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A new model of multidimensional ageing: the *BES-ageing*

Lorenzo Semplici,
LUMSA (Libera Università degli Studi Maria Ss. Assunta di Roma)

+39 0543 62327
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A new model of multidimensional ageing: the *BES-ageing*.

Lorenzo Semplici[1]

Abstract

The primary objective of this work is to construct a model of multi-dimensional ageing—the *bes-ageing*—based on the domains of the Italian BES (Istat) and using data from SHARE 2007 and 2011. This model was tested using PCA, resulting in four factors: 1) *Context Factors*, 2) *Physical and Psychological Capabilities*, 3) *Economic and Working Capabilities* and 4) *Social Participation.* These factors allow us to classify ageing under determinants that are institutional (1 and 3), natural (2) and social (4) in nature. Following this, two composite indicators are created (one weighted for component loading and one additionally weighted for citizen preferences) which allow us to focus on regional inequalities (secondary goal of the research) in static (ranking) and dynamic (sigma and gamma analysis) terms. The econometric analysis investigates two relations: 1. the bes-ageing indicators at time t-1 and the emergence of chronic disease between the two waves; 2. the same indicators and life-satisfaction. The results suggest that the model can assist in the reduction of the onset of disease, both directly and indirectly, and in the increase of life satisfaction, to a greater degree than increasing GDP and healthcare expenditures alone. The economic value of *bes-ageing* in terms of life satisfaction is also evaluated.

Keywords: active ageing, equitable and sustainable well-being, life-satisfaction, regional inequality, composite indicators

JEL numbers: I14 *Health and Inequality*; I31 *General welfare, wellbeing*; J17 *Value of life*

[1] Department of Economics, Political Science and Modern Languages, LUMSA (Libera Università degli Studi Maria Ss. Assunta di Roma), Via Pompeo Magno 22, 00192 Rome, Italy. l.semplici@lumsa.it; lorenzo.semplici@libero.it

3.1 Introduction and presentation of the new model

The demographic transition[2], defined by the WHO (1999) as the "20th century revolution in human health", and the closely connected epidemiologic transition[3] are increasing the urgency of finding a model for ageing that is economically and socially sustainable, that reduces the costs and increases the fairness of the necessary changes to the system of public assistance. (Marin, 2013). In Italy, these transitions took place prior to other European countries and other countries worldwide, and had been completed in the early 1990's when the population over 65 surpassed that of children under 15 (see, among others, Rosti, 2006 and Blangiardo, 2010). This is clearly shown in various statistical data.[4] In the last 25 years, the natality rate in Italy has decreased by two points, passing from 9.9 to 8.[5] The index of old-age population[6] and the old-age dependency ratio[7] in Italy are also striking: the former has passed from 90.01 in 1990 to 159.55 in 2015[8,] while the latter has increased from 21.73 to 34. Given the increased life expectancy and ageing of the population, as far as the epidemiologic transition is concerned, the standardized rate of persons with at least one chronic disease increased from 128.87 to 137.62 between 2005 and 2013[9] while the rate for infectious diseases decreased from 468.99 in 1992 to 166.7 in 2009.

The most significant consequences of the ageing of the population and the increase in chronic disease are: the insolvency of public pension systems[10]; increasing costs for the National Health system[11]; the risk of social exclusion and loneliness[12] (increasing numbers of elderly persons with

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[2]The demographic transition, following the work of Marazzi et al. (2014), is divided in two phases: the first relates to the decrease of the mortality rate due to improvements in diet (Livi-Bacci, 2002), hygiene and sanitation (Comodo & Macciocco, 2004) and the reduction of childbirth and childhood mortality, with consequent increase in population. The second phase concerns the decrease of the birth rate. The results of this process, as the authors show, are the increase in life expectancy and the ageing of the population (Kinsella and Philips, 2005; UN, 2007; UN, 2009; OECD, 2011).

[3]For epidemiologic transition, we intend «the transition from a population characterized by a high frequency of infectious diseases, to one with a high frequency of chronic-degenerative diseases» (Marazzi et al. 2014, p.53).

[4]The data used in the introduction are taken from the database ISTAT "Health for All", available for download at: https://www.istat.it/it/archivio/14562 . [Accessed on 8 June 2017]

[5]Italy, according to Eurostat data, had the lowest birthrate in Europe in 2015, over 6 points from Ireland, first in the ranking.

[6]The index of old-age population is the relation between the population over 65 and the population between 0-14 years in age, multiplied by 100.

[7]The index of old-age dependency is the relation between the population over 65 years in age and the population in active age (15-64 anni) multiplied by 100.

[8]In 2013, the median in the EU 28 was 116 (Eurostat).

[9]The rate has worsened more in the South (from 138.04 to 148.6), less in the Nord (from 123.34 to 139.09) and in the Center (from 128,47 to 131,76), despite the fact that the southern regions and the islands began with a notably worse situation.

[10]The inversion of the demographic pyramid shows that a greater number of pensions will become due, which will be paid for a decreasing amount of contributions paid by the young. To this already unsustainable observation, we must add the problems linked with precarious employment and unemployment, both situations which do not allow for continuity in the payment of these contributions. This will lead to increasing costs for the State and/or fewer economic benefits for the elderly. For perspectives on the reform of the pension system see, among others, Myles (2003) and Schokkaert and van Parijs (2003).

[11]In a country where the elderly dependency index is constantly increasing (demographic transition), leading to an increase in the percentage of persons with at least one chronic disease, the demand on the National Health System cannot but constantly increase. This will render the capacity to respond to demand inadequate, in several regions in

children living far from them and decreasing numbers of grandchildren to keep them active and engaged.)

The perpetual issue of regional inequality also comes into play in the area of ageing: in 2013, the healthy life expectancy at 65 years of age was 7.9 years for males and 7 for females in northern regions, while in the southern regions, it was only 4.7 and 3.5 years respectively (half that of the north.)

In short, the primary challenge of aging today[13] is the need to design and create a new system of welfare (Taylor-Gooby, 2004) with the objective not just of increasing life expectancy, but increasing years enjoyed in good health (Robine and Jagger, 2005).

The broad and multifaceted concept of *positive ageing* was born in response to this challenge[14]. This concept focuses on the regenerative and creative possibilities of ageing (Walker, 1999) including challenging widely-held views of the phenomena (Conway, 2003), and is radically different from that offered by gerontologists up until the end of the 1950's. In this, there is a shift away from a vision of ageing associated with decline, degeneration and the progressive withdrawal from social engagements and the workplace, leading to a narrowing of the life goals. (Gergen and Gergen, 2001; Zambianchi and Ricci Bitti, 2012). Instead, positive ageing seeks to cast this in a positive light, and is characterized by the implementation and use of physical, psychological, personal, intellectual and social resources in order to maintain and improve the participation of the elderly in socio-economic activity, making full use of their potential and eliminating the risk of

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particular. The percentage of public health expenditure relative to GDP grew between 1990 and 2015 by nearly one point (from 6.1% to 6.84%, with significant differences among the regions: while costs in the North and Center have increased slightly, these have fallen in the South by over 1.5%. This depends on at least two factors: first, in the south and the islands, the State no longer has the resources to respond to the growing demand for health services (in the South, the presence of persons with at least three chronic diseases is greater than in the North: in the former, the rate is 149.54 compared with 137.54 in the latter); second, healthcare emigration shifts costs from regions of emigration to those of immigration (from the South to the North).

[12]In the literature, the phenomena of *age discrimination* is discussed (Pascoe & Smart Richman, 2009; Stephan et al., 2015).

[13]Ageing has always been a central question in the life of man and many theories have been constructed around it (Achenbaum and Bengston, 1994; Bengston et al., 2009). In particular, Pierce and Timonen (2010) classify these theories by dividing them into three macro areas: biological, psychological and social. The first area, relating to the process of ageing of the organism, includes the stochastic and programmatic theories (Christafalo, 1996; Effros, 2009). The second concerns the many psychological changes that take place beginning in adulthood (Bengston et al., 2005), and includes the theory of life development (Baltes et al., 2005; Willis et al., 2009) and those which highlight the impact of culture, and in particular its influence on social relationship, on the psychological changes of advanced age (Antonucci et al., 2009). Finally, many works have examined the various social theories of ageing (see, among others: Lynott and Lynott, 1996; Marshall, 1996, 1999; Bengston et al., 1997; Estes et al., 2003; Powell, 2006). However, the authors preferred to list nine of these: the theoretical reflections on concepts of time, age and ageing; the life course perspective; the political economy of ageing perspective; the cumulative advantage and disadvantage theory; feminist theories of ageing and theories of intersecting inequalities; the moral economy of ageing perspective; post-structuralist theories of ageing; theories emphasising a sense of meaning humanistic or cultural theories of ageing; phenomenology of ageing.

[14]The international community, in particular the developed countries, have greatly contributed to the debate, demonstrating in their guidelines and other appeals the urgency of moving in the direction of *positive ageing* in order to respond to the challenges presented by ageing (see, among others: McFee and Rowley, 1996; OECD, 1998, 2000, 2007).

isolation[15]. This multiplicity of interconnected and mutually reinforcing elements leads to the creation of strategies involving not only persons over 65 years of age, but also adults under 45, in order to shape preventative policies, fundamental for good ageing.

The brief examination of several of the most important theories of *positive ageing* will be helpful in highlighting its most relevant elements, in particular as relates to its possible use for developing social and political policy.

Watson and Hall (2001, p. 24) hold that «the ability to maintain psychological and physical well being is dependent on five main categories of resources. These are human capital, psychological capital, financial capital, social capital and time (Hendricks, 1999)». Keyes (1998) offers a definition of well-being that includes five dimensions: social integration, social contribution, social acceptance, social actualization and social coherence. Indeed, the most important theories contributing to the development of the construct of *positive ageing* have been built around these various dimensions and types of social capital, as well as their possible combinations. According to Roew and Khan (1987, 1997) it is fundamental to take a systematic approach for transforming potential into active engagement with the aid of the perception of self-efficacy, that is, the conviction that the elderly is still the creator of their own destiny, able to change their circumstances and the course of events (Bandura, 2000). The theory of Kahana et al. (2002, 2005) is also in this propositive perspective: it develops the concept of ageing around the proactive role of the elderly, in contrast to the passive role that traditional gerontologists have typically attributed to them.[16] The proactiveness of the elderly is accompanied by their human agency that together builds an active lifestyle, assisting them in shaping not only their world, but also the resources and opportunities that are developed and created within it, correcting the trajectory of withdrawal and renunciation.

In this sense, proactiveness is regarded as a preventative, corrective and mixed adaptation. Proactiveness must be developed long before the stage of ageing[17] and requires two types of resources for its implementation: internal and external (financial, social and emergent – access to technology and to healthcare services). Baltes and Baltes (1990) propose a system of strategies for resources necessary for implementing proactiveness (or plasticity, as it is defined by these authors), classified by Baltes and Lang (2007) in four categories, each with a different rate of decline according to age: sensory-motor, cognitive, social and personality. This system is further divided in selection, optimization and compensation. The first element has the task of orienting a person's' life

[15]Numerous works have attempted to list the factors, resources, determinants and components of *positive ageing*. Vaillant and Mukamal (2001) indicate seven factors that lead to *positive ageing*: not smoking or quitting smoking at an early age, adaptive coping style; absence of alcohol abuse; healthy weight; stable marriage; exercise level; years of education. The WHO (2007) outlines a list of determinants for the construction of Age-Friendly Cities: transportation, housing, social participation, social inclusion, civic participation and employment, communication and information, community and health services, outdoor spaces and buildings. See also the works of Deshpande et al. (1986); Deshpande et al. (1990); Fernandez-Ballesteros (2011), Nassir et al. (2015).

[16]Passive and submissive ageing exposes the elderly to significant risk factors, such as fatalism and the consequent cycle of increasing vulnerability, that lead to a decline in general functionalities. In this regard, Rutter and Rutter (1995) emphasize the importance of planning for well being by putting into action a chain of action that, starting from constructive actions and choices, initiate a positive feedback cycle.

[17]Holahan and Chapman (2002) show the relation between the adoption of an active and propositive attitude at a young age with the presence of proactive goals forty years later.

towards objectives and projects, and may be active or reactive (creation of new goals following a shock event).

