables chosen, the model specification, and the length of the distributed lags.

It is therefore necessary to estimate an empirical model which is consistent with the theory, and is applicable to the environment which the theoretical framework assumes. When seeking to estimate a labor supply function which is compatible with the OLG model, it is essential to emphasize the age differences in the estimated elasticities, and to specify the model in line with the theoretical framework. In other words, it is necessary to explicitly address the question of whether workers at different stages of the life-cycle could have had different inter-temporal and intra-temporal responses to wage changes.

3 A macro life-cycle model

A new classical model of the dynamic household's labor supply and the firm's marginal productivity condition for labor was first introduced by Lucas and Rapping (hereafter, L-R model), and applied to the U.S. labor market. Prior to the introduction of this model, labor supply decisions were regarded as virtually irrelevant for this level of analysis, as it was assumed that aggregate labor supply was not determined by the factors which drive individual labor supply (Prescott and Wallenius 2011).

In the next section, I provide a brief presentation of a multi-period life-cycle model. Although a more realistic model would include multi-sectors, households, firms, government, and, perhaps, banking; I will limit my theoretical considerations to household and firm sectors. The main goal in this case is to provide a basis for deriving an empirically testable labor supply function for the current analysis. The model presented here shares certain characteristics with the L-R model, yet differs in some ways.

3.1 Household behavior

In an overlapping generation setting, each representative household lives up to a certain date T. In each period, the household which has reached T dies out and a newborn enters. The households derive their utility from consumption and leisure, which can be traded not only within, but also across periods.

For the sake of simplicity, I first consider the household as a single representative agent in the economy which does not correspond to the multi-generational agents in the OLG setting. In other words, the household behavior presented here is only comparable with aggregate time series analyses; e.g. Lucas and Rapping (1969) and Alogoskoufis (1987). The purpose of simplifying the model in this way is to derive the theoretical predictions of labor supply responses to wages. A more general model for multi-generational agents will be presented in the empirical estimation. For the single representative agent in the economy, the implicit lifetime utility function may be expressed as,

$$U = \frac{1}{1 - 1/\gamma} \sum_{t=0}^{T} \frac{1}{(1 + \delta)^t} u_t(c_t, l_t)^{1-1/\gamma} \tag{1}$$

where, t is age/time, δ is the rate of time preference, γ is the inter-temporal elasticity of substitution, and c and l denote consumption and leisure, respectively.

Assuming there is no income and payroll tax or any kind of social benefits, the household budget constraint is merely a function of current and future discounted assets and labor income, with the requirement that lifetime consumption does not exceed the earnings at the present value. The budget constraint can therefore be written as:

$$a_t + \sum_{t=0}^{T} \prod_{t=0}^{T} (1 + r_t)^{-1} [a_t r_t + w_t(1 - l_t)] \geq \sum_{t=0}^{T} \prod_{t=0}^{T} (1 + r_t)^{-1} c_t \tag{2}$$

where, c, l, r and a are consumption, leisure, interest rate, and assets; respectively. w is the per worker annual wage.

It is important to note that the value of l is assumed to be $l \in [0, 1]$, and reflects the age- or time-varying fraction of the total labor endowment allocated to leisure. Accordingly, $1 - l$ is the fraction of the total labor endowment devoted to work. In general, for an unemployed person, $l = 1$; whereas for a full-time worker, $l = 0$, and any value between zero and one refers to the intensive margin of labor supply. As was argued by Alogoskoufis (1987), it may be assumed such a theoretical model is not suitable for modeling the extensive margin. To conduct the analysis using aggregate data, it is necessary to use a continuous variable which is in line with the work-leisure choice by a single representative agent. This issue will be discussed in greater detail later in the paper.

The preferences in (1) are further restricted by assuming that the implicit utility function is time-separable and in the nested constant elasticity of substitution form. This gives the annual utility function,

$$u_t(c_t, l_t) = (c_t^{1-1/\rho} + \alpha l_t^{1-1/\rho})^{\frac{1}{1-1/\rho}} \tag{3}$$

where, α and ρ are the parameters of intensity for leisure and intra-temporal elasticity, respectively.

Each household maximizes its lifetime utility (1) subject to a lifetime budget constraint (2). At each age, a household solves a dynamic optimization problem, and derives its consumption and leisure. The economy is closed (i.e. it is not subject to international trade, capital flows, or migration) and both the labor market and the capital market are perfectly competitive. In addition, the household is assumed to have no bequest motive. Substituting (3) into (1), the Hamiltonian for each representative household may be expressed as:

$$H_t = \frac{1}{(1 + \delta)^t} \frac{1}{1 - 1/\gamma} (c_t^{1-1/\rho} + \alpha l_t^{1-1/\rho})^{\frac{1-1/\gamma}{1-1/\rho}} + \lambda_t [a_t r_t + w_t(1 - l_t) - c_t] \tag{4}$$

where, $\delta, \alpha, \gamma, \rho$ are the parameters of time preference, leisure intensity, inter-temporal elasticity, and intra-temporal elasticity; respectively. Subscripts t denote age/time. Let c, l, r, and a be consumption, leisure, interest rate, and assets; respectively. λ is the costate variable which can be interpreted as the marginal value of a unit change in the budget constraint. w is the annual per worker wage rate.

Maximizing (4) with respect to c_t and l_t, respectively, yields the following two first-order conditions:

$$\lambda_t = (1+\delta)^t (c_t^{1-1/\rho} + \alpha l_t^{1-1/\rho})^{\frac{1/\rho-1/\gamma}{1-1/\rho}} c_t^{-1/\rho} \tag{5}$$

$$\lambda_t w_t = (1+\delta)^t (c_t^{1-1/\rho} + \alpha l_t^{1-1/\rho})^{\frac{1/\rho-1/\gamma}{1-1/\rho}} \alpha l_t^{-1/\rho} \tag{6}$$

Combining the two first-order conditions yields (7), an expression for the intra-temporal effect of wage change on consumption and leisure or labor supply. The sign of the parameter ρ is hard to determine a priori due to the ambiguous effects of wage increases on the labor supply, as discussed in the preceding section. If ρ is positive, an increase in wages would lower the leisure-consumption ratio, and would therefore imply an increase in the labor supply; that is, the substitution effect dominates. Conversely, a negative sign of ρ implies a positive relationship between the changes in the wage rate and the leisure-consumption ratio, and thus a reduction in the labor supply, i.e. the income effect dominates.

$$l_t = \left(\frac{w_t}{\alpha}\right)^{-\rho} c_t \tag{7}$$

The change of the shadow value, λ_t, with respect to time/age equals the negative first-order condition of the Hamiltonian with respect to assets:

$$\frac{\partial \lambda_t}{\partial t} = -\frac{\partial H_t}{\partial a_t} \tag{8}$$

Therefore,

$$\lambda_t - \lambda_{t-1} = -\lambda_t r_t \tag{9}$$

Re-writing the previous equation, we get

$$\frac{\lambda_t}{\lambda_{t-1}} = \frac{1}{1+r_t} \tag{10}$$

Substituting (7) into (5), we get an expression for the shadow price λ_t represented by consumption and divided by λ_{t-1}, we get,

$$\frac{\lambda_t}{\lambda_{t-1}} = (1+\delta)^{-1} \left(\frac{c_t}{c_{t-1}}\right)^{-1/\gamma} \left(\frac{1+\alpha^\rho w_t^{1-\rho}}{1+\alpha^\rho w_{t-1}^{1-\rho}}\right)^{\frac{1/\rho-1/\gamma}{1-1/\rho}} \tag{11}$$

Equating (10) and (11), we get two Euler equations for both consumption and leisure. Of these equations, only the latter will be used to derive the labor supply function in the following section.

3.2 Labor supply function

As was previously mentioned, for a single household, l reflects the fraction of the total labor endowment allocated to leisure; thus $1 - l$ is equivalent to the fraction of total labor endowment spent in market work. This continuous variable corresponds to the intensive margin of the labor supply for the household.

In a macroeconomic context, it is necessary to ensure that the measured labor supply is comparable to that in the theoretical model. The measured labor supply has varied across previous empirical studies, and this lack of consistency has resulted in inconsistent evidence. As was discussed above, most of the variation in total man hours comes from employment variation, not from hours worked per head (Coleman 1984). In addition, this paper stresses the effect of wages on the individual labor supply decision at the extensive margin. Hence, I use the number of employed individuals instead of the total man hours as a measurement of labor supply in the aggregate economy.

Furthermore, to make the aggregate measure of labor supply consistent with the theoretical model, I use the employment rate as a proxy for the work-leisure choice by a single representative agent. This is because l takes on the value between zero and one, as does the employment rate.

Let e_t be the time-/age-varying employment rate, which is assumed to be equivalent to a fraction of the total labor endowment allocated to market work by a single representative household. Accordingly, the leisure variable for a single household in the aggregate economic context becomes the fraction of the population who are unemployed; thus, the aggregate version of leisure can be expressed by $l_t = 1 - e_t$. Hence, the dynamic change in leisure at the macro level can be written in the form:

$$\frac{1 - e_t}{1 - e_{t-1}} = \left(\frac{1 + r_t}{1 + \delta}\right)^{\gamma} \left(\frac{1 + \alpha^{\rho} w_t^{1-\rho}}{1 + \alpha^{\rho} w_{t-1}^{1-\rho}}\right)^{\frac{\rho-\gamma}{1-\rho}} \left(\frac{w_t}{w_{t-1}}\right)^{-\rho} \tag{12}$$

Taking the logarithm of (12), and using the first-order Taylor approximation for $\ln(1 - e_t)$ and $\ln(1 + \alpha^{\rho} w_t^{1-\rho})$, a linear labor supply function may be written:

$$\ln(e_t) = \ln(e_{t-1}) - \left(\frac{1 - \bar{e}}{\bar{e}}\right)\gamma \ln(1 + r_t) + \left(\frac{1 - \bar{e}}{\bar{e}}\right)\gamma\left(\frac{\rho + \alpha^{\rho}\gamma}{\gamma + \alpha^{\rho}\gamma}\right)\ln\left(\frac{w_t}{w_{t-1}}\right) + \tau \tag{13}$$

where, $\bar{e}$ is the parameter in the Taylor approximation for $\ln(1 - e_t)$, which can be interpreted as a constant value of labor supply in steady state. τ equals $(\frac{1-\bar{e}}{\bar{e}})\gamma \ln(1 + \delta)$, which will be captured by a time trend in the empirical estimation.

If the interest rate r and the wage rate w in (13) are adjusted for inflation, the model is similar to the L-R model. The only difference is that Lucas and Rapping deleted the interest rate, and therefore explicitly examined the effects of inflation on labor supply, whereas I implicitly assume that both the interest rate and the price will be governed by a single parameter, and thus have the same effect as non-labor income on the labor supply. For the model estimation, which will be discussed in more detail in the next section, r is deflated by the annual percentage change in the price index, and w is adjusted at a constant price level.

The advantage of estimating a labor supply function in the form of (13) is that it allows me to disentangle the inter-temporal and the intra-temporal responses to wage change. As was discussed earlier, such a distinction is important for a life-cycle labor supply analysis, as a wage change can be characterized by an anticipated move along the evolutionary wage path, and/or by an unanticipated wage shift. If we simply regressed the measured labor supply on wage rates, the estimated parameter would confound the two types of response. To make this point more explicitly, let β_1 represent $(\frac{1-\bar{e}}{\bar{e}})\gamma$ and β_2 equal $(\frac{1-\bar{e}}{\bar{e}})\gamma\left(\frac{\rho+\alpha^{\rho}\gamma}{\gamma+\alpha^{\rho}\gamma}\right)$, (13) can therefore be rewritten as:

$$\ln(e_t) = \ln(e_{t-1}) - \beta_1 \ln(1 + r_t) + \beta_2 \ln\left(\frac{w_t}{w_{t-1}}\right) + \tau \tag{14}$$

If we merely estimate the model with only the wage rate, and not with the interest rate, the single parameter β_2 captures both the inter-temporal and the intra-temporal responses, making the distinct effects indistinguishable. When both the interest and the wage rates are included as explanatory variables (as in the form of (14)), the two elasticities, β_1 and β_2, can be used to identify the relative magnitude of the two types of responses.

3.3 Aggregate demand for labor

To estimate the labor supply function, such as (14), it is also necessary to derive rational expectations regarding wages. This involves specifying a model for the firm sector to derive the labor demand function. Following Lucas and Rapping (1969), I assume that the firm sector is a single production sector relying on labor and capital and behaving competitively. The production function is assumed to be in the form of constant elasticity of substitution with constant returns to scale, which can be written as:

$$G_t = \left[aN_t^{-b} + (1-a)K_t^{-b}\right]^{-1/b} \tag{15}$$

where, G, N, K are real output, unit of labor, and capital inputs at time t. a measures the intensity of labor in production. $1/(1+b)$ is the elasticity of substitution, which reflects the percentage change in the capital-labor ratio as a response to the percentage change in the ratio of the wage rate to the interest rate.

Given that the firm sector seeks to maximize profit under competition, the wage rate is the marginal product of labor. Thus, the rate can be derived by differentiating the real output with respect to the number of labor inputs in (15),

$$w_t = \frac{\partial G_t}{\partial N_t} = a\left(\frac{G_t}{N_t}\right)^{1+b} \tag{16}$$

Following Lucas and Rapping (1969), by postulating the logarithm on (16), rearranging the terms, and assuming that the labor and the real output follow an order one autoregressive process, the marginal labor productivity condition may be written as:

$$\ln\left(\frac{N_t}{G_t}\right) = \pi_0 - \pi_1 \ln(w_t) + \pi_2 \ln\left(\frac{G_t}{G_{t-1}}\right) + \pi_3 \ln\left(\frac{N_{t-1}}{G_{t-1}}\right) \tag{17}$$

Rearranging the terms in (17), the aggregate demand for labor (N_t) can be expressed by the following function:

$$\ln(N_t) = \pi_0 - \pi_1 \ln(w_t) + \pi_2 \ln\left(\frac{G_t}{G_{t-1}}\right) + \pi_3 \ln\left(\frac{N_{t-1}}{G_{t-1}}\right) + \ln(G_t) \tag{18}$$

If we assume that the number of employed persons reflects the actual demand for labor, then $N_t = e_t \times P_t$, where, P_t is the total population. Hence, (18) can be re-written as:

$$\ln(e_t) = \pi_0 - \pi_1 \ln(w_t) + \pi_2 \ln\left(\frac{G_t}{G_{t-1}}\right) + \pi_3 \ln\left(\frac{N_{t-1}}{G_{t-1}}\right) + \ln\left(\frac{G_t}{P_t}\right) \tag{19}$$

3.4 Reduced form for real wage

If we assume that the labor market clears at each period and that the demand for the number of workers equals the supply of the number of workers, the reduced form of the equation for wages can be derived by equating (14) to (19), that is:

$$\begin{aligned} \ln(w_t) = {} & \phi_1 + \phi_2 \ln(e_{t-1}) - \phi_3 \ln(1 + r_t) + \phi_4 \ln(w_{t-1}) \\ & + \phi_5 \ln\left(\frac{G_t}{G_{t-1}}\right) + \phi_6 \ln\left(\frac{N_{t-1}}{G_{t-1}}\right) + \phi_7 \ln\left(\frac{G_t}{P_t}\right) + \tau + u_t \end{aligned} \tag{20}$$

3.5 Theoretical prediction of model parameters

The preceding theoretical discussion of real wages and the labor supply generates two main predictions. First, the sign of the intra-temporal elasticity of labor supply w.r.t. wages can be either positive or negative, depending on whether income or substitution effects dominate. Second, the sign of the inter-temporal elasticity of labor supply w.r.t. wages can only be positive, as this is the labor supply response to the evolutionary wage rate, which is known to the household; i.e. there are only substitution effects.

There is no theoretical prediction of the relative magnitude of inter-temporal and intra-temporal elasticities. Hence, a statistical inference for the two parameter estimates will be made. In order to quantify the relative magnitude of the inter-temporal and the intra-temporal responses, I assume that $\alpha = 1$, household's utility weight on leisure is equal to that of consumption.[4] Thus, the relative magnitude can be written as $\frac{\rho}{\gamma} = \frac{2\beta_2}{\beta_1} - 1$. Given this, the hypotheses are as follows:

Hypothesis 1: If $\frac{\beta_2}{\beta_1} > 1$, the substitution effect dominates within the period, and the intra-temporal elasticity outweighs the inter-temporal elasticity of the labor supply w.r.t. the wage increase; i.e. $\frac{\rho}{\gamma} > 1$.

Hypothesis 2: If $\frac{1}{2} < \frac{\beta_2}{\beta_1} < 1$, the substitution effect dominates within the period, but the intra-temporal elasticity is outweighed by the inter-temporal elasticity of the labor supply w.r.t. the wage increase; i.e. $0 < \frac{\rho}{\gamma} < 1$.

Hypothesis 3: If $0 < \frac{\beta_2}{\beta_1} < \frac{1}{2}$, the income effect dominates within the period, but the intra-temporal elasticity is outweighed by the inter-temporal elasticity of the labor supply w.r.t. the wage increase; i.e. $-1 < \frac{\rho}{\gamma} < 0$.

Hypothesis 4: If $\frac{\beta_2}{\beta_1} < 0$, the income effect dominates within the period, and the intra-temporal elasticity outweighs the inter-temporal elasticity of the labor supply w.r.t. the wage increase; i.e. $\frac{\rho}{\gamma} < -1$.

Hypothesis 5: If $\frac{\beta_2}{\beta_1} = 1; i.e. \beta_2 = \beta_1$, the intra-temporal elasticity equals the inter-temporal elasticity of the labor supply w.r.t. the wage increase; i.e, $\frac{\rho}{\gamma} = 1$.

3.6 Empirical evidence of model parameters

Table 1 summarizes the model estimates from Lucas and Rapping (1969) and Alogoskoufis (1987), both of which are based on the U.S. aggregate time series data. The first column shows the estimates for the reduced form for the wage equation corresponding to (20). The coefficients in the second to the fourth columns are for the labor supply functions similar to (14). Notably, the estimated impact of wages on labor supply is larger in Lucas and Rapping (1969) than in Alogoskoufis (1987). This partly due to the differences in the measurements of labor supply, as the former used aggregate total man hours, while the latter used employment rates.

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[4] The α parameter represents the utility weight the household attaches to leisure relative to consumption. If α is greater than one, the household prefers leisure to consumption, and therefore supplies less labor. Conversely, if α is smaller than one but greater than zero, the household prefers consumption to leisure, and therefore supplies more labor. Two special cases are when α equals zero and one. The former case refers to the fixed labor supply assumption, in which a household is expected to choose no leisure; thus, it reduces to a constant relative risk aversion utility function (CRRA). The latter case refers to the assumption of an equal utility weight on leisure and consumption; that is, the household is expected to be indifferent about whether it consumes a unit of goods or a unit of leisure, *ceteris paribus*. As can be seen in (7), if α equals one, the leisure-consumption choice is only influenced by the wage rates and governed by the parameter of intra-temporal elasticity.

Table 1:
Evidence from previous empirical studies

	Lucas and Rapping (1969)		Alogoskoufis (1987)	
Variables	**Reduced form** **ln (w_t)**	**Man-hours** **ln (h_t)**	**Employment rate** **ln (e_t)**	**Employment rate** **ln (e_t)**
$\ln(w_t)$	x	1.40	0.90	0.91
$\ln(w_{t-1})$	0.44	−1.39	−0.85	−0.91
$\ln(1 + r_t)$	x	x	0.34	0.35
$\ln(h_{t-1})$	−1.15	0.64	x	x
$\ln(e_{t-1})$	x	x	1.01	1.00
$\ln\left(\frac{G_t}{G_{t-1}}\right)$	−1.22	x	x	x
$\ln\left(\frac{N_{t-1}}{G_{t-1}}\right)$	1.24	x	x	x
$\ln\left(\frac{G_t}{P_t}\right)$	1.25	x	x	x
Parameter constraints	x	x	x	$\ln(w_t) = \ln(w_{t-1})$ $\ln(e_{t-1}) = 1$

It is noteworthy that the difference between the two models in Alogoskoufis (1987), which used the employment rate as a dependent variable, is that one of the models imposed two restrictions on the parameters: the coefficients on the current and the lagged wages were equal to each other, and the lagged employment rate was constrained to one. This restriction allowed the author to compare the relative magnitude of the inter- and intra-temporal elasticity of substitution. Based on their parameter estimates, the ratio $\frac{\rho}{\gamma}$ is 4.2, which suggests that the static elasticity of substitution between consumption and leisure is more than four times greater than the inter-temporal elasticity of substitution.

The two empirical studies reviewed here suggest that the short-run labor supply elasticity with respect to wages is positive, and is around unity. Lucas and Rapping (1969) obtained large estimates, 1.4; and further claimed that the Keynesian type assumption of elastic short-run labor supply is valid. Alogoskoufis (1987), on the other hand, showed that the intra-temporal elasticity of substitution outweighs the inter-temporal elasticity.

4 Data and methods

4.1 National transfer accounts Sweden 1985–2003

The age profile of labor income in the National Transfer Accounts (NTA) is a comprehensive measure of the age differentials in the market value of total labor supply, weighted by all of the members of a population in a particular age group (Lee and Ogawa 2011). By definition, NTA labor income includes employees' labor earnings, self-employed labor income, fringe benefits, and payroll tax contributed by employers. The NTA time series for Sweden includes repeated cross-sectional age profiles over the period 1985–2003. For each year, the relationship between the total and the age-specific labor income at the aggregate level can be expressed as:

$$Y_t = \sum_x Y_{x,t} = \sum_x w_{x,t} \times E_{x,t} \tag{21}$$

where, x and t denote age and time, respectively. Let Y be the aggregate annual labor income, E be the number of employed person in the economy, and w be de facto annual wage per employee.

Equation (21) implies that the NTA age-specific labor income is a product of the de facto annual wages for those who are employed and the number of employees in the same age group. That is:

$$Y_{x,t} = w_{x,t} \times E_{x,t} = w_{x,t} \times \frac{E_{x,t}}{P_{x,t}} \times P_{x,t} \tag{22}$$

where, $P_{x,t}$ is the age-specific population at time t.

It is evident from (22) that the aggregate age-specific labor income ($Y_{x,t}$) based on the NTA definition confounds the effects of the market wage rate ($w_{x,t}$), the employment rate ($\frac{E_{x,t}}{P_{x,t}}$), and the population size in each age group $P_{x,t}$. Dividing (22) by age-specific population on both sides yields per capita age-specific labor income as a function of the wage rate times the employment rate,

$$y_{x,t} = w_{x,t} \times \frac{E_{x,t}}{P_{x,t}} = w_{x,t} \times e_{x,t} \tag{23}$$

where, $e_{x,t}$ denotes the employment rate for each age group at time t.

From (23), it is obvious that the difference between the NTA labor income and the conventional wage rate is affected by the employment rate. They would be equivalent if, and only if, the condition of full employment is satisfied; that is, if the equilibrium wage rate is at the market clearing level of no voluntary and involuntary unemployment. In this regard, the NTA provides a framework which is consistent with general equilibrium theory by linking population structure and aggregate national income. But since the empirical data suggest that unemployment always exists, the NTA labor income should not be analyzed in isolation. To gain an understanding of the dynamic age profiles of labor income over time, it is necessary to look at the variation in these decomposed components; namely, wage and employment rates.

The NTA time series for Sweden provides information on per capita age-specific labor income for each year between 1985 and 2003; i.e. $y_{x,t}$ in (23). The wage rate per employed person, $w_{x,t}$, is then calculated by dividing $y_{x,t}$ by the employment rate, $e_{x,t}$ for each age and time. Unfortunately, the employment rates provided by Statistics Sweden are aggregated by the following age groups: 16–19, 20–24, 25–34, 35–44, 45–54, 55–59, and 60–64. Hence, the derived wage rates are computed in accordance with these age groups. All of the wage rates are adjusted to the price level in the year 1985. The price information was obtained from Statistics Sweden. Furthermore, I use a series of short-run annual yields as a proxy for asset return r in (14), which are extracted from the Annual Swedish stock prices and returns, and from the bond yields for 1856–2006 published by the Swedish Riksbank.

4.2 Age profiles over time

To examine the changing age distribution of work compensation and employment rates overtime, the data are fitted by the Lee–Carter method (Lee and Carter 1992). This approach allows me to capture the changing shape of the life-cycle wage rates and the labor supply, and to investigate the age-specific responses to the overall trends of the two variables.

There have been dramatic social and economic changes over the investigation period: the economic crisis of 1990–1993, the passage of new legislation on the pension system in 1994 which mandated a move toward a notional defined contribution model, and the implementation of the legislation in the early 2000s. To account for the impact of changing macroeconomic and institutional conditions, the time-varying age profiles are fitted for four sub-periods: 1985–89, 1990–93, 1994–99, and 2000–03.

4.3 Estimating labor supply function

4.3.1 Population composition index

The yearly variation in the number of employed persons, such as E in (22), may be influenced by changes in the labor force composition over time, such as the time-varying distributions of age, gender, and education, etc. If such compositional effects exist, the estimated elasticity of labor supply with respect to wage may be biased. Thus, following Lucas and Rapping (1969), the annual number of employed person E is deflated by the population compositional index M, which may be written as:

$$M_t = \frac{\sum_{i=1}^{n} \left(\frac{E_{0,i}}{P_{0,i}}\right) \times P_{t,i}}{E_0} \tag{24}$$

where, subscript t and i is time and each of the population subgroups,[5]. E and P are the number of employed person and the population. Subscript zero refers to the initial time period.

As Lucas and Rapping (1969) argued, this index generates a counterfactual variable which reflects the relative increase in the labor force which would have occurred solely due to the variation in the composition of the population, holding the group-specific employment rates constant. Therefore, deflating E by M will eliminate the impact of population compositional changes on the number of employed persons.

4.3.2 Aggregate time-series estimation

As was argued above, since E needs to be deflated by M, the employment and the wage rates must follow the same procedure. Thus, (14) may be rewritten as:

$$\ln (e_t/M_t) = \ln (e_{t-1}/M_{t-1}) - \beta_1 \ln(1 + r_t) + \beta_2 \ln\left(\frac{w_t/M_t}{w_{t-1}/M_{t-1}}\right) + \tau + \epsilon_t \tag{25}$$

Accordingly, the reduced form equation for wage becomes:

$$\begin{aligned}\ln(w_t) = \phi_1 + \phi_2 \ln (e_{t-1}/M_{t-1}) - \phi_3 \ln(1 + r_t) + \phi_4 \ln (w_{t-1}/M_{t-1}) \\ + \phi_5 \ln\left(\frac{G_t}{G_{t-1}}\right) + \phi_6 \ln\left(\frac{N_{t-1}}{G_{t-1}}\right) + \phi_7 \ln\left(\frac{G_t}{P_t M_t}\right) + \tau + u_t\end{aligned} \tag{26}$$

The price and the interest rates are assumed to be exogenous to the household in this model, while the labor supply and the wage rates are assumed to be endogenous. Two-stage least squares (2SLS) is applied to estimate the elasticity of the labor supply with respect to wages, β_2 in (25). Equation (26) is estimated at the first stage to form the household's expectations regarding wages. The instrumental variables in the reduced-form equation are $\ln\left(\frac{G_t}{G_{t-1}}\right)$, $\ln\left(\frac{N_{t-1}}{G_{t-1}}\right)$, and $\ln\left(\frac{G_t}{P_t M_t}\right)$. I use the annual gross domestic product (GDP), collected by Statistics Sweden, as a proxy for total output G. The series is deflated by a price index with the base year 1985.

It is important to note that the variables G, N, P, and M are assumed to be exogenous to wages. The theoretical model presented earlier assumes that wages are determined by the firm sector based on their total output G and the demand for labor N. However, it could be argued that population size P and population composition index M are endogenous to wages, as fertility, mortality, and migration might be influenced by income. Nevertheless, following Lucas and Rapping (1969), they are treated as predetermined factors based on the argument that current demographic patterns, particularly for fertility and mortality, are the result of past decisions which

[5] The subgroups are similar to Lucas and Rapping (1969). i's refer to 14 age-gender groups; that is, male and female groups for each of the age groups used by Statistics Sweden when reporting annual employment rates: 16–19, 20–24, 25–34, 35–44, 45–54, 55–59, and 60–64.

depend partly on past wages. Furthermore, it might take decades for the impact of wages on demographic outcomes to become noticeable. Therefore, P and M are regarded as exogenous to current wages.

The interpretation of the three instruments in (26) is straightforward. $\ln\left(\frac{G_t}{G_{t-1}}\right)$ is the annual growth rate of the economy. $\ln\left(\frac{N_{t-1}}{G_{t-1}}\right)$ reflects the units of labor input for each unit of output; i.e. the marginal productivity condition for labor. $\ln\left(\frac{G_t}{P_t M_t}\right)$ is the GDP per capita deflated by the population composition index, or the counterfactual per capita output in an economy which is not driven by changes in the population composition.

Equation (25) is identical to the model estimated by Alogoskoufis (1987), presented in the last column in Table 1. This is a restricted model with two coefficient constraints which allow us to test hypotheses 1–5. A more general labor supply function, the unrestricted model in the form of (27), is also estimated and reported in the following section. This model is similar to the two models by Alogoskoufis (1987) presented in columns 2 and 3 in Table 1.

$$\begin{aligned} \ln(e_t/M_t) = \theta_0 + \theta_1 \ln(e_{t-1}/M_{t-1}) - \theta_2 \ln(1+r_t) \\ + \theta_3 \ln(w_t/M_t) - \theta_4 \ln(w_{t-1}/M_{t-1}) + \tau + \epsilon_t \end{aligned} \tag{27}$$

It is important to stress that the estimation using (25), (27), and (26) corresponds to a single representative household. In the estimation, the wage and the employment rates are aggregated over all age groups. Thus, the estimated elasticity is consistent with the aforementioned theoretical model, and is comparable with the previous empirical evidence summarized in Table 1. For the age-specific analysis, model modifications are illustrated in the next section.