The contribution of Cartensen et al. (1999) on the theory of socioemotional selectivity is important for understanding the choice of life goals and the relationships which are pursued as a result. According to this theory, choices are influenced by a person's' perception of future time: the more advanced in age a person becomes, the more their perception is limited and their life goals focus increasingly on the conservation and reinforcement of relationships, a perspective that progressively closes the elderly in themselves and results in their isolation. Hence, for *positive ageing*, it is fundamental to design a model of ageing that opens the elderly to a new understanding of their future time, one that is capable of giving renewed recognition and appreciation for their status within the community[18]. This requires the presence of social environments that are adequate and, in particular, stimulating, and serves to increase the capacities of the elderly by cultivating those resources they already possess. Finally, the capacity to creatively and intelligently develop alternatives in response to changes is linked with the ability to compensate for loss[19].

Numerous initiatives for developing National Intervention Strategies have arisen from these theories. Major initiatives along these lines have taken place in New Zealand (Dalziel, 2001)[20], Australia (Andrews, 2002), the United Kingdom (HM Government, 2005) and Ireland (Irish Department of Health, 2013)[21]. Intervention strategies have also been implemented by public authorities at a local level. Noteworthy examples of this may be found in the Alpine Shire[22] and in the Wingecarribee Shire[23] in Australia. The common ground of these initiatives consists in three elements: a positive view of ageing, a new appreciation of elderly persons, and the need for the participation of elderly persons in the development of social well-being.

[18]Stevernik and Lindenberg (2006) indicate that the need for status, one of the three needs that must be met in order to reach a condition of social well being – the others being those for affirmation and affection – as the most difficult to satisfy in the stage of ageing, as it is closely connected to working activities. Yet again the combination of internal and external resources is necessary in order to create the possibility for meeting this need.

[19]For further discussion of the theories cited, see, among others, Zambianchi and Ricci Bitti (2012) and Docking and Stock (2017).

[20]In the 2014 report on Positive Ageing Strategy in Nuova Zelanda, sponsored by the Office for Senior Citizens, 10 goals are found: income, health, housing, transport, ageing in the community, cultural diversity, rural services, positive attitudes, employment opportunities, opportunities for personal growth and participation.

[21]Using the DELPHI technique (process of participation consisting, in this case, in three simultaneous rounds involving academics and researchers academics and researchers, public sector, voluntary sector, and older people – groups and individuals -) 56 indicators were identified across 4 areas: participation, healthy ageing, security, cross-cutting objectives (information, combating ageism).

[22]The Alpine Positive Ageing Strategy has the goal of maximising the quality of life, participation and social recognition of elderly persons who live in and visit the Alpine Shire. The strategy consists of five points: Enabling Basic Needs to be Met; Optimise Physical and Mental Health and Wellbeing; Maximise Independence for Frail and Disabled; Promote Community and Social Engagement; Build a Supportive Culture for Positive Ageing.

[23]The Positive Ageing Strategy of Wingecarribee Shire was planned for the twenty year period 2016-2036, with a bottom-up approach. From this consultation process four areas were revealed, which were used to design the strategy: safe and accessible community, independence and good health, participation in community life, information and communication.

In conclusion, sharing the views of Davey and Glasgow (2006) and that of the theory of *positive ageing*, the *disengagement theory of ageing* (Cumming and Henry, 1961) must be rejected and the need to remain *actively engaged* in society (Havighurst and Albrecth, 1953) must be emphasized.

Among the variations of *positive ageing*, the most frequently found is that of *active-ageing*, which has also been promoted by the WHO. Through the years, this concept has increased in importance and evolved from its original construct, which required the capacity to be physically active or active in the workplace[24].

In 2002, the WHO offered a definition of *active ageing* with a clear multidimensional perspective, holding that this should be understood as "the process of optimizing opportunities for health, participation and security in order to enhance quality of life as people age" , and clarifying that the term «active» indicates the "continuing participation in social, economic, cultural, spiritual and civic affairs, not just the ability to be physically active or to participate in the labour force"[25], while the term health indicates, from a multidimensional perspective, the "physical, mental and social well being"[26].

Ageing thus depends, as the literature has shown[27], on multiple factors that together contribute to the determination of well being.

Davey and Glasgow (2006) offer at least two critical observations on the approach of *positive ageing*: first, the excessive attribution of sole responsibility for individual actions; second, the risk of degeneration in "marginalizing activism" which distracts from the needs of the most vulnerable, in that ageing regards not only persons capable of being actively employed in society and making autonomous choices, but also those elderly persons who are already living in fragile conditions.

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[24]Zaidi and Howse (2017) discuss the development of the concept of positive ageing that, they hold, can be understood and classified in four different categories: *Productive Ageing* (Butler and Gleason 1985), *Successful Ageing* (Rowe and Kahn 1987, 1997; Baltes and Baltes 1990; Bowling, 1993; Baltes and Carstensen, 1996), *Healthy Ageing* (WHO 1990, 2015; Peel et al. 2003, 2005; Ryff and Singer 2009) and *Active Ageing* (WHO 2002; Walker 2002). The above-cited work of Davey and Glasgow (2006) uses a similar division. For a further review of the literature see Foster and Walker (2014).

[25]The contributions of Fortujin et al. (2006) are interesting in this matter. These identify three broad categories of activities in which the elderly are traditionally and actively involved: those centered around the domestic sphere, the individual and the community to which they belong; Bukov et al. (2002) classifies their participation in three different areas – collettive, productive and political -.

[26]WHO (2002, p.12).

[27]Among the models of multidimensional ageing it is useful to recall that offered at a worldwide level by the WHO and implemented by Constança et al.(2012), who identify six determinants of *ageing*: personal, behavioural, social environment, health and social services, physical and economic environment. Another model of multidimensional ageing has been proposed by HelpAge International (2013, 2014 e 2015), that has lead to the development of the Global AgeWatch Index, composed of four domains: *income security*; *health status*; *enabling environment*; *capability*. For Europe (UE8) there is the synthetic model of the Active Ageing Index (Zaidi, 2015 e 2016), which is comprised of 22 indicators divided in 4 domains: *employment*; *participation in society*; *independent, healthy and secure living*; *capacity for active ageing*. For a review and comparison among unidimensional and multidimensional approaches, see Boudiny (2013). Another approach present in the literature consists in the direct calculation of *life satisfaction by* by means of composite indicators created *ad hoc* (Neugarten et al., 1961; Adams, 1969; Wood et al., 1969; Barret and Murk 2006).

Another important point relates to the role of social and political institutions in this new demographic picture.

The response to these criticisms must come from extending responsibility to other subjects; these, in fact, determine "from the outside" the conditions for ageing through their choices and, because of their position as third parties, may be able to proactively protect and take care of persons in critical situations.[28] As emphasized by Settersten and Trauten (2009), these situations can open the door to reflection, from which new approaches may arise.

It is thus necessary to look for a model of ageing that takes into due consideration both the relation between the different elements determining the well-being of persons, as well as the possible use of a framework for designing social and economic initiatives that can be shared by various civil actors (Institutions, Businesses, Citizens and Civil Society), one that may guarantee continuous well-being as the seasons of life advance.

Sharing and continuity are necessary for the success of a model that should, if possible, require implementation at two levels: on one hand, public investments to ensure there is adequate infrastructure and whatever else may be necessary for creating a context favorable to dignified living; on the other hand, proactive actions by citizens and businesses (private parties), participating in the common good through their economic, civil and social engagement. Public and private participation are two faces of the same coin (the Republic) that together contribute to the creation of relations between rights and duties, permitting the full development of human life.

From the criticisms of *positive ageing* and for the above-mentioned reasons, imagining a new model of ageing emerges as a priority. This new model must be based on a multidimensional view of human action that is equitable and sustainable and which includes, in a single paradigm, both private and public action, adopting the constitutional perspective[29] of multidimensional well-being.[30]

In this sense, ISTAT and CNEL gave rise in 2013 to a model that is currently respected and well-known, and not only within Italy: the BES.[31] This model consists in the following indicators:

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[28]Walker (2009) warns against the risk of institutional paternalism, preferring to consider the state as one who accompanies persons along the evolution of their lives.

[29]See, among others, the work of Burchi et al., 2014.

[30]The debate on the reductionist view of well being, which holds that the GDP is the primary indicator of well being, has grown in recent years and finally resulted in this theory being definitely surpassed. Robert Kennedy, in his well-known speech on 18 March 1968 at the University of Kansas, affirmed that the GDP «measures everything in short, except that which makes life worthwhile». The literature has shown the truth of Kennedy's intuition and the need to adopt a model of multidimensional well being (see, among others, Easterlin, 1974; Sen 1980; UNDP, 1996; Veenhoven, 1996; Oswald, 1997; Kahneman et al. 1999; Sen, 1999; Diener, 2000; Frey and Stutzer, 2000; Di Tella et al., 2001; Easterlin, 2001; Frey and Stutzer, 2002; Blanchflower and Oswald, 2004; Di Tella and McCulloch, 2006; Kahneman and Krueger, 2006; Kahneman et al. 2006; Dolan and White, 2007; Clark et al., 2008; Graham, 2009; Stiglitz et al, 2009; Diener et al., 2010; UNDP, 2010).

[31]The BES is the fruit of a project created to measure the progress of Italy not just from an economic perspective, but also from a social and environmental point of view. The BES is the first approach to multidimensional well being and its design included the direct inclusion of representatives of civil society, showing with this choice the need for broad-based participation that renders the statistical tools understandable and broadly shared. The BES consists in 12 dimensions of well being including 130 indicators that measure not only the level of different elements as well as the

Health, Education and Training, Work and Life Balance, Economic Wellbeing, Social Relationships, Politics and Institutions, Security, Subjective Wellbeing, Landscape and Cultural Heritage, Environment, Research and Innovation, Quality of Services[32].

The relations between specific BES indicators and chronic disease or health conditions in general is supported by a broad literature across various fields. As far as the area of Health is concerned, Schwanen and Ziegler (2011) show the relation existing among wellbeing, independence and mobility, while Millán-Calenti et al. (2010) demonstrate that the indicators ADLA (activities of daily living) e IADLA (instrumental activities of daily living) can predict morbidity and mortality. The WHO (2001) has drawn the attention of the international community to the broader need to promote mental health, while Moussayi et al. (2007) have demonstrated the relation between depression and chronic disease. Gokulakrishnan et al. (2017) and Chien et al. (2010) show the existence of a positive relation between programs aiming to improve lifestyles and two specific chronic diseases: diabetes and heart disease.

Moving on to the indicator of Security, Santana et al. (2009) show that crime and urban decay have a negative impact on health. More in general, there is a relation between the conditions of the neighbourhood in which a person lives, their quality of life and their health (Booth et al., 2000; Ziersch et al., 2005; Sugiyama et al., 2009). The areas of Environment and Work and Life Balance, as far as context factors is concerned, contributes significantly to determining health conditions.

In particular, numerous scholars find that there is a relation between climate change and worsening health conditions (Frumkin e McMichael, 2008; Frumkin, 2010; Kessel e Stephens, 2011; Hansen et al., 2013), between the environment and general and life quality (Gobbens e van Assens, 2017), also as relates in particular to the elderly (Garin et al., 2014 and Hassanvand et al., 2017). As far as this is concerned, Bayer had already noted in 1988 the central role of healthy and secure employment. Conn et al. (2009) suggest implementing the possibility of physical activity in the workplace in order to combat the negative effects of a sedentary lifestyle. International institutions (ENWHP, 2005 e WHO 2010) have also contributed to offering principles and guidelines for the creation of working environments capable of improving, or at least not worsening, the health conditions of workers. Finally, as far as work-life balance is concerned, Doyle and Timonen (2009) emphasize the importance of employment that is not just a *job* but also *work-care* in order to promote a holistic working activity, that is, one that is not merely a question of retribution.

Similarly important is the relation between socio-economic conditions (Economic Well-Being domain) and health (see, among others, Pickett and Pearl, 2001; Gopal and Siapush, 2002; Dowd et al., 2011; Egen et al., 2016; Shaw et al. 2017). There are also numerous other studies that, in various countries, demonstrate the relation between economic inequality and unequal distribution of chronic disease and morbidity (Shi et al., 2003; Clark et al., 2008; Orueta et al., 2013; Korda et al.,

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divergence among them. Moreover, as can be read in the ISTAT website, "con la nuova Legge di bilancio approvata il 28 luglio 2016, il Bes entra per la prima volta nel Bilancio dello Stato e consente di rendere misurabile la qualità della vita e valutare l'effetto delle politiche pubbliche su alcune dimensioni sociali fondamentali" (http://www.istat.it/it/benessere-e-sostenibilit%C3%A0/misure-del-benessere. Accessed on 8 June 2017.

[32]To these must be added the domain of Subjective Well Being, which in this work is not considered, because the analysis that will be developed will involve the use of subjective data and the reference to life satisfaction, based on the declared perception of one's own life condition.

2014). The question of elderly housing is related to this area, in particular the trend of *social housing* as reported in the research by Dunn (2000) and Howden-Chapman (2004), which can have a positive impact on health when it is of high quality.

Easy access to essential services (Quality of Services domain) is also connected with health, in particular as relates to the satisfaction of needs for medical treatment (Derose et al. 2011) and the possibility to use transportation services (Green et al., 2014). Difficulty in accessing services increases with age, aggravating issues related to prevention and to maintaining independence (Porell and Miltiades, 2001; Fitzpatrick et al., 2004). Another important question related to public services is the relation between their usage and cultural factors (Zagaria, 2013; Keyvanara et al. 2017). User satisfaction may serve as a valid *proxy* for measuring the degree of accessibility, not just in terms of vicinity, but also in terms of availability, of services which fully meet user needs (Alazri and Neal, 2003).

Health conditions are also positively affected by access to cultural resources (Landscape and Cultural Heritage), in particular the possibility of enjoying cinemas, museums, exhibitions etc. (Cuypers et al., 2011 and Boinkum et al., 2016). Similarly, health can be improved by the implementation of technologies (Research and Innovation), from the spread of the internet (Sanchez-Valle et al., 2017) to the design of true *smart homes* (Lê et al., 2012). The research conducted by Sum et al. (2009) also shows the relation between the use of the internet and the principal indicators of good ageing (level of perceived psychological well being, perceived health, life satisfaction, feeling of connection to the community), and introduces the concept of the feeling of community online[33].

Recently, there has been increasing evidence of the relation between the improvement of health and political participation (Politics and Institutions), in particular, that between the possibility of influencing institutional policy, especially at a local level, and public trust in these institutions (see, among others: Kahssay and Oakley, 1999, WHO, 2005, Laverack, 2006, Heritage and Dooris, 2009). This has been translated into policy in the *Healthy cities* project promoted by the WHO.

The positive relation between pro-social behaviours (Social Relations) and improved health conditions has been thoroughly demonstrated. Bourassa et al. (2015) hold that social participation can predict the evolution of cognitive function as people age. Among the indicators of social participation, the most widely used is that of volunteering activities. Morrow-Howell et al. (2003) show the effects of this activity on well being, while Onyx and Warburton (2003) and Casiday et al. (2008) highlight the positive relation between volunteering and the health of the most elderly persons. Becchetti et al. (2015), supported by a transversal literature spanning many disciplines (see, among others, Hunter and Linn, 1980; Oman et al., 1999; Liang et al., 2001; Duline et al., 2003; Musick and Wilson, 2003; Post, 2005; Hutchison et al., 2006), show the existence of a positive relation between volunteering and both objective (synthetic indicators of health –adla, iadla, casp, etc..-; symptoms; indicators of specific illness, cancer, asthma, diabetes etc.) and subjective (health satisfaction) health conditions, when combined with the adoption of a suitable

[33]McMillan and Chavis (1986) divided the sense of community in four dimensions: feeling of belonging, influence, integration and satisfaction of needs, shared emotional connection. It is possible to consider the concept introduced by Sum et al. (2009) as a fifth, transversal element with the capacity to augment the effects of the four above-mentioned elements.

lifestyle. Promoting volunteering can therefore be included among potential public policy initiatives in the area of health, as suggested by Jenkinson et al. (2013). Finally, Fortinsky et al. (2007) present the positive effects of caregiving activities on both mental and physical health. Similarly important are relationships within the family: Hughes et al. (2007) show the beneficial effect on the health of grandparents by taking care of their grandchildren.

The direct and indirect relationship between education and health has been recently demonstrated in a broad literature (among others, see: Grossman, 2006; Meara et al., 2008; Olshansky et al., 2012). In the first place, higher levels of education reduce the possibility of onset of various forms of senile dementia (Contador et al., 2016) and improve health conditions in general (Arendt, 2005) also in terms of life expectancy (Corsini, 2010). In the second place, education contributes to good ageing by reducing risk-increasing behaviours, that is, by improving lifestyle overall. (Wagstaff, 1986; Erbsland et al., 1995; Gilleskie and Harrison, 1998; Ross and Wu, 2005; Kenkel et al. 2006). Davey (2002) shows the relation between *active ageing* and education, while Simone and Scuilli (2006) demonstrate that continuing education is related to cognitive benefits.

In the light of these findings, the present paper has the objective of constructing a model of ageing that takes into account psycho-physical elements (health dimension), institutional considerations (security, environment, work, economic well being, quality of services, landscape and cultural heritage, research and innovation) and active life choices (politics and institutions, social relationships, education and training), based on the multidimensional conception of well being found in the BES indicators (Istat and CNEL, 2013 and 2014; Istat 2015 and 2016), and using data from Italy[34] at an individual level compiled in the SHARE - *Survey of Health, Ageing and Retirement in Europe* – in 2007 and 2011 (*wave* 2 and 4).

The term *bes-ageing*, which will be used to describe the proposed application of the BES framework to the evaluation and design of ageing policy, answers the criticisms of promoting marginalization raised by *positive ageing*, by giving a fundamental role to public institutions for the implementation of context factors (external resources), while recognizing the fundamental need to conceive of the person as a proactive agent (cognitive, social and community resources) albeit within the limits resulting from the inevitable decline that natural (biological) ageing entails (psychological and physical resources). Based on a multidimensional approach to well being, *bes-ageing* is based on the concept of integral human development, which should continue even in the life phase of advanced age, even if to a different degree.

Bes-ageing is a perspective that can, within its multiple dimensions, include in a unified model the apparently different and conflicting views of theories of ageing (biological, psychological, social), leading to positive synergy: these theories can be helpful to better define the various dimensions of well being, while these dimensions can offer a complex yet unified frame of reference, aiming ultimately to encompass the determining factors for well being within the process of ageing. This proposed multidimensionality entails a multidisciplinary design, requiring the inclusion of many diverse experiences and capacities, all working in harmony in order to improve the lives of people. The objective, in short, is to increase the resilience, defined by Staudiger et al. (1999) as the capacity to maintain a high degree of life satisfaction, of the elderly.

[34]Valle d'Aosta, Abruzzo and Molise are excluded from the analysis due to lack of available SHARE data.

The present work is divided in six sections (including the introduction and conclusion.) In the second section, after the presentation of the database and the methodology used for the creation of the composite indicators used in the subsequent sections, the principal components are analysed in order to test the multidimensional ageing model presented in the introduction. In the third section, the rankings constructed from the regional values of the composite *bes-ageing* indicators are presented and the *sigma-convergence* is analysed. In the fourth section, two hypotheses are tested using econometric analysis. The first of these is that the composite indicators of bes-ageing have a positive impact in terms of a reduced onset of chronic disease. The second is that the composite indicators of bes-ageing explain life satisfaction better than regional pro-capita GDP and regional public expenditures. Last, in the fifth section, the economic significance of the model is evaluated by calculating the value of non-market goods based on data related to happiness.

3.2 Principle components analysis and creation of the composite indicators

The data for the analysis of the ageing model have their source in the two waves (2 and 4) of the *Survey of Health, Ageing and Retirement in Europe* (SHARE), carried out respectively in 2007 and 2011. SHARE is a database panel that includes more than 45,000 observations of persons over 50 years of age across 19 European countries[35]. SHARE includes variables related to health conditions (disease, symptoms, synthetic indicators), socio-economic conditions, and social and family relationships. The following analysis will refer to the data for to Italy alone (nearly 4,000 observations.)

In this database, data at a regional level relative to five indicators representative of related BES dimensions are included (Pickpocketing for Security, Recycling for Environment, Spending_on_culture for Landscape and Cultural Heritage, Internet for Research and Innovation and Trouble_getting_service for Quality of Services)[36].

The other BES dimensions are represented by the following SHARE variables: Adla2, Iadla2 and Eurod2 for Health; Attend_education for Education and Training; Retemp for Work and Life Balance; Logincome_norm for Economic Well Being; Voluntary_work for Social Relationships; Polcom_part for Politics and Institutions.

In Table 3.1, the legend for the variables used throughout the work may be found, while the descriptive statistics of the sample are contained in Table 3.2 (socio-demographic variables) and in Table 3.3 (base indicators and composite indicators)

The characteristics of the sample are as follows:

- 56% of the sample population is female;
- the average age is around 66 years;
- the median number of years of education is almost 8;
- the average household is composed of 2 to 3 members;

[35]Austria, Germany, Sweden, Netherlands, Spain, Italy, France, Denmark, Greece, Switzerland, Belgium, Israel, Czech Republic, Poland, Ireland, Hungary, Portugal, Slovenia and Estonia.

[36]The source of these further variables is Istat (statistical tables attached to BES Report 2016).

- 16% of the sample reports that their mother is still living;
- almost 6% of the sample reports that their father is still living;
- approximately 12% of the sample is widowed;
- 16% reports that they are a smoker;
- 38% reports drinking alcoholic beverages almost daily;
- around 55% never or almost never does physical activity;
- 64% is obese or overweight;
- around 64% of the sample experienced the onset of at least one chronic disease between the two sampling periods (2007 and 2011);
- the average life satisfaction reported has a value greater than 7.

The variable relative to the number of diseases is calculated taking the following chronic conditions into consideration:

1. hypertension or high blood pressure;
2. heart attacks (including myocardial infarction, coronary thrombosis and other cardiac problems);
3. stroke or cerebrovascular disease;
4. cancer or malignant tumor (excluding minor skin cancers);
5. Parkinson's disease;
6. diabetes mellitus;
7. asthma;
8. arthritis, including osteoarthritis and rheumatoid arthritis;
9. gastric or duodenal ulcer;
10. cataracts;
11. femoral neck fracture.

The model was tested by use of principle component analysis on the base indicators (normalized with the Min-Max procedure – Formula A3.1 in Appendix 3) chosen as representative of the BES indicators (Pickpocketing, Recycling, Spending_on_culture, Internet, Trouble_getting_services, Adla2, Iadla2, Eurod2, Voluntary_work, Attend_education, Polcom_part, Logincome_norm, Retemp)[37]. Four components resulted from this analysis[38]: 1) *Context Factors*; 2) *Physical and Psychological Capabilities*; 3) *Economic and Working Capabilities*; 4) *Social Participation* (table 3.5). These confirm the idea that the factors contributing to the determination of ageing may be subdivided according to the following classification: *natural ageing*, depending on the physiological process of physical decline; *institutional ageing*, depending on those aspects which

[37]Before proceeding with the PCA, the indicators were subjected to the Bartlett sphericity test and the KMO test (OECD, 2008). The results of both, reported in Table 3.4, suggest that the analysis is possible. In fact, the least *p-value* of 0.05 in the first test allows us to reject the null hypothesis of the absence of intercorrelation of the indicators. Knapp & Swoyer (1967) and Tabachnick & Fidell (1989) allow us to proceed, for further confirmation, with the analysis of KMO, that in our case results in a value of almost 0.8, thus suggesting the possibility of proceeding to PCA analysis (Kaiser & Raise, 1974).

[38]The components included in the analysis are those that report a level of eigenvalue greater than 1. The four components have a cumulative explanatory capacity equal to nearly 62% of the variance. These thresholds are advised by OECD (2008).

relate primarily to the sphere of state actions, both in terms of legislation and the capacity of implementation best practices in order to improve the surroundings (in this case, the Region); *active ageing*, depending on the choices which individuals make in relation to their social and political participation, time dedicated to caregiving and continuing education. Figure 3.1 outlines the structure of the proposed *bes-ageing* model.

To compile the model, a preliminary composite indicator was first created: the Besageing. Specifically, this composite is the result of the weighted arithmetic mean of the base indicators. The weights assigned correspond to the square of the component loadings, extracted from the rotation matrix[39], rounded to the nearest integer and multiplied by the part of the total variance explained by the component to which the specific indicator belongs. This approach was developed by Nicoletti et al. (2000), and presented by OECD (2008) in the "*Handbook on constructing composite indicators: methodology and user guide*", published by the OECD[40]. See Formula A3.2 in Appendix 3.

A second composite indicator was also created (Besageing_fqts[41]) by weighting the base indicators for both component loading and for spending preferences[42], as spread among the BES domains. These preferences were expressed by Italian citizens and measured in a 2013 survey promoted by the Forum Nazionale del Terzo Settore within the scope of the Formazione Quadri del Terzo Settore (FQTS)[43]. In this way, there is at the same time both positive weighting from the elaboration of the component loading, as well as normative weighting from the joint effect of the budget allocation process and public opinion[44], so as to ensure the benefits of both while reducing their limitations[45]. The comparison between positive and normative weightings is reported in Table 3.6.