4.3.3 Age-specific time-series estimation

Before we can estimate the age-specific labor supply function, certain adjustments need to be made to make the model and the data compatible.

The NTA time series data are in the form of repeated cross-sections of age-specific labor income over time. Ideally, to ensure that the data reflect relatively realistic life-cycle dynamics, it would be beneficial to estimate the data using either an age-specific cohort perspective or a cohort-specific period perspective. However, given the aggregation of the employment rates into multi-year age groups and the limited time span of the data, such an analysis is not feasible. Presently, the only option is to pursue the analysis in an age-specific period setting. Although this strategy is inferior to conducting a synthetic cohort analysis, it is certainly preferable to conducting an aggregate time series analysis. As the estimated elasticities are distinguishable by age groups, this approach will provide us with greater insights into how the elasticity of the labor supply with respect to wages may differ at various stages of the life-cycle.

Given the age-specific period setting, equations (25),(26) , and (27) are modified in the following way. Let x be age and t be calendar time, the estimation equation for age-specific labor supply be based on (25) is,

$$\ln(e_{x,t}/M_t) = \ln(e_{x,t-1}/M_{t-1}) - \beta_{x,1}\ln(1 + r_t) + \beta_{x,2}\ln\left(\frac{w_{x,t}/M_t}{w_{x,t-1}/M_{t-1}}\right) + \tau_x + \epsilon_{x,t} \quad (28)$$

And the reduced-form equation for age-specific wages corresponding to (26) is,

$$\ln(w_{x,t}) = \phi_{x,1} + \phi_{x,2}\ln(e_{x,t-1}/M_{t-1}) - \phi_{x,3}\ln(1 + r_t) + \phi_{x,4}\ln(w_{x,t-1}) + \phi_{x,5}\ln\left(\frac{G_t}{G_{t-1}}\right) + \phi_{x,6}\ln\left(\frac{N_{t-1}}{G_{t-1}}\right) + \phi_{x,7}\ln\left(\frac{G_t}{P_t M_t}\right) + \tau_x + u_{x,t} \quad (29)$$

For the unrestricted model, (27), the corresponding age-specific equation may be written as,

$$\ln(e_{x,t}/M_t) = \theta_{x,0} + \theta_{x,1}\ln(e_{x,t-1}/M_{t-1}) - \theta_{x,2}\ln(1 + r_t) + \theta_{x,3}\ln(w_{x,t}/M_t) - \theta_{x,4}\ln(w_{x,t-1}/M_{t-1}) + \tau_x + \epsilon_{x,t} \quad (30)$$

The main difference between the aggregate and the age-specific time series equations is that the two endogenous variables, employment rates and wages, are disaggregated into age groups. It must be noted that the elasticity estimated by such a specification does not reflect the actual life-cycle behavior, as the age-specific variables vary only over time, not by age. To interpret the parameter as an intertemporal elasticity of substitution, it is necessary to assume that a change in the age-specific variable over time (between x, t and $x, t + 1$) approximately equals a change across the age-period (between x, t and $x + 1, t + 1$).

All of the variables assumed to be exogenous (M, r, G, N, P) are measured at the aggregate level. This assumes that the households at the different ages are exposed to identical macroeconomic conditions at each time period, but are affected differently.

Parameters in the reduced-form equation (29) shall be interpreted as the age-specific effect of aggregate economic changes on wages. In turn, this forms the wage expectation for each age group, and relates it to the age-specific employment rates. The age-specific elasticity estimates are not equivalent to the theoretical model presented earlier; nor are they directly comparable with the estimates in Table 1. Nonetheless, decomposed elasticities by age are useful for addressing the question of whether the labor supply response to wages differs over the life-cycle. More importantly, is it necessary to calibrate an array of life-cycle or age-specific elasticities in the OLG model?

As was mentioned above, an age-specific period setting might not be ideal for studying life-cycle behavior, as year-to-year variation may only approximate behavioral modification over the life-cycle. Since the data are treated as if they were in the age-specific period rather than in the cohort-specific period setting, the parameters ($\beta_{x,2}$ and $\theta_{x,3}$ in (28) and (30), respectively) shall be interpreted as a vector of 'quasi' life-cycle labor supply elasticities.

Figure 1:
Fitted age profiles of per capita real wage (log scale) by sub-periods using the Lee–Carter method

5 Results and discussion

5.1 Some descriptive results

Figures 1 and 2 illustrate the predicted average age profiles of real wage and employment rates by sub-periods, respectively, using the Lee–Carter method. In general, the wage rate is consistently higher for older workers than for younger workers, which is in line with the predictions of the theories reviewed in the previous section. However, the pattern appears to be shifting toward older ages over time.

Until 1999, the age-earning profiles are characterized by a steep increase from the labor market entry age, peaking at ages 45–54, and gradually declining thereafter. This pattern is in line with Skirbekk's summary of the OECD data, which indicates

Figure 2:
Fitted age profiles of labor force participation rate (log scale) by sub-periods using the Lee–Carter method

that workers' wages peak at ages 45–54 in 17 out of the 19 OECD countries (Skirbekk 2003).[6]

However, in the 2000–2003 period this pattern changed. As the light gray line in Figure 1 illustrates, during this period wages peaked at ages 55–59, and earnings remained high through age 64. These results are somewhat similar to the findings

6 These countries are Australia, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Mexico, the Netherlands, New Zealand, Norway, Portugal, Sweden, Switzerland, and the U.S.

Figure 3:
Comparison of fitted age-specific responsiveness in real wages and labor force participation 1985–2003

of Lee et al. (2011) for the U.S., which show that earnings among men have been increasing steadily with age. According to Lee et al. (2011), one of the explanations for this shift could be that younger workers no longer possess an educational advantage over older workers.

This shift may also be explained using the efficiency wage hypothesis or the shirking model. Alternatively, it may be attributed to factors such as the wage-productivity discrepancy, the nature of the optimal wage profile, the value placed on work experience, and the trade union preference given to older workers. All of these factors may contribute to the trend toward higher compensation levels for senior workers and lower wages for junior workers.

If we look at Figures 1 and 2 simultaneously, we can see that over the life-cycle both wages and employment appear to be hump-shaped. This is in line with the ISH prediction that wage and labor supply should be positively correlated; however, the rate of change for the two life-cycle series vary at different ages. From age 16 to age 34, the employment rate grows at more or less the same pace as wages. But the employment curve flattens out between age 35 and 54, while the wage curve trends continuously upward.

The most striking feature is the divergence of employment and wages after age 54. The decline in employment is too steep to be explained by decreasing wages. This divergence seems to be amplified over time, particularly for the most recent period (2000–03), in which employment drops considerably while wage rates flatten out between age 54 and 64. Taken together, this evidence implies that the ISH might not be able to fully explain the labor supply over the entire life-cycle, as it falls short in explaining the sharp decline in employment after age 54.

Figure 3 shows the relative age-specific contribution to the overall change in wages and employment over the period 1985–2003. If we look at the youngest and the oldest workers in this figure, it is evident that the wage and the labor supply responses are negatively associated. For workers aged 16–19, wage growth is nearly zero with respect to one unit of change in aggregate wage rate, whereas employment changed by more than 40 per cent for each unit of change in the aggregate employment rate. At the other extreme, workers aged 60–64 gained more than 20 per cent for each unit of increase in their overall wages, which is more than twice as high as their employment response.

5.2 Estimated elasticities of the labor supply w.r.t. real wages

5.2.1 Aggregate estimates

The estimates reported in Table 2 are comparable to those summarized in Table 1, as they are all obtained based on aggregate time series data and are equivalent to the labor supply of a single representative household.

The reduced form estimates presented in the first column in Table 2 have the same signs as those estimated by Lucas and Rapping (1969) (see Table 1, first column). The magnitude of the coefficients are, however, much larger than those reported by Lucas and Rapping (1969). I further applied the Sargan-Hansen test (See Overid sargan in Table 2) to verify the validity of the instruments. For all three instruments, I did not reject the null hypothesis that these instruments are valid, uncorrelated with the error term, and correctly excluded them from the labor supply estimation equation.

The second and third columns of Table 2 report the parameter estimates of the labor supply function (25) and (27), respectively. The estimated elasticity of the labor supply is 0.76, which is not far from the elasticity reported by Alogoskoufis (1987) (See the last column of Table 1). The unrestricted elasticity (0.92) is the same as it is in the third column of Table 1. Both my estimates of labor supply elasticity and the estimates from Alogoskoufis (1987) are less than unity; however, the estimates reported in Lucas and Rapping (1969) are much larger. This might be partly due to the differences in the measurement of labor supply; i.e. by man hours or by the employment rate.

Table 2:
Estimation of Aggregate time series data, reduced form (26), labor supply (25) and (27)

Variables	(26) $\ln(w_t)$	(25) $\ln(e_t/M_t)$	(27) $\ln(e_t/M_t)$
$\ln(w_t/M_t)$		0.759**	0.916
		(0.299)	(0.645)
$\ln(w_{t-1}/M_{t-1})$	0.669*	−0.759**	−0.424
	(0.362)	(0.299)	(0.695)
$\ln(1 + r_t)$	0.069	−0.555***	−0.155
	(0.281)	(0.115)	(0.290)
$\ln(e_{t-1}/M_{t-1})$	−2.076	1	0.935***
	(1.580)		(0.240)
$\ln(G_t/G_{t-1})$	−1.813		
	(1.639)		
$\ln(N_{t-1}/G_{t-1})$	1.756		
	(1.730)		
$\ln(G_t/P_tM_t)$	2.064		
	(1.668)		
τ	0.000	−0.001	−0.012**
	(0.009)	(0.001)	(0.005)
Constant	−0.102	1.550	21.052**
	(16.289)	(1.401)	(9.766)
Observations	18	18	18
R-squared	0.987		0.937
F-test (p-value)		0.525	
ρ/γ		1.732	
Overid sargan (p-value)			0.244

Note: Standard errors in parentheses
***p<0.01, **p<0.05, *p<0.1
Overid: Sargan over-identification test.
F-test: equality test for hypothesis 5: H_0: $\beta_1 = \beta_2$ ($\rho = \gamma$)
ρ/γ: the relative magnitude of intra- to inter-temporal elasticity.

The time trend, τ, captures factors which might shift over time. These factors are the steady state labor supply in the Taylor approximation $\frac{1-\bar{e}}{\bar{e}}$, the inter-temporal elasticity of substitution γ, and the rate of time preference $\ln(1 + \delta)$. Since γ and $\ln(1 + \delta)$ are theoretically positive, the estimated negative time trend in both the restricted and the unrestricted models (See τ in the second and third column of Table 2) implies that the constant in the Taylor approximation or the steady-state labor supply follows a downward trend over time. Such a downward trend is in line with the pattern shown in Figure 2: i.e. a decrease in employment rates at all ages from the early 1990s to the 2000s.

In terms of the relative magnitude of intra- and inter-temporal elasticity, the estimated $\frac{\rho}{\gamma}$ in Table 2 suggests that the intra-temporal outweighs the inter-temporal elasticity of substitution, a finding which is similar to Alogoskoufis (1987). According to his coefficient estimates in the restricted model, column 3 in Table 1, the $\frac{\rho}{\gamma}$ is 4.2. The estimate of this ratio in the present study is lower, or 1.7, which suggests that the static elasticity of substitution between consumption and leisure is 70 per cent greater than the inter-temporal elasticity of substitution; however, this inequality does not hold statistically. The F-test in Table 2 does not reject the equality test between ρ and γ, which implies that the intra-temporal and the inter-temporal elasticity of substitution are statistically the same, and confirms the validity of hypothesis 5.

5.2.2 Age-specific estimates

The parameters by age-specific estimation vary across age groups in both the reduced form wage equation and the labor supply function. Table 3 reports the coefficients for the age-specific estimation reduced from the equation. The most striking feature is the disproportionate impact of macroeconomic conditions on wages across the different age groups. The annual rates of economic growth, the marginal productivity conditions for labor, and the population composition adjusted for GDP per capita all had much larger effects on wages for those under age 34 than for their older counterparts (see $\ln(G_t/G_{t-1})$, $\ln(N_{t-1}/G_{t-1})$,and $\ln(G_t/P_tM_t)$ in the first three column of Table 3).

It is also important to note that the age-specific time trends (τ_x in Table 3) for the period 1985–2003 show that wages followed a downward trend for workers under the age of 34, and an upward trend for workers aged 45+. This result is in line with the findings by Lee et al. (2011) for the U.S., which indicate that the earnings of older men have been rising more quickly than the earnings of younger men. It is important to stress that the wage rates are deflated by the population composition index; thus, the wage effects of macroeconomic variation and the long-term trend do not confound any impact from the age-gender distributional change in the population.

Table 4 reports the coefficient estimates of the unrestricted labor supply function corresponding to equation (30). From the first row in Table 4, we can see that the short-run labor supply elasticity with respect to real wages differs considerably across age groups. Individuals aged 16–24 appear to have had a relatively elastic supply schedule compared to older workers. Following the interpretation of this elasticity by Lucas and Rapping (1969), the Keynesian assumption of a relatively elastic short-run supply schedule is only confirmed for the workers aged 34 or younger.

The age groups 35–44 and 55–59 are the only groups whose labor supply elasticities (around 0.9) are close to the aggregate estimate in the third column of Table 2. This implies that the aggregate time series estimation does not capture

Table 3:
Estimation of age-specific time-series data, reduced form Eq. (29)

Variables	16–19	20–24	25–34	35–44 $\ln(w_{x,t})$	45–54	55–59	60–64
$\ln(w_{x,t-1}/M_{t-1})$	−0.001	0.660**	0.211	0.559	0.349	0.521	0.804*
	(0.365)	(0.210)	(0.283)	(0.363)	(0.338)	(0.352)	(0.391)
$\ln(1 + r_t)$	−0.497	0.244	0.425	−0.106	0.096	−0.003	0.306
	(1.719)	(0.443)	(0.258)	(0.340)	(0.304)	(0.326)	(0.606)
$\ln(e_{x,t-1}/M_{t-1})$	3.197	0.424	2.647**	−1.236	0.874	−0.660	−0.329
	(1.988)	(0.594)	(1.037)	(0.950)	(1.786)	(0.791)	(0.577)
$\ln(G_t/G_{t-1})$	12.604	1.237	2.825**	−0.563	0.472	−0.090	0.281
	(9.421)	(1.588)	(0.948)	(0.795)	(0.787)	(0.594)	(0.860)
$\ln(N_{t-1}/G_{t-1})$	−11.428	−1.723	−3.899**	0.695	−0.807	0.054	0.221
	(7.934)	(1.648)	(1.257)	(0.972)	(0.786)	(1.057)	(1.644)
$\ln(G_t/P_tM_t)$	−11.090	−0.744	−2.884**	0.890	−0.373	0.403	0.172
	(8.550)	(1.586)	(1.097)	(0.800)	(0.815)	(0.700)	(1.181)
τ_x	−0.010	−0.016	−0.007	−0.000	0.003	0.004	0.006
	(0.064)	(0.015)	(0.009)	(0.010)	(0.011)	(0.011)	(0.027)
Constant	23.835	27.437	11.870	1.821	−5.250	−6.563	−11.246
	(109.523)	(27.143)	(15.065)	(17.637)	(19.229)	(19.539)	(47.655)
Observations	18	18	18	18	18	18	18
R-squared	0.825	0.944	0.990	0.975	0.969	0.988	0.970

Note: Standard errors in parentheses
***p<0.01, **p<0.05, *p<0.1

the age differences in labor supply elasticity. Multi-generational models, such as the OLG, might need an array of age-specific parameters to reflect the behavioral differences across different stages of the life-cycle.

The estimates for the restricted labor supply model, equation (28), are reported in Table 5. As was discussed above, the parameter constraints allow us to examine the relative magnitude of intra- and inter-temporal elasticity by the ratio ρ/γ. This ratio also varies with age, as shown in the last row of Table 5. The aggregate time series estimate of this ratio is 1.7 (see ρ/γ in Table 2). However, this estimate is confirmed only for the age groups 20–24, 25–34, 35–44, and 55–59, as their estimates are all greater than one. This suggests that the static elasticity of substitution between consumption and leisure outweighs the inter-temporal elasticity of substitution, in line with hypothesis 1. However, consistent with hypothesis 5, the equality test of ρ and γ (see F-test in Table 5) suggests that the intra- and the inter-temporal elasticity are statistically equal to each other, except among the oldest age group.

The ρ/γ ratio for workers aged 60–64 is -1.5, which implies that the static elasticity outweighs the inter-temporal elasticity, and that it is further dominated by the income effects. This provides some supporting evidence for the backward-bending labor supply curve discussed previously; however, this estimate needs to be interpreted with caution because this age group is the most likely to be transitioning

Table 4:
Estimation of age-specific time-series data, unrestricted Eq. (30)

	16–19	20–24	25–34	35–44	45–54	55–59	60–64
Variables				$\ln(e_{x,t}/M_t)$			
$\ln(w_{x,t}/M_t)$	1.169**	1.539***	0.390*	0.934	0.422**	0.978	0.710
	(0.529)	(0.423)	(0.201)	(0.628)	(0.213)	(0.670)	(1.688)
$\ln(w_{x,t-1}/M_{t-1})$	−0.390	−1.047**	−0.030	−0.583	−0.092	−0.475	−0.321
	(0.266)	(0.475)	(0.259)	(0.611)	(0.132)	(0.621)	(1.509)
$\ln(1+r_t)$	−0.288	−0.486	−0.132	0.067	−0.085	0.092	−0.664
	(1.747)	(0.619)	(0.205)	(0.263)	(0.151)	(0.288)	(0.858)
$\ln(e_{x,t-1}/M_{t-1})$	0.109	0.731***	0.639***	1.201***	0.818***	1.209***	1.267*
	(0.448)	(0.188)	(0.158)	(0.350)	(0.171)	(0.329)	(0.651)
τ_x	−0.037*	−0.015**	−0.013***	−0.004	−0.007**	−0.011**	−0.008
	(0.019)	(0.008)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)
Constant	68.748*	26.993**	22.536***	6.240	11.587*	19.242**	12.878
	(35.782)	(13.580)	(7.016)	(8.527)	(5.942)	(9.507)	(9.591)
Observations	18	18	18	18	18	18	18
R-squared	0.821	0.921	0.966	0.925	0.937	0.870	0.814
Overid sargan	4.560	0.677	8.369	0.862	3.334	0.919	1.237
Overid sargan p-value	0.102	0.713	0.0152	0.650	0.189	0.632	0.539

Note: Standard errors in parentheses
***p<0.01, **p<0.05, *p<0.1
Overid: Sargan over-identification test.

to retirement. Unfortunately, the data do not allow us to incorporate the economic incentives for retirement in the estimation; thus, it is very likely that the wage effect on the labor supply is overestimated, and that the income effects would diminish if pensions and/or other non-labor-related social benefits for the elderly were controlled for.

6 Conclusion

To assess the economic consequences of population aging and to evaluate the possible solutions to the problems which are expected to arise in conjunction with this trend, a thorough consideration of labor supply behavior is necessary. Hence, this paper examines the macro behavior of real wages and the labor supply in the Swedish labor market over the period 1985–2003. The descriptive analysis shows that the labor supply, as measured by the employment rate, is not strongly correlated with wages over the later working life, as the decline in the labor supply is too steep to be explained by wage change over old ages. Moreover, the age-wage profiles reveal a pronounced shift toward old age over time, whereas the age-employment profiles do not. These patterns cast doubt on the explanatory power of the ISH, at least for the later part of the life-cycle.

Table 5:
Estimation of age-specific time series data, restricted Eq. (28)

Variables	16–19	20–24	25–34	35–44 $\ln(e_{x,t}/M_t)$	45–54	55–59	60–64
$\ln(w_{x,t}/M_t)$	0.381	1.470***	0.593**	0.331	0.099	0.236	−0.230
	(0.253)	(0.350)	(0.231)	(0.192)	(0.088)	(0.236)	(0.332)
$\ln(w_{x,t-1}/M_{t-1})$	−0.381	−1.470***	−0.593**	−0.331	−0.099	−0.236	0.230
	(0.253)	(0.350)	(0.231)	(0.192)	(0.088)	(0.236)	(0.332)
$\ln(1+r_t)$	−0.782	−0.870***	−0.479***	−0.272**	−0.150*	−0.227**	−0.929***
	(1.263)	(0.239)	(0.091)	(0.100)	(0.072)	(0.088)	(0.128)
$\ln(e_{x,t-1}/M_{t-1})$	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
τ_x	−0.001	−0.003*	−0.001	−0.000	0.000	0.000	0.001
	(0.004)	(0.002)	(0.001)	(0.001)	(0.000)	(0.001)	(0.002)
Constant	1.103	6.496*	1.497	0.937	−0.763	−0.639	−2.169
	(8.498)	(3.082)	(1.411)	(1.294)	(0.805)	(1.532)	(2.997)
Observations	18	18	18	18	18	18	18
F-test (p-value)	0.777	0.247	0.677	0.792	0.693	0.973	0.00457
ρ/γ	−0.0253	2.377	1.474	1.438	0.318	1.083	−1.496

Note: Standard errors in parentheses
***p<0.01, **p<0.05, *p<0.1
F-test: equality test for hypothesis 5: H_0: $\beta_1 = \beta_2$ $(\rho = \gamma)$
ρ/γ: the relative magnitude of intra- to inter-temporal elasticity.

Combining the time-varying NTA age profiles with other macroeconomic variables allowed me to estimate the age-specific labor supply function, which is theoretically consistent with the overlapping generation framework. Unlike traditional macroeconomic analyses which rely on National Accounts to estimate a single elasticity for all demographic groups, the NTA data structure enabled me to estimate an array of quasi life-cycle parameters. This can serve as a new basis for calibrating the overlapping generation models with age-specific elasticities. Some key findings in my econometric analysis are summarized as follows.

(1) In the aggregate model, the estimated elasticity of the labor supply with respect to real wages is very close to that of Alogoskoufis (1987) and of Lucas and Rapping (1969). The economic magnitude of the inter-temporal elasticity of substitution is smaller than the economic magnitude of the intra-temporal elasticity of substitution, but there appears to be no statistical difference.

(2) The age-specific estimates show considerable variation in the short-run labor elasticity with respect to wages, as well as in the relative magnitude of inter- and intra-temporal elasticities across age groups. This implies that the elasticities estimated in traditional macroeconomic studies, e.g. Alogoskoufis (1987) and Lucas and Rapping (1969), can only reflect the labor supply behavior in a single representative household framework, but not in a multi-generation setting, such as the OLG.

(3) The variation in age-specific estimates further suggests that an array of 'quasi' life-cycle parameters are needed in order to calibrate the OLG models for the multi-generational economy.

(4) The parameter equality test shows that the inter- and the intra-temporal elasticities are of about the same magnitude for most age groups. This suggests that the two elasticities are equally important in governing labor supply decisions over a large span of the working life, at least prior to age 60.

I would like to conclude this paper by mentioning some limitations of this study and some potential extensions of the current analysis for future research. The patterns found for real wages and the labor supply, and for the relationship between the two, are in an age-specific period setting; therefore, they may be more literally interpreted as the working behavior in a quasi life-cycle framework. To better reflect the real life-cycle behavior, synthetic cohort studies are certainly preferable. This approach is, however, not readily implementable given the current state of the NTA time series for Sweden. Thus, an expansion of the data over a longer time horizon is desirable, and should be considered one of the core tasks in the future development of the NTA project.

This study stresses the wage impact on labor supply, but it ignores the value of outside options, such as schooling and retirement, which might be particularly important for younger and older workers. Therefore, one possible extension of the analysis in future research would be to investigate the rate of return to schooling and the economic incentives for retirement, and their potential impact on labor supply decisions.

The estimated elasticities in this study are very likely to be different from the findings of longitudinal studies using micro data. It is important to stress that the choice of the level of the analysis as well as of the type of data depend on the research question and the aim of the study. To examine detailed heterogeneity among individuals, micro-level analysis would certainly be preferred. Nonetheless, to apply the individual elasticities to macro models, such as the OLG-CGE, it is necessary to ensure the equivalence of the parameters in the two environments implied by the aggregation theory (Browning et al. 1999; Prescott and Wallenius 2011). For one of the purposes of this paper, providing some additional insights on the calibration of OLG models, my estimates are appropriate, as they correspond to the average of each representative generation.

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Working after age 50 in Spain. Is the trend towards early retirement reversing?

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Abstract

As the baby boom cohort approaches retirement, there has been considerable uncertainty about the economic sustainability of the social security systems in most of the developed world. In recent decades, Spain has had both one of the oldest populations and the lowest levels of employment among the population aged 50 and over in Europe. This article addresses these issues by investigating the relationship between ageing and labour participation in the adult population. We examine the changes in employment exit patterns among men and women between 1999 and 2012, and the factors which influence early retirement, using the Spanish Labour Force Survey (panel dataset). We found clear gender effects in retirement behaviour in terms of the shares of the population who were not working and the predictors of early retirement. The partner is shown to be more relevant in the retirement timing decisions of men, while dependents are found to be more relevant in the decisions of women. Moreover, the likelihood of exiting the labour market early appears to be decreasing among women, and increasing among men.

1 Introduction

Since the end of the 20th century, scholars and policy-makers in general have been increasingly concerned about the demographic, social, and economic consequences of population ageing (Dixon 2003; Christensen et al. 2009; Bloom et al. 2011). In discussions of this issue, much attention has been focused on the relationship between demographic ageing and the labour market. The declining workforce is driven by two factors: on the one hand, the working-age population is decreasing

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due to sustained low levels of fertility (Barwell 2001; Aaronson et al. 2006); while on the other, the retired population is increasing, especially with the baby boom cohorts approaching retirement ages (Díez 1999, Auer and Fortuny 2000, Díaz and Llorente 2005). This phenomenon of a decline in the size of the population of active ages has led some observers to express considerable uncertainty about the economic sustainability of the European welfare system, and particularly of Europe's pension systems.

Several studies have focused on the transition from working to non-working status at older adult ages. Job characteristics, labour market structures, and the institutional background play significant roles in the transition from employment to permanent retirement (Burtless and Moffitt 1984; Antolín and Scarpetta 1998; Cano et al. 2000; Flippen and Tienda 2000). Furthermore, a range of demographic characteristics—such as gender, age, educational attainment, and family responsibilities—have considerable influence on the timing of retirement (Auer and Fortuny 2000; Garrido 2004; Ortiz 2004; Flores 2008; Dittrich et al. 2011).

The Spanish population structure is among the oldest in Europe (Puyol 2005). Moreover, as in most other European countries, in Spain the ages at which adults leave the labour market have been falling (Quinn 1999; Gendell 2001; Garrido and Chuliá 2005; Christensen et al. 2009).

This paper examines the patterns of employment of the adult population in Spain, paying special attention to the permanent early exits of older adults and the interrelationship between an individual's early retirement and his or her family arrangements. Among adults approaching the state pension age (SPA),[1] we seek to characterise the nature of labour market exits which result in permanent inactivity, evaluating the effects of socio-demographic determinants on withdrawal from employment. Specifically, this paper will:

1. *Describe the employment patterns of individuals near the SPA in Spain, before and after the economic crisis in 2008.*
2. *Examine the socio-demographic determinants which influence the transition to permanent labour inactivity among older adults in Spain.*

The focus of the paper is on early exits from the labour market among the adult population; i.e. entry into retirement by individuals who have not yet reached the SPA (age 65), when they can claim 100% of work-related pension benefits. Before this age, access to various benefit regimes is based on contextual conditions, individual characteristics, and the terms of pension schemes. These regimes will be described in greater detail in the following section.

[1] The state pension age (SPA) was 65 for both sexes in Spain until 2013, when it started to gradually increase. The SPA will reach 67 in 2030. The SPA is the age at which an individual can apply for 100% of a retirement pension, based on the number of years worked and the contributions made to the pension system.

We will study exits from employment among adults between the ages of 50 and 64, or under the SPA (the point at which the majority of workers enter retirement). We have chosen to focus on this age range in our study because previous research has shown that labour market participation rates of males start to decline around age 50 (Gómez-León 2013). Moreover, this decline appears to be driven by the difficulties individuals face in re-entering employment at this stage of their life (Chan and Stevens 2001; Hofäcker 2006), and the incentives they are offered by companies or by private or public schemes to remain outside of the workforce (Shultz et al. 1998; Oswald 1999; Dittrich et al. 2011).

The transition to inactivity among the adult population can be analysed from a variety of perspectives and with a multiplicity of determinant factors. Using a demographic approach, we will investigate in this paper the changes in the ages at which workers exit employment and the socio-demographic factors which influence early retirement among the adult population, including differences in sex, educational attainment, and household composition. Specifically, we will analyse the evolution of employment and early exits among the adult population in Spain, highlighting the effects of family and economic contexts during the period of study (1999–2012) and the gender differences in the Spanish labour market.

2 Contextual and individual background

In recent years, European governments have expressed concerns about the decline in the size of the working population, whose contributions are needed to sustain the dependent population; i.e. those who are not in employment. Recent policy debates have therefore focused on ways to encourage people to spend more time in employment, and in particular to delay their permanent exit from the labour market. Regulations which limit early retirement and which extend the retirement age beyond the SPA have been introduced in most European countries (European Union 2012). Yet despite these efforts, in recent decades the employment rates of 55–64-year-olds have declined considerably in most European countries, and the mean actual retirement age has fallen in most OECD countries (Auer and Fortuny 2000; López 2004; Antón et al. 2007; Bloom et al. 2011). In the case of Spain, where the SPA was set at 65 until 2013, the mean age of exit has consistently been below this level for the last three decades, with a mean age of exit of around 62 in 2012.

Withdrawal from the labour market is basically determined by three interrelated dimensions: the institutional or legal context (macro level), the structural or economic context (meso level), and individual characteristics (micro level).

The first dimension is the institutional or legal context, which is determined primarily by the policy and legal framework. This context limits and conditions the duration of an individual's years in employment by regulating the age of entrance into the labour market and the age of exit or retirement. The retirement age is typically set through regulated sources of income, such as social pensions or other economic benefits (Casey and Wood 1994; García 2003). Individuals who have worked for a period of time generally have access to a retirement pension after fulfilling certain requirements. If individuals are leaving the labour market temporarily or have not yet met the requirements for retirement, they can apply for other types of benefits, including unemployment benefits; this is a widely used pathway to an early labour market exit among older adults, as discussed below.

The decline in the mean age of retirement is attributable in large part to the introduction in the 1970s and 1980s of specific schemes and regulations which facilitated early retirement. The explicit goal of these schemes, which were promoted by governments and companies, was to reduce the size of the labour force (Shultz et al. 1998; García 2003). However, in countries such as Finland and the UK, policies with the opposite aim have been promoted since the end of the 1990s, with positive but limited results (Nickell 2003; López 2004; Díaz and Llorente 2005; Garrido and Chuliá 2005).

The universal Spanish social security system dates from 1963 (Erdogan-Ciftci et al. 2008), when a unitary model of social protection encompassing both private and sector-based schemes was implemented. In addition to providing retirement and unemployment benefits, this social protection system provides other forms of support, including benefits for widows and for individuals with work-related disabilities.[2] The pension system is financed through a pay-as-you-go model. A range of schemes was created within this system to allow for early retirement. For example, individuals may apply from the age of 50 onwards to receive various kinds of social benefits which can later be linked to early retirement benefits (see Table 1).

The second dimension corresponds to the structural or economic context, and thus refers to the labour market conditions which can affect workforce supply and demand. For example, lower employment rates may be caused by an economic recession or by changes in the economic system. Several studies have found that labour inactivity among elderly adults tends to be especially high in countries in which early retirement programmes have been heavily promoted (Blöndal and Scarpetta 1998; Gruber and Wise 1999). In many cases, these programmes had been introduced as a response to an economic recession, but went on to become permanent mechanisms of labour force regulation.

By the end of the 20th and the beginning of the 21st centuries, the Spanish economy was growing steadily. This process of expansion was based on a large-scale restructuring of industry and the economy during the 1980s, and on Spain's integration into the European Union. Largely as a result of participation in early retirement schemes, the Spanish labour force supply was reduced in almost all of the productive sectors during this period, and especially in the industrial and agricultural sectors. At that time, agriculture was the most important sector of the

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2 Detailed information on the benefits and the pension system in Spain can be found in: Cano et al. (2000). 'El mercado de trabajo y su medición en España.' Estadística Española **Vol. 42** (Núm. 146), Zubiri (2003). El futuro del sistema de pensiones en España. Madrid, Instituto de Estudios Fiscales.

Table 1:
Features of pathways to early exit from employment in Spain

Age	Access to (early) exits schemes or social benefits	Years in employment required (min–max)
50	Social benefits (i.e. unemployment up to 2 years)	
52	Early retirement for workers in specific dangerous occupations	15
52–56	Early retirement for disabled workers	15
60	Early retirement schemes for particular workers	15–30
60 61 (2013)	Compulsory early retirement	30 33 (2013)
61 63 (2013)	Partial retirement (voluntary)	30 33 (2013)
65 65–67 (2013)	Full retirement	10–25 15–35 (1980) 15–38,5 (2013)
65 65–67 (2013)	Part work/Part retirement	
After 65–67 (2013)	Delayed retirement	

Source: *Ministerio de Empleo y Seguridad Social* (http://www.empleo.gob.es) and *Sindicato de Comisiones Obreras* (http://www.ccoo.es).

Spanish economy (Díez 1999). Although male labour participation continued to decline, with exits occurring as early as at age 50, employment rates among the 50–54 age group generally rose during the period of steady economic growth which started at the end of the 1990s. (Miret-Gamundi and Gómez-León 2009).

The third dimension refers to the individual context, which influences both entry into and duration of participation in the labour market. During the last century, key life events such as family formation, educational achievement, and entry into the labour market underwent important transformations, both in terms of the moment at which these events occur, as well as in the length of time spent in various states throughout the life cycle (Baizán et al. 2001; Esping-Andersen 2004; Olmo and Herce 2011). The delaying of these events, together with rising life expectancy, may lead us to assume that events such as the exit from employment should also be delayed. However, improvements in health and life expectancy have not translated into a longer working life. Instead, the proportion of the population who leave the labour market in their early fifties has been increasing over time. This represents a premature exit period of nearly 15 years prior to the defined SPA (age of 65). We focus on in our analysis this age range.

Together with macro-economic determinants, individual determinants heavily influence the exit from the labour force. Patterns of employment and of the transition to retirement differ significantly by gender, especially at the ages in which we are interested: i.e. 50–64. In Spain, men have much higher rates of employment than women, as men are generally expected to assume the breadwinner role, while women tend to be engaged in informal work, such as taking care of the household and the family (Garrido 2004; Lindeboom and Kerkhofs 2009). Moreover, the low activity rates among women appear to be related with their living arrangements, as women who live with a partner are much less likely to be working (Even and MacPherson 1994; Ruhm 1996; Ortiz 2004).

The likelihood of remaining in the labour force also differs by type of occupation. In this paper, educational attainment will be used as a proxy for occupation, as previous studies have shown that people with higher levels of education are more likely than their less educated counterparts to remain in the labour market (Sicherman and Galor 1990; Garrido and Chuliá 2005; Dittrich et al. 2011).

While in our analysis we include several determinants of the decision to retire, such as age, education, family arrangements, and the employment status of the partner; other factors which are not included here may also play an important role, and should therefore be mentioned. For instance, a large number of studies have shown that health status is a predictor of the transition to retirement (Pinzón-Fonseca 2011; García-Gómez et al. 2014). Moreover, the employment history and income of an individual (with women having shorter durations and lower wages in general) may also determine earlier or later transitions to retirement.

3 Data and methods

3.1 Data and variables

The data used in this study come from the Spanish Labour Force Survey (LFS), conducted by the National Institute of Statistics in Spain. The LFS is a nationally representative rotating panel, set as a continuous quarterly survey (one-sixth of the sample is changed in each round). As a result, each household could be followed in up to six waves, for a total of a year and a half. The survey collects information (the reference is the week previous to the day of interview) regarding all of the members of the household,[3] including information on the respondents' sex, marital status, educational attainment, and labour activity.

The study used all of the waves of the LFS data from 1999 to 2012, or 161 waves for the entire period. This allowed us to analyse short-term changes, and to conduct a more general analysis of the labour market (Greene 2004). Our analysis starts in 1999, since this is the year in which the relationship of the individuals within the household can pinpointed; in particular, we are interested in the presence of children,

[3] Secondary or stage households are excluded, as are collective households, hospitals, and military lodgings.

Table 2:
Summary statistics of the sample

Variables	**Frequency of total observations / Mean (standard deviation)**
Dependent variable	
Employment status	
Working	49.5%
Not working	50.5%
Main independent variables	
Household arrangements	
Living alone	6.4%
Living with partner only	21.4%
Living with partner and dependent children	9.6%
Living with partner and parents	2.7%
Living with dependents (children/parents)	5.2%
Living with partner/older children/others	54.7%
Partner's employment status (n = 442,132)	
Partner is working	54.8%
Partner not working	45.2%
Covariates	
Sex Males	40.3%
Females	59.7%
Age	56.6 (4.46)
50–54	36.6%
55–59	33.3%
60–64	30.0%
Education level	
Illiterate	2.4%
No schooling	11.6%
Primary	38.6%
Vocational training	19.9%
Secondary	15.5%
Bachelor's or higher	12.1%
Observations (individuals-waves)	1,750,410
Individuals	533,145

Source: Spanish Labour Force Survey.

parents, and partners. Our study population is comprised of all of the respondents aged 50 to 64 who could have been observed up to six times during the period of analysis. We thus have 1,750,410 observations of a final subsample of 533,145 individuals, 59.7% of whom are females. Descriptive statistics of the variables used in the analysis are presented in Table 2.

Dependent variable

A variety of approaches can be applied to analysing early retirement behaviours. Defining the group of people who take early retirement is challenging. If we take into account all of the individuals who are not working, the group could include all of the following: those who have never worked, those who have stopped working but do not meet the requirements to receive an early or a full retirement pension, those who are receiving a pension, and those who combine part-time employment with pension benefits. In our study, we follow previous scholars who differentiated between individuals who are actively engaged in employment and those who are not (Antolín and Scarpetta 1998; Antón et al. 2007). Therefore, we will focus on two main states: 1) working and 2) not working. This approach allows us to include in the non-working group all individuals who were not actively engaged in employment, regardless of whether they were receiving a retirement or disability pension or another form of social benefits, or had no income at all.

Independent variables

Our study focuses on the differential effects of family arrangements for men and women. Based on a literature review, we also include other factors as control variables. Table 2 shows the main characteristics of the variables used in the analysis. Thus, the *age* of individuals is split into three different groups to control for the increasing likelihood that they will retire as they approach the age of 65.

Economic factors are controlled for with the variable *time*. During the period of study, a phase of substantial economic growth was observed (accompanied by an increase in labour force demand) until 2008, when the economic crisis hit the Spanish economy. A reversal of this positive trend then occurred (at least in terms of demand for labour among males, an issue we will analyse in the following section) and employment rates at all ages were negatively affected. To account for these changes, time will be split into dummy variables for each year in the study (1999–2012).

According to the human capital theory developed by (Becker 1964), individuals who complete higher levels of education are expected to have higher wages. Moreover, other studies (Sicherman and Galor 1990) have pointed out that the acquisition of education, knowledge, and experience is associated with improvements in working conditions and status over time. Thus, education increases an individual's chances of entering and remaining in employment, and of getting a better job (Garrido and Chuliá 2005; Dittrich et al. 2011). However, in a study which compared Germany with the United Kingdom (Oswald 1999), a significant association between higher education levels and the postponement of the exit from employment was found among German men only.

Because the Spanish educational system has undergone five major reforms in recent decades, the education variable recorded in the LFS has changed over time. Therefore, the standardisation of the variable (see Appendix A.1) takes into account the changes in the classifications used. The categories for the *education* variable are as follows:

1. Illiterate or non-schooled
2. Primary
3. Secondary
4. Vocational training
5. Bachelor's or higher

In terms of household characteristics, from 1999 onwards the LFS dataset includes the relationships of all of the household members surveyed. This information allows us to derive a variable which reflects the respondents' family arrangements, including their relationships to their parents, their partner, and their children. We also take into account the age of the household members, assuming that the household members who were under age of 16 were dependents, and that the presence of dependents would be associated with a decreased probability of being in employment among women, and an increased probability among men. In addition, we assume that adults who were living with a parent were more likely to change jobs or exit employment, as the elderly parent was likely to be a dependent (Schneider et al. 2013).

We also examined gender differences in the influence of the employment pattern of the partner/spouse on the probability of being out of the labour market. Since the retirement decision is often made jointly by the couple (Ruhm 1996; Mark et al. 1999; Ortiz 2004), using the *partner's employment status* variable, we expect to observe among those respondents whose partner was in employment a reduced risk of being out of work.

Regarding household arrangements, the variable of *living arrangement* has being created with the following mutually exclusive categories:

- Living alone
- Living with a partner only
- Living with a partner and dependent children
- Living with a partner and parents
- Living with potential dependents (young children or parents)
- Living with a partner/adult children/others

3.2 Methods (data analysis)

As the study focuses on the early retirement patterns of the adult population in Spain, we start the first section with a general descriptive analysis which compares the age of exit from employment for different European countries, and examines the remaining life expectancy at age 60 in Spain according to the years in employment from this age onwards.

The employment patterns are then built using the LFS in order to illustrate the trends associated with different activity statuses (employed/unemployed/inactive) for males and females aged 50 to 64 between 1976 and 2012.

To ensure that our estimates are unbiased—i.e. are not affected by unobserved individual characteristics—the relationship between family arrangements and the permanent exit from employment was estimated using a random effects (RE) model. RE models are useful in this context because they allow us to take into account the fact that each individual can have more than one observation over time (Diggle 2002); and up to six observations in our case. The model assumes that the variation across individuals is random and is uncorrelated with the other predictors included in the model. An advantage of the RE model is that it allows us to include in our analysis time-invariant variables, such as education and sex, and to specify those characteristics which may or may not influence the predictor covariates. To check for the precision of the results and the inclusion of the time-variant covariates, the results from the RE model were compared with the ordinary least square (OLS) models.

As our dependent variable is dichotomous, logistic regression with random effects was used to estimate the probability of being out of the labour market, including other variables to control for time, age, economic activity of the partner, and education.

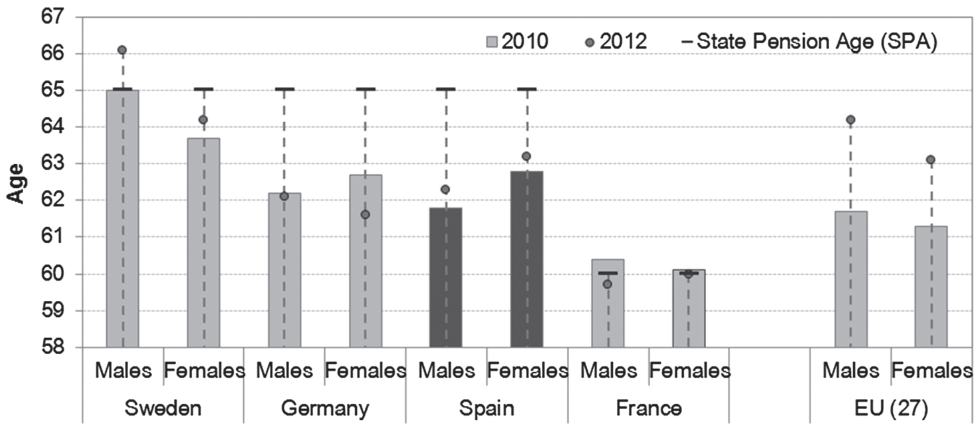
While our control variables cover a range of important determinants, the lack of other factors could bias our results, and should thus be mentioned. For instance, our dataset does not include information about health status, which is an important predictor of the transition to retirement. Moreover, the employment history and income of the individuals (with females having shorter employment careers and lower wages in general) may also determine earlier or later transitions to retirement.

4 Demographic potential of the workforce

The current political and social debates regarding labour force participation often focus on ways to encourage people to work beyond the SPA (age 65). However, a large proportion of individuals do not remain active in the labour market up to this age, as the mean age of exit from the labour market indicates.

Figure 1 shows that several European countries have a mean age of exit below the SPA, albeit with important differences by gender. Moreover, in some countries the situation does not appear to have improved between 2010 and 2012. Across the European Union (UE-27), the mean age of exit in 2012 was 63 for females and 64 for males, up from 61 for both genders in 2010. Three main patterns can be distinguished from the figure. In the first group of countries, which includes Sweden, Denmark, and Switzerland, the mean age of exit is relatively high, and even surpasses the SPA for males. In the second group of countries, which includes Germany and Spain, the mean age of exit is higher for females than for males, with Spain showing modest improvements between the 2010 and 2012. In the third group

Figure 1:
Average effective age of labour market exit and state pension age (SPA) by sex. European Union and selected countries (2010 and 2012)



Source: Eurostat, data for 2010 consulted on 24/06/2013; 2012 consulted on 27/11/2014 (OECD 2013).

of countries, which includes France and Italy (with differences by sex), the SPA levels are very low compared with the other countries. These countries are, however, in the process of raising the age beyond 65, in line with the rest of the European Union.

This pattern of increasingly early exit from employment has been occurring since the 1970s and 1980s, when most of the OECD countries used early retirement programmes to respond to economic crises and restructuring. Since the 1980s in Spain, the total number of years spent in employment has been falling due to early retirement. Meanwhile, over the same period, life expectancy has been rising.

These two opposing phenomena are depicted in Figure 2, which shows the life expectancy at birth (light grey bars) and the years spent in employment (dark grey bars) according to the age of exit from the labour market. As we can see from the graph, in 2010 life expectancy at birth was 79.1 for men and 85.1 years for women, 2.1 and 4.9 years longer than in 1970. However, during the same period, the number of years spent in employment decreased, as people were leaving the labour market at progressively young ages.

It is noteworthy that in 1970 the average age of exit from employment was considerably higher than 65, especially among working women, who, on average, remained in the labour market beyond age 70. By 1990, a significant reduction in the number of years the average person was working had already taken place, with a large share of the labour force retiring before age 65. This trend was especially pronounced among males. By 2010, the number of working years had fallen ever further, to 3.2 years below 65 for men, and to 2.2 years below 65 for women.

Figure 2:
Life expectancy at birth by employment status and sex. Spain (1970, 1990, and 2010)

Note: Years in employment are calculated using the mean age of labour market exit.
(*) The value indicates the difference between the mean age of labour market exit and the SPA (at age 65).
Source: Institute of National Statistics (www.ine.es) for the life expectancy; Eurostat (http://epp.eurostat.ec.europa.eu) consulted on 24/06/2013 for the mean age of exit from employment.

Figure 2 also shows that the effective mean age of retirement—and, hence, the average number of years an individual spends in the labour market—has decreased over the last 40 years. This has occurred despite political efforts to increase the mean age of retirement to 67; a policy which has already been implemented in countries such as Spain and Germany.

5 Labour market patterns of the adult population in Spain

Having documented the decrease in the mean age of labour market exit, we now examine the labour market status of individuals who are under age 65. Figure 3 shows the proportions of Spanish males aged 50 to 64 who were employed, unemployed, or inactive for the period 1976–2012. The highest level of employment was observed at the beginning of the period, or in the mid-1970s, when around 80% were working. This level had dropped markedly by the end of the 1970s and the beginning of the 1980s, stabilising in 1985 at 65%; but then falling even lower during the 1990–1994 economic crisis, to 58%. During the 1995–2008 period of strong economic growth, employment levels increased, but only to 69%; far lower than the levels reached in the 1970s. The economic crisis of 2008 disrupted this trend, with employment falling to 1996 levels, or to about 60%.

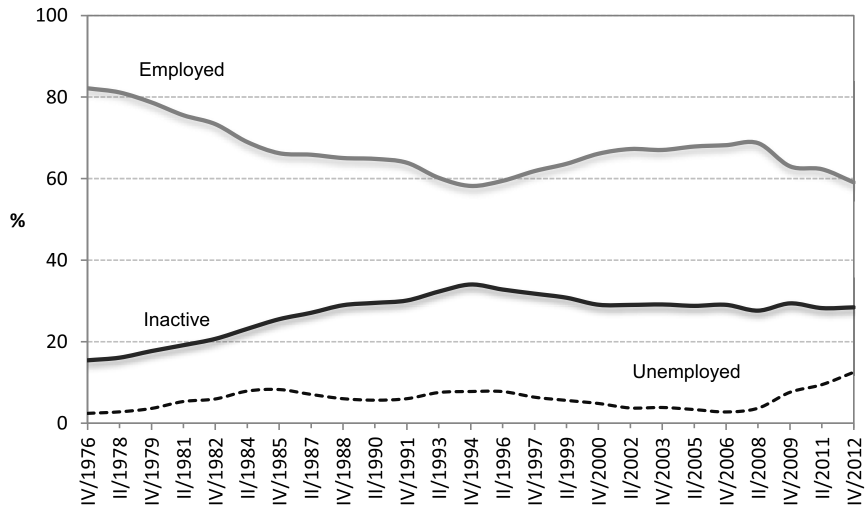
Given the decline in employment levels in the first half of the period, the unemployment rate should have risen more steeply than it did: among 50–64-year-olds, the unemployment rate increased only from 2% in 1976 to 8% in 1996 and to 12% by 2012. It therefore appears that a very large number of people in this age group who were not employed had become inactive, thus permanently exited the labour market shortly thereafter.

The proportion of 50–64-year-old men who were inactive was around 15% in 1976. This share had doubled by 1994, and then remained at around 25% until 2012. Even during times of economic growth, the share of 50–64-year-old men who were inactive remained steady. This trend is likely attributable to the intensive use of the early retirement programmes which were created during the Spanish restructuring process of the 1980s, and which continued to be available in the subsequent decades.

Figure 4 shows the labour market trends among 50–64-year-old women from 1976–2012. When we compare these trends with those shown in Figure 3, we can see that much higher proportions of women were out of the labour market for the entire period of analysis. From 1976 to 1994, between 75% and 77% of women aged 50–64 were inactive. These percentages decreased steadily to 47% by 2012. This trend illustrates the changes in Spanish society since the 1980s, with women entering most spheres of socio-economic and political life. However, for the adult population nearing retirement, this shift did not take place until the mid-1990s.

Unlike male labour market participation, female labour market participation does not seem to have been affected by the economic crisis in the 1970s or the 1990s. However, the economic crisis which started in 2008 appears to have had a modest impact on female labour participation, albeit with a certain delay. For instance, the percentage of women in employment stagnated in 2009–2010, and had fallen slightly by 2012. This decline has affected the unemployment rates of women. In the first part of the period of analysis, unemployment rates for women were very low, which indicates that relatively few women of these ages were actively looking for a job. This situation started to change in the 1990s, but the female unemployment rate remained low, at around 5%.

Figure 3:
Male population aged 50–64, by labour market status. Spain (1976–2012)



Note: Roman numbers correspond to the trimester in any given year.
Source: Spanish Labour Force Survey (LFS).

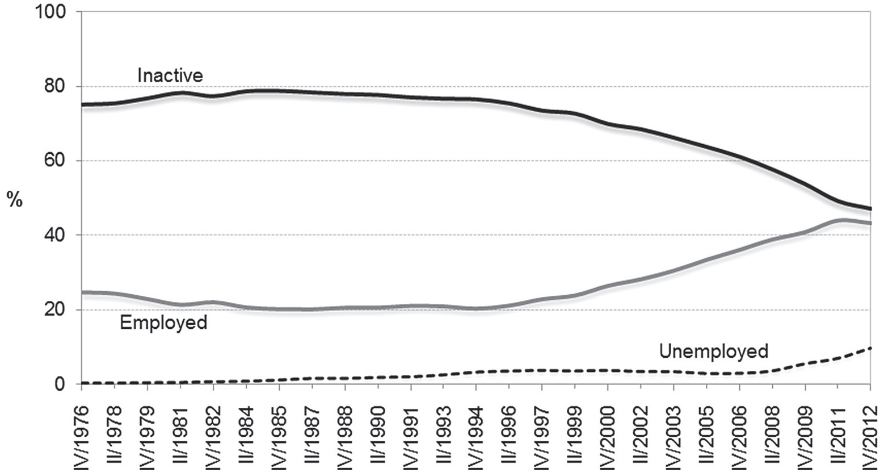
Especially remarkable is the significant increase in the unemployment rate for women aged 50–64 since the start of the crisis in 2008, to 10%. This trend is particularly interesting, as until recently this was one of the population groups who seem to have been most protected from the crisis, as older women are especially likely to be employed in the public sector with a permanent contract. This higher rate, may, however also be a response to the higher unemployment and inactivity rates among men in this on-going crisis.

During the entire period of study (1976–2012), there were clear sex differences in labour market participation: i.e. the male trends followed the ups and downs of the economic cycles, whereas the female trends did not. In the next section we will analyse sex-specific employment trends for different periods of time and different levels of educational attainment.

6 Demographic determinants of early retirements

The previous sections showed that male and female patterns of employment clearly differed. While the participation levels of women were much lower than those of men throughout the period, the increase in labour market participation among women does not appear to have been affected by the economic downturn which started in 2008. Moreover, this pattern of a low level of employment among women

Figure 4:
Female population aged 50–64, by labour market status. Spain (1976–2012)



Note: Roman numbers correspond to the trimester in any given year.
Source: Spanish Labour Force Survey (LFS).

at older ages could be also be related to the fact that many women take on the role of family caregiver, especially if there is another source of income in the household (which could be the partner's income or the pension benefits of the parents).

In the following analysis, we will address this issue by selecting two models (one for each sex) to test the effect of having potentially dependent family members at home; and the effect of time to control for changes in the patterns before and after the 2008 crisis (using the period between 1999–2008).

Before discussing in detail the results of the analysis for males and females, we first present the results of two models which we ran for the entire sample (males and females together) to check whether it was pertinent to use the random effects model instead of the simple logistic regression (see Appendix A.2). The results show the same effect (negative or positive) for all of the variables in the study; however, the levels are significantly different, with higher coefficients for the random effects model. Moreover, although the variance is in large part due to the differences across the waves (96.8%), the residuals within individuals are highly significant (4.6***); it is therefore important to take this variance into account.

Having analysed in the previous section employment status in the cross-sectional data for the entire period, we will now focus on 1999–2008, a period for which we have data on the respondents' family arrangements. Using discrete panel data, Table 3 depicts for this period the transition probabilities of changes in employment states over two consecutives waves (up to six waves for each individual), for males and females separately. As we noted in the literature review, entry into employment

Table 3:
Transitions in employment status between waves by sex, period 1999–2012. Spain (50–64 years old)

		State in t_{x+1}					State in t_{x+1}		
	Males	**Working**	**Not working**	**Total**		**Females**	**Working**	**Not working**	**Total**
State in t_x	Working	402,830	17,146	419,976	**State in t_x**	Working	219,168	14,948	234,116
		95.9%	4.1%	100.0%			93.6%	6.4%	100.0%
	Not working	10,750	199,614	210,364		Not working	12,840	339,969	352,809
		5.1%	94.9%	100.0%			3.6%	96.4%	100.0%
	Total	413,580	216,760	630,340		Total	232,008	354,917	586,925
		65.6%	34.4%	100.0%			39.5%	60.5%	100.0%

Note: The transition probabilities use panel data for nested observations within individuals.
Source: Spanish Labour Force Survey (LFS).

at adult ages is relatively rare. As expected, we observed relatively few transitions into or out of the labour market in our sample of individuals aged 50 to 64, although the patterns differed by sex.

In Table 3, we have 630,340 observations of males and 586,925 observations of females which could have been recorded across the six waves. In the last observation, 65.6% of the men were working. Meanwhile, more than half (60.5%) of the women were not working—a higher share than the one observed in the cross-sectional analysis, specially after 2008.

This stresses the importance of taking into account the differences in the behavioural patterns of men and women. Relatively few women were still working at these ages, but among those who were working, their probability of remaining in employment was similar to that of men. Thus, employment status was highly stable among both sexes, with more than 90% staying either in or out of employment. By contrast, the rate of transition into employment was lower with 5% among men and nearly 4% among women.

The results from the logistic model with random effects are presented in Table 4. The models show a high degree of intraclass correlation between the residuals within individuals and between the overall error terms for females and males (96% and 97%, respectively). Meanwhile, the standard deviation within groups should also be taken into account (8.6 and 9.9, respectively).

In terms of family arrangements, we found similarities with previous studies: i.e. living with a partner increases the chances of being out of the labour market, with a stronger effect for males. However, the contrary effect is found if the occupation status of the partner is taken into account. If the partner is in employment, the probability of an employment exit is reduced; this supports the observation

Table 4:
Family arrangements' impact on the likelihood of exit from employment. Spanish individuals aged 50–64, period 1999–2012

Logistic regression with random effects	Females			Males		
	Coeff.	P	Std. Err.	Coeff.	P	Std. Err.
Household arrangements (ref. Living alone)						
with a partner only	0.123	***	0.036	1.247	***	0.045
with a partner and dependent children	−0.098	*	0.052	0.103	**	0.047
with a partner and parents	−0.327	***	0.068	−0.235	**	0.114
with dependents (children /parents)	−0.539	***	0.186	−0.060		0.232
Partner's employment (ref. not working)						
Partner is working	−1.388	***	0.031	−1.567	***	0.034
Control variables						
Age (ref. 50–54)						
55–59	1.213	***	0.035	1.922	***	0.040
60–64	2.836	***	0.050	9.950	***	0.081
Education (ref. Illiterate)						
No schooling	−0.740	***	0.119	−2.082	***	0.169
Primary	−1.171	***	0.118	−3.333	***	0.171
Vocational training	−2.117	***	0.120	−3.901	***	0.174
Secondary	−4.628	***	0.125	−4.663	***	0.178
Bachelor's or higher	−14.039	***	0.136	−6.892	***	0.192
Year (ref. 1999)						
2000	0.115	**	0.056	0.147	***	0.052
2001	−0.116	*	0.065	0.165	***	0.063
2002	−0.213	***	0.068	0.182	***	0.069
2003	−0.477	***	0.069	0.102		0.071
2004	−1.005	***	0.068	0.091		0.072
2005	−1.606	***	0.069	0.218	***	0.072
2006	−2.167	***	0.069	0.065		0.071
2007	−2.492	***	0.069	−0.029		0.071
2008	−2.678	***	0.070	0.285	***	0.071
2009	−2.879	***	0.070	1.099	***	0.070
2010	−3.057	***	0.071	1.475	***	0.070
2011	−3.292	***	0.071	1.828	***	0.071
2012	−3.234	***	0.074	2.644	***	0.073
Constant	10.462	***	0.131	−4.658	***	0.179
sigma_u	8.558		0.029	9.945		0.043
Rho	0.957		0.000	0.968		0.000
No. of observations (individual-wave)	703,948			728,499		
No. of groups (individuals)	259,766			182,366		

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Note: Separate models for males and females, controlling for random effects within individuals.

Source: Spanish Labour Force Survey (LFS).

mentioned in the literature review that retirement timing is often decided jointly within a couple.

In general, we found that having a potentially dependent person living in the household (a child under age 16 or an elderly parent) is negatively associated with the probability of being retired. This finding is contrary to our expectations, especially for females. In the case of women, the family composition in the household does not appear to have negatively conditioned their employment participation. One reason for this result could be that the presence in the household of a parent did not impose a burden; on the contrary, an adult who was living with a parent was more likely to be employed than an adult who was living alone or only with a partner. To further analyse this phenomena, other variables should be taken into account, such as the health of the parent, or the individual's reasons for being out of the labour market.

We were, however, surprised to find that men had a greater likelihood of exiting the labour market if they were living with a partner and children (under age 16); although the likelihood of an exit was much lower than it was if they were living with a partner only, which could be explained by the joint decision-making of the couple. Moreover, the risk of retirement was lower among men who were living with a partner and dependents (living with children and parents was negatively related, but this result was not statistically significant). In this case, it appears that the need for an income source reduced the likelihood that men would leave employment, especially when other household members could take care of the other needs in the household.