[39]The approach used for the matrix rotation is that of *varimax*. This methodology is used to minimize the number of indicators that have a high *loading* on the same component.

[40]In the literature, the use of component loadings (or factor loadings) is widespread as factors in the process of weighting. See among others: Hollenstein, 1996; Nardo et al., 2005; Werwatz et al., 2005; Mishra, 2007; Gòmez-Limòn and Riesgo, 2009; Ferrara et al, 2015.

[41]On this, see Formula A3.3 in Appendix 3.

[42]Determined in this manner, the weights thus follow the mixed methodology of the budget allocation process (see, among others: Hope et al., 1992; Kao et al., 2007) e di public opinion (Tarantola et al., 2002).

[43]These preferences were developed and recalibrated in order to be representative of the Italian population by Becchetti et al. (2016a).

[44]This approach of double weighting was developed in Becchetti et al. (2016b).

[45]Following OECD (2008), while the (objective) statistical weights offer advantages in terms of correction of statistical redundancy, they also have the following limits: need for correlation between indicators and incapacity to show political preferences and priorities. Conversely, the (subjective) weights resulting from the survey are beneficial in that they are an expression of the citizens, legitimizing political action, but with the following costs: the weights could reflect specific local conditions; there is a risk of incoherence linked with the difficulty of circular thinking due to a number of indicators greater than 10; the weight could measure the urgency or the necessity of political intervention and not the direct importance of the indicator.

3.3 Ranking and analysis of *sigma and gamma convergence*

This section aims to develop a comparison among regions in static terms (geographical distribution and ranking) and non-parametric dynamics[46] (sigma and gamma convergence[47]), based on the values of the composite indicators created in the previous section.

As far as the regional distribution of *bes-ageing* is concerned, both from statistical weighting alone and from double weighting, the result is an Italy divided in two: on the one side, the center-northern regions, and on the other, those of the center-south, which have stayed at the bottom of the ranking throughout the years. The Besageing 'winners' of 2007 are Trentino Alto-Adige, followed by Emilia Romagna and Friuli Venezia Giulia. In 2011, Lombardia is ranked in third place, Friuli Venezia Giulia gained one place while Emilia Romagna slipped into fourth place. At the other end of the Besageing ranking, the only change over the years has occurred in the third to last position, where Calabria took the place of Campania, while Sicily and Puglia remained in last and penultimate place respectively. For further details, see Figure 3.2-3.3 and the ranking in Table 3.7.

The lack of significant change in the differences between center-north and center-south are confirmed both by the analysis of sigma convergence[48], which attests to the absence of a process of convergence in terms of the values of the indicator, and by the gamma convergence analysis[49], which shows the stability of the situation in terms of the positions occupied by the Regions in the ranking (Kendall coefficient - Formula A3.10 in Appendix 3 – over 0,95 - Table 3.8). It can be noted that, for the first type of analysis, the CV – Formula A3.4 and A3.7 in Appendix 3 – and the Gini coefficient – Formula A3.5 and A3.8 in Appendix 3 – take values near to zero (Table 3.8), while the Interquartile Range – Formula A3.6 and A3.9 in Appendix 3 - has a value between 6% and 8% (7,7% for Besageing and 5,9% for Besageing_fqts). This means that, on the one hand, there are no evident convergence processes (CV and Gini), and on the other, there is a divergence

[46]The parametric (*beta-convergence*) and non parametric (*sigma e gamma convergence*) models have been frequently applied in macroeconomics in order to measure inequality and convergence processes among States, especially in relation to economic growth (Siegel, 1956); Baumol, 1986; Barro e Sala-i-Martin, 1991; Mankiw et al., 1992; Friedman, 1992; Islam, 1995; Quah, 1996; Sala-i-Martin, 1996; Monfort, 2008; Young et al., 2008; Dvorokovà, 2014). Recently, these methodologies have been used to study other phenomena, such as well being. Several works in this sense are those of Hobijn-Frances (2000), Giles-Feng (2003), Ferrara and Nisticò (2013), Pretty (2013), e Ferrara et al. (2016).

[47]The presence of a gamma convergence is possible even in the absence of a sigma convergence (Boyle e McCarthy, 1997).

[48]With this type of analysis, the aim is to investigate the trend of the index of inequality of the variable taken into consideration (in our case, the Besageing and the Besageing_fqts). According to Boyle and McCarthy (1997), this is a simple, undistorted measurement and can be calculated using different indices of inequality. In the analysis proposed, the coefficient of variation is selected (relation among the standard deviation and the median), the interquartile relation (between the fourth and first quartile) and the Gini index. The formulas are found in the Appendix 3. Other indicators are the Theil index, the interdecile relation and the interquartile difference (see, among others, Baldini and Toso, 2004).

[49]This analysis aims to measure the mobility of the statistical units over time in the cross-country distribution of the variable under consideration, with a non-parametric approach. In particular, it measures the changes that occur in the ordinal ranking of the statistical units of the variable studied over time. This is measured with the concordance coefficient of Kendall (W) developed by Siegel (1956) and closely linked with the coefficient of correlation of Spearman (Legendre, 2005), that can take values between 0 and 1: the closer the value to 0, the greater the mobility within the distribution with consequent evidence of convergence.

between the best (last quartile) and worst (first quartile). This corresponds to an increase in the divergence between the best Regions compared to the others in the period under consideration.

3.4 Econometric analysis

In this section, econometric analysis will be used firstly to investigate whether or not there is a link between the composite bes-ageing indicators at time t-1 and the variation of the number of new diseases[50] reported in the interview conducted between the two waves. In particular, a model of probit regression is used to test whether a higher level of *bes-ageing* at time t-1 reduces the probability of the onset of disease between the two periods ($Deltadiseasebin_{i,t}$), while controlling for a series of sociodemographic (Gender, Age, Eduyears, Widowed, Mather_alive, Father_alive, Oneclosechildren, N_grandchildren and Hhsize) and lifestyle (Smoking, Drinking, Vig_activity and Overweight_obese) variables at time t-1, and inserting a dummy variable for each Region. We also also investigate whether *bes-ageing* has a greater or more significant impact compared with two variables traditionally used for the design of macroeconomic policy: the regional GDP pro-capita (*Loggdp*) and regional public health expenditure pro-capite (*Loghealth_expenditure*)[51]. Equation 3.1 summarizes the model tested.

$$Deltadiseasebin_{i,t} = \alpha + \beta BesageingCI_{i,t-1} + \gamma\, Loggdp_{i,t-1} + \gamma\, Loghealth\_expenditure_{i,t-1} + \\ + \sum_{k=1}^{K} \delta_k\ SocioDem_{i,t-1} + \sum_{l=1}^{L} \lambda_l\ LifeStyle_{i,t-1} + \sum_{g=1}^{G} \kappa_g\, DRegion_{i,g} + \varepsilon_{i,t} \qquad (3.1)$$

$$s.c.:\ \ disease_{t-1} = 0$$

Where *BesageingCI* indicates the variables referring to the composite indicators of *bes-ageing* for individual *i*: Logbesageing and Logbesageing_fqts. The results of these two models as defined are reported in Table 3.9 and Table 3.10 respectively, which show the following results:

- for both models, the impact of *bes-ageing* is a reduction of the probability of the onset of new disease with a significance level of 99%;
- in both models, both GDP pro-capite as well as public health expenditure pro-capite do not have a significant impact;
- in both models, increases in age correspond to an increase in the onset of disease;
- in both models, the variables which refer to family life reduce the probability of the onset of disease.

These results are confirmed by a series of robustness checks (age, level of education and level of public health expenditure pro-capite), reported in Table 3.11. It must be emphasized that in the models with composite weighting for *component loading* alone (1, 3 and 5), the level of significance is reduced from 99% to 95% in all sub-samples analysed. In the models of *bes-ageing*

[50]The model assumes that the number of diseases at time t-1 is equal to zero.

[51]All statistical units present in wave 2 are also present in wave 4. If this were not the case, it would be necessary to proceed by implementing estimates by using various correction procedures, in order to avoid distortions due to the worsening health conditions or the death of the interviewed subjects. (Becchetti et al., 2015), as suggested in the literature (see, among others, Raab et al., 2005; Nicoletti and Peracchi, 2005; Vandecasteele and Debels, 2007).

with double weighting (2, 4 and 6), the only reduction in the level of significance is found in the subsample of those with less education (model 4).

The second objective of the present section is to investigate the causal link between the composite indicators of bes-ageing and life satisfaction. To test our hypothesis of a positive relation between the two variables, a *pooled ologit* regression model is created, as in Equation 3.2:

$$Life\_sat_{i,t} = \alpha + \beta BesageingCI_{i,t} + \gamma\, Loggdp_{i,t} + \gamma\, Loghealth\_expenditure_{i,t} + \\ + \sum_{k=1}^{K} \delta_k\ SocioDem_{i,t} + \sum_{l=1}^{L} \lambda_l\ LifeStyle_{i,t} + \\ + \sum_{v=1}^{V} \chi_v\ DInt\_Year_{i,v} + \sum_{g=1}^{G} \kappa_g\, DRegion_{i,g} + \varepsilon_{i,t} \qquad (3.2)$$

Where $Life\_sat_{i,t}$ is the variable that measures the *life satisfaction* of individual *i* and $BesageingCI_{i,t}$ is the variable that measures the level of *bes-ageing* of the same. In particular, this variable refers to both the composite Logbesageing and to Logbesageing_fqts.

The model is tested controlling for the causal link with GDP pro-capite ($Loggdp_{i,t}$), for public health expenditure pro-capite ($Loghealth\_expenditure_{i,t}$), for the above-mentioned socio-demographic variables ($SocioDem_{i,t}$), for lifestyle ($LifeStyle_{i,t}$), with a dummy variable for each year of data included ($DInt\_Year_{i,v}$), and a dummy variable for each region ($DRegion_{i,g}$).

The results are reported in Table 3.12 and Table 3.13 and confirm the hypothesis, for both composite indicators, of a positive and significant relation (99%) between bes-ageing and life satisfaction. Moreover, fair and sustainable ageing explains life satisfaction better than the strictly economic variables typically used to predict positive changes in life quality.

3.5 Monetization of the impact of bes-ageing on health

This section aims to estimate the economic significance of the link between our model, found in the composite indicators of bes-ageing, and the onset of chronic disease, as examined in section 4. To this end, the *associated compensating surplus* is calculated using the approach described by Becchetti et al. (2015) in order to measure the value of non-market goods based on data related to happiness (see, among others: Welsch, 2002; Luechinger, 2009; Frey et al. 2009; van Praag and Baarsma, 2005; Luechinger and Raschky, 2009). The analysis is divided in three phases:

1) a regression analysis (Equation 3.3) to measure the significance of the relation between the non-market good (the number of chronic diseases) and *life satisfaction*;
2) the calculation in terms of monetary compensation for the onset of disease (Formula 3.4): how much money would be necessary for the life satisfaction of an individual to remain constant following the onset of a new disease?
3) The monetary value of the benefits of *bes-ageing*: how much does *bes-ageing* reduce the costs of the onset of disease?

As far as concerns the first point, the equation to be estimated with a *pooled ologit* model is as follows:

$$Life\_sat_{i,t} = \alpha + \beta Diseases_{i,t} + \gamma\, Loggdp_{i,t} + \gamma\, Loghealth\_expenditure_{i,t} + + \sum_{k=1}^{K} \delta_k\, SocioDem_{i,t} + \sum_{l=1}^{L} \lambda_l\, LifeStyle_{i,t} + + \sum_{v=1}^{V} \chi_v\, DInt\_Year_{i,v} + \sum_{g=1}^{G} \kappa_g\, DRegion_{i,g} + \varepsilon_{i,t} \quad (3.3)$$

Where $Life\_sat_{i,t}$ is the variable that measures the life satisfaction of the individual *i* and $Diseases_{i,t}$ is the variable that measures the number of chronic diseases of the same.

The model is tested controlling for GDP pro-capite ($Loggdp_{i,t}$), for public health expenditure pro-capite ($Loghealth\_expenditure_{i,t}$), for the above-mentioned socio-demographic variables ($SocioDem_{i,t}$), for lifestyle ($LifeStyle_{i,t}$), for a variable dummy for each year of data included ($DInt\_Year_{i,v}$), and for a dummy variable for each Region ($DRegion_{i,g}$).