The effect of age was as expected: as the individual approached the age of 65, the probability of being out of employment increased, with stronger effects for males. The estimates for education were similar: i.e. the higher the level of education an individual had, the lower the probability was that he or she would exit the labour market; although the coefficients differed by sex.

The protective effect of education for employment was higher among males, and the effect was higher until the secondary level, at which point men and women had similar coefficients. For the upper level of bachelor's degree or higher, females had a much higher coefficient; thus, being highly educated had an especially strong effect on the probability of exiting employment among women.

The estimates for the dummy variable of time also showed important differences between males and females: for the entire period of analysis (1999–2012), women had increasingly negative coefficients, indicating that their retirement risk declined over time (even after 2008); whereas the variable had the opposite effect among men. Men had positive signs for all of the years (except for 2007, although this was not statistically significant), which implies that they had a higher risk of retirement than the reference group of 1999. The coefficients indicate that the trends were stable in the early years, and that there were no differences between 2003 and 2007. However, in 2008 the coefficients increased systematically, and the risk of being out of employment rose sharply.

7 Discussion

(Early) retirement patterns have been studied extensively from economic and demographic perspectives, and a wide variety of methods have been applied in these investigations. The purpose of this paper was to investigate the effect of family composition on early retirement for the population near the state pension age of 65. The Spanish Labour Force Survey (LFS) is a national representative survey which is most often used to study labour market changes. But because these survey data are complex and have only recently become available, they have so far been used mainly in a cross-sectional format, rather than as panel data.

Using the LFS in our study as a panel dataset, we were able to apply a random effects framework to investigate the employment status of the adult Spanish population, thereby taking unobserved heterogeneity and variations within individuals into account.

The first objective of this paper was to analyse the labour market participation of adults between the ages of 50 and 64. Our findings indicate that men had higher levels of employment than women during the entire period. The results further show that male labour participation followed macro-economic variations, decreasing during times of economic depression and increasing in periods of economic expansion. It is worrying that even during the phases of economic growth in our study period male employment rates did not approach the levels of the 1970s, and that in the first four years of the current crisis the rates had fallen to the lowest levels since the 1970s.

The reverse trend was found for women. Female employment rates grew steadily, and do not appear to have been affected by economic cycles or labour market policies which promoted a reduction in the workforce. Until the late 1980s, less than one-third of women over the age of 50 were participating in the labour market. But the figures since the 1990s suggest that women are becoming increasingly active in the economy. Particularly interesting are the patterns of employment after 2008, which show that labour market participation rates are declining among men but increasing among women.

Our second research objective was to analyse the socio-demographic determinants of the transition to permanent labour inactivity of the adult population in Spain. The results show that the exit from employment is strongly influenced by family arrangements, by education, and—in the case of males—by the economic crisis of 2008.

In terms of family arrangements, living with a partner has been shown to be an important determinant of employment during the early 21st century for both sexes: i.e. in line with the retirement joint decision model, the analysis showed that the chances of an individual being in employment were affected by whether his or her partner was working. This finding is similar to those of several previous studies (Mark et al. 1999; Ortiz 2004; Garrido and Chuliá 2005). Moreover, using separate models for each sex, we found that females were less likely to leave employment for any type of family arrangement except living with a partner only, while males who were living with a partner only, or with a partner and dependent children, had an increased risk of entering retirement. However, the presence of an elderly parent (regardless of the presence of others) increased the likelihood of staying in employment. Thus, living with a parent appears to encourage adults to continue working.

Our analyses were adjusted for several covariates to control for the effects of other important predictors. Level of education was found to be a significant determinant of the likelihood or remaining in employment among older adults. Our study population included large shares of individuals who had only a primary school education or vocational training. The results clearly showed that highly educated males and females were more likely to remain in employment after age 50. After controlling for the period of analysis and family composition, this effect was found to be especially strong among women, but comparatively weak among men.

Limitations

Several limitations of our research should be mentioned here. The analyses conducted for this paper were based on employment status, and considered all of the individuals who reported in the survey that they were not working to be early retirees. Moreover, unmeasured biases could have affected our results. For example, because health status was not recorded in the LFS, we could not control for the health status of the respondents or of their family members. Both health indicators are important predictors of stopping work, as individuals who are disabled or who have informal care responsibilities are less likely to remain in employment (Lindeboom and Kerkhofs 2009; Schneider et al. 2013). We also did not control for other factors, such as differences in retirement patterns by occupational sectors, the trade-off between income earned prior to retirement and pension benefits (Díaz and Llorente 2005; García-Gómez et al. 2014), and cohort pattern changes (Garrido 2004).

Longitudinal datasets are particularly useful for studying transitions and life course events, but there is a scarcity of such datasets in Spain. We therefore used the panel data of the LFS, which have a number of advantages, as was previously discussed. But since we did not have the full employment histories of the individuals, the analysis here refers to the changes which occurred within a year and a half. This short period may not be sufficient to analyse the effects of the changes which occurred over the adult ages before retirement.

8 Conclusion

At the start of the 21st century, the Spanish labour market is still characterised by significant gender divisions. This situation should change for younger generations as they approach the SPA (which has already shifted from 65 to 67 in Spain), as today's young people will have spent their childhood and adult life in a different social context. In particular, we can expect more women to become actively engaged in the social, political, and economic spheres.

In general, we have confirmed the importance of family composition for individuals as they reach the age of retirement; finding that having a family tends to encourage people to remain in employment rather than to retire early, except among people who live with a partner only. The effect on employment of living with a parent is stronger among females, while among males the presence of a partner, rather than the presence of dependents, appears to have a greater influence.

The improvements in educational attainment during the second half of the 20th century barely affected the population aged 50 and over. However, we expect that subsequent generations in Spain will reach retirement ages with higher levels of education, and that they will therefore be more likely to delay retirement.

Finally, the analysis showed that early exits from employment among adults have not been declining; on the contrary, they have been increasing, at least among men. During the economic expansion, employment rates increased and the risk of early retirement decreased among women; whereas among men employment rates increased moderately, but the risk of early retirement also rose. After the onset of the economic crisis in 2008, these gender-specific trends in labour market attachment among this age group continued: the risks of early retirement increased among men and decreased among women.

Policy implications can be drawn from these results. For instance, the higher rates of early retirement among males could be forcing the partners of those who retire to also stop working. Early retirement schemes seem to play an important role in driving people out of the labour market. We have confirmed that in recent decades a large proportion of the Spanish population have been inactive, even during the expansion of the Spanish economy in the first decade of the 21st century. The finding that highly educated individuals are less likely to retire early reinforces the need for re-qualification and training programmes for the adult population, as such programmes will prepare them to face the requirements of a constantly changing labour market.

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Appendix

Table A.1:
Classification of education levels used in the Labour Force Survey, Spain

Educational level	1992 I/1992–IV/1999	2000 I/2000–IV/2004	2000 I/2005–
Illiterate or non-schooled	0, 1, 2	0–3	80, 11, 12
Primary	3	04, 05	21–23
Vocational training	5, 6	06, 07, 9–13	31, 33, 34, 36, 41, 51, 53
Secondary	4	08	32
Bachelor's or higher	7, 8, 9	15–19, 20–31	(50), 52, 54–56, (59), 61

Note: Roman numbers correspond to the trimester in the year.
Source: Methodological documentation from the Spanish Labour Force Survey (LFS), www.ine.es.

Table A.2:
Coefficients from the random effect and logistic regression models of exit from employment. Spanish individuals aged 50–64, period 1999–2012

Variable		Random effect	Logistic regression
Age group (Ref. 50–54)	55–59	−4.6517269***	−1.3809676***
	60–64	−3.0306076***	−.9254262***
Education (Ref. illiterate)	No schooling	−1.2745979***	−.60700117***
	Primary	−2.0990315***	−.95527769***
	Vocational training	−2.8924968***	−1.1685589***
	Secondary	−4.7066073***	−1.5244851***
	Bachelor's or higher	−8.1719743***	−2.3694812***
Year (Ref. 1999)	2000	.46496853***	.04116479***
	2001	.32837089***	−0.01858511
	2002	.24007136***	−0.01752625
	2003	−0.00104075	−.0342946***
	2004	−.34822911***	−.05727066***
	2005	−.66487853***	−.07947445***
	2006	−1.1141239***	−.1288721***
	2007	−1.3942593***	−.17644001***
	2008	−1.3846567***	−.18793123***
	2009	−1.1040909***	−.11846196***
	2010	−1.0346155***	−.09003472***
	2011	−.98668031***	−.10141166***
	2012	−.52102874***	−.03234491**
Household arrangements (Ref. Living alone)	Living with a partner only	.53937921***	.1644103***
	Living with a partner and dependent children	−.1550163***	.03997679***
	Living with a partner and parents	−.17293362**	−.03145328**
	Living with dependents (children/parents)	−.35097697*	−.11841031***
Partner's employment (Ref. Not working)	Partner is working	−1.2159281***	−.32222306***
Sex (Ref. Males)	Females	13.955721***	1.7147895***
_cons		.83101968***	1.3402433***
lnsig2u _cons		**4.6172855*****	
N		1,432,447	1,432,447
Rho		0.9685	

Note: Legend: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.000$.
Source: Spanish Labour Force Survey (LFS).

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Retirement and leisure: a longitudinal study using Swedish data

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Abstract

This study explores engagement in leisure activities in relation to retirement among individuals aged 58–75 using Swedish longitudinal data over the 1981–2010 period. Our focus is on the relationship between leisure engagement before retirement and retirement timing, as well as on the relationship between leisure engagement before and after retirement. Engagement in leisure is measured through participation in several leisure activities which are popular in Sweden. The results indicate that leisure engagement is not associated with retirement timing when period is considered in the models. It is noteworthy that when the effect of period is excluded, but central predictors of retirement timing are included, leisure engagement is shown to be statistically significant. The results also indicate that leisure engagement patterns in retirement tend to be a continuation of preretirement leisure engagement patterns. The policy implications of these results for active ageing and health are discussed.

1 Introduction

Health and economic factors are the main predictors of retirement. But as health continues to improve and longevity continues to rise, other less studied predictors, such as leisure engagement, may become increasingly important. Employees may evaluate their ability to participate in leisure activities when they retire, and, depending on their assessment of the attractiveness of and their options for engaging in leisure activities, be pulled towards retirement or towards remaining in paid work (Beehr 1986; Laslett 1996; Higgs et al. 2003). Employees may expect to be able to spend more time on leisure activities when they retire (Watts 1987; Laslett 1996), but the ability to engage in leisure activities is not distributed equally

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among older individuals (Freysinger 1999). In this study, we explore the relationship between leisure engagement and retirement timing in Sweden, as well as individuals' engagement in leisure activities before and after retirement using a unique set of longitudinal data. Improving our knowledge about the role leisure activities play in retirement timing is very useful, particularly in a country such as Sweden, in which many older employees enter retirement while still healthy, a large proportion of workers retire before age 65, the number of years spent in retirement has been rising steadily, and the share of older people (ages 60+) in the population is expected to increase dramatically (Jacobzone et al. 2000; Berleen 2003; Kinsella and He 2009). In addition, Sweden's rather flexible gender-neutral public pension system (Sundén 2006) and high rates of labour force participation among women (OECD 2008) make it possible to study both men's and women's motivations for retirement. In addition, investigating whether leisure activities are associated with retirement timing is a highly relevant topic in the current context, in which many countries are considering raising the retirement age, but also want to have an active and healthy older population who are engaged in various leisure activities. If, however, older individuals become more involved in leisure activities, they may want to decrease or cut short their labour force participation, which is in conflict with the goal of raising the retirement age. In addition, leisure activities in old age have been found to be beneficial for life satisfaction (Fly et al. 1981), health, and longevity (Everard et al. 2000; Lennartsson and Silverstein 2001; Agahi et al. 2011). Leisure may also prevent social isolation (Rowe and Kahns 1998), and help older people cope with the loss of family members, friends, or functions (Silverstein and Parker 2002; Janke et al. 2008). Because of the many benefits to elderly people of participation in leisure activities, leisure engagement is often promoted at a national level. Increasing the share of the older population remain who remain healthy and active, and who can therefore contribute to society and do not require care, has been cited as an important governmental goal in several countries (Taylor et al. 2004; Zaidi et al. 2013). Having additional knowledge about participation in leisure activities among the elderly would be beneficial for individuals and the public, as it could contribute to improvements in health, and thus help to lower public health care costs.

The purpose of this study is twofold. First, the importance of leisure engagement on the transition to retirement is explored. There is little existing research on this topic, either internationally or for Sweden. In most of the studies which have looked at leisure engagement, the results have been 'spillovers' from investigations on other subjects (e.g. Beehr et al. 2000; Strain et al. 2002; Janke et al. 2006). Second, we investigate how engagement in leisure activities changes shortly after retirement. Previous studies on leisure engagement have been inconclusive: some have indicated that participation in leisure activities after retirement increases, whereas others have found that it decreases or does not change (Beehr and Nielson 1995; Gauthier and Smeeding 2003; Agahi et al. 2006). In our analysis, we use country-representative longitudinal data from the Swedish Level-of-Living survey (LNU) collected between 1981 and 2010. This data set is unique in that it includes a wide range of detailed questions on leisure engagement, and thus captures to a great extent the diversity of leisure engagement patterns among the Swedish population. Leisure activities are defined as activities individuals engage in when they are not fulfilling paid or household obligations (Blackshaw 2010). Respondents are asked how often in their leisure time they *engage* in certain activities, including *going to the cinema*, *shows*, *and restaurants*; *reading books*; *meeting friends and family*; and engaging in *political activities*, *study circles*, *hobbies*, *music*, *dancing*, *gardening*, and *church activities*. The definition of *engagement* is based on a quantitative estimation of the frequency of a particular activity (i.e. *never*, *sometimes*, or *often*). The questions are nearly identical in all of the waves, which facilitates comparisons over a very long period of time. It is also possible to take a life course approach because a large proportion of the sample is a panel, and the data include many demographic, socio-economic, and individual measures. The data have been used for earlier studies of leisure engagement in Sweden, especially among elderly people (e.g. Agahi et al. 2006; Agahi et al. 2011). This study is the first to use the 2010 panel to examine leisure engagement in old age.

1.1 The Swedish public pension system

The Swedish gender-neutral public pension system[1] has various incentives and regulations which provide workers with flexibility in deciding when they wish to leave the labour force. Although the mandatory retirement age was 65 until 2003, a large proportion of employees left the labour market earlier.[2] Women were more likely than men to retire early, a phenomenon which has been attributed in part to the survivor's pension (Palme and Svensson 1999). In 2003, a new pension system was introduced in which employees were given the flexibility to retire at any point between the ages 61 and 67. Individuals also have the option of moving to a part-time schedule (Sundén 2006). Since 2003, the average retirement age for both genders has remained stable at 64, with a slight increase after 2004 (Olsson 2011). However, variation in retirement timing is increasing, with many individuals retiring both before and after reaching age 65. Additionally, an increasing proportion of individuals combine paid work and retirement (Ministry of Social Affairs 2011).

1 Between 1960 and 2003, the public pension system was a pay-as-you-go system which included a flat-rate benefit and an income-related supplement pension, or ATP. Individuals with a low or a non-existent ATP received supplemental benefits. Along with the pension scheme, there were occupational pensions (Palme and Svensson 1999). The pension system introduced in 2003 consists of a pay-as-you-go part and a funded part based on an income pension and a premium pension. In addition, there is an occupational pension, a private savings element, and a guaranteed pension for individuals with a low or a non-existent income. Labour income, parental leave, study benefits, military duty, and unemployment benefits are all included in the calculation of lifelong income (Sundén 2006).

2 Part-time early retirement from age 60 and disability retirement for individuals under age 65 who cannot perform gainful employment. The system also included possibilities for postponing retirement to age 70 (Palme and Svensson 1999).

2 Leisure in old age

Leisure activities are generally defined as being voluntary, rewarding and enjoyable; although these activities may be connected to paid work or to household or family tasks (Blackshaw 2010). The relationship between leisure and obligations is not dichotomous or mutually exclusive. What is considered leisure is a matter of personal perception (Blackshaw 2010). In addition, the expansion of leisure activities and the reduction of paid work during the 20th century indicate that paid work is becoming less important (Kraus 1984; Rojek 2000; Aguir and Hurst 2007). In addition, providing people with opportunities to engage in leisure activities, such as through public leisure facilities or subsidies of leisure costs, has become part of the political agenda (Kraus 1984; Olson 1993; Rojek 2010).

This study focuses on older individuals, a population group who have increased their participation in leisure activities in recent years (Nowotny 1994; Agahi and Parker 2005). Previous studies on ageing have shown that engagement in daily leisure activities has many health and social benefits (Menec 2003; Lennartsson and Silverstein 2001; Silverstein and Parker 2002; Agahi et al. 2006; Klumb and Maier 2007). Most European countries follow governmental directives to promote *active* ageing and to encourage older people to remain healthy, energetic and independent so they can continue to contribute to the economy and society (OECD 1998; Zaidi et al. 2013), while minimising their contribution to the public health burden (Taylor et al. 2004).

However, not everyone has the ability to engage in leisure. Although national policies create leisure opportunities (Olson 1993), levels of engagement in leisure vary considerably between individuals (Rojek 2000; Blackshaw 2003). The greatest limitations in old age are related to age, low income, and poor health (Hogas et al. 1998; Strain et al. 2002; Janke et al. 2006). Another constraint on participation in leisure activities is whether an individual has companionship when engaging in activities, and whether these activities are of a social character (Kelly 1995). The geographical area is also important, as individuals may be unable to participate in certain leisure activities because those activities are not available in their residential area (Jackson 1994). Another barrier to leisure engagement among older people is a lack of motivation (Rosenkotter et al. 2002). When we look at gender differences in leisure engagement patterns, we can see that women are more likely than men to participate in informal activities and are less likely to engage in physical leisure activities; whereas men are more likely than women to engage in formal and physical leisure activities (Bennett 1998; Bittman and Wajcman 2000). These gaps can be partly explained by the fact that, historically, women had fewer opportunities than men to engage in leisure opportunities due to economic constraints and the pressure to take on time-consuming domestic responsibilities (Rojek 2010; Blackshaw 2003). Moreover, individuals may have other obligations which are perceived as being more important than engagement in leisure, such as care responsibilities. Women are more likely than men to have care responsibilities. In many situations these duties conflict with leisure, and thus represent a source of strain and tension for individuals and families. However, caring can also provide people with pleasure and satisfaction (Bedim and Guinan 2009). In addition, individuals may volunteer instead of or as part of their leisure engagement (Stebbins 1996; Wilson 2000). Studies have found that people spend more time volunteering after retirement than before they leave the labour force (Hank and Erlinghagen 2009; Van den Bogaard et al. 2014).

3 Retirement transition

There are many factors which can influence retirement timing. Although the focus of this paper is on leisure engagement, the following section presents some of the central factors involved in a valid specification of the associations in the analyses.

National pension systems and the labour market regulate retirement behaviours (Gould 2006), but health and economic factors constitute the strongest determinants for retirement (Hayward et al. 1989; Taylor and Shore 1995; Barnes-Farrell 2003; Nordenmark and Stattin 2009). Individuals with lower income and educational levels are the most likely to have physically demanding occupations which can result in health problems, and are therefore more likely than individuals with higher income and educational levels to retire early (Hayward and Grady 1986; Hayward et al. 1989; Blekesaune and Solem 2005). However, individuals without economic resources may have to continue work to earn higher pension benefits (Henkens 1999; Barnes-Farrell 2003). It is also possible that individuals with better economic resources may postpone retirement because they are active in occupations offering economic and status rewards which they are reluctant to lose by retiring (Laslett 1996; Soidre 2005). Retirement timing is also influenced by years in the labour force. Women with long work disruptions due to childbearing may postpone retirement to earn higher pension benefits (Henretta et al. 1993). A similar situation may arise for individuals with long periods of unemployment (Beehr and Bennett 2008).

Increasing labour force participation among women has given women the right to pension benefits based on their labour market income (Johnson 2004). A general trend among married couples is for spouses to retire at or around the same time. Because the male partner in a couple is often older than the female partner, men tend to postpone retirement while women tend to retire earlier (Ho and Raymo 2009). Other family-related matters which might lead an individual to postpone retirement or to retire early include having care responsibilities for a child (Pieta and Hayward 2002; Pienta 2003), grandchild (Szinovacz and Davey 2005), an older parent (Hatch and Thompson 1992; Himes 1994), or a spouse (Szinovacz and DeViney 2000; Pienta 2003).

4 Framework and hypotheses

4.1 Leisure activities and retirement timing

The main concept of the theory of trade-off regarding leisure is that because time spent on leisure entails a loss of potential earnings, the price of leisure is foregone earnings. If people were rational, they would enter the labour market and continue to work only for as long as the benefits from their earnings outweighed the benefits of leisure time. This choice mechanism has been widely used in economics to analyse individuals' decisions about whether to work and whether to work part time or full time (Gratton and Taylor 2004). It can be assumed that when individuals are at the threshold of retirement, they evaluate their earnings and potential retirement leisure. If the benefits of leisure engagement outweigh the option of continuing to work, people will choose to retire. An informed choice is possible because individuals have a general overview of their potential employment earnings and pension benefits (Haworth and Veal 2004).

Related to this reasoning is the push-pull perspective which is commonly presented in the retirement literature. According to this theory, employees evaluate what they consider to be of value to them, and they are either pushed or pulled towards retirement or towards continuing to work. Push and pull factors are contextually dependent, and individuals perceive them differently (Barnes-Farrell 2003). In the context of this study, the economic theory on the work-leisure trade-off and the pull-push approach are combined, and preretirement leisure engagement is considered a motivator and a pull factor for retirement. If retirement is considered a period of life in which people have more time for leisure, then it is possible that preretirement leisure sets an individual's expectations regarding which activities he or she might want to engage in after retirement. Previous research has found that participation in leisure activities may motivate people to retire because they are familiar with the activities they might wish to engage in during retirement, and value those activities more than employment and earnings. Although the frequency of an individual's participation in particular leisure activities may not necessarily increase during retirement (Bosse and Ekerdt 1981; Agahi et al. 2006), the person's expectations regarding leisure engagement may serve as a pull towards retirement (Beehr 1986; Higgs et al. 2006). By contrast, individuals who are not active in leisure activities may not have a clear idea of how to replace paid work, and may therefore not feel pulled towards retirement (Fly et al. 1981; Henkens 1999). It is also possible that those who lack leisure skills and who do not know what to do with their leisure time may view retirement negatively, and may not want to retire (Gee and Ballie 1999). Other studies have found that the expectation of being able to participate in leisure activities does not motivate people to retire, but the lack of evidence on this issue may be attributable to the small, cross-sectional samples used in these studies (Bosse and Ekerdt 1981; Taylor and Shore 1995; Henkens 1999; Beehr et al. 2000).

In keeping with the primary purpose of this study—namely, to investigate how engagement in leisure activities before retirement may be associated with retirement timing—an initial hypothesis is proposed: *individuals who are more involved in leisure activities before retirement retire earlier than individuals who are less involved in leisure activities before retirement*. Arguably, a reverse hypothesis can be suggested, because it is likely that individuals who are more engaged in certain leisure activities will postpone retirement as they may need a higher income to continue their participation. In addition, individuals with health problems may retire earlier, which may explain their low levels of leisure engagement prior to retirement. This study cannot make causal claims about the relationship between leisure and the timing of retirement, because it is not clear whether engagement in leisure activities influences retirement timing, or whether individuals foresee their retirement and change their engagement in leisure activities in the years prior to retirement.

4.2 Preretirement leisure and postretirement leisure

The theoretical framework for the second main goal of the study is based on three frequently applied theories in social gerontology: continuity theory, activity theory and disengagement theory. These theories provide plausible explanations of how engagement in leisure activities before retirement develops over time. According to continuity theory, most retirees continue to participate in the leisure activities in which they participated before retirement as a replacement for paid work (Atchley 1976). Critics of this theory have suggested that it is often not possible for older people to maintain their previous lifestyle due to the various constraints that accompany increasing age (Matras 1990). According to activity theory, individuals adapt to new life situations in retirement and find activities which are suitable for their life phase. Research has shown that retirees are most satisfied with their life if they are active and strive to engage in activities to replace paid labour (Harvighust 1961). The disengagement theory describes a separation process between the retiree and the social world, in which retirees do not seek out new activities, but rather engage in familiar activities, and systematically disengage from activities with increasing age (Cumming and Henry 1961). These three theories are not necessarily mutually exclusive; they can be applied together to explain the same life phase or different phases of retirement and old age (Glamser and Hayslip 1985; Howe 1988). For instance, disengagement theory can help to explain engagement in activities at ages when the natural decline in abilities begins, and continuity theory and activity theory may help to explain behavioural patterns closer to the retirement transition.

For the purposes of this study, it can be argued that if leisure activities before retirement are associated with retirement timing, then it is possible that leisure engagement before retirement preconditions leisure engagement after retirement. The findings of some studies have shown that entering retirement increases engagement in leisure activities, and thus support activity theory (Iwasaki and Smale 1998; Janke et al. 2006; Van den Bogaard et al. 2013). However, the results of other studies have indicated that retirement does not increase engagement in leisure activities (Bosse and Ekerdt 1981; Rosenkoetter et al. 2001; Talyor et al. 2004; Agahi et al. 2006; Berger et al. 2005). The findings of still other studies have shown that engagement in leisure activities declines with increasing age, and thus support disengagement theory (Griffin and McKenna 1999).

To meet the second main goal of this study—namely, to investigate the level of engagement in leisure activities before retirement—three hypotheses are formulated.

Continuity theory: *The level of engagement in leisure activities after retirement is continuous with the level of engagement in leisure activities before retirement.*

Activity theory: *The level of engagement in leisure activities after retirement is higher than the level of engagement in leisure activities before retirement.*

Disengagement theory: *The level of engagement in leisure activities after retirement is lower than the level of engagement in leisure activities before retirement.*

This study addresses changes in levels of engagement in several activity domains, but not changes in specific forms of leisure. However, changes in activity type before and after retirement are addressed by the analysis. In addition, the study examines several different leisure activities, because different leisure activities may have different relationships with the retirement transition: i.e. participation in some activities may be associated with a postponement of retirement, while participation in other activities may be associated with early retirement.

5 Data and methods

LNU is a panel survey which was first conducted in 1968, and was replicated in 1974, 1981, 1991, 2000, and 2010. The sample in 1968 consisted of a random sample of 1/1000 of the Swedish population aged 15 to 75 (approximately 6000 individuals). As a supplement to the original panel, additional respondents are selected in each wave, and individuals who have turned 76 are excluded. For instance, the panel in 2010 consisted of individuals born in 1935–1981 who were previously interviewed at least once in previous LNUs, which corresponded to 5881 individuals. In addition, the sample was augmented with previous respondents' children who took part in LNU 2000. To make the sample representative of the Swedish population aged 15–75, two new random samples from cohorts born in 1982–1991 and immigrants born in 1935–1981 who migrated to Sweden in 2000–2009 were included. The same procedure was used for each wave. The total sample frame for LNU 2010 was 8889 individuals, of whom 61.5 per cent participated (or 72 per cent including respondents who answered a short interview). LNU 1991 had a response rate of 76.6 per cent, and LNU 1981 had a response rate of 82.4 per cent.[3] LNU is complemented by register data and covers topics such as family, social relations, income, wealth, working conditions, health, education, housing, political life, and leisure activities (www.sofi.su.se).[4]

In this study, four survey years are pooled together: 1981, 1991, 2000, and 2010. The total number of individuals in all four waves is 10,466. Individuals were observed over different periods during the 1981–2010 period. The criteria for being included in this study's sample are that the individual 1) had been interviewed at least twice 2) was at least 58 years old, and had 3) not retired before age 58. Each individual entered the sample from any wave when the criteria were fulfilled. The sample used here consisted of 2875 individuals born in the 1915–1952 period, of whom 1358 did not retire, and 1517 retired during the observation years of 1982–2010. Of these individuals, 31 per cent participated in four waves, 27 per cent participated in three waves, and 42 per cent participated in two waves. Of the total sample, 49 per cent were men, and 51 per cent were women. Of those who retired, the age at retirement varied between 58 and 75, with a mean age of 63. The earliest age of retirement was restricted to 58 because it is possible to retire early at age 58 through occupational pension schemes. Sensitivity analyses have been conducted with age restrictions of 55 and 60, and the results were similar to those presented in the study. Of the sample, 13 per cent retired at ages 58–59. Observing individuals from an earlier age would increase the risk of sampling individuals who retired due to disability. The year of retirement was self-defined by the respondents. The data include no direct information on whether the transition was voluntary or forced. Swedish retirees are permitted to continue to work after retirement, although it is rare for them to do so. While the data contain no information on this phenomenon, a question about the desire to work after retirement was included in the 1981, 1991, and 2000 surveys. This may indicate whether the transition to retirement was voluntary or forced. Approximately 90 per cent of the individuals who retired in 1981–2000 said they did not wish to continue working.

5.1 Leisure activity domains

The range of leisure activities from LNU has been used in several studies (Samuelsson 2002), and is representative of the most popular leisure activities among the Swedish population. Some of the categories include a wide scope of activities (e.g. hobbies), whereas others are narrowly defined (e.g. reading books). The degree of physical engagement and commitment each activity entails also varies. Several of the activities are seasonally dependent (e.g. gardening) or require financial resources (e.g. going to shows). The activities are clearly gendered in

[3] The response rate for LNU 1968 was 90.8 per cent, and the response rate for LNU 1974 was 85.2 per cent.