The results are reported in Table 3.14: the number of chronic diseases (Diseases) has a significant negative impact (at 99%) on life satisfaction.

The calculation in terms of monetary compensation (CS) of the onset of at least one disease is calculated from the following Formula:

$$CS_{it} = gdp(1 - \exp(\hat{\beta} * \hat{\delta}^{-1} Deltadiseasesbin) \quad (3.4)$$

Where: $\hat{\beta}$ is the coefficient of the number of diseases estimated in the model of Equation 3.3; $\hat{\delta}$ is the coefficient of the GDP pro-capite estimated by the same equation; gdp is the level of GDP pro-capite given by the average of the two time periods under examination[52]; $Deltadiseasesbin$ is the variation in the number of chronic diseases between the two waves. This last term is assumed to be equal to 1, given that it is a dichotomous variable, such that monetary compensation will be calculated, in coherence with our model, only if the individual *i* has contracted at least one chronic disease.

Finally, the monetary benefit of *bes-ageing* (Besageing e Besageing_fqts) is calculated as the product of the monetary value of the number of chronic diseases (Formula 3.4) and the impact of bes-ageing (Besageing e Besageing_fqts) at time t-1 on the variance (delta) in the number of chronic diseases. This number is the result of the relation between the beta coefficient of *bes-ageing*

[52]The choice was made to use GDP and not per capita income for several reasons. First, income is already included within the bes-ageing composite and considering it again would give problems of collinearity. Second, it seemed more fitting to use the GDP in as much as it is a synthetic measurement that is traditionally used to evaluate the progress of a society and the actions of its institutions in specific sectors. In other words, the intention is to evaluate the degree to which a multidimensional approach can contribute to progress, even considered from a reductionist perspective.

(Besageing e Besageing_fqts) at time t-1 and its standard error, calculated based on the regression model of Equation 3.1 (Table 3.9 and 3.10).

The cost in terms of life satisfaction of the onset of new chronic disease amounts to over 9,000 euro GDP pro-capite (both for Besageing and for Besageing_fqts), while the benefit of the model of bes-ageing on happiness, that is, its positive effect on the onset of disease multiplied by CS, varies between 24,429 euros GDP pro-capite for Besageing and 28,705 euros for Besageing_fqts (Table 3.15).

Table 3.16 aims to offer further points to take into consideration for the implementation of specific policies: the benefits of *bes-ageing* may be divided among the various indicators which constitute the composite indicator, on the basis of their respective component loading as results from the analysis of the principle components. Indicators which refer to *natural ageing* are left out of this subdivision, since it is not possible to intervene directly in order to change these. Among the indicators of *active-ageing*, the greatest benefit derives from the choice to participate in community and political life, while among those related to *institutional-ageing*, the greatest benefit derives from investments related to employment.

3.6 Conclusion

The model of bes-ageing can provide a positive response to the challenges presented by the demographic and epidemiologic transition by offering a multi-dimensional approach to ageing, one that is able to include the many dimensions of human action and human life, coordinating individual choices and public initiatives to build a social context favourable to a process of ageing that continues to be fruitful in terms of integral human development. Another advantage of bes-ageing may be found in the clear reference of its concepts and statistical data to the BES, a framework of multidimensional well being that is already established, respected and implemented at a national level. This may become a paradigm for designing a broad range of social and economic initiatives. The analysis of its principle components validates the model and identifies, based on the eleven dimensions of well-being considered, four macro reference areas (the emergent components): *Context Factors* (environment, landscape and cultural heritage, research and innovation, security and quality of services), *Physical and Psychological Capabilities* (health), *Economic and Working Capabilities* (economic well being, work and life balance) and *Social Participation* (social relationships, politics and institutions, education and training). These components allow us to create a classification of the determinants that influence the ageing process: *institutional ageing*, composed of policy for the improvement of *Context Factors* and public initiatives to develop the *Economic and Working Capabilities*; *natural ageing*, composed of the physiological effects connected to the *Physical and Psychological Capabilities*; *active ageing*, composed primarily of individual choices relative to *Social Participation*. It is necessary to note that each of these determinants contributes to the creation of a fair and sustainable ageing process through public initiatives and private choices, each of which may be held to have a prevalent influence within a given aspect of ageing. The econometric analysis gives us significant evidence of the value of the model (synthesized in two composite indicators – positive weighting and double positive and normative weighting): in the first place, in terms of the reduction of the probability of the onset of

new chronic diseases (results controlled by gender, age, family situation, lifestyle and geographic origin, and which are robust for a series of sub-samples) and, secondarily, in terms of ability to explain effects on life satisfaction. In both relations examined above, the indicators of *bes-ageing* offer a more significant contribution that variables for regional GDP pro-capite and regional health expenditure pro-capite. This signifies that fair and sustainable ageing can offer a paradigm for designing initiatives which would increase the efficiency of available economic resources, which are not alone sufficient to have a significant impact, neither on the (objective) onset of new diseases nor on the (subjective) life satisfaction of the elderly.

In the final section, the positive effect of the model is calculated in economic terms, using an approach which measures non-market goods based on data related to happiness. The results are relevant not just in terms of cost reduction, but also for the potential benefits: fair and sustainable ageing can be an important impetus for the planning of social policy capable of being economically efficient, without being weighed down by an exclusive focus on economic growth. In short, *bes-ageing* can help to reduce the onset of new disease, both directly and indirectly through increases in life satisfaction[53], by acting as a catalyst on individual choices and institutional actions.

Last, but not least, analysing the econometric results with the situation of various regions in static (ranking) and dynamic (convergence processes), we find another important contribution of the model of *bes-ageing.* This model could be a key for designing initiatives to reduce the inequality among regions. Indeed, in the absence of public or private initiatives to bring changes within the various areas examined, there is a risk that the ongoing demographic transitions will continue to amplify the already significant divergence in well being between North and South.

[53]Bachelet et al. 2015 show that a greater level of life satisfaction reduces the probability of illness.

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Table 3.1 – Legend of Variables Used

Variables	Description	Source
Gender	Dummy variable = 1 if the respondent's gender is female. 0 otherwise	SHARE (wave 2 and 4)
Age	Age of the respondent	SHARE (wave 2 and 4)
Eduyears	Years of education	SHARE (wave 2 and 4)
Logincome	Ln of household total gross income. Its value is equal to the sum over all household members of the individual-level values of: annual net income from employment and self-employment (in the previous year); Annual public old age/early or pre-retirement/disability pension (or sickness benefits); Annual public unemployment benefit or insurance, public survivor pension from partner; Annual war pension, private (occupational) old age/early retirement/disability pension, private (occupational) survivor pension from partner's job, public old age supplementary pension/public old age/public disability second pension, secondary public survivor pension from spouse or partner, occupational old age pension from a second and third job; Annual public and private long-term insurance payments; Annual life insurance payment, private annuity or private personal pension, private health insurance payment, alimony, payments from charities received; Income from rent. Values of the following household level variables are added: Annual other hhd members' net income; Annual other hhd members' net income from other sources; Household bank accounts, government and corporate bonds, stocks/shares; mutual funds.	SHARE (wave 2 and 4)
Loggdp	Ln of regional gross domestic product per capita	Istat
Loghealth_expenditure	Ln of regional Public health expenditure per capita	Istat
Vig_activity	Frequency of sports or vigorous activities (0/1 dummies): >1 in a week; 1 in a week; 1 or 3 in a month; hardlyever or never.	SHARE (wave 2 and 4)
Smoking	Dummy variable=1 if the respondent smokes at the present time	SHARE (wave 2 and 4)
Drinking	Frequency of alcohol consumption in the last 3 months (0/1 dummies): Almost Every Day; 5 or 6 days in a week; 3 or 4 days in a week; 1 or 2 days in a week; 1 or 2 days in a month; <1 day in a month; never in the last 3 months	SHARE (wave 2 and 4)
Overweight_obese	Dummy variable=1 if the respondent is overweight (29.9<BMI<34.9) or obese (BMI>34.9). 0 otherwise	SHARE (wave 2 and 4)
Oneclosechild	Dummy variable=1 if the respondent has at least one close (lives less than 1 km away) child. 0 otherwhise.	SHARE (wave 2 and 4)
N_grandchildren	number of grandchildren	SHARE (wave 2 and 4)
Hhsize	Household size	SHARE (wave 2 and 4)
Widowed	Dummy variable = 1 if the respondent has widowed. 0 otherwise	SHARE (wave 2 and 4)
Mother_alive	Dummy variable = 1 if the respondent has the mother still alive. 0 otherwise	SHARE (wave 2 and 4)
Father_alive	Dummy variable = 1 if the respondent has the father still alive. 0 otherwise	SHARE (wave 2 and 4)
Life_sat	How satisfied is the respondent with life (0-10 scale)	SHARE (wave 2 and 4)
Int_year	Year interview: 2007 (wave 2); 2011 (wave 4)	SHARE (wave 2 and 4)
Codnuts2	Code of the Italian Regions: 1 "Piemonte"; 2 "Liguria"; 3 "Lombardia"; 4 "Trentino Alto-Adige"; 5 "Veneto"; 6 "Friuli	SHARE (wave 2 and 4)

	Venezia Giulia"; 7 "Emilia Romagna"; 8 "Toscana"; 9 "Umbria"; 10 "Marche"; 11 "Lazio"; 13 "Campania"; 14 "Puglia"; 15 "Basilicata"; 16 "Calabria"; 17 "Sicilia"; 18 "Sardegna"		
Diseases	Total number of diseases that the respondent declares to have (sum of the diseases that the doctor has told the respondent to have)	SHARE 2 and 4)	(wave
Deltadiseasesbin	Dummy variable=1 if delta between number_diseases(t)-number_diseases(t-1)>0. 0 otherwhise.	SHARE 2 and 4)	(wave
Pickpocketing	Rate of pickpocketing by region (per 1,000 people) –normalized-	Istat 2016)	(BES
Recycling	Municipal waste collected separately by region (%) –normalized-	Istat 2016)	(BES
Spending_on_culture	Municipal government current spending on cultural heritage management by region –normalized-	Istat 2016)	(BES
Internet	People of 16-74 years who have used the Internet at least once a week in the last 3 months by region (%)–normalized-	Istat 2016)	(BES
Trouble_getting_services	Families who claim to have much trouble getting at least 3 basic services by region (%)–normalized-	Istat 2016)	(BES
Adla2	Activities of daily living index normalized. The ADLA (Activities of Daily Living) index measures the self-evaluated skills in performing the following tasks: dressing, bathing or showering, eating and cutting up food, walking across a room and getting in or out of bed. The index (ranging from 0 to 5) is higher the higher the difficulties in performing these tasks due to the reduced respondent's mobility.	SHARE 2 and 4)	(wave
Iadla2	Anstrumental activities of daily living index normalized. The IADLA (Instrumental Activities of Daily Living) index is calculated by summing responses on the self-evaluated skills in performing the following tasks: telephone calls, taking medications and managing money. The index (ranging from 0 to 3) is higher in presence of higher difficulties in performing these tasks due to the reduced respondent's mobility.	SHARE 2 and 4)	(wave
Eurod2	Depression scale normalized (high is depressed)	SHARE 2 and 4)	(wave
Voluntary_work	Dummy variable=1 if the respondent took part in voluntary or charity work (in the last month). 0 otherwise	SHARE 2 and 4)	(wave
Attend_education	Dummy variable=1 if the respondent attended educational or training course (in the last month). 0 otherwise	SHARE 2 and 4)	(wave
Polcom_part	Dummy variable=1 if the respondent took part in political or community organization (in the last month). 0 otherwise	SHARE 2 and 4)	(wave
Logincome_norm	Logincome normalized	SHARE 2 and 4)	(wave
Retemp	Dummy variable=1 if the respondent is retired or employed. 0 otherwise	SHARE 2 and 4)	(wave
Besageing	Composite indicator of bes ageing (component loadings weighting)	/	
Besageing_fqts	Composite indicator of the bes ageing (component loadings and survey FQTS weighting)	/	
Logbesageing	Ln of besageing	/	
Logbesageing_fqts	Ln of besageing_fqts	/	