[4] For a more detailed description of the data collection and sample, see (Eriksson and Åberg 1987) and (Evertsson and Magnusson 2014).

practice. It is important to note that it is not always obvious which activities should be classified as leisure and which should not. Thus, the leisure activities examined in this study's setting, Sweden, may not be considered leisure activities in another setting. For instance, church activity may not be considered a leisure activity in countries with high levels of religiosity. In addition, each of these activities may have different effects on retirement timing. For instance, if the activities are of a social or a physical character, it is possible that individuals who engage in such activities will postpone retirement because they have the strength to continue paid work, and because participation in these activities add to their strength. By contrast, people who participate in certain activities may be motivated to retire early, because they find greater satisfaction in these activities than in paid work, or because the activities demand more regular participation.

The respondents answered the questions '*Do you usually perform the following as a leisure activity...*' by answering '*never*', '*sometimes*', or '*often*'.[5] A data limitation is that the ranking of participation frequency was crude, making the discrete change of frequency participation somewhat limited. A similar dilemma was detected by (Konolaan et al. 2000). However, the participation frequencies may indicate a qualitative change in activity. Furthermore, the variation in leisure activities in this study is a subjective measure. Other studies measuring participation in activities have included more detailed scales, such as hours per week (Rosenkoetter et al. 2001), or finer categories (Beehr and Nielson 1995; Nimrod 2007).

Following previous research, a component factor analysis was used to identify the structures of subgroups of leisure activities and to create activity indexes (Beehr and Nielson 1995; Griffin and McKenna 1999; Lennartsson and Silverstein 2001; Samuelsson 2002; Nimrod 2007). The analysis was conducted on reported leisure engagement before retirement. From the rotated factor matrix (Table 1), it is possible to estimate five subgroups of so-called leisure activity domains (Lennartsson and Silverstein 2001). Activities are presented in a domain if the factor loading was above 0.5. This threshold was chosen because in previous methodological literature, 0.5 has been shown to be a *good* cut-off for factor loadings (Comrey and Lee 1992). The factor loadings indicate underlying structures, and it is possible for activities to load with several activities in multiple domains.

Domain 1 explained the largest variance, at 54 per cent. Four items loaded on domain 1: *reading books, going to restaurants, going to the cinema* and *going to shows* (including theatre, concerts and museums) (labelled *cultural activities*). The two activities which loaded on the next domain were *visiting friends/relatives* and *friends/relatives visiting* (labelled *social relationships*). The activities in domain 3 were *political activities, study circles* and *hobbies* (labelled *political activity,*

[5] Church activities were measured with six possible answers: none, about once a year, a few times a year, about once a month, a few times a month, and once week or more. We coded the first two categories as never, the two middle categories as sometimes, and the two last categories as often.

Table 1:
Rotated component loadings for 14 survey items on activities

Component	**1**	**2**	**3**	**4**	**5**
Cinema	**0.718**	0.071	−0.074	0.261	0.009
Theatre	**0.761**	0.030	0.230	0.067	0.113
Restaurant	**0.558**	0.022	0.092	0.243	0.385
Reading books	**0.623**	0.070	0.133	−0.278	−0.386
Gardening	0.074	0.214	0.167	0.056	**0.591**
Hobbies	0.017	0.073	**0.725**	−0.135	0.306
Sports*	0.404	0.103	0.050	−0.256	0.143
Study circle	0.308	−0.002	**0.589**	0.132	0.014
Dancing	−0.037	0.023	0.046	**0.670**	0.146
Music	0.225	0.020	0.049	**0.566**	−0.155
Church activity	−0.135	0.167	0.294	0.311	**−0.554**
Political activity	0.018	0.049	**0.516**	0.082	−0.194
Visiting friends/relatives	0.136	**0.906**	0.037	0.064	0.086
Friends/relatives visiting	0.035	**0.926**	0.065	−0.026	0.020
Eigenvalues	2.728	1.594	1.215	1.085	1.012
Percentage of total variance	17.049	9.964	7.597	6.782	6.325

Note: Loadings $\geq .10$
*Sports do not load with any other item.

hobbies and study circles). Domain 4 consisted of *music* (playing or singing) and *dancing* (labelled *dance and music*). The fifth domain consisted of two activities, *gardening* and *church activities* (labelled *gardening and church activities*). Engaging in *sports* (including a variety of exercise activities) did not load with any of the other activities and was therefore deleted from the study. Applying a lower cut-off of 0.4 would mean that sports could be added to domain 1, and applying a higher cut-off of 0.6 would mean that several domains would ‘lose’ activities. For instance, domain 5 would not be applicable because the loadings for the two activities in this particular domain are below 0.6. Other activity groupings were tested for the purposes of this study, such as creating domains based partly on the results of the factor analysis and partly on subjective groupings (e.g. including church activities in domain 3 and hobbies in domain 5). Other groupings did not significantly change any conclusions drawn in this study.

The five continuous indexes were standardised to a 0–8 range. The values were then categorised as follows: *never* (0–2), *sometimes* (3–5), and *often* (6–8). Never engaging suggests very low participation levels, but not necessarily a complete absence of participation. Additional consideration was given to individuals who *often* participated in only one of the activities within each activity domain. For example, individuals who *often* read books but did none of the other activities in the index were assigned the highest score in the index. Ignoring this condition would lead to a bias in which individuals who are very active in only one activity are

Table 2:
Descriptive statistics of the leisure domains

	% Never	% Sometimes	% Often	% Total
Cultural activities	33.8	60.2	6.0	100
Social relationships	5.1	55.7	39.2	100
Political activity, study circles and hobbies	67.9	29.2	2.9	100
Dance and music	76.8	21.2	2.0	100
Gardening and church activity	27.7	38.6	33.7	100

mistakenly assigned to the low or middle category. While it is possible to divide the indexes into more categories, this would cause the number of cases in each category to become quite small, which would make it more difficult to distinguish between active and non-active individuals. An alternative would be to dichotomise engagement into active/non-active, but such indicators may be too crude. It is also possible to use continuous indexes. Sensitivity analyses using OLS regressions with domains as a continuous scale indicated that there were some similarities with the analyses with categorised domains. However, using a continuous scale did not identify variation in *engagement levels*, which this study seeks to address. In addition, a sensitivity analysis with all of the activities included in a single index was tested, as were analyses in which each activity was treated separately. The results of the sensitivity analysis did not indicate how the different activities were associated with retirement timing or leisure engagement after retirement, and the separate analyses generated results similar to those of the models with categorised domains.

In Table 2, the frequencies of leisure engagement for the full sample are presented.[6] We can see that the majority of the sample sometimes engaged in cultural activities, but that very few engaged often. Furthermore, a large proportion of the sample sometimes engaged in social relationships, and very few never engaged. It was much more common to never engage in political activities, study circles and hobbies, and dance and music. Very few respondents engaged in these activities often, and approximately one-fifth engaged sometimes. Involvement in gardening and church activities was more equally distributed; close to 40 per cent of respondents engaged sometimes.

[6] Descriptive statistics distributed over 1981–2010 period can be found in Appendix A.1.

5.2 Method of analyses

In the first part of the analysis, engagement in leisure activity domains before retirement is explored in relation to retirement timing using discrete-time survival analysis. The event of interest is the transition to retirement, which is recoded in discrete time because the data only contain annual information. Individuals' retirement transitions are observed during the 1981–2010 period from age 58 until they retire or turn 75, or until the last LNU in 2010. Discrete time methods do not require the specific time of retirement because an individual's survival history is defined by a set of discrete time intervals. We apply complementary log–log functions which provide proportional hazard models and hazard ratios (Allison 2010). The leisure activity domains in this analysis are time-varying and may be measured before age 58 depending on age the individual retires, turns 75, or last participates in the LNU.

For an evaluation of the second objective, multinomial logistic regression is used because the outcome variables have three categories (Retherford and Choe 1993). In the multinomial regression models, the leisure activity domains *after* retirement serve as the outcome variables, and the leisure activity domains *before* retirement serve as the main independent variables. Here, only individuals who retired before 2010 are included (N = 1110). For these particular analyses, activity domains are measured at two time points: engagement before retirement is derived from the 1981, 1991, or 2000 surveys; and engagement after retirement is derived from the 1991, 2000, or 2010 surveys. Like the discrete-time survival analysis, the activity domains can be measured before age 58.

The covariates are measured before retirement or in the most recent survey in which the respondent participated, depending on whether the respondent retired during the study period. The covariates are selected based on previous research and statistical evaluations during the study's process (see Appendix Table A.2 for details). A test for multicollinearity did not reveal a correlation between the covariates. The two health indexes, *psychological well-being* and *physical mobility*, are based on several self-reported answers to questions defined in the original data. Self-reported health is highly correlated with objective physical and mental health indicators (Wallace and Herzog 1995). *Place of residence* is defined by standardised homogeneous regions generated for distinct geographical areas in Sweden (Statistics Sweden 2003). *Socio-economic status* is divided into 1) manual workers, 2) non-manual workers, and 3) the self-employed. Farmers and fishermen are counted as self-employed (Statistics Sweden 1982).

In the first part of the analysis, some of the covariates can be considered confounders to both retirement and leisure engagement, particularly for socio-economic status and the two health measures. Socio-economic status is associated with the amount of time and resources spent on leisure, and is highly associated with retirement timing. Moreover, health is a reason to both exit the labour force and continue paid work, and it may influence opportunities to engage in leisure.

6 Results

Table 3 presents the results from the complementary log–log binary models (presented in the first column of Table 3) and the models which include all of the covariates separately for each activity domain, as well as a final model which includes all of the activity domains (presented in the last column of Table 3).

The results from the separate binary models for each activity domain (see first column in Table 3) indicate that there are statistically significant associations between engagement in leisure activities before retirement and the risk of retirement. The results indicate that individuals who engage in cultural activities before retirement have a higher propensity to retire than people who never engage in these activities. The results also indicate that sometimes engaging in social relationships decreases the risk of retirement. Engagement in political activities, study circles, and hobbies is positively with retirement timing. Engaging sometimes or often in dance and music is negatively associated with retirement timing. Individuals who sometimes engage in gardening and church activities retire later than those who never engage, and those who frequently engage in these activities retire earlier. Overall, the results indicate that engagement in cultural activities and frequent engagement in gardening and church activities is associated with early retirement; whereas engagement in political activities, study circles, hobbies, dance and music and modest engagement in social relationships, gardening and church activities is associated with a postponement of retirement.

When covariates are added in models 6–10, the significance of the leisure domains disappears. An exception is the dance and music category, which continues to be negatively associated with retirement risk. Stepwise models (available upon request from author) show that the period was predominantly responsible for the loss of a significant effect of activity engagement on retirement timing, which suggests that leisure activities retained the same pattern as in the binary models if period was excluded. We see the same pattern in model 11, which includes all of the leisure domains. As expected, in models 6 to 10 we also see that the strongest predictor of retirement is age, and the highest risk of retirement is at age 65. The other covariates follow the same pattern in all of the models and generally follow previous research on the predictors of retirement timing. Having a partner and having poor

Table 3:
Hazard ratios of retirement by leisure activity domains. Complementary log–log models

		Binary Models 1–5 *	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11
Cultural activities	Never (r)	1	1					1
	Sometimes	1.28*	1.06					1.05
	Often	1.62***	0.96					0.92
Social relationships	Never (r)	1		1				1
	Sometimes	0.76**		0.89				0.95
	Often	1.16		0.99				1.02
Political activity, study circle, hobbies	Never (r)	1			1			1
	Sometimes	0.53***			0.90			1.03
	Often	0.53***			0.94			1.03
Dance and music	Never	1				1		1
	Sometimes	0.50***				0.83***		0.77**
	Often	0.71*				0.87		0.90
Gardening, church activity	Never (r)	1					1	1
	Sometimes	0.80***					0.97	1.10
	Often	1.54***					0.91	0.95
Age	58 (ref)		1	1	1	1	1	1
	59		1.01	1.01	1.01	1.01	1.01	1.01
	60		1.90***	1.90***	1.90***	1.90***	1.90***	1.90***
	61		1.77***	1.76***	1.76***	1.77***	1.77***	1.76***
	62		1.88***	1.87***	1.88***	1.88***	1.89***	1.88***
	63		3.00***	2.98***	2.99***	2.99***	3.01***	2.99***
	64		2.50***	2.48***	2.49***	2.49***	2.52***	2.49***
	65		8.80***	8.73***	8.76***	8.76***	8.86***	8.76***
	66		2.10***	2.08***	2.09***	2.09***	2.12***	2.09***
	67		0.88	0.87	0.87	0.87	0.88	0.87
	68		0.75	0.74	0.75	0.75	0.76	0.75
	69		0.62*	0.61*	0.61*	0.61*	0.63*	0.61*
	70–75		0.29**	0.29**	0.29**	0.29**	0.28**	0.28**
Period	1982–2009 (continous)		1.06***	1.05***	1.07***	1.07***	1.07***	1.05***
Gender	Men (r)		1	1	1	1	1	1
	Women		0.96	0.96	0.98	0.97	0.97	0.98
Partner status	Single/Divorced/Widow (r)		1	1	1	1	1	1
	Married/Cohabiting		1.14**	1.14**	1.14**	1.14**	1.16*	1.14**
Place of residence	Small/medium communities/ countryside (r)		1	1	1	1		1
	Metropolitan cities and suburbs		0.94	0.94	0.93	0.93	0.93	0.93
Have children	Have children (r)		1	1	1	1	1	1
	Have no children		1.03	1.04	1.03	1.03	1.03	1.03
Physical mobility	Normal mobility (r)		1	1	1	1	1	1
	Reduced mobility		1.01	1.00	1.00	1.00	1.00	1.00
	Highly reduced mobility		0.99	0.98	0.97	0.96	0.96	0.97
Psychological well-being	Average (r)		1	1	1	1	1	1
	Lower than average		1.15**	1.15**	1.15**	1.14**	1.14**	1.15**
Socio-economic status	Manual workers (r)		1	1	1	1	1	1
	Non-manual workers		1.02**	1.02	1.03	1.02	1.02	1.02
	Self-employed		0.80**	0.80**	0.80**	0.80**	0.80**	0.80**

Note: *N* of subjects 2875; *N* of single failures 1548; *N* of observations 27391.
(r) reference category, Significance levels *$p < .05$; **$p < .01$; ***$p < .001$.
*The binary models are run separately for each leisure activity domain, and include only the activity domains separately on retirement timing.

psychological well-being are positively associated with retirement timing, and self-employment is negatively associated with retirement timing. In the models stratified by gender (not presented here), the results show similar patterns.[7]

Next, we turn to Tables 4a and 4b and the results from the multinomial logistic regressions in which engagement in leisure activity domains before and after retirement is explored. A likelihood-ratio test showed that the models including preretirement leisure activity domains improved the fit of the models.

The results from both the binary and the full models on engagement in cultural activities indicate that higher levels of engagement before retirement (i.e. sometimes or often) are associated with higher relative levels of engagement after retirement. Individuals who never engage in cultural activities do not tend to engage in these activities after retirement. The results further indicate that individuals who sometimes engage in cultural activities are more likely to engage in these activities often after retirement. It is also more likely for individuals who frequently participated in cultural activities before retirement to move down one engagement level (rather than to stop participating completely) than it is for individuals who never participated in these activities before retirement to move up one engagement level after retirement.

The pattern for the rest of the leisure domains is similar. The results indicate the importance of engagement or lack of engagement in the activity domains for engagement in those activities when retired. Thus, individuals largely continue their existing patterns of engagement after retirement, or make modest changes. Furthermore, in some cases the ratios are very high for the category *often*, which suggests that only a small number of the individuals who engaged frequently in the domain before retirement stopped engaging after retirement.

The results from the covariates indicate that women are more likely to engage in all activity domains except gardening and church activities. Having a partner is positively associated with engagement in social relationships, political activities, hobbies, study circles, and gardening and church activities. Individuals without children are less likely to engage in social relationships, dance, and music after retirement. Living in a metropolitan area is positively related with engagement in cultural activities and social relationships, but is negative for engagement in political activities, hobbies, study circles, gardening and church activities. The results also show that individuals with reduced physical mobility are less likely to engage in

[7] Moreover, additional analyses have been conducted in which we estimated effect of the change in the level of engagement between two waves, 1981 and 1991, on retirement timing. Due to data restrictions, the analyses included a subgroup of individuals consisting of those who participated in three waves (1981, 1991, and 2000), with the restriction that they had to have retired between 1992 and 2000 ($N = 516$). The descriptive statistics indicated that the largest proportion of individuals did not change their activity level between the waves, and that more individuals had a higher level of leisure engagement in 1981, when they were younger, than they did in 1991. This pattern varied somewhat between the activity domains, but was in general rather similar. The results from the complementary log–log models (not presented here) were not statistically significant for any of the activity domains.

Table 4a:
Multinomial logistic regression. Level of engagement in leisure activities after retirement

	Model 1 Cultural activities				Model 2 Social relationships				Model 3 Political activity, study circle, hobbies			
	Sometims *vs* Never		Often *vs* Never		Sometimes *vs* Never		Often *vs* Never		Sometimes *vs* Never		Often *vs* Never	
	Binary	Full	Binary	Full	Binary	Full	Binary	Full	Binary	Full	Binary	Full
Cultural activities												
Sometimes	10.16***	7.79***	8.68***	6.09***								
Often	6.73***	6.29***	21.1***	18.29***								
Social relationships												
Sometimes					6.21***	5.38***	9.51***	8.32***				
Often					9.76***	8.48***	29.60***	24.44***				
Political activity, study circle, hobbies												
Sometimes									3.63***	3.28***	2,82***	2.92***
Often									3.74***	3.27***	4.09***	4.07***
Age of retirement (65)												
58–60		1.38		1.65		1.62		1.64		0,94		0.66*
61–64		1.73**		2.02***		1.35		1.61		1.17		1.14
66 OR older		1.61*		2.08**		2.55**		3.10**		1.52		1.81**
Year of retirement 1982–2009		1.03**		1.05***		1.03		1.01		0.97*		1.02**
Gender (men)												
Women		1.38*		1.83***		1.35		1.51*		1.39		1.49***
Partner Status (single/divorced/widow)												
Married/Cohabiting		1.42*		1.61*		2.12***		2.33***		1.08		1.44**
Having children (have children)												
Have no children		1.26		0.99		0.79		0.60*		1.19		0.91
Place of residence (small/medium communities, countryside)												
Metropolitan cities and suburbs		1.64**		2.17***		1.45***		1.42***		0.67*		0.86
Physical mobility (normal mobility)												
Reduced mobility		0.60**		0.89		0.80		0.50**		0.98		0.92
Highly reduced mobility		0.72		0.95		0.34**		0.22***		0.52		0.63
Psychological well-being (average)												
Lower than average		1.40		1.20		0.64*		0.63*		0.65*		0.87
Socio-economic status (manual workers)												
Non-manual workers		2.25**		2.49***		1.26		1.29		1.94***		1.61***
Self-employed		0.77		0.83		1.21		0.94		1.66		1.08

Note: Reference category in parenthesis. Significance levels $*p < .05$; $**p < .01$; $***p < .001$; $N = 1110$.

cultural activities and social relationships, and individuals with poor psychological well-being are less likely to engage in social relationships and political activities, hobbies and study circles. In addition, non-manual workers are more likely to engage in cultural activities, political activities, hobbies and study circles, whereas self-employed are more likely to engage in dance, music, gardening and church activities.

Table 4b:
Multinomial logistic regression. Level of engagement in leisure activities after retirement

	Model 4 Dance and music				Model 5 Gardening, church activity			
	Sometimes *vs* Never		Often *vs* Never		Sometimes *vs* Never		Often *vs* Never	
	Binary	Full	Binary	Full	Binary	Full	Binary	Full
Dance and music	8.05***	10.95***	2.33**	2.49***				
Sometimes	16.92***	14.78***	12.32***	14.31***				
Often								
Gardening, church activity					4.76***	4.46***	4.66***	4.46***
Sometimes					3.44***	3.17***	11.22***	3.12***
Often								
Age of retirement (ref = 65)								
58–60		1.44**		0.63*		0.91*		0.65*
61–64		1.32		1.28		1.03		1.09
66 or older		0.78		1.35		0.98		1.06
Year of retirement 1982–2009		0.89***		1.01*		1.02		1.04***
Gender (ref = men)								
Women		1.97		1.12		0.84		0.95
Partner Status (single/divorced/ widow)								
Married/Cohabiting		1.31		1.33		1.13		1.42*
Having children (have children)								
Have no children		1.69		0.64**		1.19		1.09
Place of residence (small/medium communities, countryside)								
Metropolitan cities and suburbs		0.56		1.32		0.69		0.70**
Physical mobility (normal mobility)								
Reduced mobility		0.64		0.63		0.67		0.86
Highly reduced mobility		0.00		0.97		0.58		0.61
Psychological well-being (average)								
Lower than average		0.87		0.96		0.80		0.91
Socio-economic status (manual workers)								
Non-manual workers		1.28		1.66**		1.46*		1.42**
Self-employed		2.19**		0.98*		2.24**		1.18

Note: Reference category in parenthesis. Significance levels *$p < .05$; **$p < .01$; ***$p < .001$; $N = 1110$.

To identify a potential disengagement process, additional analyses were conducted with the interaction between the age at retirement and the number of years between retirement and the survey year. The results did not show any consistent patterns or statistically significant results. Moreover, a robustness check using the same models analysed separately for men and women showed a pattern which was nearly identical to the one presented above, with a few exceptions. For instance, partner status was found to be statistically significant for men but not for women, which indicates that having a partner is more important for leisure engagement among retired men than among retired women. Another example is that physical mobility is important for engaging often in any of the activity domains among women, but not among men.

7 Discussion

The focus of this study was the association between preretirement leisure activities and retirement timing and the association between preretirement leisure and postretirement leisure. These associations were tested with five leisure activity domains derived from four waves of the longitudinal Swedish Level-of-Living survey collected between 1981 and 2010.

In binary analyses, engagement in leisure before retirement was clearly associated with retirement timing. However, with the inclusion of other predictors, leisure engagement did not retain its significance. The predominant predictor that altered the effects for leisure activities was the period of retirement. Thus, the proposed hypothesis, *individuals who are more involved in leisure activities before retirement retire earlier than individuals who are less involved in leisure activities before retirement*, is not supported when we consider the period in the models. This is not surprising because changes in the pension system and the labour market can be attributed to the period. Hence, changes in the pension system or in the labour market may result in a general postponement of retirement or in early retirement. In this case, the risk of retirement decreases for the 1981–2010 period. The only association that remains is dance and music; i.e. engagement in dance and music is associated with a postponement of retirement. It is noteworthy that when the effect of period of retirement is excluded but the central predictors of retirement timing are included (such as health, income, education and marital status), the statistical significance of leisure engagement is retained; thus, the hypothesis is partly confirmed. The specific leisure activities which were related to earlier retirement were frequent engagement in cultural activities and in gardening and church activities; whereas the activities which were associated with a postponement of retirement were social relationships, political activities, study circles, hobbies, dance and music, and modest levels of engagement in gardening and church activities. It is possible that individuals who engage in cultural activities do not want to engage in activities which are time-consuming, regular, or physically or psychologically demanding. This may be because these individuals are in poor health, and prefer to engage in occasional and passive activities which are less demanding. We may assume that these individuals retire early for the same reason. It is also is possible that the individuals who engage in (costly) cultural activities are also those who can afford to retire early. Moreover, it is possible that social relationships, political activities, study circles, hobbies, church activities, dance and music are activities which are more physical, social, intellectual and regular; and that these activities demand more planning and engagement than cultural activities. Individuals who engage in these activities might be social people who have both the physical and psychological energy to interact with others and to participate in physical and intellectual activities. In turn, these activities may provide these individuals with additional physical and psychological strength. Thus, these individuals may be more likely than others to have the ability to continue to work.

Although not all leisure activities are positively associated with retirement, the results of this study indicate that an association does exist. Previous studies have reported no statistically significant results. An important contribution of this study is that, unlike previous studies on this issue, we investigated the direct association between leisure engagement and retirement timing. From the results presented here, it seems plausible to relate leisure engagement before retirement with retirement behaviours. In such a scenario, there is a risk that political aspirations to raise the retirement age will not be efficient if individuals value leisure more than continued labour force participation. This is particularly true in cases in which leisure activities lead to earlier retirement, which creates a conflict between the need to encourage people to remain in the labour force in light of an ageing population, and the need to have a healthy older population supported by activities which encourage the postponement of retirement. A policy scenario which addresses this conflict might, for example, involve the promotion of engagement in activities which are associated with a postponement of retirement when older workers are still active in the labour force, such as through a health care allowance tied to employment which increases with increasing age. Another option is to make the cost of leisure activities tax deductible for older individuals who participate in the labour force. Such policies, which inherently cater to individuals still in paid work, would not only promote better health (as individuals who are active in their leisure time have been found to be both healthier and more satisfied with life), but may also encourage workers to postpone retirement. A suggestion for further research is to investigate why certain activities or dimensions of activities are associated with early retirement or postponed retirement, and to examine the question of whether retirement timing depends on whether leisure activities are physical, social, or intellectual.

The second association we explored was that of leisure activities before and after retirement, using a subsample which included retirees. To explain the association, we generated three hypotheses based on three common theories in social gerontology. The first hypothesis was based on continuity theory (Atchley 1976). The overall pattern supported the hypothesis, indicating that individuals tend to have the same level of engagement before and after retirement. The second hypothesis, which was based on activity theory (Harvighust 1961), implied that the level of engagement in leisure activities is likely to increase after retirement. We found that individuals were more likely to increase their engagement after retirement if they had sometimes engaged in the activity domains before retirement, possibly because they were exposed to the activities before retirement, and simply increased their engagement after retirement as a substitute for work. Thus, the findings in this study partially support the hypothesis.

The last hypothesis, which was based on disengagement theory (Cumming and Henry 1961), suggested that leisure engagement would decrease after retirement. The results do not support this hypothesis. This is likely because individuals do not disengage from activities they previously enjoyed within a short period after retirement. To indicate disengagement, we would need to find that older individuals who had retired several years previously show a pattern of decreased leisure engagement, and that younger individuals show continuous or increased engagement. This was not the case. The theory may better explain activity levels in later periods of life, which are not investigated in this study. It is also possible that individuals initiate a disengagement process many years before retirement by decreasing or stopping their engagement in leisure activities; hence, this process is not well captured in this analysis, and may be of greater relevance for individuals with poor health.

In sum, the results indicate that individuals tend to have the same level of engagement in leisure activities before and after retirement. Furthermore, individuals are more likely to decrease or increase their level of engagement than they are to completely stop participating in their previous activities or to start a new activity. The results clearly show that it is important that people are exposed to leisure activities before retirement if the goal is to encourage them to participate in these activities after retirement (Rosenkotter et al. 2001). This conclusion is also supported by the finding that a rather large proportion of retirees were not engaged in any leisure activity before or after retirement. This result appears to support the hypothesis based on activity theory. Moreover, there is a large risk that individuals who are not active will suffer from poor health and low levels of life satisfaction. As others have noted, it is essential to consider that the natural decline of physical and mental capabilities can be slowed or hastened depending on lifestyle (Taylor et al. 2004). This is especially important because 'non-activity' is the most stable form of activity behaviour in old age (Glamser and Hayslip 1985). Thus, it seems to be in the best interests of both individuals and society at large to encourage retirees to remain active (Rowe and Kahn 1998; Rojek 2010; Zaidi et al. 2013), in part by promoting participation in the activities individuals choose to engage in before retirement—because, as this study has shown, these activities are often carried over into retirement (see discussion by Rosenkotter et al. 2002). A broader concern is therefore to understand how governmental policies can be structured to ensure that older individuals have equal rights to engage in leisure activities (Kraus 1983; Olson 1993).

The findings of this study expand our knowledge of how engagement during labour force participation changes at retirement, and indicate that individuals do not enter retirement with the same tendency to be active. A suggestion for future research is to investigate in more detail the conditions under which individuals are likely to be active upon entering retirement. Future research should also investigate how health is affected by the level of engagement in leisure activities in relation to retirement, and should examine whether there are differences between non-active individuals before and after retirement and active individuals who continue to be active after retirement.

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Appendix

Table A.1:
Distribution of the leisure activity domains, 1981–2010 (%)

	1981	1991	2000	2010
Cultural activities				
Never	37.3	33.7	31.1	27
Sometimes	43.2	62.2	62.0	62.1
Often	19.5	4.1	6.9	10.9
Total	100	100	100	100
N	2853	2875	1741	1063
Social relationships				
Never	4.0	6.2	5.2	6.6
Sometimes	47.7	77.3	49.7	43.4
Often	48.3	16.5	45.1	49.6
Total	100	100	100	100
N	2853	2875	1741	1063
Political activity, study circle and hobbies				
Never	30.9	36.3	49.7	50.2
Sometimes	38.4	52.7	39.6	42.4
Often	30.6	10.8	10.6	7.4
Total	100	100	100	100
N	2853	2875	1741	1063
Dance and music				
Never	71.9	71.2	86.6	88.0
Sometimes	10.1	27.1	10.1	10.2
Often	18.0	1.7	3.3	1.8
Total	100	100	100	100
N	2853	2875	1741	1063
Gardening, and church activity				
Never	31.0	36.3	26.1	23.5
Sometimes	32.2	50.4	33.8	22.1
Often	36.8	13.3	40.1	54.4
Total	100	100	100	100
N	2853	2875	1741	1063

Table A.2:
Distribution of covariates (%)

Covariates		% All	% Not retired	% Retired
Age of retirement	58			7.3
	59			6.5
	60			10.8
	61			8.9
	62			8.5
	63			11.9
	64			8.9
	65			24.9
	66			5.7
	67			2.1
	68			1.4
	69			0.9
	70–75			1.9
Year of birth	1916–1928	40.4	68.5	15.4
	1929–1938	25.8	15.2	35.3
	1939–1948	23.9	11.8	34.7
	1949–1952	10.0	4.5	14.7
Gender	Men	49.5	47.8	50.9
	Women	50.5	52.2	49.1
Partner status	Single/Divorced/Widow	39.7	54.2	26.7
	Married/Cohabiting	60.3	45.8	73.3
Place of residence	Small/medium community and countryside	72.4	72.3	72.5
	Sthlm/Gbg/Malmo: inner-city/suburbs	27.6	27.7	27.5
Ever having children	Have children	74.8	65.7	82.9
	Have no childless	25.2	34.3	17.1
Physical mobility	Normal mobility	66.2	67.9	64.5
	Reduced mobility	26.7	25.3	29.0
	Highly reduced mobility	7.1	6.8	6.5
Psychological well-being	Average	78.0	79.7	76.7
	Lower than average	22.0	20.3	23.3
Socio-economic status	Non-manual workers	49.5	38.7	51.2
	Manual workers	40.0	42.4	39.3
	Self-employed (incl. farmers, fishermen)	11.2	18.9	9.4
N		2875	1358	1517

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More with less: the almost ideal pension systems (AIPSs)

*Gustavo De Santis**

Abstract

After exploring the rationale of pension systems, I outline the essential characteristics of 'almost ideal pension systems' (AIPSs), an improved version of the pay-as-you-go (PAYG) model. Depending on the policy choices, to be expressed in relative terms with parameters that range between zero and one, several—and possibly very different—forms of AIPSs can take shape: e.g. with high or low pension benefits, or with early or late retirement. (Almost) independent of the version chosen, AIPSs compare favourably in theory and in simulations to all other PAYG pension systems: for example, AIPSs are found to be superior in terms of their ability to ensure a balanced budget, intergenerational equity, resilience in the face of virtually all possible demographic and economic changes, and constancy at the preferred level for the relative economic well-being of the three basic age groups (young people, adults, and seniors). In addition, AIPSs are able to reduce, and even partly redress, the normally perverse redistributive effects that derive from heterogeneity in survival rates between subpopulation groups.