Table 3.2 – Descriptive analysis: socio-demographic variables

Variable	Obs	Mean	Std. Dev.	Min	Max	[95% Conf.	Interval]
Gender	3974	0,559	0,497	0	1	0,544	0,575
Age	3974	66,578	9,162	40,5	100,5	66,300	66,900
Eduyears	3974	7,640	4,497	-15	25	7,501	7,780
Hhsize	3974	2,533	1,057	1	9	2,500	2,566
Mother_alive	3829	0,166	0,372	0	1	0	0
Father_alive	3913	0,058	0,234	0	1	0	0
Widowed	3960	0,118	0,323	0	1	0,108	0,128
N_grandchi~n	3964	2,200	2,851	0	20	2	2
Oneclosech~d	2807	4,008	1,728	1	5	3,944	4,072
Smoking	3971	0,164	0,370	0	1	0	0
Drinking							
<1 month	3970	0,035	0,184	0	1	0,030	0,041
1-2 month	3970	0,028	0,165	0	1	0,023	0,033
2-3 week	3970	0,056	0,231	0	1	0,049	0,064
3-4 week	3970	0,030	0,171	0	1	0,025	0,035
5-6 week	3970	0,024	0,152	0	1	0,019	0,028
almost every day	3970	0,381	0,486	0	1	0,366	0,396
Vig_activity							
1_week	3970	0,104	0,305	0	1	0,094	0,113
1or3_month	3970	0,098	0,298	0	1	0,089	0,107
Hardlyever_never	3970	0,544	0,498	0	1	0,528	0,559
Overweigh~se	3886	0,643	0,479	0	1	0,628	0,658
Loggdp	3974	10,136	0,275	9,730	10,500	10,127	10,144
Loghealth_expenditure	3974	7,481	0,068	7,380	7,643	7,479	7,484
Deltadiseasesbin	3974	0,642	0,479	0	1	0,627	0,657
Life_sat	3921	7,477	1,763	0	10	7,422	7,533

Table 3.3 – Desecriptive analysis: indicators of the *bes-ageing* model

Variable	Obs	Mean	Std. Dev.	Min	Max	[95% Conf.	Interval]
Simple indicators[54]							
Pickpocketing	3974	0,564	0,295	0	1	0,554	0,573
Recycling	3974	0,461	0,331	0	1	0,451	0,471
Spending_on_culture	3974	0,347	0,245	0	1	0,339	0,354
Internet	3974	0,572	0,351	0	1	0,561	0,583
Trouble_getting_services	3974	0,600	0,347	0	1	0,590	0,611
Adla2	3972	0,959	0,149	0	1	0,955	0,964
Iadla2	3972	0,974	0,139	0	1	0,969	0,978
Eurod2	3909	0,755	0,220	0	1	0,748	0,762
Voluntary_work	3961	0,110	0,313	0	1	0,100	0,120
Attend_education	3961	0,018	0,133	0	1	0,014	0,022
Polcom_part	3961	0,022	0,146	0	1	0,017	0,026
Logincome_norm	3904	0,756	0,082	0	1	0,754	0,759
Retemp	3974	0,740	0,439	0	1	0,726	0,754
Composite indicators							
Besageing	3836	0,562	0,112	0,130	0,941	0,559	0,566
Besageing_fqts	3836	0,584	0,107	0,146	0,934	0,581	0,588

Table 3.4 – Preliminary Test for the Principle Component Analysis

Bartlett test of sphericity	Kaiser-Meyer-Olkin Measure of Sampling Adequacy
Chi-square = 21781.272 Degrees of freedom = 78 p-value = 0.000 H0: variables are not intercorrelated	KMO = 0.783

[54] The base indicators are normalized between 0 and 1 with the Min-Max methodology (Formula A3.1 in Appendix 3).

Table 3.5 – Principle component analysis (rotated matrix –*varimax*-)

	Context Factors	Physical and psychological Capabilities	Economic and working Capabilities	Social Partecipation
Pickpocketing	0,366	0,012	0,040	-0,056
Recycling	0,435	0,032	-0,032	-0,051
Spending_on_culture	0,434	-0,016	0,039	0,031
Internet	0,490	-0,009	0,018	0,000
Trouble_getting_services	0,490	0,013	0,018	-0,030
Adla2	-0,001	0,665	-0,012	0,011
Iadla2	0,013	0,652	-0,080	-0,012
Eurod2	-0,046	0,352	0,330	0,005
Logincome_norm	0,024	-0,042	0,595	0,087
Retemp	-0,001	-0,039	0,724	-0,056
Voluntary_work	0,061	0,052	-0,037	0,549
Attend_education	-0,007	-0,026	-0,018	0,538
Polcom_part	-0,047	-0,017	0,025	0,625
Var Exp	3,796	1,768	1,285	1,201
Var Exp/Tot	0,472	0,220	0,160	0,149

Figure 3.1 – The BES-Ageing Model

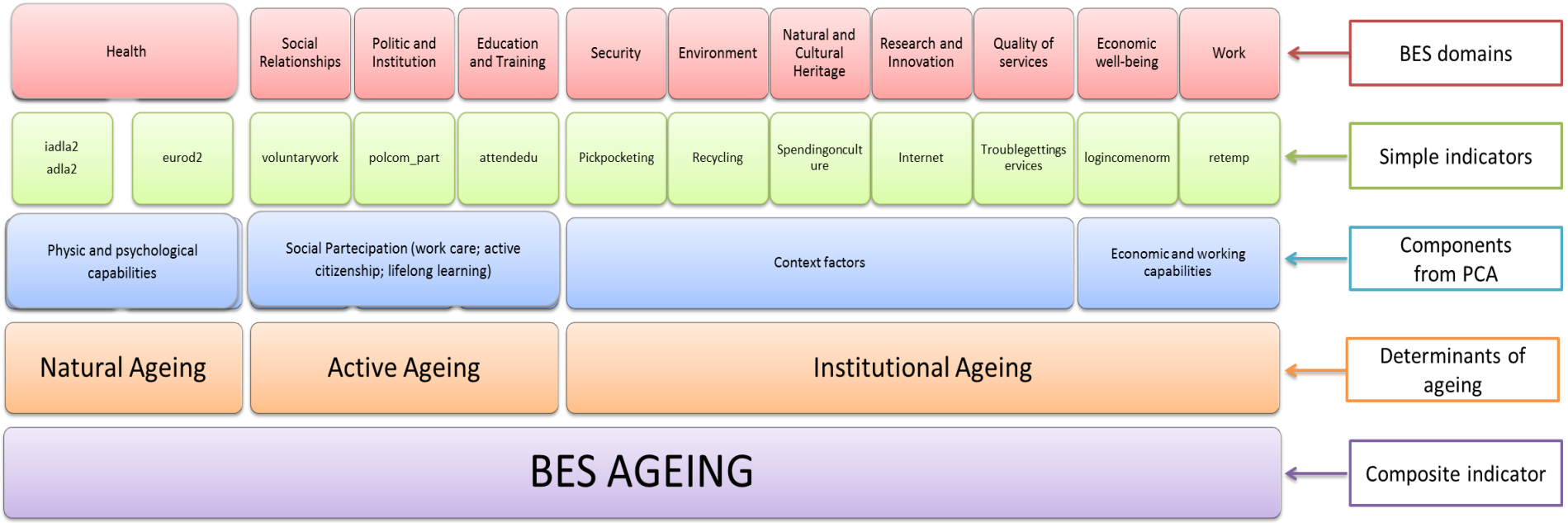

Table 3.6 – Positve (statistical) weights and normative weights (from the survey)

	Statistical weights	Survey weights
Pickpocketing	0,035	0,066
Recycling	0,049	0,088
Spending_on_culture	0,049	0,080
Internet	0,062	0,092
Trouble_getting_services	0,062	0,082
Adla2	0,115	0,162
Iadla2	0,111	0,162
Eurod2	0,032	0,162
Voluntary_work	0,079	0,070
Attend_education	0,075	0,136
Polcom_part	0,102	0,039
Logincome_norm	0,092	0,079
Retemp	0,136	0,106

Figure 3.2 – Graphical Comparison among Regions of Besageing level (2007 and 2011)

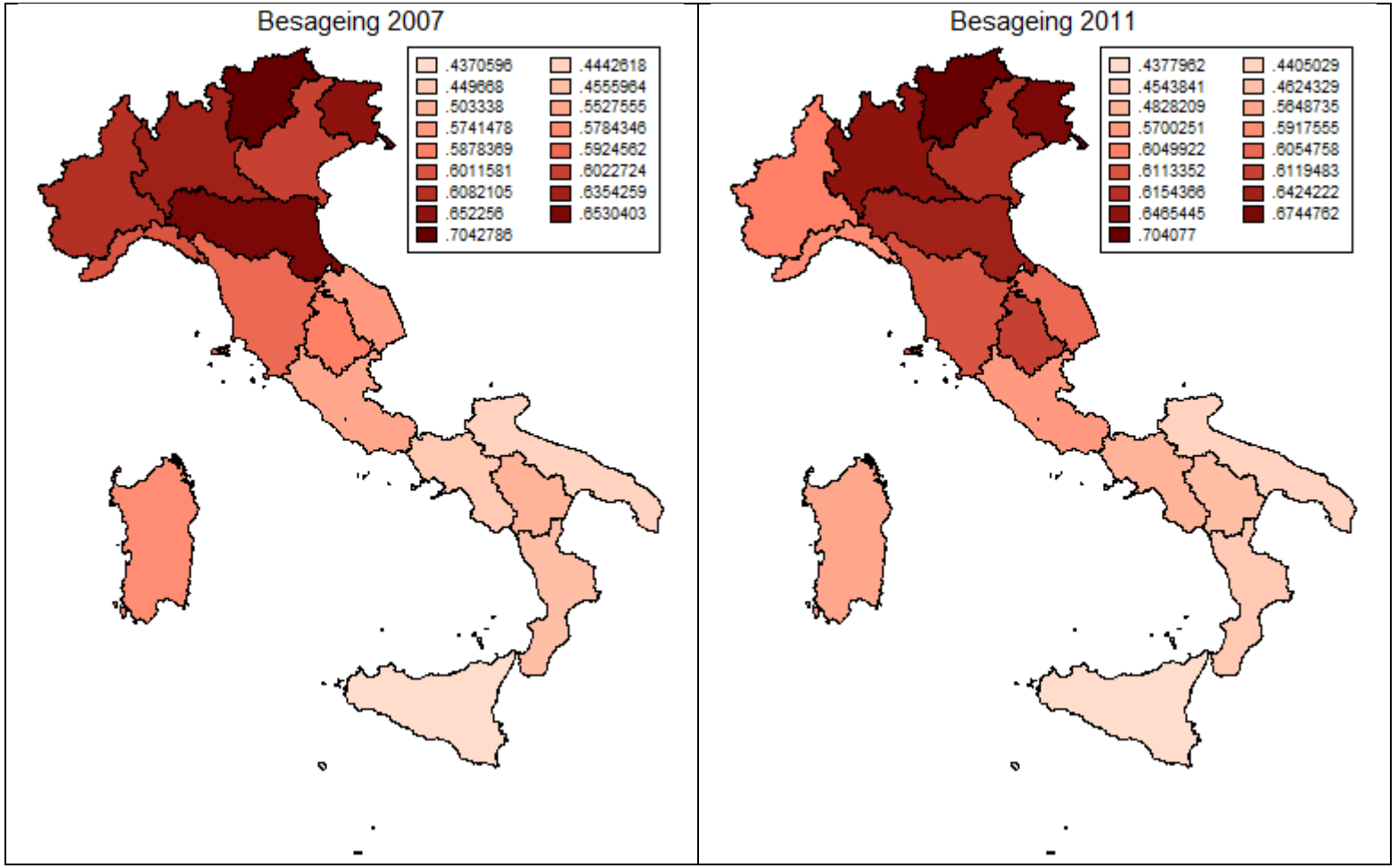

Figure 3.3 - Graphical Comparison among Regions of Besageing_fqts level (2007 and 2011)