1 Introduction

Some time ago (De Santis 2003, 2011, 2012),[1] I proposed a new *family* of pay-as-you-go (PAYG) pension systems, which I called 'almost ideal pension systems', or AIPSs. AIPSs were designed to serve both as a theoretical standard of reference against which to assess the performance of all other systems, and as a practical solution to the pension problems of the developed countries, especially in Europe, where mature, but usually unbalanced, PAYG pension systems already operate.

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[1] Sections 1 to 4 of this paper overlap with my previous work. The rest of the paper is new.

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There are an infinite number of possible versions of AIPSs with a common rationale but with very different shapes, depending on the policy choices (see below). In this paper, I do not discuss the 'best' possible form of AIPSs, or offer practical advice on how to transition from an existing pension arrangement to an AIPS. Instead, my goal is to illustrate the very general characteristics of the AIPSs subset.

The name itself calls for some clarification. Even if, as we will see shortly, this type of arrangement proves superior to all of its PAYG alternatives (defined benefit (DB), defined contribution (DC), notional defined contribution (NDC), and risk sharing (RS)), there are several reasons why many observers consider AIPSs to be less than ideal. First there are trade-offs which cannot be ignored. For example, more generous pensions benefits must somehow be financed, either through higher contributions or later retirement (or both). Second, AIPSs allow for transfers of money between two or three population subgroups *only:* i.e. from people of working ages to seniors, and, if so desired, children. Meanwhile, a large share of the transfers which are standard features of the modern welfare state are not accounted for (e.g. protection against unemployment and poverty). Thus, AIPSs are not a panacea for all social problems, and need to be complemented by other welfare institutions. Finally, *every element* of AIPSs is defined in relative terms, while the absolute levels vary over time. For example, the retirement age moves in line with the changing average length of life,[2] and the average amount of the pension benefit is not defined in euros, but as a fraction of the average earnings of *adults* in a specific period. Moreover, the payroll contribution rate oscillates over time around a predefined average. I have two responses to these kinds of objections. First, the future is unpredictable, and if some subgroups are protected from uncertainty, others will have to bear more than their 'fair' share of it. Second, working in strictly relative terms is the only way to make tenable promises which can be kept forever in every possible economic and demographic scenario, without the need to predict the future or to ever adjust the system.

AIPSs are an *infinite* subset of possible pension systems; the actual form they take depends on the policy choices (parameters ranging between zero and one). In this paper, I set out to prove that all of these versions share a number of desirable properties, including automatic adjustment to all demographic and economic shocks. The discussion is deliberately kept at a very high level of generality, and the examples which are occasionally provided are just that: examples. If AIPS were ever to be applied in practice, however, two more steps would be needed: 1) the preferred set of policy parameters would have to be chosen (and, possibly, protected from ill-considered changes over time, by, for example, requiring that qualified parliamentary majorities approve any revisions), and 2) a plan for transitioning from the current situation to the selected form of AIPS would have to formulated. Both

2 AIPSs can also work with fixed threshold ages, but this variant is not discussed here.

steps present several theoretical and practical challenges[3] which cannot be discussed here. In all of my examples, I will simply assume that a specific, somehow optimal form of AIPS is and has always been in existence.

After providing a general, but very schematic, overview of the rationale of pension systems (Section 2), and of AIPSs in particular (Sections 3 to 6), I run a simulation to support my claim that AIPSs are better than other PAYG pension arrangements (Section 7). I conclude with a discussion of the issue of heterogeneity and intra-generational equity (Section 8).

2 A selected presentation of the aims and risks of pensions systems

Very broadly, pension systems do two main things: they "provide income security to retirees, [and] they *may* also aim at redistribution across population groups, such as lifting the low-income elderly out of poverty" (Kohli and Arza 2011, p. 251; my emphasis). As pension systems are complex and expensive, several key issues tend to arise in discussions of these systems, most of which have been mentioned by (Kohli and Arza 2011) themselves. In this paper, however, I will focus on two issues in particular: viability and risk distribution.

Viability is a notion that parallels that of 'sustainable development' (UN 1997): a pension system must be designed so that it can be maintained *indefinitely in its present form* without significantly depleting or degrading resources (e.g. reserve capital) and without adversely affecting future generations. Of course, the rules of the pension system *can* be changed over time if social preferences vary, but if change proves to be unavoidable (e.g. because the system is collapsing), then some groups will have taken more than their share, while other groups—typically the younger generations—are left to pay the bill.

Viability introduces two main constraints. The first constraint is the need to balance the budget: i.e. inflows must match outflows. This, however, rarely happens in practice.[4] The second constraint is one which economists tend to emphasize: namely, that pension systems should not (even unintentionally) induce negative economic side effects. One such effect is the potential impairment of current or future production, which occurs in two main ways: labour market participation may be discouraged by high taxes or early retirement schemes (Gruber and Wise 1999; Sánchez-Romero et al. 2013; OECD 2013), and savings may be depressed (Börsch-Supan 2008).

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[3] Complex utility functions would have to be maximized, taking into account the possible adaptive reactions of individuals and institutions. Past promises would also have to be taken into account.

[4] A (limited) structural imbalance could be theoretically justified, to the extent that the pension system is considered a public good (like the legal system or national defence) which is partly financed with taxes. This variant, not discussed here, would not affect the working of AIPSs.

It is occasionally argued that funding a pension system is better than relying on PAYG. But this assertion is both unwarranted (Orszag and Stiglitz 2001; Barr 2002) and irrelevant, because existing PAYG pension systems cannot be (easily) dismantled. Thus, the only viable option is to reform these systems. In these reform efforts, (actuarial) equity[5]—i.e. a close correspondence between the amounts people pay into the system in their adult years and the amounts they receive in retirement—is deemed essential to induce participation in both the official labour market and the pension system. Unfortunately, equity is difficult to achieve, both given the budget constraints (that is, how can future pension resources be matched exactly with the actuarially fair expectations of future retirees?) and the need to redistribute benefits to favour the poor. Thus, it appears that some sort of compromise between these conflicting demands is needed.

As for the *risk issue*—which I am discussing here only very schematically—the main question is who gains and who loses if projections prove to be inaccurate. For example, economic growth, employment rates, inflation, or population ageing may not develop as expected. Pension schemes rarely tackle the issue of risk explicitly, but implicitly and in practice they always provide an answer. For instance, the defined contribution system (in which the payroll contribution rate is predefined) protects the employed because workers know in advance what fraction of their salary they will forego in order to make pension contributions, but leaves pensioners exposed to a substantial degree of income variation. Attempts to protect both age groups (adults and seniors) are not easily reconciled with the need to balance the budget. For example, the now popular notional defined contribution (NDC) system is designed to predefine both payments and benefits. In practice, however, this translates into either budget imbalances or the application of 'adjustment factors' (forcing pension benefits to correspond to the available resources), which reintroduces exposure to certain categories of risk. It therefore appears that 'risk sharing' between population subgroups (Musgrave 1981; Gonnot et al. 1995) is the best option—and AIPSs, as we will see, represent an improved version of this idea.

Two more issues may be considered. This first is fertility. It is already low in developed countries, and pension systems may aggravate the problem by depriving children of their economic utility for their ageing parents. Thus, several scholars have suggested that pension benefits should be linked not only to individual contributions, but also to individual fertility (Demeny 1986, 1987; Cigno and Werding 2007).

The second is the risk of 'inverse redistribution', or distribution from the poor to the rich. As pension systems transfer resources from working-age adults to the elderly, they favour long-living population subgroups, including higher earners, who on average spend proportionally more years in retirement and receive more benefits

[5] Interest in actuarial equity has recently increased, which explains the popularity of NDC (notional defined contribution) systems (Settergren and Mikula 2006; Kruse 2010; Knell 2013; Sánchez-Romero et al. 2013; OECD 2013).

than they paid for through contributions (Belloni et al. 2013). This anti-egalitarian feature is normally more than counterbalanced by other mechanisms through which the rich are 'taxed' and forced to transfer a portion of their pension contributions to the poor. These mechanisms are, however, complicated, and can be difficult to control.

3 The basics of AIPSs – almost ideal pension systems

As was noted above, AIPSs (almost ideal pension systems)[6] are not a *single* specific PAYG pension arrangement. They are an infinite subset of arrangements based on a system of relationships between three types of variables: policy, exogenous, and dependent.

Policy choices, which ideally would be considered very carefully and then once made maintained forever (or at least protected from ill-considered changes by, for example, requiring that qualified parliamentary majorities approve all revisions), are to be expressed in the form of parameters, ranging between zero and one on the following five *relative* variables:

i. The proportion of life to be spent in the (arbitrarily defined) conditions of young (Y^*) and old (or senior, S^*). What remains is the proportion spent in adulthood $A^* = 1 - Y^* - S^*$,[7]
ii. The *relative* standard of living the pension system must provide to the young through child benefits (χ), and, on average, to seniors through pension benefits (π; both child benefits B and pension benefits P are relative to the average net adult labour income ${}^aW$).
iii. The relative importance of actuarial equity (Q) vs. redistribution ($1 - Q$) within the system.

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[6] In the following, I will keep the presentation at the simplest possible level, and I will assume that a) a unique AIPS covers the entire population, with budget equilibrium (revenues match outlays) and no side costs (e.g. management costs and interests); b) the current (cross-sectional, time-varying) life table constitutes a convenient standard of reference for the asymptotic age structure of the population; and c) the reference shares of young people, adults, and seniors are kept constant forever (Y^*, A^*, S^* – see below). All of these assumptions can be relaxed (not shown here). Wages may be gross G if considered before the payment of the contributions C to the pension system, or net W after this payment (eq. (3)). All of the economic variables are before income tax (not considered here).

[7] Asterisks denote the variables (or parameters) of the reference population: Y^*, A^*, are S^* are simply (constant) quantiles of the life years in the reference (here: stationary) population. The ratios (e.g. S^*/A^*) that derive from these proportions (eq. (1)) are called 'life course ratios' by Sanderson and Scherbov (2013, p. 677).

The *independent variables* are assumed to vary unpredictably.[8] Luckily, there is no need to forecast them. These variables may instead be observed in each year t (and, when relevant, for each age x). The relevant variables are:

a. the ‘reference’ age structure (the age structure of the current stationary population[9]) $L_{t,x}$,
b. the age structure of the current population $P_{t,x}$,
c. the employed E_t and their gross wage G_t, and
d. for each ‘senior’ s (anybody aged β_t or over), the current value of his or her total (past) contributions to the pension system, or virtual capital, $K_{s,t}$, and the average of these virtual sums K_t $(= \sum_s {}^sK_t/S)$.

The combination of the exogenous, time-varying variables (a–d) and the (ideally constant) policy parameters (i–iii) determines the dependent variables of the system as follows:

1. *Threshold ages:* The age structure of the reference (stationary) population provides the current total number of life years $T_{t,0} = \Sigma_x \; L_{t,x}$. The (time-varying) threshold ages α_t and β_t must be such that Y^* $(= T_{t,0-\alpha}/T_{t,0})$ and $S^*(= T_{t,\beta+}/T_{t,0})$ are exactly at their target (policy) values (Figure 1).
2. *Age groups:* The (exogenous) age structure of the population and the threshold ages (shown in Figure 1) produce the current number of young, adults, and seniors in the population (Y_t, A_t, and S_t; Figure 2).
3. *Contribution rate:* Given the policy parameters χ and π (relative levels of child and average pension benefits) and the population shares, two equilibrium contribution rates can be computed: the current rate (c_t) and the reference rate (c^*):

$$c_t = \frac{S_t\pi + Y_t\chi}{A_t + S_t\pi + Y_t\chi} \tag{1}$$

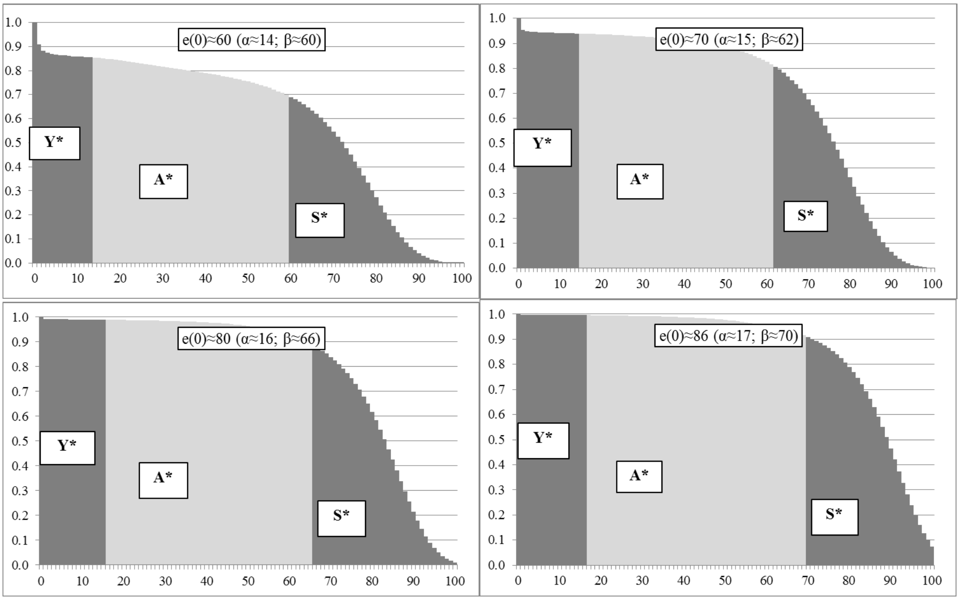
$$c* = \frac{S^*\pi + Y^*\chi}{A^* + S^*\pi + Y^*\chi} \tag{2}$$

c_t varies over time, together with the current proportions of young people, adults, and seniors in the population; but remains around an average (or asymptotic) value which is c^* with no (or relatively little or only temporary) migration, and is very close to c^* when migration is instead strong and persistent (see De Santis, 2011, and Figure 6, below).

[8] Even mortality, the most regularly evolving demographic phenomenon in the past 60 years, has systematically defied the expectations of the experts (Oeppen and Vaupel 2002; Shkolnikov et al. 2011). In all cases, everything is by definition unpredictable in the long run, and AIPSs are designed to last forever.

[9] Perhaps averaging over the most recent n (e.g. three or five) life tables so as to smooth changes, or considering the alternatives (e.g. CAL, or ‘lagged cohort life expectancy’; (Guillot and Kim 2011)). However, neither option is discussed here. In all cases, small errors in the choice of the reference populations are of scarce theoretical and practical relevance.

Figure 1:
Four examples of reference age structures (with e_0 ≈ 60, 70, 80, and 86, respectively) with their corresponding threshold ages when Y^* = 20% and S^* = 20% (illustrative policy choices)



Source: HMD (period data for Italy 1946, 1957, 1989 and Japan 2009; women) and the author's calculations.

4. The *net (average) wage of the employed* W_t is their gross wage G_t minus their contributions C_t (= $G_t c_t$) to the pension system

$$W_t = G_t - C_t = G_t - G_t c_t = G_t(1 - c_t) \tag{3}$$

5. The *net (average) wage of the adults* ${}^aW_t$ is

$$ {}^aW_t = W_t \frac{E_t}{A_t} = W_t\, e_t \tag{4}$$

where $e_t = E_t/A_t$ is the employment rate at time t, and ${}^aW_t$ (= $W_t e_t$) is the total labour production *per adult*. ${}^aW_t$ encompasses both (average) labour productivity W_t (of the employed) and participation e_t—in short, all the essential information about the labour market.

6. *Child benefits* B_t and the *average pension benefit* P_t are pegged to this new variable ${}^aW_t$ through the policy parameters χ (relative child benefit) and π (relative pension benefit)

$$B_t = \chi\, {}^aW_t \tag{5}$$

$$P_t = \pi\, {}^aW_t \tag{6}$$

7. While child benefits B_t are the same for all children, *individual pension benefits* ${}^sP_t$, may (and arguably should) be linked to past contributions. The relative importance of each senior's past contribution is ${}^sK_t/K_t$ (${}^sK_t$ and K_t are, respectively, the individual and the average current values of the cumulated past contributions of the seniors to the pension system), and the weight of this component in the determination of individual pension benefits ${}^sP_t$ is the policy parameter $Q (0 \leq Q \leq 1)$

$$ {}^sP_t = \underbrace{Q\frac{{}^sK_t}{K_t}P_t}_{\text{Bismarck}} + \underbrace{(1-Q)\,P_t}_{\text{Beveridge}} = P_t\left(1 - Q + Q\frac{{}^sK_t}{K_t}\right) \tag{7} $$

Individual pension benefits have a 'Bismarckian' and a 'Beveridgean' element. The former element links current benefits (${}^sP_t$) to past contributions (${}^sK_t$), the importance of which is assessed in relative terms (${}^sK_t/K_t$) and weighs Q [policy choice; $0 \leq Q \leq 1$]. The latter weighs $(1 - Q)$ and is redistributive: i.e. it tends to give every senior the same (average) pension.

Equation (7) shows that the average P of all pension benefits is precisely what the system needs to be in equilibrium, which rarely occurs in pension systems.[10] Moreover, this approach forces policy makers to state explicitly the exact degree of actuarial equity Q and redistribution $(1 - Q)$ they want the system to have.[11]

4 The rationale of AIPSs

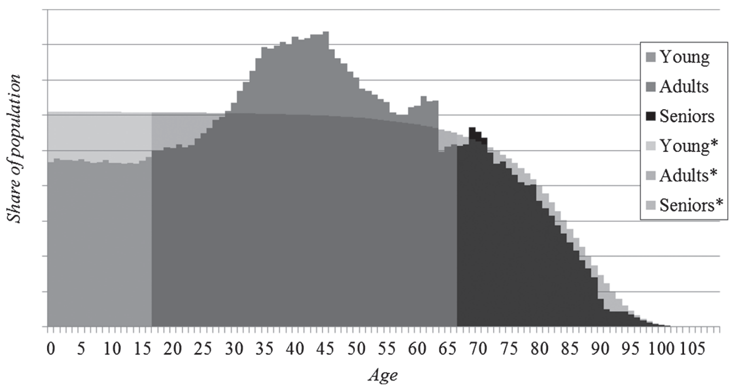
Even in this still very general form in which no policy decision has yet been taken, AIPSs display some advantages over most or all of the alternatives. First, this system minimizes the political risks associated with pensions which may arise when current generations appear to be taking advantage of future generations (Orszag and Stiglitz 2001; Barr 2002). This is because all of the policy decisions—i.e. the five parameters Y^*, S^*, π, χ, and Q—are, by definition, general, explicit and (forever) viable.

Second, AIPSs have the explicit goal of keeping intergenerational transfers in line with current production, measured in terms of labour production per adult ${}^aG_t$ (= 1, the implicit economic *numeraire* of the system), and consistent with collective preferences regarding how much to transfer (π and χ), and to whom: generally, only

[10] The Swedish pension system is an exception, but it solves the problem in a more complicated way. More importantly, it modifies only pension benefits without touching the contribution rate (Kruse 2010), which means that the burden of the adjustment falls entirely on the seniors. The same holds for the 'point system' that some countries use; e.g. Germany.

[11] Equation (7) implicitly defines the minimum pension benefit, paid to those who never contributed to the system (${}^sK = 0$): ${}^{\min}P = (1 - Q)P$. Note that this minimum pension may be very low; even zero if $Q = 1$.

Figure 2:
Reference and current age structure in Italy, 2010 (where $e_0 \approx 81.6$) with their corresponding threshold ages when $Y^* = 20\%$ and $S^* = 20\%$ (illustrative policy choices)



Note: Life table: average of men and women, years 2009–2010.
Source: Istat and the author's calculations.

to individuals who are conventionally considered too old (or too young) to work and earn a living.[12]

Declining mortality is the single most important cause of population ageing (Preston and Stokes 2012). But with constant 'life course ratios', longer life spans cease to be an issue: every extra year of life is automatically divided into the three shares (Y^*, A^*, and S^*) which had been agreed upon at the start, and which preserve the reference contribution rate c^* (eq. (2)) at its original, socially preferred level.[13]

However, mortality and, to an even greater extent, migration and fertility affect the *current* age structure of the population. Low fertility, for instance, causes ageing, and when there are more seniors and fewer adults, the contribution rate increases (eq. (1)). This lowers the net wages of both the employed (W_t) and the adults (^aW_t),

[12] But both children and seniors can, and are implicitly encouraged to, work in the market: in this case they earn both their wage and their pension (or child) benefit. Collectively, this results in higher employment $e = E/A$; higher adult labour income ^aW, and (with constant π and χ) higher transfer benefits. Child benefits can, in an AIPS, be used to counteract the fertility-depressing effect of pension systems (not discussed here).

[13] Other versions of AIPS with fixed α or β, or both, are also possible (albeit worse), but are not discussed here. Just how reactive the threshold ages must be to variations in life expectancy can be inferred qualitatively from Figure 1. Note, however, that while the threshold ages serve exclusively to define who in the population is to be considered a young person, an adult, or a senior (and therefore is or is not entitled to an age-related benefit); they have no other implications: for instance, nobody is obliged to join or leave the labour market at any age.

which through the constant (policy) parameters π and χ spreads to pensions and child benefits. Thus, all are worse off, but the relative position of each group remains unaffected (see also the simulation of Section 7). A similar scenario may also occur when the age structure shifts because of changes in migration (De Santis 2011) or mortality.

On the economic front, an increase in production (e.g. because of higher labour productivity W_t, or employment $e = E/A$, or both) translates into higher values of ${}^aW_t$, and with constant π and χ, into higher benefit transfers. In short, when the economy improves (or deteriorates), all of the three population groups are, on average, *equally* better (or worse) off.

5 What if variables assumed to be exogenous are instead endogenous?

A few key variables of the system may be endogenous, at least in part. For example, labour force participation, especially at older ages, depends very much on the characteristics of the pension system itself. Can AIPSs depress labour force participation?

There are two possible answers here. The simplest is that AIPSs are an *infinite* set of possible pensions arrangements, the nature of which depends entirely on the five policy choices (parameters) indicated above. A discussion of this issue is not appropriate here, as it is the responsibility of national parliaments and governments—preferably with the help of welfare and labour experts—to select the combination of parameters which ‘maximizes utility’, however it is defined. Take Q, for instance: the higher it is (up to one), the closer is the correspondence between past contributions and future pension benefits. In this case, what is taken from labour income is not a tax but forced saving, which is returned to the workers a few years later after they enter retirement. This arrangement would not be expected to discourage labour participation. On the other hand, a high value of Q will leave a large number of seniors who made small (or no) contributions to the pension system while working with low (or no) pension benefits. Picking ‘the best’ Q for each country is strictly a matter of social preferences (probably mediated by policy makers).

The second answer is that, excluding very extreme policy choices (e.g. $Q = 0$), AIPSs tend to *raise*, not lower, the employment rate e in two ways. First, no pension benefit is ever paid before age β.[14] Second, pension benefits are also paid from age

[14] Which apparently deprives the employed of the freedom to choose when to retire, and the fact that β_t varies in time (increasing with e_0) makes things even worse. See (De Santis 2012) for a rebuttal.

β onwards to those with their own labour (or capital) income,[15] which should give people a strong incentive to remain economically active.

AIPSs do not generally discourage saving, especially when compared to other pension systems. But again, the effects on saving depend on the policy choices. If transfers are very generous (high relative pension benefits π and correspondingly high contribution rates c^* and c_t), personal savings will likely be low, both because of budget constraints during working ages (when pension contributions are high), and because of a reduced incentive to save further as the level of forced saving is already high. But even in this case there will be some personal saving on the part of those who prefer (or fear that they may be forced) to retire early before reaching the standard (and moving) pensionable age β_t, and who want to secure a source of income between a fixed age (say, 60 years) and the official retirement age β_{t+z}, z years from now. Once again, the question is what the best combination of parameters ($S*$, π, and Q) is, not whether AIPSs are effective.

6 AIPSs vs. NDC systems

AIPSs have several features in common with notional defined contribution (NDC) systems. Both systems provide incentives to work in the legal labour market and to pay contributions because both are based on actuarial equity. Both AIPSs and NDC systems operate on the principle that the pension load must somehow be linked to the nation's current production levels (Barr 2002), though this link is looser in NDC systems than in AIPSs. In NDC systems, past contributions confer rights to a given pension *amount*,[16] whereas in AIPSs past contributions confer rights to a given pension *share* of the current product.

AIPSs are more general (and therefore better) than the NDC system, which can in some senses be viewed as a version of AIPS: one with no redistribution ($Q = 0$), no automatic adjustment of threshold ages (α and β), no child transfers ($\chi = 0$), variability in the π ratio (average pension benefit to average net adult wage), no consideration for the employment rate e, and an improper re-evaluation of past contributions.

In AIPSs, revenues (contributions) match outlays (pension and, possibly, child benefits) in every single year, while in NDC systems this is not guaranteed unless ex-post adjustment factors are introduced, as has been done in Sweden. With AIPSs all of the adjustments have exactly the same relative impact on all age groups thanks

[15] The reason is that pension benefits are not a manifestation of benevolence: they are part of an intergenerational contract under which people agree to pay into the system in their working years with the expectation that they will receive the exact amount they were promised in their senior years. See also footnote 12.

[16] Although in practice this is mediated by the re-evaluation coefficients used to transform past contributions into their present, cumulated value.

to the constant policy parameters χ and π, and no distinction is made between older seniors who retired long ago and newly retired seniors.[17]

Even those who favour a close correspondence between contributions and benefits normally leave some room for redistribution, which, incidentally, can compensate for the implicit inverse distribution (from the poor to the rich) inherent in all uncorrected pension systems because of the heterogeneity in survival rates (Section 8). With AIPSs, the precise degree of redistribution to the poor can be chosen and maintained forever.

7 AIPSs at work in simulations with population homogeneity

In the following I present several simulations which illustrate how AIPSs outperform alternative PAYG pension systems, both in a context of population homogeneity (this section) and in a context of heterogeneity (the next section).

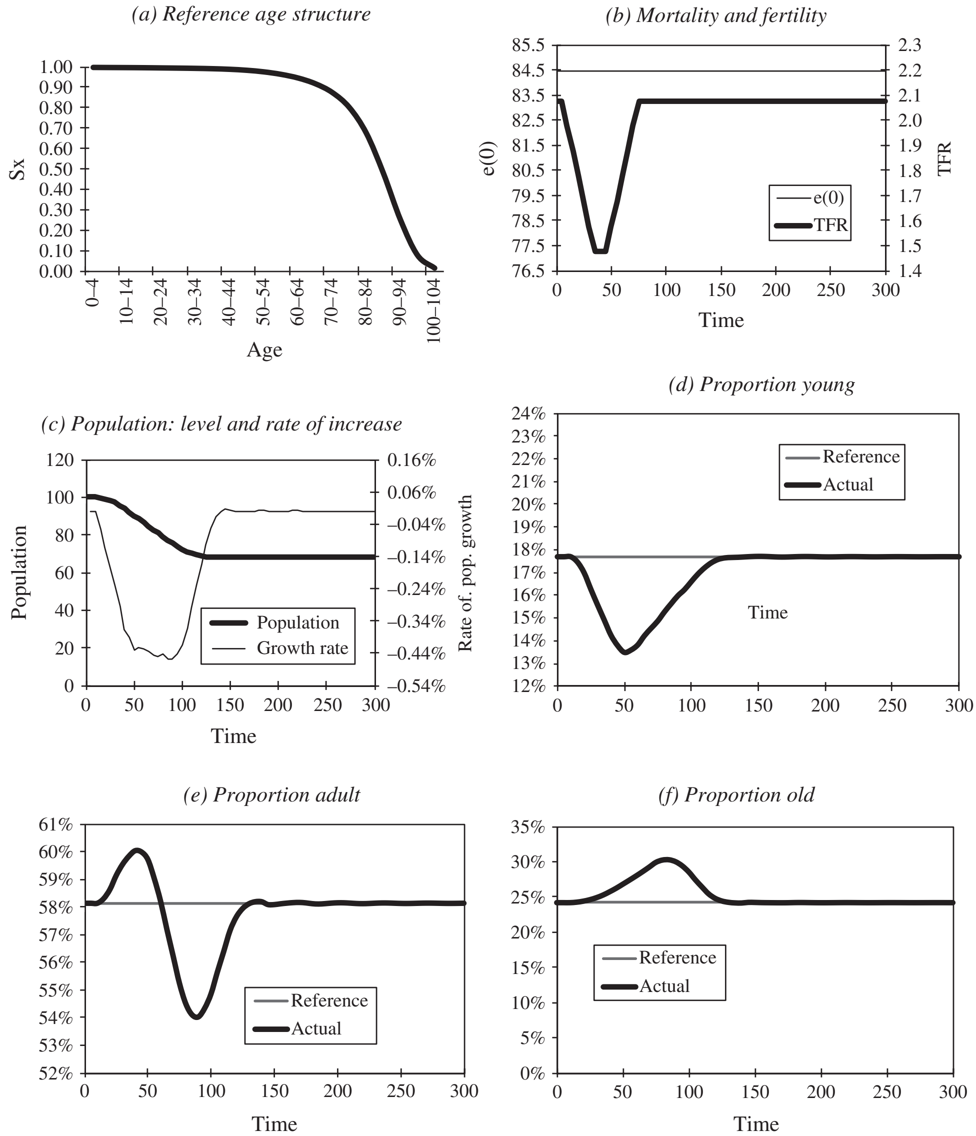
7.1 The demo-economic scenario

Figure 3 summarizes the (very simple) demo-economic scenario of this section: life expectancy does not change ($e_0 = 84.4$, panels *a* and *b*) and migration is excluded. Fertility first declines, from TFR $\approx$ 2.1 to 1.5, and then recovers its initial (reproduction) level of TFR $\approx$ 2.1 (panel *b*). The population declines by almost one-third in 100 years, and then stabilizes at the new, lower level (panel *c*). While the *reference* shares of young people, adults, and seniors (Y^*, A^* and S^*—panels *d*, *e*, and *f*) never change (policy choice), the *current* shares (Y, A, S) move in 'waves', and eventually return to their original (reference, asymptotic) level. The starting and the end points of the simulation are in equilibrium because I want to compare the performance of the various systems in troubled times (those in between), when everything else is under control. The scenarios extend for 300 years because I also want to investigate the intergenerational implications of the compared arrangements to find out whether there are unintended intergenerational gains or losses; and, if so, how high they are.

Mortality variations (improvements, notably) are excluded from this simulation not because they are unlikely to happen, but because their effect is obvious: either the threshold ages are adjusted upward in a proper and timely manner (preserving the chosen reference shares Y^*, A^*, and S^*), which brings us back to the scenario considered here; or they are not, which means that as the population gets older, contribution rates increase or pension benefits diminish (or both). However, the

[17] In most pension systems, including in NDC systems, the relative position of the oldest seniors becomes progressively worse (*vintage pensioners*), because their initial pension benefits are not fully re-evaluated (based on prices *and* labour productivity).

Figure 3:
Assumptions for a simulation on the operation of alternative PAYG pension systems



Source: Author's simulations.

ranking of the various pension systems, along with their pros and cons, remains basically the same.[18]

The effects are similar for migration: the presence of immigrants makes things easier in the short run, because the old age ratio S/A (seniors/adults) declines; but in the long run, as immigrants start to age, the age structure tends to return to its 'normal' state, which is generally similar to the reference age structure (De Santis 2011).

As for the economy, inflation is excluded here[19]. There is a slow increase in the employment rate $e = E/A$, from 70% to 76%, counterbalanced by a decrease in labour productivity, from $G_0 = 1$ to $G_{300} = 0.921$. The two variables evolve in such a way that eG (gross total labour earning per adult: the key summary economic indicator in AIPSs) remains exactly the same for the entire period. My reason for making this very peculiar choice is my desire to highlight the fact that AIPSs are the only pension systems which automatically recognize that, in this case, the long-run standard of living of the community has not changed, despite the (mutually offsetting) changes in employment and labour productivity; consequently, there is no reason to change contributions and benefits.

7.2 Four pension systems

The simulation compares four pension systems. All are subject to budget constraints (contributions match benefits in every single year), and all have the same, purely illustrative, starting point: the contribution rate is $c_0(= c^*) = 20\%$, child benefits are excluded ($\chi = 0$), and the average pension benefit is $\pi_t = 60\%$ of the average net adult labour earning.

1. The *defined contribution* (DC) system stipulates that the contribution rate remain constant at 20%.
2. The *defined benefit* (DB) system stipulates that pension benefits remain at their starting level (which happens to be $P_0 = 0.336$, where G_0, the average gross labour earning in year 0, is one).
3. The *risk sharing* (RS) (Musgrave 1981; Gonnot et al. 1995) system stipulates that the ratio between the average pension and the average net labour earning *of the employed* P_t/W_t remains constant (at 42%).

[18] In most cases, however, the superiority of AIPSs becomes even clearer (not shown here) because the threshold ages increase regularly with e_0 (not 'by jumps') and because *all* of the pension benefits (including those paid to very old pensioners) are properly adjusted every year, whereas most other arrangements protect the older pensioners and impose adjustments only on the younger ones.

[19] This simplifies matters considerably and runs counter to my thesis. With AIPSs inflation is perfectly neutral by definition, thanks to the constant policy parameter π. In the other pension systems this is very rarely the case.

4. The *almost ideal pension system* (AIPS) stipulates that the ratio between the average pension and the average labour earning *of the adults* $P_t/{}^aW_t$ remain constant (at π = 60%).

The NDC system is not explicitly considered in this scenario: its peculiarity lies in how it treats individual cases and not the average case discussed here. Moreover, in most of its practical applications (e.g. in Italy) it has no embedded budget equilibrium, and is therefore not comparable. If a balanced budget were to be introduced 'in the Swedish way'—that is, with a constant contribution rate but varying pension benefits—the NDC system would coincide, on average, with the DC system presented here. If a balanced budget were introduced by adjusting the contribution rate, the NDC system would not differ from the DB system. Finally, if the NDC system were introduced (with considerable complications) in a way that preserved a predefined ratio between pension benefits on the one hand and net labour earnings on the other (of the employed or of the adults), then it would coincide, at least in the aggregate, with the RS system or the AIPS.

7.3 Three criteria for comparison

My criterion of preference is constancy (or, as a second best, minimum variability) over time of a few key variables. These are, in decreasing order of importance:

1. the cross-sectional relative welfare π_t,
2. intergenerational equity E^g, and
3. the contribution rate c_t.

The cross-sectional relative welfare is simply the policy parameter π of *AIPS* or the ratio between the average pension benefit and the average net adult labour earning. The basic idea is that the pension system should not lead to *unplanned* (and therefore, by assumption, socially undesired) changes in the relative standards of living of the three age groups relevant for the system: young people, adults, and seniors.[20]

All of the generations should ideally get back as pensioners the contributions they paid in while working. This is an explicit goal of funded systems, but the issue also matters in PAYG pension systems. After a cohort is extinct, we can check whether this cohort's budget sheet was in balance, and, if not, how much the cohort gained or lost. In this paper, the proposed indicator of intergenerational equity (E^g) is zero in case of perfect equity. If it is negative, this indicates that the members of, for instance, cohort g received less on average in pension benefits than they paid in contributions.

[20] As for intra-generational equity (discussed in the next section), *AIPSs* are the only schemes that expressly keep it under control, through the Q parameter of eq. (7).

Finally, the contribution rate c_t should ideally remain constant, so as not to affect unpredictably the cost of labour or the standard of living of the employed (net of their pension contributions).

A couple of preliminary considerations should be mentioned here. In all pension systems, ageing makes things worse, all other things being equal. In this simulation, because of low fertility, the age structure of the population gets considerably older at first, with the worst period coming 80–90 years after the start of the simulation. Since the average adult labour earning remains constant (by construction) and there are relatively few adults in the population, the average standard of living declines. This worsening of living conditions can either be spread over the entire population (the best case, in my view) or be concentrated on a smaller group. In this scenario, a constant contribution rate—which is apparently a good thing in itself—simply indicates that the standard of living of the employed (essentially, the adults) remains the same, and the burden of the bad situation falls entirely on the shoulders of the seniors.[21]

Another important preliminary point is that in all systems based on upward transfers (in which resources flow from the adults to the seniors) population increases or decreases are equivalent to capital gains or losses (Lee 1994). As the population declines in our scenario, there is an equivalent loss of capital. Therefore, there *must* be intergenerational inequity: at least some cohorts will get back less in pension benefits than they paid in contributions. The relevant question is not about the amount of the loss itself (which is basically the same in all four pension systems[22]), but about its concentration: the worst possible case is when the loss falls entirely on a single cohort, while the best possible case is when this loss is spread equally across all of the cohorts under study. This can be measured by the variance of the generational losses: the lower the variance (i.e. the more equally spread these losses are), the better.

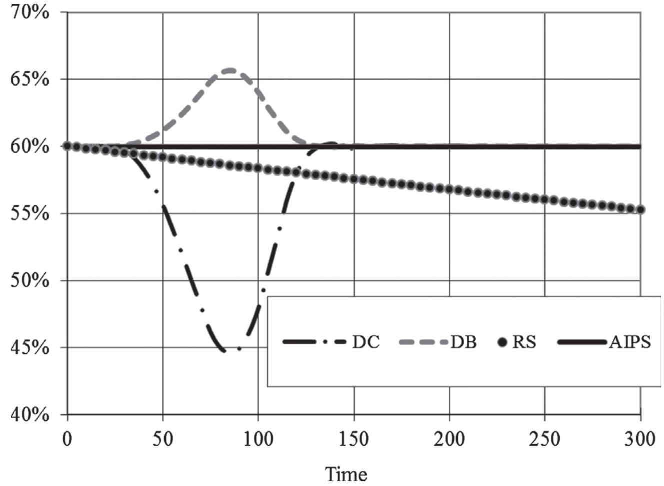
7.4 Results

The results of the simulation can be summarized in three figures. Figure 4 shows the evolution over time of what I think is the single most important indicator: the ratio between the average pension benefit and the average net adult's wage. Only *AIPS*, by construction, always preserves the original (socially preferred) value. *RS* (risk sharing) is the second best option, but by focusing only on the labour earnings of the employed (whose labour productivity declines here) it fails to consider that there is a counterbalancing increase in the employment rate, and unjustifiably pays progressively lower pension benefits. Other solutions (DC or DB) are far worse.

[21] The reverse happens when pension benefits remain constant (as in the DB scenario).

[22] But with AIPSs child benefits are possible, which can substantially reduce this problem (not discussed here).

Figure 4:
Cross-sectional relative welfare of seniors with respect to adults (π_t)

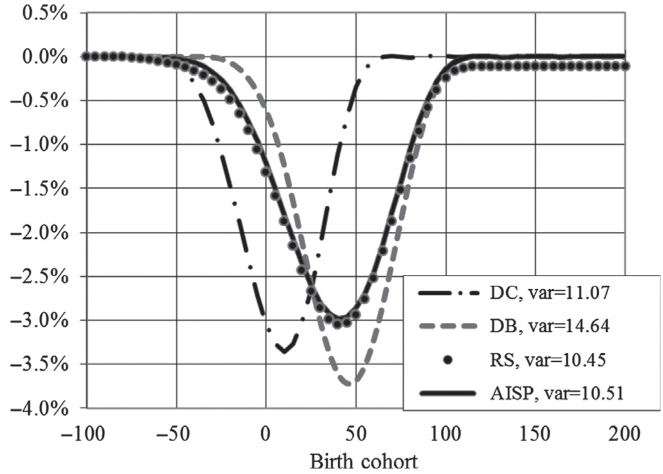


Note: DC: defined contribution; DB: defined benefit; RS: risk sharing; AIPS: almost ideal pension system.
Source: Author's simulations.

My second indicator is intergenerational equity. In Figure 5 this indicator is relative to the average lifetime earnings of a cohort, and negative values indicate a loss. As expected, all of the proposed pension systems suffer a capital loss in this scenario (up to 3%–4%) because of population reduction, but, as measured by the variance of the generational losses, the concentration of this loss is highest in the DB system (a few cohorts pay a high price), and lowest in the RS system. The AIPS is the second-best option, according to this indicator.

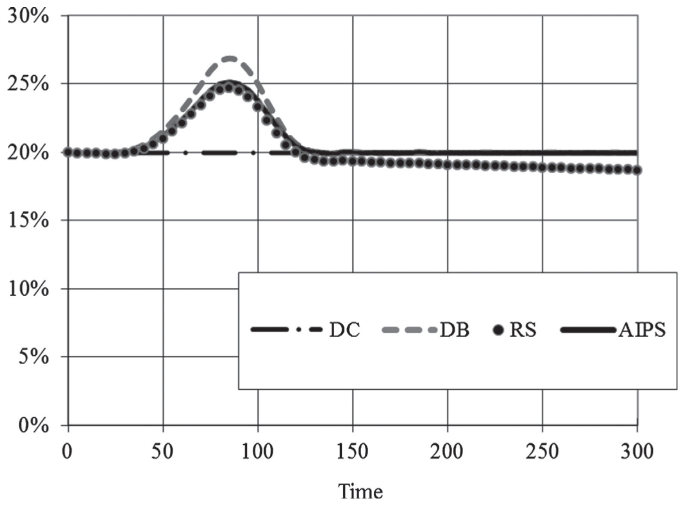
Finally, Figure 6 considers the payroll contribution rate c_t, which remains constant only in the DC system (by definition). This means that the employed are isolated from what happens to the standard of living of the population as a whole, which, however, has its drawbacks, as discussed above. In all of the other cases the contribution rate varies over time, but in the AIPS (and in the RS system) this change is smaller than in the DB system, because it is assumed that the deteriorating economic conditions must translate into lower standards of living for all of the population subgroups, and that this decline is proportionally the same for everybody, working-age adults and seniors alike. It should be noted that in the RS system as well, c_t declines over time because pensions benefits are, in our scenario and with this mechanism, progressively smaller.

Figure 5:
Intergenerational equity ^{g}E (*net cohort gain or loss, relative to total pension contributions*)



Note: DC: defined contribution; DB: defined benefit; RS: risk sharing; AIPS: almost ideal pension system; var: variance of the loss (a higher variance signals greater inequality in the distribution of the loss).
Source: Author's simulations.

Figure 6:
Payroll contribution rate c_t



Note: DC: defined contribution; DB: defined benefit; RS: risk sharing; AIPS: almost ideal pension system.
Source: Author's simulations.

Table 1:
Demographic assumptions and policy variables for the simulation: two stationary subpopulations, blue and white collars, with different average lengths of life

		Blue C.	White C.	All
Life expectancy	e_0	79.2	84.3	81.7
Contribution rate	c	20%	20%	20%
First threshold age	α	20	20	20
Second threshold age	β	65	65	65
Share of young people	Y, Y^*	25.1%	23.6%	24.4%
Share of seniors	S, S^*	20.2%	24.2%	22.2%

Source: Author's simulations.

8 AIPSs and population heterogeneity

All of the pension systems are based on average population survival, and therefore favour long-living population subgroups at the expense of others, because those who live longer benefit from pension payments for more years. It seems worthwhile to try to evaluate the extent of the intra-generational inequity caused by these demographic differences, and, if possible, to reduce it. In AIPSs this is feasible, within limits.

For the sake of clarity, I will consider only a very simple case, with no demographic or economic change over time. The introduction of dynamics would make the problem more difficult, but it would not add anything to the focal point of discussion here: the extent of intra-generational (between groups) unfairness implicit in a pension system with common rules but heterogeneous subpopulations, and the possible remedies.

Table 1 displays the essential information. A stationary population is made up of two equally numerous stationary subpopulations, blue and white collars, who are, by assumption, rigidly separated since birth, with no upward or downward social mobility. The average length of life is assumed to be shorter for blue than for white collars (${}^{b}e_0 = 79.2$, ${}^{w}e_0 = 84.3$). The difference, 5.1 years, is larger than it is between the equivalent male subgroups in Finland (van Raalte et al. 2014), a developed country where heterogeneity in survival in particularly high (Mackenbach et al. 2003). However, in more specific population subgroups, the gaps can be even wider (Blanpain 2011).

In all of the scenarios the pension system is in equilibrium, the average length of life for the entire population is 81.7 years (including both blue and white collars), and $\alpha = 20$ and $\beta = 65$ are the conventional threshold ages that separate the young people ($Y = Y^* = 24.4\%$) from the working-age adults ($A = A^* = 54.4\%$), and the working-age adults from the seniors ($S = S^* = 22.2\%$).

Table 2 (panels to be read clockwise) summarizes the main conclusions of our four scenarios. In scenario *A* the average adult labour earnings are the same

Table 2:
Economic and policy scenarios (A to D, clockwise) for the evaluation of the intra-generational equity of an AIPS arrangement with population heterogeneity: blue and white collars

	Blue	White
Scenario A): Q=1; π=.6, χ=0		
^{a}W	1	1
Benefits/Payments	88.6%	111.2%

	Blue	White
Scenario B): Q=1; π=.6, χ=0		
^{a}W	1	2
Benefits/Payments	85.4%	107.1%

	Blue	White
Scenario D): Q=0.9; π=.5, χ=0.1		
^{a}W	1	2
Benefits/Payments	101.3%	99.4%

	Blue	White
Scenario C): Q=0.7; π=.6, χ=0		
^{a}W	1	2
Benefits/Payments	99.8%	100.1%

Source: Author's simulations.

in the two groups, blue and white collars,[23] $Q = 1$ (perfect actuarial equity; no redistribution to the poor), $\chi = 0$ (no child benefits) and $\pi = 0.60$ (the average pension benefit is 60% of the average net earnings of an adult). In this case, as expected, blue collars, who die younger, lose money: they get back in benefits only about 89% of the amount they paid in contributions. The balance goes to white collars, who spend more years collecting a pension, and who receive about 11% more than they paid in.

In scenario *B*, white collars earn on average twice as much as blue collars, all else being equal. In absolute terms the transfer of resources is now larger than before (because, with $Q = 1$, those who earn more and pay higher contributions also receive proportionally higher pension benefits). This explains why blue collars lose more than they did in scenario *A*: their benefits correspond to only around 85% of their payments. The 14.6% blue collars lose goes to white collars, but it becomes a mere +7.1% for the white collars, because the incomes (labour earnings and pensions) of the white collars are twice as high as those of the blue collars. In sum, these figures remind us of the risk of an involuntary, but substantial, transfer of resources from the poor to the rich in a pension system if no corrective action is taken to adjust for the different survival rates of the two groups.

A simple corrective measure would be to introduce some redistribution from the rich to the poor through the *Q* parameter. In scenario *C* this *Q* parameter is set at 70%, which means that the pension system mainly (70%) uses actuarial equity, but also has a non-trivial Beveridgean (or redistributive) component ($1 - Q = 30\%$).

[23] In this table and in the following the average adult labour earnings of the reference category (blue collars and men) is normalized to one, while the others may earn the same (one), or twice as much (two; white collars), or half as much (0.5; women). Reminder: the average labour earnings *of the adults* ^{a}W are the average earnings of the employed ^{e}W multiplied by the employment rate $e(= E/A)$ (eq. (4)).

This is enough to completely offset the advantage of the longer living group: both blue and white collars now get back in pension benefits around 100% of the amount they paid in contributions when they were employed.

With the inclusion of some child benefits (in scenario D, $\chi = 10\%$ of the average net adult earning, and pension benefits are reduced to $\pi = 50\%$, so as to maintain the contribution rate at $c \approx 20\%$), the explicit Beveridgean component $(1 - Q)$ can be substantially mitigated. Already with $(1 - Q) = 10\%$ life-time payments match life-time benefits for both blue and white collars. This happens because child benefits are intrinsically Beveridgean: each child receives the same amount, which is relatively high for poor (blue collar) families and relatively low for rich (white collar) families.

In short, even with extreme assumptions (no social mobility and very marked differences in survival and earnings), introducing a mild degree of redistribution into the system can fully compensate the poor for the economic disadvantages they suffer because of their shorter lives (mainly as pensioners).

However, this does not solve all of the problems. Table 3 mirrors Table 2, but now I compare men and women.[24] Men die younger, but they earn more (both their employment rate and their average labour earnings are higher): in Table 3 (scenarios *B*, *C*, and *D*), their average adult earnings are supposed to be twice as high. In this case, with $Q = 1$, there is a substantial transfer of resources from men to women because women outlive men (scenarios *A* and *B*). All attempts at introducing some Beveridgean component make this situation worse (scenarios *C* and *D*), because in this case the rich (males) are also those who die younger. This transfer of resources from men to women is compatible with women receiving lower pension benefits: in scenario *B*, for instance, the average woman's yearly pension benefit is exactly half as large as the average man's because no redistribution is envisaged, and because women earn half as much in their adult years.

The prevalent opinion is that this transfer of resources from men to women is a just compensation for the obstacles women encounter in professional life: for example, they are discriminated against in the labour market and have more family obligations (Bonnet and Hourriez 2012). I disagree, but I would rather not discuss this topic here. I introduced it merely to show that AIPSs make it possible to keep the relevant variables under control, even if redressing biases is not always easy.

9 Conclusions

AIPSs are based on a few simple concepts. In economic terms, these systems reflect in practice the basic observation made by (Barr 2002) that pension 'rights' are simply a claim on current production. The current production is the salary mass *EG* (the employed multiplied by their gross average labour revenue), which

[24] The average durations of life for men and women cited in Table 3 are those observed in Italy in 2010.

Table 3:
Economic and policy scenarios (A to D, clockwise) for the evaluation of the intra-generational equity of an AIPS arrangement with population heterogeneity: men and women

	Men	Women
Scenario A): Q=1; π=.6, χ=0		
^aW	1	1
Benefits/Payments	88.6%	111.2%

	Men	Women
Scenario B): Q=1; π=.6, χ=0		
^aW	1	0.5
Benefits/Payments	92.1%	115.5%

	Men	Women
Scenario D): Q=0.9; π=.5, χ=0.1		
^aW	1	0.5
Benefits/Payments	82.7%	133.8%

	Men	Women
Scenario C): Q=0.7; π=.6, χ=0		
^aW	1	0.5
Benefits/Payments	84.3%	130.7%

Source: Author's simulations.

AIPSs reinterpret as A^aG, where $^aG(= eG)$ encompasses the only two economic variables which matter in this field: how many are employed E, given the adult population A ($e = E/A$), and how productive they are (G). The challenge is to fine-tune these claims so that pension benefits remain 'fair' (high enough, but economically sustainable) at all times. What is 'fair' is not for demographers or economists to decide: that is determined by policy makers, who may of course base their decisions in part on economic and welfare analyses on choice optimization (not discussed here). This principle also applies in determining the appropriate allocation across the life span of young, adult, and senior ages; and on the optimal degree of redistribution that should be embedded in the system.

In terms of demography, several options can be considered, but keeping the shares of young Y^*, adults A^*, and seniors S^* constant in the reference population appears to be the most obvious and most sensible choice. As life spans grow longer and people maintain their health at older ages (a trend which is not discussed here), the threshold ages must shift upwards in order to preserve the socially preferred balance between the average time spent as a non-producer (child or senior) and as a working adult. Regardless of their cause (survival, fertility, or migration), the changes in the current age structure translate into a time-varying contribution rate which ensures that the financial equilibrium of the system is always preserved.

AIPSs are designed to remain viable forever even without modifications. Thus, changes are possible, but are never necessary. While the implementation of such a system may seem to be too ambitious, AIPSs appear to be the only effective way for future generations to protect themselves from the rapacious demands of the present generation. In the long run we may well all be dead, as Keynes (and others) prophesized, but our children will not; I therefore submit that a properly designed pension system should form part of our legacy.

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How large are the effects of population aging on economic inequality?

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Abstract

The attention given to Piketty (2014) has renewed interest in the level and causes of inequality. In this paper, we look at the role that population aging plays in increasing economic inequality. We provide estimates of the magnitudes of the effects on inequality of three different factors related to population aging: capital intensification, changing population age structure, and increasing longevity. Changing age structure is found to have a small effect on aggregate inequality, while capital deepening and longevity-based life cycle savings are shown to be more important. Taken together, our findings suggest that aging has a substantial effect on economic inequality.

1 Introduction

Thomas Piketty's 2014 book, *Capital in the 21st Century*, has sparked an enormous resurgence in interest in inequality. Demography is one of the factors at the heart of Piketty's prediction of rising inequality. In this paper, we discuss several of the mechanisms through which population aging could influence economic inequality and try to provide estimates of the magnitude of each factor.

The three aspects of population aging we consider are the slowdown in population growth from fertility decline, the accompanying shift to older age structures, and increases in longevity. The rate of population growth influences inequality through its effect on the capital intensity of the economy (Piketty 2014, Solow 1956). The older age structure of the population has the potential to influence aggregate measures of inequality because of the tendency of inequality to increase with age (Paglin 1975, Lillard 1977, von Weizsäcker 1989). Longer life has its

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own effect on inequality through changes in the economic life cycle (Lee and Goldstein 2003). In considering these three factors, our goal is not to discuss all of the demographic factors that might influence inequality. For example, among the interesting aspects of population aging that we do not cover are the effects of longer life and lower fertility on inheritances. Other features like differential fertility, international migration, and the role of intergenerational transfers are also important potential mechanisms through which demographic change may influence economic inequality.

In this paper, we seek to connect demography with economic inequality. This approach is similar to those which have attempted to link population growth to economic growth and savings. For example, the Solow model shows how slower population growth with constant savings can lead to capital accumulation and higher living standards, and Piketty makes the further argument that higher capital intensity is associated with higher levels of inequality. Where Bloom et al. (2001) and others have argued that the demographic dividend in savings that accompanies the demographic transition will come to an end as populations age, we investigate the compositional consequences of these same age structure changes for inequality. Finally, as rising longevity increases life-cycle savings and thus the amount of capital in the economy, we explore here the consequences of longer time horizons for changes in the distribution of capital.

Methodologically, we use simple approaches to describe and quantify these different effects. In the first section on capital intensification, we show the compositional effects of changing the factors of the economy on the inequality of total income from assets and labor earnings. A good approximation of the compositional effect can be obtained simply by changing the shares in a weighted average of earnings and capital-based income. In the second section, we apply Lam's (1984) stable population theory results to the age profiles of inequality in income and net worth, constant at levels observed in the 2001 U.S. Consumer Expenditure Survey (Federal Reserve 2013). In the last section, we estimate the effect of increased life-cycle savings by stretching out current schedules in a stylized manner consistent with increases in longevity.

Among the many possible measures of inequality, we focus on the share of wealth held by the top decile of the population. This measure is readily interpretable, and makes comparison with the work of Piketty and his colleagues straightforward. The share of the top decile also turns out to be readily estimable from other information on means, medians, and variances, by assuming a log-normal distribution of income and assets. Although not applicable to the richest rich, the assumption of log-normality is reasonable enough for studying the holdings of the top 10 percent. The appendix provides a derivation of our estimator for the holdings of the top decile.

2 Kinds of inequality

Both cross-sectional and longitudinal measures of inequality are of potential interest. The most common measures of inequality are taken in the cross section, at a moment in time. Measures like the variance of assets or the share held by a given upper fraction are usually made in reference to the population as it is observed at a moment in time, across all ages.

From a welfare point of view, it can make more sense to compare inequality over the life cycle. Levels of inequality within a given age group or over the life cycle might be considerably lower than the levels observed in the cross section (Lillard 1977). On the other hand, cross-sectional inequality may have considerable salience from a psychological point of view. A 20-year-old may well feel disadvantaged relative to a 40-year -old, even if she knew with certainty that she will eventually reach age 40 herself. This feeling can be attributed partly to impatience with having to wait 20 years, partly to uncertainty, and partly to human psychology and the inability of people to make fully compensating comparisons over time.

Cross-sectional inequality may also be of substantial importance because of its role in determining power. In politics, individual votes, campaign contributions, and other influence is all cross-sectional; with the individual's relative power being determined by the amount of influence others have at that moment.

Finally, market prices are determined largely by supply and demand at a moment in time. Intertemporal substitution is costly and uncertain. Credit markets are not perfect. Thus, the distribution of resources at a moment in time will influence prices.

3 Capital intensification

Personal or household income is the sum of labor income and asset income. The distribution of income therefore depends on the size and distribution of both labor and asset income—and their covariance. According to Piketty, because wealth is far more unequally distributed than labor income, increasing capital intensity generally results in greater income inequality. "The most important factor [determining capital intensity] in the long run is slower growth, especially demographic growth, which, together with a high rate of saving, automatically gives rise to a structural increase in the long-run capital/income ratios, owing to the law $\beta = s/g$." (Piketty 2014:173) This assertion is based on the assumption that saving rates are constant while demography varies. The same long-run relationship or 'law' can be readily derived from the Solow growth model and is quite general.[1] In the long run the growth rate g

[1] For example, in the Solow models steady state, in order to keep capital per head constant, $sf(k) = gk$, where s is the savings rate, k is capital per worker, and $f(k)$ gives output per worker as a function of capital per worker. It follows that $k/f(k) = s/g$. $k/f(k)$ is beta.

of National Income equals the rate of productivity growth plus the rate of population growth, n.

Accordingly, changing population growth rates alter the capital intensity. The annual population growth rates of the rich industrial nations have varied between −0.5% and +1% in recent decades, and are projected to remain at these levels in the coming decades. The annual productivity growth rates of these countries are expected to be around 1.5%. Piketty assumes that the average saving rate will be 10%. Thus, with $n = 1\%$, $\beta = s/g$ will be $4 = 10/(1 + 1.5)$. With $n = 0$, β will be $6.7 = 10/(1.5)$. And with $n = -0.5\%$, $\beta = 10$. Thus, we see that the population growth rate can play a very important role. Because many of the observed variations in the population growth rate are relatively short-term fluctuations attributable to, for example, baby booms and busts, their effects will be muted. But over the long term, population growth rates may also be expected to vary by around one percent.

These results, which link slower growth to capital intensification, are straightforward. Current wealth is accumulated from past savings. If economic growth (from productivity and population) is rapid, then these savings will have been accumulated starting from a base that is low relative to current income. Thus, current wealth levels will be low relative to current income levels. However, this tells us nothing about issues such as why people save or how wealth is transmitted. If people have very short lives, then wealth will be largely inherited. If people have infinitely long lives, then there will be no inherited wealth.