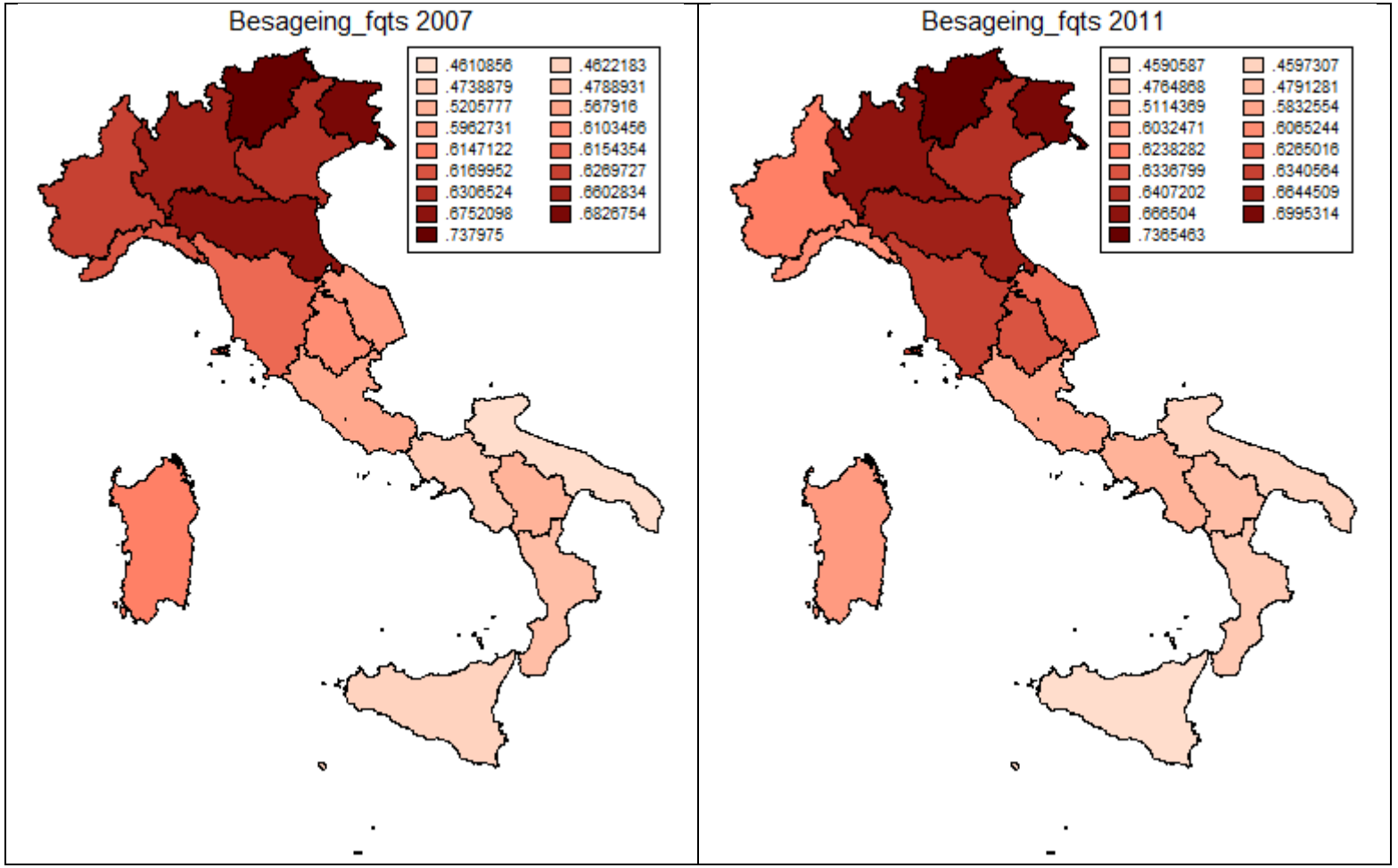

Table 3.7 – Comparison of rankings

	Besageing				Besageing_fqts		
Region	2007	2011	$\Delta_{2007-2011}$	Region	2007	2011	$\Delta_{2007-2011}$
Trentino Alto-Adige	1	1	=	Trentino Alto-Adige	1	1	=
Emilia-Romagna	2	4	-2	Friuli Venezia Giulia	2	2	=
Friuli Venezia Giulia	3	2	+1	Emilia-Romagna	3	4	-1
Lombardia	4	3	+1	Lombardia	4	3	1
Piemonte	5	9	-4	Veneto	5	5	=
Veneto	6	5	+1	Piemonte	6	9	-3
Liguria	7	10	-3	Liguria	7	10	-3
Toscana	8	7	+1	Toscana	8	6	+2
Umbria	9	6	+3	Sardegna	9	11	-2
Sardegna	10	12	-2	Umbria	10	7	+3
Marche	11	8	+3	Marche	11	8	+2
Lazio	12	11	+1	Lazio	12	12	=
Basilicata	13	14	-1	Basilicata	13	14	-1
Calabria	14	15	-1	Calabria	14	15	-1
Campania	15	13	+2	Campania	15	13	+2
Puglia	16	16	=	Sicilia	16	17	-1
Sicilia	17	17	=	Puglia	17	16	+1

Table 3.8 – Sigma and gamma convergence analysis

	Sigma convergence			Gamma convergence
	CV	Rapp. 75/25	Gini	Kendall Index
Besageing	0,006	0,077	0,006	0,962
besageing_fqts	0,004	0,059	0,006	0,967

Table 3.9 – Impact of Besageing on the probabily of onset of chronic disease

Probit	(1)	(2)	(3)	(4)	(5)	(6)
	deltadiseasesbin if diseasesw2==0					
Logbesageing(t-1)	-1.314***	-1.314***	-1.314***	-1.529***	-1.626***	-1.669***
	(0.426)	(0.426)	(0.426)	(0.516)	(0.585)	(0.621)
Loggdp(t-1)		0.308	-0.341	-0.319	-0.221	-0.240
		(0.806)	(1.015)	(1.064)	(1.165)	(1.225)
Loghealth_expenditure(t-1)			5.647	6.581	1.757	4.466
			(12.234)	(12.664)	(13.232)	(14.097)
Gender				-0.032	-0.073	-0.107
				(0.135)	(0.149)	(0.163)
Age(t-1)				0.035***	0.032***	0.035***
				(0.008)	(0.010)	(0.010)
Eduyears(t-1)				0.000	-0.010	-0.013
				(0.014)	(0.016)	(0.016)
Widowed(t-1)					0.461	0.351
					(0.334)	(0.346)
Mother_alive(t-1)					-0.012	-0.011
					(0.018)	(0.019)
Father_alive(t-1)					-0.010	-0.021
					(0.035)	(0.037)
Oneclosechild(t-1)					0.075	0.057
					(0.048)	(0.050)
N_grandchildred(t-1)					-0.067**	-0.077**
					(0.033)	(0.034)
Hhsize(t-1)					-0.280***	-0.283***
					(0.075)	(0.078)
Vig_activity (t-1)						
1_week						0.334
						(0.229)
1or3_month						0.049
						(0.252)
Hardlyever_never						0.122
						(0.151)
Drinking (t-1)						
5or6days_week						0.386
						(0.411)
3or4days_week						0.041
						(0.360)
1or2_week						-0.020
						(0.288)
1or2_month						-0.304
						(0.384)
<1_month						0.716
						(0.462)
0_in_3months						-0.099
						(0.159)
Smoking(t-1)						-0.172
						(0.170)
Overweight_obese(t-1)						0.180
						(0.142)
Dummy Region	yes	yes	yes	yes	yes	yes
Constant	yes	yes	yes	yes	yes	yes

Observations	524	524	524	524	468	462
Pseudo R-squared	0.075	0.075	0.075	0.110	0.148	0.171

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 3.10 - Impact of Besageing_fqts on the probability of onset of chronic disease

Probit	(1)	(2)	(3)	(4)	(5)	(6)
	deltadiseasesbin if diseasesw2==0					
Logbesageingfqts(t-1)	-2.029***	-2.029***	-2.029***	-2.405***	-2.543***	-2.539***
	(0.549)	(0.549)	(0.549)	(0.669)	(0.759)	(0.804)
Loggdp(t-1)		0.175	0.257	0.434	0.581	0.509
		(0.804)	(1.061)	(1.127)	(1.243)	(1.305)
Loghealth_expenditure(t-1)			-0.713	-1.472	-6.813	-3.638
			(12.629)	(13.230)	(13.999)	(14.849)
Gender				-0.074	-0.120	-0.147
				(0.135)	(0.149)	(0.164)
Age(t-1)				0.035***	0.031***	0.035***
				(0.008)	(0.010)	(0.010)
Eduyears(t-1)				0.003	-0.006	-0.010
				(0.014)	(0.016)	(0.016)
Widowed(t-1)					0.464	0.359
					(0.333)	(0.344)
Mother_alive(t-1)					-0.013	-0.012
					(0.018)	(0.019)
Father_alive(t-1)					-0.009	-0.019
					(0.035)	(0.037)
Oneclosechild(t-1)					0.077	0.058
					(0.049)	(0.050)
N_grandchildred(t-1)					-0.066**	-0.077**
					(0.033)	(0.034)
Hhsize(t-1)					-0.281***	-0.283***
					(0.076)	(0.078)
Vig_activity						
						0.333
1_week						0.332
						(0.231)
1or3_month						0.045
						(0.253)
Hardlyever_never						0.119
						(0.152)
Drinking						
5or6days_week						0.390
						(0.410)
3or4days_week						0.039
						(0.362)
1or2_week						-0.001
						(0.290)
1or2_month						-0.270
						(0.393)
<1_month						0.689
						(0.462)
0_in_3months						-0.094
						(0.159)
Smoking(t-1)						-0.181

						(0.171)
Overweight_obese(t-1)						0.173
						(0.142)
Dummy Region	yes	yes	yes	yes	yes	yes
Constant	yes	yes	yes	yes	yes	yes
Observations	524	524	524	524	468	462
Pseudo R-squared	0.073	0.073	0.073	0.108	0.147	0.172

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 3.11 – Robustness checks

	(1)	(2)	(3)	(4)	(5)	(6)
	deltadiseasesbin if diseasesw2==0					
	age<66,558		eduyears_mod<7.668		Loghealth_expenditure<7.481	
Logbesageing(t-1)	-1.619**		-2.348**		-1.675**	
	(0.681)		(1.113)		(0.669)	
Logbesageing_fqts(t-1)		-2.592***		-3.695**		-2.653***
		(0.885)		(1.465)		(0.877)
Loggdp(t-1)	-1.537	-0.722	0.064	1.210	-0.318	0.539
	(1.474)	(1.559)	(2.410)	(2.558)	(1.280)	(1.379)
Loghealth_expenditure(t-1)	15.234	6.654	17.227	4.940	6.798	-2.326
	(17.859)	(18.570)	(24.022)	(25.781)	(14.724)	(15.650)
Female	-0.009	-0.067	-0.018	-0.092	-0.189	-0.239
	(0.190)	(0.192)	(0.331)	(0.330)	(0.176)	(0.177)
Age(t-1)	0.056***	0.057***	0.044**	0.044**	0.032***	0.032***
	(0.016)	(0.016)	(0.018)	(0.018)	(0.011)	(0.011)
Eduyears_mod(t-1)	-0.006	-0.003	0.025	0.040	-0.035**	-0.032*
	(0.020)	(0.020)	(0.143)	(0.144)	(0.017)	(0.018)
Widowed(t-1)	0.148	0.151	0.247	0.275	0.151	0.163
	(0.398)	(0.396)	(0.478)	(0.479)	(0.358)	(0.356)
Mother_alive(t-1)	0.001	-0.001	-0.028	-0.031	-0.007	-0.009
	(0.020)	(0.020)	(0.039)	(0.039)	(0.021)	(0.021)
Father_alive(t-1)	-0.043	-0.040	0.025	0.021	-0.019	-0.017
	(0.035)	(0.035)	(0.129)	(0.129)	(0.040)	(0.040)
Oneclosechild(t-1)	0.116*	0.117*	0.172**	0.179**	0.056	0.057
	(0.066)	(0.067)	(0.078)	(0.078)	(0.055)	(0.056)
N_grandchildred(t-1)	-0.067	-0.069	-0.044	-0.043	-0.089**	-0.089**
	(0.048)	(0.048)	(0.047)	(0.047)	(0.040)	(0.040)
Hhsize(t-1)	-0.340***	-0.338***	-0.262**	-0.264**	-0.277***	-0.278***
	(0.089)	(0.089)	(0.133)	(0.134)	(0.087)	(0.087)
	(1.281)		(2.153)		(1.294)	
Vig_activity						
1_week	0.308	0.308	0.103	0.070	0.288	0.300
	(0.269)	(0.271)	(0.451)	(0.449)	(0.253)	(0.255)
1or3_month	0.011	0.012	-0.009	0.000	0.168	0.167
	(0.295)	(0.296)	(0.464)	(0.468)	(0.275)	(0.276)
Hardlyever_never	0.054	0.058	0.286	0.273	0.116	0.114
	(0.179)	(0.180)	(0.263)	(0.265)	(0.160)	(0.161)
Drinking						
5or6days_week	0.319	0.332			0.410	0.420
	(0.456)	(0.456)			(0.475)	(0.476)
3or4days_week	-0.318	-0.334	0.782	0.795	0.189	0.179
	(0.429)	(0.429)	(0.746)	(0.762)	(0.422)	(0.421)

1or2_week	0.192	0.210	-1.099**	-1.096**	-0.127	-0.112
	(0.309)	(0.310)	(0.499)	(0.503)	(0.305)	(0.305)
1or2_month	-0.038	0.018	-0.336	-0.334	-0.295	-0.252
	(0.397)	(0.412)	(0.736)	(0.753)	(0.406)	(0.417)
<1_month	0.900*	0.874*	1.076	1.025	0.718	0.691
	(0.487)	(0.486)	(0.674)	(0.676)	(0.444)	(0.445)
0_in_3months	-0.012	-0.015	0.101	0.101	-0.137	-0.130
	(0.189)	(0.189)	(0.266)	(0.266)	(0.168)	(0.168)
Smoking(t-1)	-0.144	-0.156	0.211	0.180	-0.192	-0.205
	(0.182)	(0.182)	(0.325)	(0.325)	(0.184)	(0.184)
Overweight_obese(t-1)	0.326**	0.309*	0.332	0.332	0.187	0.179
	(0.165)	(0.166)	(0.247)	(0.248)	(0.150)	(0.151)
Region dummy	yes	yes	yes	yes	yes	yes
Constant	yes	yes	yes	yes	yes	yes
Observations	358	358	167	167	406	406
Pseudo R-squared	0,1662	0,1657	0,2548	0,2563	0,162	0,1627

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 3.12 – Impact of Besageing on *life satisfaction*

Pooled Ologit	(1)	(2)	(3)	(4)	(5)	(6)	(7)
				life_sat			
Logbesageing	2.323***	2.322***	2.324***	2.323***	2.083***	2.163***	2.027***
	(0.202)	(0.202)	(0.202)	(0.202)	(0.234)	(0.499)	(0.514)
Loggdp		-0.735		-0.849	-0.718	-0.467	-0.369
		(2.577)		(2.599)	(2.603)	(0.838)	(0.937)
Loghealth_expenditure			0.352	0.410	0.389	-4.555	-5.998
			(1.396)	(1.408)	(1.399)	(4.019)	(4.756)
Gender					0.039	0.209	0.249
					(0.065)	(0.146)	(0.160)
Age					-0.016***	0.000	0.002
					(0.004)	(0.011)	(0.011)
Eduyears					0.029***	0.029**	0.031**
					(0.007)	(0.014)	(0.015)
Widowed						-0.188	-0.182
						(0.183)	(0.191)
Mother_alive						0.075	0.063
						(0.247)	(0.246)
Father_alive						0.210	0.345
						(0.496)	(0.511)
Oneclosechild						-0.015	-0.006
						(0.040)	(0.041)
N_grandchildred						0.036	0.037
						(0.025)	(0.028)
Hhsize						0.102	0.071
						(0.073)	(0.077)
Vig_activity							
1_week							-0.020
							(0.236)
1or3_month							-0.474**
							(0.240)
Hardlyever_never							-0.413**
							(0.192)
Drinking							
5or6days_week							0.322
							(0.347)
3or4days_week							-0.211
							(0.472)
1or2_week							-0.129
							(0.294)
1or2_month							-0.135
							(0.377)
<1_month							0.296
							(0.322)
0_in_3months							0.123
							(0.160)
Smoking							-0.189
							(0.214)
Overweight_obese							0.075
							(0.151)
Dummy year	yes	yes	yes	yes	yes	yes	yes
Dummy region	yes	yes	yes	yes	yes	yes	yes
Constant	yes	yes	yes	yes	yes	yes	yes

Observations	3,823	3,823	3,823	3,823	3,823	857	839

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 3.13 – Impact of Besageing_fqts on *life satisfaction*

Pooled Ologit	(1)	(2)	(3)	(4)	(5)	(6)	(7)
				life_sat			
Logbesageingfqts	3.741***	3.741***	3.744***	3.743***	3.637***	3.450***	3.295***
	(0.245)	(0.245)	(0.245)	(0.245)	(0.282)	(0.627)	(0.648)
Loggdp		-0.066		-0.223	-0.055	-0.728	-0.647
		(2.586)		(2.608)	(2.605)	(0.828)	(0.924)
Loghealth_expenditure			0.547	0.562	0.558	-7.385*	-8.631*
			(1.393)	(1.405)	(1.397)	(4.037)	(4.721)
Gender					0.134**	0.271*	0.303*
					(0.064)	(0.146)	(0.160)
Age					-0.014***	0.002	0.004
					(0.004)	(0.011)	(0.011)
Eduyears					0.020***	0.023	0.025*
					(0.007)	(0.014)	(0.015)
Widowed						-0.146	-0.147
						(0.183)	(0.191)
Mother_alive						0.098	0.083
						(0.249)	(0.248)
Father_alive						0.200	0.324
						(0.491)	(0.504)
Oneclosechild						-0.015	-0.007
						(0.040)	(0.041)
N_grandchildred						0.043	0.042
						(0.027)	(0.029)
Hhsize						0.118	0.088
						(0.074)	(0.078)
Vig_activity							
1_week							-0.020
							(0.236)
1or3_month							-0.490**
							(0.239)
Hardlyever_never							-0.373*
							(0.193)
Drinking							
5or6days_week							0.346
							(0.354)
3or4days_week							-0.238
							(0.466)
1or2_week							-0.133
							(0.295)
1or2_month							-0.190
							(0.382)
<1_month							0.261
							(0.318)
0_in_3months							0.088
							(0.160)
Smoking							-0.181
							(0.214)

Overweight_obese							0.082
							(0.151)
Dummy year	yes	yes	yes	yes	yes	yes	yes
Dummy region	yes	yes	yes	yes	yes	yes	yes
Constant	yes	yes	yes	yes	yes	yes	yes
Observations	3,823	3,823	3,823	3,823	3,823	857	839

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 3.14 – Impact of the number of chronic diseases on *life satisfaction*

	(1)	(2)	(3)
Pooled Ologit		life_sat	
Loggdp	-0.930	0.398	0.490
	(2.577)	(0.820)	(0.926)
Loghealth_expenditure	-0.158	-1.224	-3.475
	(1.394)	(4.001)	(4.836)
Diseases	-0.282***	-0.192***	-0.209***
	(0.023)	(0.052)	(0.055)
Gender		-0.038	0.052
		(0.136)	(0.153)
Age		0.007	0.010
		(0.011)	(0.011)
Eduyears		0.042***	0.042***
		(0.015)	(0.015)
Widowed		-0.268	-0.277
		(0.181)	(0.188)
Mother_alive		0.036	0.037
		(0.251)	(0.250)
Father_alive		0.203	0.340
		(0.489)	(0.499)
Oneclosechild		-0.002	0.009
		(0.039)	(0.040)
N_grandchildred		0.019	0.023
		(0.023)	(0.025)
Hhsize		0.038	0.009
		(0.073)	(0.076)
Vig_activity			
1_week			-0.041
			(0.229)
1or3_month			-0.442*
			(0.240)
Hardlyever_never			-0.402**
			(0.191)
Drinking			
5or6days_week			0.378
			(0.338)
3or4days_week			-0.220
			(0.441)
1or2_week			-0.119
			(0.286)
1or2_month			0.043
			(0.372)
<1_month			0.223
			(0.338)
0_in_3months			0.214
			(0.158)
Smoking			-0.256
			(0.210)
Overweight_obese			0.142
			(0.152)
Dummy year	yes	yes	yes
Dummy region	yes	yes	yes
Constant	yes	yes	yes

Observations	3,921	875	856

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 3.15 – Monetization of the impact of Besageing (and Besageing_fqts) on health

Model	Gdp (average)	beta GNM	beta GDP	CS	beta bes	se bes	benefit value bes
Besageing	26177,65	-0,209	0,49	9089,668	-1,669	0,621	-24429,4
Besageing_fqts	26177,65	-0,209	0,49	9089,668	-2,539	0,804	-28704,8

Table 3.16 – Benefits of *bes-ageing* shared among the indicators for which (public or private) intervention is possible

Dimension	Variable	Statistical weight (from first PCA)	bv bes	bv bes_fqts
aa	Voluntary_work	0,078568	-1919,36	-2255,27
aa	Attend_education	0,075397	-1841,9	-2164,26
aa	Polcom_part	0,101515	-2479,96	-2913,98
ia	Pickpocketing	0,034887	-852,273	-1001,43
ia	Recycling	0,049209	-1202,15	-1412,54
ia	Spending_on_culture	0,049006	-1197,18	-1406,7
ia	Internet	0,062395	-1524,27	-1791,03
ia	Trouble_getting_services	0,062497	-1526,76	-1793,96
ia	Logincome_norm	0,092244	-2253,47	-2647,85
ia	Retemp	0,136252	-3328,56	-3911,09

Note: aa=active-ageing; ia=institutional-ageing; bv=benefit value

Appendix 3

Normalization: Min-Max Approach

$$I_{it} = \begin{cases} \dfrac{(x_{it} - Min_{x_i})}{(Max_{x_i} - Min_{x_i})} 60 + 70 \quad if\ the\ indicator\ has\ positive\ polarity \\ \dfrac{(Max_{x_i} - x_{it})}{(Max_{x_i} - Min_{x_i})} 60 + 70 \quad if\ the\ indicator\ has\ negative\ polarity \end{cases} \qquad (A3.1)$$

where $Max_{x_{it}}$ and $Min_{x_{it}}$ are, respectively, the maximum and minimum indicator j, between the n statistical units, in T years considered.

Weighting and aggregation of simple normalized indicators

$$BESAGEING_{it} = \frac{\sum_{j=1}^{m} I_{ijt} ws_j}{\sum_{j=1}^{m} ws_j} \qquad (A3.2)$$

$$BESAGEINGFQTS_{it} = \frac{\sum_{j=1}^{m} I_{ijt} (wp_j + ws_j)}{\sum_{j=1}^{m} (wp_j + ws_j)} \qquad (A3.3)$$

Dove:

- BESAGEING: composite indicator of *bes-ageing* (only statistical weights)
- BESAGEINGFQTS: composite indicator of *bes-ageing* (statistical and survey weights)
- i: i-esima statistical unit (by 1 to n)
- t: t-esimo year (by 1 to T)
- I: simple indicator
- j: j-esimo composite indicator (by 1 to m)
- wp: weight by survey[55] (derived from mix of budget allocation process and public opinion in FQTS's survey)
- ws: weight by statistic analysis (derived from principal component analysis)

[55] For assumption:the weights are constant over time.

Sigma-convergence:

The formula of the inequality indices used for the *sigma-convergence* are as follows:

$$CV_t = \frac{\sigma_t}{\mu_t} \quad \text{(A3.4)}$$

$$G_t = \frac{1}{2n^2\mu_t}\sum_{i=1}^{n}\sum_{j=1}^{n}|I_{ti} - I_{tj}| \quad \text{(A3.5)}$$

$$R_t^{(75/25)} = \frac{R_t^{75}}{R_t^{25}} \quad \text{(A3.6)}$$

Dove:

- CV_t is the coefficient of variation at time *t*;
- σ_t is the standard deviation at time *t*;
- μ_t is the simple arithmetric mean at time *t*;
- G_t is the Gini index at time *t*;
- I_{ti} is the indicator of Region *i* at time *t*;
- $R_t^{(75/25)}$ is the relation between the forth quartile (R_t^{75}) and the first (R_t^{25}) at time *t*.

The convergence is measured as the difference between the index at time *t* and the index at time 0 (*t*-1). Hence, from formulas A3.4, A3.,5, and A3.6, the following equations are obtained:

$$\sigma\_conv_{0-t} = CV_t - CV_0 \quad \text{(A3.7)}$$

$$\sigma\_conv_{0-t} = G_t - G_0 \quad \text{(A3.8)}$$

$$\sigma\_conv_{0-t} = R_t^{(75/25)} - R_0^{(75/25)} \quad \text{(A3.9)}$$

If the value of the index decreases ($\sigma\_conv_{0-t} < 0$), there will be a convergence process; on the contrary, if it increases ($\sigma\_conv_{0-t} > 0$), there is a divergence.

Gamma-convergence

This is measured using the concordance coefficient of Kendall (W). In the analysis proposed, reference is made to a binary version of the same, that is based on the concordance between the rank at time 0 and the rank at time 1. The Kendall index may also be calculated in its binary version based on the correlation coefficient of Spearman (r_s):

$$W = \frac{(r_s+1)}{2} \qquad \text{(A3.10)}$$