The results also rest on assumptions that may or may not be true. One portion of savings consists of life-cycle savings, or funds that are accumulated to provide income for retirement. This portion of savings should be strongly influenced by fertility, longevity, and population age distribution. Furthermore, what matters in this context is net savings, after allowing for the portion of savings that is needed to maintain or replace capital that wears out; that is, gross savings minus depreciation. The rate of depreciation should depend on the age of the capital stock. When the economy is growing rapidly (g is high), then the capital stock will be young and – all other things being equal – have a lower depreciation rate; and when g is low, the capital stock will be old and have a higher rate of depreciation. These considerations cast some doubt on the assumptions underlying the law of long-term capital intensity.

Others have discussed the assumptions underlying Piketty's formulation elsewhere. Here, we set these complications aside and instead focus on estimating the magnitude of Piketty's compositional effect of capital intensity on inequality.

Consider the hypothetical case in which population growth in the United States falls from its recent historic rate of about $n = 1$ percent per year to zero percent. As our calculation above showed, this increases the steady-state capital/income ratio from its current level reported by Piketty of about four to close to 6.7.

To estimate the effect of this change in the capital labor ratio on income inequality, note that the share of income attributable to returns on capital (Piketty's α) is $r\beta$, the product of the rate of return to capital times the capital/income ratio (Piketty).

Taking $r = 0.05$, this gives us a share of capital income to total income of 0.2 for $\beta = 4$ and 0.34 for $\beta = 6.7$.

If we assume the same ranking of labor earnings and capital earnings (i.e. a perfect correlation), then the share of total income held by the top 10 percent will be a simple weighted average of the shares held by the top 10 percent of labor earners and the top 10 percent of earners from capital. We denote the holdings of the top decile as $H_{.1}$, with superscripts l referring to labor income, k capital income and $l + k$ referring to total income. The relationship between these when the correlation is perfect is

$$H_{.1}^{l+k} = (1 - r\beta)H_{.1}^{l} + r\beta H_{.1}^{k}, \tag{1}$$

where $r\beta$ is the share of total income from capital and $1 - r\beta$ is the share from labor.[2] Differentiating with respect to β, assuming, as per Piketty, a constant rate of return, then gives us

$$\frac{dH_{.1}^{l+k}}{d\beta} = r(H_{.1}^{k} - H_{.1}^{l}). \tag{2}$$

Table 1 provides the top decile shares of labor income, asset income, and total income reported by Piketty for different stylized inequality regimes. It also shows the effect on the top decile share of total income of a unit increase in β, using the above result. We see that the effects are larger for more unequal societies, reflecting the tendency for capital income to concentrate more than labor income.

The value of this derivative for the United States allows us now to state the estimated effect of a one percent slowdown in population growth. As we saw above, this change in population growth increased β from 4.0 to 6.7; and we can now say that this would increase the share held by the top decile by about five percentage points, or $(6.7 - 4.0) * 0.0175$.

This kind of calculation represents an upper bound for the composition effect, because we have assumed a perfect correlation between labor income and asset income, as well as a perfect correlation between the existing asset income at a given β and any new asset income implied by a higher value of β. The correlations are likely to be high; but the lower they are, the smaller the compositional effect will be. Simulation with uncorrelated labor and asset income suggests that the effect on the share held by a top decile of a unit increase in β would be about one percentage point, or slightly more than half of the 1.75% found for the case of perfect correlation. [3] As Piketty (pages 244–246) has argued that the correlation between labor and asset income is quite high in modern industrial societies, we believe that a reasonable estimate of the derivative of the top decile's share with respect to β would be close to the case of perfect correlation, or about 1.5 percent.

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[2] These accounting identities are discussed by Piketty on page 52. The addition of top deciles of labor and asset income holds because of the assumption of perfect correlation in the two types of income.

[3] Our simulation was based on log-normal distributions of labor and capital, with the appropriate ratio of mean labor income to mean asset income.

Table 1:
Piketty's estimates of labor and asset income received by the top decile for various inequality regimes with our estimate of the effect on total income of a unit increase in the capital/income ratio β

	Low inequality (Scandinavia, 1970s)	**Medium inequality (Europe, 2010)**	**High inequality (US 2010, Europe 1910)**	**Very high inequality (US 2030?)**
Labor income (H_l)	20%	25%	35%	45%
Asset income (H_k)	50%	60%	70%	90%
Total income (H_{l+k})	25%	35%	50%	60%
Effect of β increase ($dH_{l+k}/d\beta$)	1.50%	1.75%	1.75%	2.25%

Note: For example, if β were to increase by 2.0 from a 'low inequality' baseline, then the top decile share of income (H_{l+k}) would increase from 25% to 28% (2.0 × 1.50%). The first three lines of this table are from Piketty (p. 247-249). The derivative is our calculation based on change in weighted average of top decile share of labor earnings and capital earnings, assuming new capital earnings are perfectly correlated with existing capital earnings.

Our calculation suggests that the capital intensification accompanying a hypothetical end to population growth in the United States would increase the total income of the top decile by about four to five percentage points. This increase in inequality is substantial, but it is still smaller than the differences across inequality regimes, which are on the order of 10 to 15 percentage points of total income held by the top decile (shown in the third row of the table). Our finding that slow growing Europe would have lower levels of inequality than the more rapidly growing United States tells us that population growth is not the overwhelming determinant of inequality. Our calculations do, however, indicate that changes in population growth within countries will, if Piketty's formulation holds, indeed result in quantitatively important increases in inequality.

4 Shifting age structure

Over the course of the demographic transition, the population initially gets younger as population growth accelerates. Then, as fertility falls, there is a transitional period during which there are relatively few children and elderly people, and many people of working age. As fertility remains low, the people who had been of working age grow older, and the population rapidly ages. At the end of the transition, the age structure of the population becomes similar to that of a stable population with low fertility.

The period in which the share of the population who are of working age is growing and the share of the population who are dependents (young and old) is shrinking gives rise to the 'demographic dividend'. This dividend in dependency rates can also be seen when we attempt to measure population-level inequality. Because inequality increases as cohorts age, a population with a relatively large share of young people will tend to be more equal. As population aging implies that a greater share of the population will progress to ages characterized by more inequality, aggregate measures of inequality may be expected to increase as the population grows older.

In considering the magnitude of the effect of shifts in age structure on population inequality, it is useful to begin with the standard decomposition of the population variance into the between and within variances of subpopulations, which in our case are defined by age groups. For an age-structured population with a share $c(x)$ at age x, the population variance decomposition is

$$\sigma^2_{\text{pop}} = \sum_x c(x)\sigma^2_{\text{within}}(x) + \sum_x c(x)(\bar{\mu} - \mu_x)^2, \tag{3}$$

where $\sigma^2_{\text{within}}(x)$ is the variance within age group x, $\bar{\mu}$ is the population mean, and μ_x is the mean for each age group.[4] The standard deviation is the square root of the variance.

Lam (1984) applied the formula above to stable populations and showed that the derivative of the log of the population variance is given by

$$\frac{d \log \sigma^2_{\text{pop}}(n)}{dn} = \alpha(\bar{x} - \bar{x}_b) + (1 - \alpha)(\bar{x} - \bar{x}_w), \tag{4}$$

where Lam's α (unrelated to Piketty's α) is the share of the total variance in equation (3) above that is between groups, $\bar{x}$ is the mean age of the economic quantity of interest (e.g. the mean age of log-earnings), $\bar{x}_b$ is the mean age weighted by each age group's share of between-age variance, and $\bar{x}_w$ is the mean age weighted by each age group's within-group variance.

Lam's results show the role of two offsetting effects. Consider income profiles for which the mean and the variance both rise with age. Younger people tend to have relatively low incomes. If we increase population growth, the share of the population who are young will rise, and the share of the population who are of the ages at which incomes tend to be far below average will also increase. Thus, the between-group variance will increase. In this case, the between component of variance will increase

[4] This standard decomposition of the variance of a mixture of subpopulations has been applied to the age composition of population inequality by Lam (1984) and von Weizsäcker 1989).

the variance if population growth increases, and it will decrease the variance if population growth declines.

The variance within age groups will be in the opposite direction. If the variance within groups increases with age, then reducing population growth will result in a concentration of the population at older, higher within-group variance ages. Thus, a decline in population growth will cause this component of the variance to increase.

5 U.S. age profiles of inequality

Lam's approach can be applied to contemporary age profiles of income and asset accumulation. We first describe the profiles currently observed in the United States and then analyze the effect of declining population growth. For comparability, we consider the same scenario used for studying capital deepening, reducing the growth rate by one percent.

We obtain age profiles for inequality in the United States from the published tabulation of the Survey of Consumer Finance. These tabulations report the mean and the median pretax family income and family net worth by age group of the family head.[5] Using the log-normal approximation allows us to estimate all of the moments from the reported means and medians. In order to convert family income to individual income by age, we multiply each family-level quantity by the age-specific headship rate that we tabulated from the 2014 Current Population Survey.

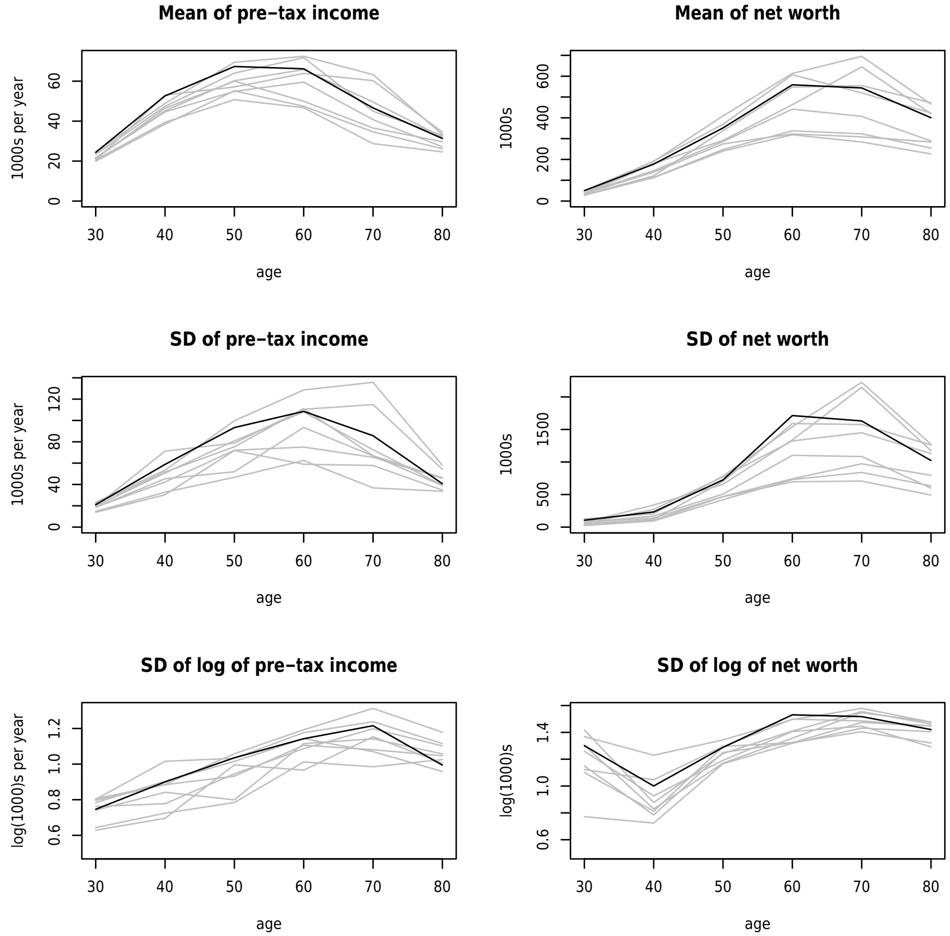
Several features of Figure 1 are worth noting. First, the top row shows the life-cycle patterns we would expect to see from increasing earnings and savings during the working years and declining earnings and assets after retirement. Assets continue to increase longer than earnings, reflecting the returns on capital and the delays in drawing down during retirement. Substantial assets are left at age 80, which suggests that large bequests are likely. This figure does not show the much lower medians observed at each age.

Second, the pattern of variability of income and assets shown by the standard deviation in the second row is remarkably similar to the life-cycle profile average levels shown in the first row. In part, these are mechanical effects of scale. As income and assets increase, their variability also increases.

The third row shows the standard deviation of the log of pre-tax income. This is the σ parameter in the log-normal distribution. This measure of relative variability is closely related to the coefficient of variation. It reveals that the increase in variability is not just a function of a rising mean but also exists in relative terms. Indeed, the pattern for income is nearly linear and increases steadily up to ages 65–75. The pattern for net worth is more complicated, as net worth rises rapidly between ages

5 The micro data are available for more detailed tabulations and other definitions of stock and flow of wealth.

Figure 1:
Age profiles of income and assets estimated from the Survey of Consumer Finances, triennially from 1989 to 2013. The solid black lines are from 2001. All amounts are in 2013 constant dollars. Estimates are made from the reported means and medians reported in Federal Reserve (2014), assuming a log-normal distribution at each age



40 and 60, and then plateaus thereafter. Among the youngest age group net worth varies considerably, but this is relative to a near-zero base.

We now replicate Lam's analysis for the SCF profiles using the 2001 profiles shown in bold in Figure 1.[6] We decompose the variance of the logarithm of income

[6] We note that our analysis here does not account for the trend toward increasing inequality at a given age that can be seen in these schedules, as well as in those in other countries. See, for example, Bönke, Corneo, Lüthen (2015) for cohort changes in Germany.

Table 2:
The effect of a one percent decline in population growth on the variance of the logarithm of income and net worth and accompanying quantities from Lam's stable population analysis and our analysis using the 2001 U.S. Survey of Consumer Finances

	Total variance $n = 0$	Within age group component	Between age group component	Mean ages $\bar{x}$	x_w	x_b	Effect of 1% less pop. growth on total variance	on top decile share ($H_{0.1}$)
Income	1.11	1.01	0.10	51.9	55.8	48.8	+3.3%	+0.7%
Net worth	2.40	1.79	0.61	51.9	54.7	37.5	−1.5%	−0.3%

Note: The effect of 1% less population growth on total variance is obtained by calculating the derivative of log variance with respect to n using Lam's formula and then multiplying by $\Delta n = -1\%$. The effect on the top decile is obtained by estimating $\Delta\sigma$ as half of the change in the total variance and applying the log-normal approximation of the top decile shown in the appendix.

(and of wealth). Measures of welfare and utility are often more closely related to the logarithm of earnings or wealth. Moreover, a convenient property of the standard deviation of the logarithm is that it can be easily converted into the share held by the top decile, assuming a log-normal distribution.

For income, we find (see first line of Table 2) that a one percent reduction in the population growth rate increases the variance by about 3%. In terms of the share held by the top decile, this implies an increase of about 0.6 percentage points (e.g. from 50% to 50.6%).[7] The magnitude of this effect is detectable, but is still quite small. It is much smaller than the four to five percentage point increase in the top decile share of income that we estimated for the capital-deepening response to the same decline in population growth.

For net worth, we find (see second line of Table 2) that the aging of the population due to slower population growth actually decreases the variance by about 1.5%. This small negative effect results from a much stronger compressing effect of the between-age-group component of variance. Intuitively, we would expect that the population-level variability of assets would be compressed, because there would be fewer young people with very low asset levels. This effect can be seen in the low average age (37.5) of the between-age-group variance weighted mean age and in the larger share of the 'between' component of variance relative to the total.

Although there is intuitive appeal to the idea that shifting the population to ages of greater within-age-group inequality should increase aggregate inequality, the actual effects turn out to be quite small. The direction of the effect also appears to be highly

[7] Increasing the variance by 3% increases the SD by about 1.5%. The relationship between the share held by the top decile and the SD of the log of a log-normally distributed quantity is approximately $0.4 \times SD$. If the SD has a value of one, then the total effect on the holdings of the top decile will be an increase of 0.6 percentage points.

sensitive to the details of the age profiles of the mean and the variance. Although income and assets have the same general age profile (in Figure 1), the profiles differ enough that the relative importance of the within-group and the between-group variances in formula (3) can change substantially. Lam (1984) also found that the sign and the magnitude of the effect of changing population growth rates on inequality are susceptible to small differences in the earnings profiles and the age ranges under consideration. The older age structure of aging populations appears to be at most a minor driver of population-level measures of inequality.

6 Stretching the economic life cycle

Although the major cause of population aging is declining fertility, increases in longevity are a key factor in the individual economic life cycle. Life expectancy at birth is increasing by about 0.15 years per year in the United States, and life expectancy at age 60 is increasing at about 0.1 years per year. In Japan, life expectancy is increasing much more rapidly, with period life expectancy increasing by about 0.25 years per year. In the next half-century, we can expect to see adult longevity increase by some five to 10 years.

As a cohort ages, there is a more opportunity for their incomes and assets to fluctuate randomly. Thus, a cohort tends to see increases in within-age-group variance as it gets older. As increases in longevity extend the period of time over which fluctuations can occur, they are generally associated with increases in both life-cycle and population-level inequality.

The effects of increasing longevity on the life-cycle patterns of earnings, consumption, and savings are complex. It is, however, easy to perform a simulation in which we modify our observed schedules of mean and variance by linearly extrapolating the extra five years of working life that we expect to gain over the next half-century.

Figure 2 shows the result of such a hypothetical stretching of the economic life cycle. We apply the stretching to both the means and the standard deviation. For income, the result of stretching is to slow the decline in the mean and the SD. For net worth, the result is to extend the period of accumulation, leading to a higher peak mean net worth and to higher peak variation.

We simulate the consequences of these new schedules by calculating the aggregate inequality implied by the original and the stretched schedules. The results of this analysis are shown in Table 3.[8]

We can see from this simulation that the effect of stretching the schedule is considerably greater for assets than for income. This makes sense given the profiles shown in Figure 2, in which the extrapolated increase beyond age 60 is much larger

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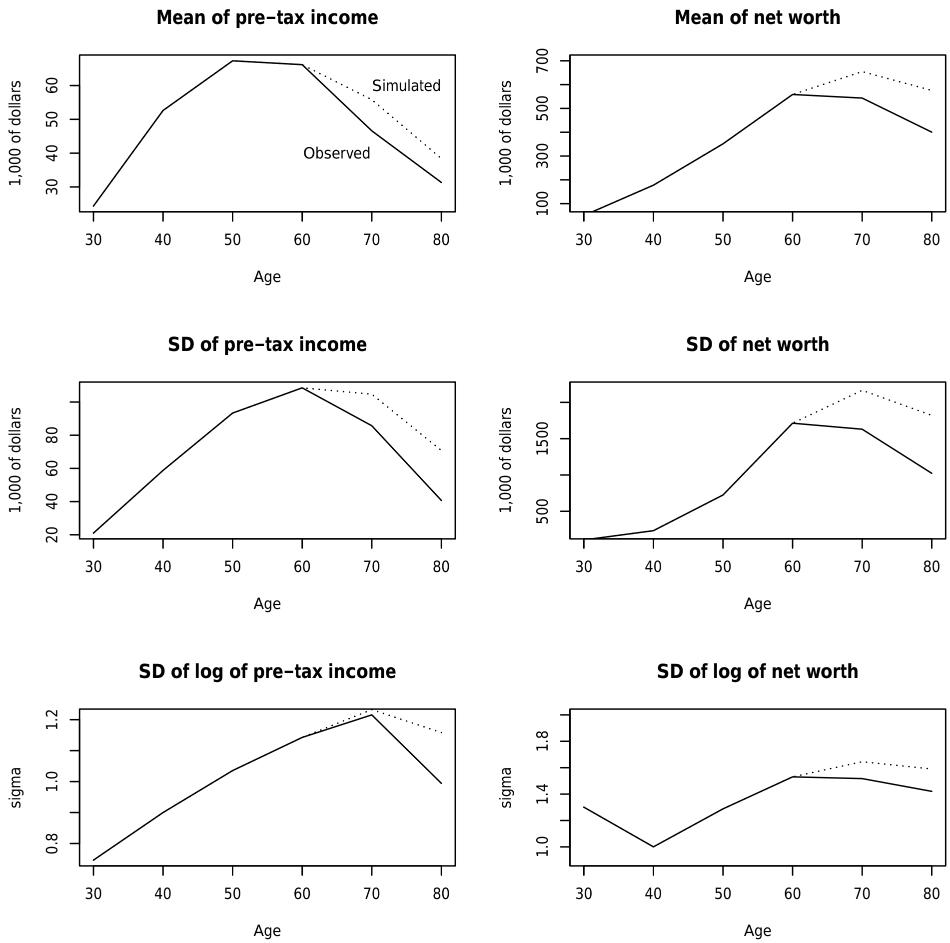
[8] Our analysis here does not take into account the induced changes in interest rates or the wage rates; this simplification is consistent with treating the U.S. economy as open to international forces.

Figure 2:
Original and longevity-stretched age profiles of income and assets estimated from the Survey of Consumer Finances, 2001 (in 2013 constant dollars)



Note: Stretched profiles with an additional five years of longevity are obtained by extrapolating the trend from ages 50 to 60 and an additional five years to age 65. See the text for details.

than the original pattern of increase predicted for assets. This result is plausible, as we can imagine that living longer will have a greater effect on inequality through the compounding of random shocks to assets than through the compounding of shocks to earnings.

In Table 3, we see that the effect of the approximately five-year increase in longevity is a one to two percent increase in inequality, as measured by the share held by the top decile. While this is not a trivial effect, it is considerably smaller than the four to five percent increase in the share held by the top decile that we simulated

Table 3:
Inequality (top decile share) implied by the original and the stretched schedules of income and net worth

	Pre-tax income	Net worth
Original	44.6%	62.8%
Stretched	45.3%	64.9%
Difference	0.7%	2.1%

Note: The original schedule is based on the 2001 Survey of Consumer Finance, as shown in Figure 2. The stretched schedule extrapolates five additional years of the trend linearly from the observed values at ages 50 and 60, as shown in Figure 2. Inequality is estimated by applying these schedules to the stationary populations using the life tables of the United States in 2000, and a simulated version of the 2050 life table (note that the life expectancy in the 2050 life table is five years longer).

from falling fertility and the capital deepening that would result from a 1% decrease in the population growth rate.

7 Discussion

In this paper we have estimated the magnitudes of some of the important effects of demographic change on aggregate economic inequality. Our purpose has been to gain insight into the relative importance of several different mechanisms.

The first pathway we examined was the increase in capital intensity that accompanies a slowdown in population growth. To estimate the magnitude of this 'Piketty' effect, we calculated the increase in capital his model would predict for the United States if population growth were to slow by about one percent. We found that this effect would produce a significant increase in income inequality, raising the share of income held by the top decile by about four to five percentage points. To put this increase in perspective, we should note that the top decile in the United States now has about 50 percent of income. An increase of five percent in the earnings of the top decile would take the country about a third of the way to what Piketty calls "very high inequality," in which 65% of income is held by the top decile.

The second pathway of demographic change we looked at was the shift in the age structure toward the older and more unequal ages that may be expected to accompany a slower population growth rate. This effect is, as David Lam found in his development of the subject, less clear-cut than it might at first seem. This is partly because the increases in inequality with age are not so enormous that a change in population composition has a large effect and partly because changes in population-level inequality in the within-age-group and the between-age-group components partially offset one another. As there are more old people, the population shifts toward ages at which there are higher levels of within-age-group inequality. But at the same time, the presence of fewer young people pushes down the numbers of those with earnings that are far below average, which tends to lessen between-age-group inequality. Applying Lam's results for stable populations to the United States schedules of income and assets in 2001, we find that the net result of a one percent decline in population growth would increase the share of income held by the top decile by something like one-half of one percent. This 'Lam' effect might be detectable, but it appears that it would be much smaller than the 'Piketty' effect.

Finally, we consider the consequences of increased longevity on longer periods of life-cycle savings (Lee and Goldstein 2003). We crudely simulate the effect of extending life by the five years that are forecast over the next half century by stretching out the schedules we observe for 2001. We extrapolate the age trend observed from 50 to 60 an additional five years out to age 65, inserting this additional period of earnings and capital accumulation into the economic life cycle. We find that the aggregate inequality implied by these longer life profiles is an increase in the share held by the top decile of around one to two percent. The size of this longevity effect is in-between the 'Lam' age structure effect and the 'Piketty' capital intensity effect, both of which can be seen as consequences of changing fertility.

Together, the three mechanisms we explored could account for around seven percent of the increase in the share of income held by the top decile. This would be a substantial increase in inequality.

Income inequality expanded between 1970 and 2010, as the share of income held by the top decile of the population increased by about 20% in the United States and by about 5% in Europe (Piketty p. 324, Figure 9.8). We know that demography cannot explain the differences between Europe and the United States, since the United States has faster growth rates and a younger population than Europe. However, if we apply our results of the potential impact of demographic change within these two regions, we would expect to observe that population aging in the United States will lead to substantial increases in inequality in that country. In Europe, the same magnitude of change would be even more dramatic, more than doubling the increase in inequality seen in recent decades.

In this analysis, we have considered each of three factors independently. We considered capital deepening without taking age structure into account. We applied age structure profiles to changing populations without taking macroeconomic constraints into account. Finally, we considered age profiles of inequality without taking macroeconomic constraints into account. A more complete modeling approach would consider capital deepening in the context of the population age structure and the economic life cycle, rather than in the ageless context of Solow's neo-classical growth model.

Steps toward the development of more integrated models have been made by Lee, Mason, and Miller (2003) and by Romero-Sanchez (2013). Their approaches include the consideration of intergenerational transfers (notably, public pension programs), general equilibrium interest rate effects, and the combined forces of fertility decline and longevity increase. A key assumption in each of these models is how the age at retirement reacts to increases in longevity. Without increases in the retirement age, the increase in life-cycle savings needed for retirement is quite large, and produces even larger increases in the capital output ratio (β) than those considered here. Another important consideration is the role played by public pay-as-you-go transfer systems. These benefits can have the effect of replacing life-cycle savings and lessening β and are redistributive (or, at most, proportional to labor earnings). Thus, transfer programs can reduce the inequality-increasing effects of population aging.

We expect that the resurgence of interest in the topic of economic inequality sparked by Piketty will inspire many studies of the demographic influences on economic inequality. Our initial foray into this field suggests that there is indeed room for a substantial compositional increase in inequality, assuming Piketty is right about increased capital intensification and its compositional effect on inequality. However, the direct age structure effect appears to be of minor importance. Finally, the increase in the average lifespan also appears to have a substantial impact on life-cycle savings. Considered together, these findings give us reason to suspect that population aging will exacerbate the increases in inequality seen in recent years, strengthening the case that we should be concerned about who owns what in the 21st century.

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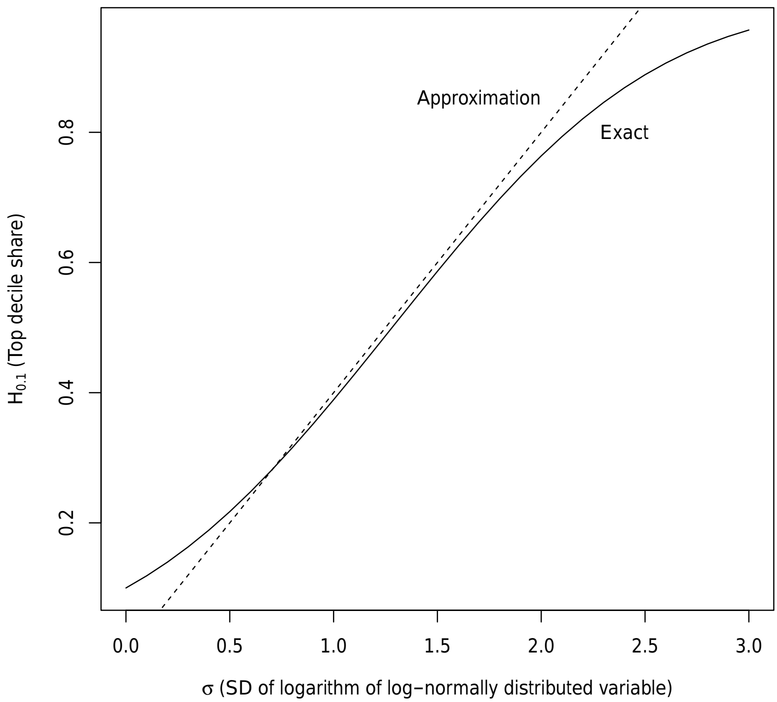
Appendix: Estimation of top decile share of log-normal distribution

Figure A.1:
Accuracy of linear approximation of top decile share of a log-normally distributed variable by value of σ



Let H_p be the 'have curve' for the top p of the population. For example, $H_{0.1}$ would be the share held by the top 10 percent.

When a quantity is log-normally distributed, we can approximate the share held by the top decile quite accurately for values of σ ranging from 0.5 to 2.0, the range of economic inequality seen in many populations. The approximation is

$$H_{0.1} \approx \frac{1}{\sqrt{2\pi}}\sigma = 0.40\sigma. \tag{A.1}$$

The accuracy of this approximation can be seen in Figure A.1.

To derive, we first express the 'have' function H in terms of the more common Lorenz function L for the share held by the bottom fraction of the population. This gives us $H_{0.1} = 1 - L_{0.9}$, where $L_{0.9}$ is the share held by the bottom 90 percent. The Lorenz curve for the log normal is known to be

$$L_{0.9} = \Phi(\Phi^{-1}(0.9) - \sigma), \tag{A.2}$$

where Φ is the cumulative distribution function of the standard normal (Cowell 2009, p. 154).

The linear approximation of the cumulative distribution of the standard normal for values x above zero is

$$\Phi(x) \approx \frac{1}{2} + \frac{x}{\sqrt{2\pi}}. \tag{A.3}$$

In our case, we use the approximation (A.3) to estimate the Lorenz function (A.2). Substituting $x = \Phi^{-1}(0.9) - \sigma = 1.28 - \sigma$ into (A.2) gives

$$L_{0.9} \approx \left(\frac{1}{2} + \frac{1.28}{\sqrt{2\pi}}\right) + \frac{\sigma}{\sqrt{2\pi}} \approx 1 + \frac{\sigma}{\sqrt{2\pi}}. \tag{A.4}$$

Substituting back into H gives the desired result in (A.1).