World Scientific
www.worldscientific.com

THE IMPACT OF POPULATION AGEING ON ECONOMIC GROWTH: A BIBLIOMETRIC SURVEY

RENUGA NAGARAJAN

CEF.UP, Faculdade de Economia
Universidade do Porto
Rua Dr Roberto Frias
4200-464, Porto, Portugal
renuga_nagarajan@yahoo.com

AURORA A. C. TEIXEIRA*

CEF.UP, Faculdade de Economia
Universidade do Porto; INESC TEC, OBEGEF
Rua Dr Roberto Frias
4200-464, Porto, Portugal
ateixeira@fep.up.pt

SANDRA SILVA

CEF.UP, Faculdade de Economia
Universidade do Porto
Rua Dr Roberto Frias
4200-464, Porto, Portugal
sandras@fep.up.pt

Population ageing and its influence on the economic growth has long been the focus of major concern. Using bibliometric techniques we found that: (1) although ageing has increasingly attracted more researchers within economics literature, the relative weight of ageing and economic growth related papers does not evidence a clear positive trend; (2) recent studies reveal the willingness of researchers to evaluate less immediate mechanisms relating ageing and economic growth; (3) the increase in the use of empirical methods reflects a trend to test economic phenomena with real-world data against the theory; (4) very few studies focus on developing and less developed countries.

Keywords: Ageing population; economic growth; bibliometrics; less developed countries.

JEL Classifications: J10, H50, O30, C89

1. Introduction

The process of demographic transition, mostly associated with increasing longevity and decreasing fertility, has led the world to the era of the "ageing population". Hodgson (1988) and Bloom and Williamson (1998) argue that the ex-post effect of the demographic

---

*Corresponding author.

dividend was the main reason behind the ageing problem. According to Hodgson (1988), in the early 20th century, orthodox demographers considered themselves as "population pessimists" and assumed that population growth would negatively influence capital accumulation and technological change. Due to this pessimistic perspective, the problem of a decreasing fertility rate became relevant for many countries, and policies were designed to invert this trend.

The world population began to decline in the mid-1970s when, in many developed countries, the working-age populations (aged between 25–59 years) started to increase faster than the child population (Lee *et al.*, 2011). This imbalance in the population structure has created the so-called "demographic dividend", translated in terms of positive productivity growth in developed countries for some years (Bloom *et al.*, 2001; Navaneetham and Dharmalingam, 2012). However, over time, this unequal age structure has become a demographic burden and has created the current ageing problem.

The advances in technology and science were crucial to instigating the demographic dividend and enhancing the field of medical science, greatly increasing the possibilities of individuals to live longer and healthier lives. This evolution materialized, for instance, in a rising trend in life expectancy for European countries, from 2002 to 2009 (Eurostat, 2013). Indeed, since 2007, the average life expectancy for countries such as Luxembourg, Spain, Germany, Portugal, Austria, France and Italy is over 80 years of age (Eurostat, 2013). Given the current fall in the fertility rate, it is predicted that the prime working age group will be lower than the old age group in the near future, which means a demographic change with significant influence on the national economies (Mason, 2005). Inequality in age structures, especially in the case of a growing old age group, is expected to have multiple effects on the overall economic performance of countries.

The influence of the ageing problem on economic development is manifest. Several studies (e.g., Bloom *et al.*, 2001; Creedy and Scobie, 2002; Alders and Broer, 2004; Weil, 2006; Sobotka *et al.*, 2010; Yong and Saito, 2012; Mason and Lee, 2013) not only confirm the existence of an ageing population in developed countries, but also identify and analyze the main mechanisms underlying the influence of ageing on economic growth: con-sumption and saving patterns, public expenditure, and human capital.

Regarding the mechanism associated to consumption and savings, Bakshi and Chen (1994) and Walder and Döring (2012) argue that the degree of inequality regarding the population age structure of a country impacts on the consumption pattern of its households. Due to the ageing problem, the overall demand for certain goods will be affected, since they will not provide any utility for the older household (Walder and Döring, 2012). For instance, in a country with a high old age population, the overall demand for education will decline as the consumption preferences of the old age group fall more on medical care.

The rise in the ageing population is also expected to affect public expenditure and, thus, economic growth (Meijer *et al.*, 2013). According to Eiras and Niepelt (2012) and Lisenkova *et al.* (2012), when a country faces an increase in the old age population, public spending on social security expenses and the medical system will be higher than the corresponding spending on education and other forms of development. Additionally, an increase in the old age group will also affect a country's sources of income. A decline in the

working age group and an increase in the old age group will provide less tax revenue. This demographic evolution may also affect Foreign Direct Investment (FDI). Indeed, Davies and Robert III (2006) show that foreign firms will not invest in a country with an ageing population since the working age population is scarce, therefore negatively affecting the country's capability to produce wealth. Finally, the potential imbalance in the government budget, meaning increasing deficits due to the ageing problem, may also impact on the economy (Tosun, 2003; Lisenkova *et al.*, 2012).

In most developed countries, government policies and the non-altruistic behavior of couples have reduced the fertility rate (Alders and Broer, 2004). As a result, their populations are composed of many working age individuals and fewer children to succeed them in the future (Lee *et al.*, 2011). This disproportional age structure leads to scarcity in labor supply and a decline in labor productivity, because the individuals' capacities seem to change along with their age (Alam and Mitra, 2012). According to Mincer (1974), the productive capacity of a society composed of an older labor force will be remarkably different (lower) from one with a younger labor force.

Considering the consequences of population ageing on economic growth, and the contributions that have been published on the matter in recent years, it seems timely to take a comprehensive and objective account of this stream of the literature. Thus, based on bibliometric methods, this study intends to: (i) analyze the emergent topics associated with this literature; (ii) identify the relative scientific importance of the main mechanisms involved in the relationship between ageing and economic growth; (iii) analyze and categorize the main methodological approaches that have been used in the literature; and, (iv) identify the main regions and/or countries to which research has paid greater attention.

The paper is structured as follows. After the Introduction, Section 2 describes the methodology employed in the bibliometric analysis. Section 3 details the results of the analysis, providing an evaluation of the evolution of the literature in terms of main mechanisms analyzed (Section 3.1), main types of research and the relative frequency of types associated to each mechanism (Section 3.2), main empirical methodologies used to analyze the available data (Section 3.3), and the countries and group of countries (developed, developing and least developed countries) to which the studies have dedicated the most attention (Section 3.4). Finally, Section 4 concludes and offers some considerations regarding future research on this topic.

2. Methodology

In order to achieve the four goals identified above, data on published articles were collected from Sciverse Scopus (from Elsevier).[1] Bibliometric studies are, in general, based on three main sources of data: the ISI Web of Science (WOS), Google Scholar (GS) and Scopus.

---

[1] Scopus is the world's largest search engine for abstract and citation databases of peer-reviewed articles. It has tools to track, analyze and visualize research. The search engine covers a wide range of published articles, journals and documents. It is easy to use and to obtain research information quickly, also helping to maximize library resources more efficiently. Considered as a tool to sort, refine and quickly identify results, it helps to focus on the outcome of the research conducted, requiring less time to master the databases. Data was accessed on 4 February 2013.

WOS is the oldest citation resource, containing the most prestigious academic journals, whereas GS and Scopus appeared in 2004 (Adriaanse and Rensleigh, 2013). (Adriaanse and Rensleigh, 2013, p. 741) demonstrate that "Scopus performed better (surpassed) WOS and GS regarding inconsistencies (incorrect title, -author, -volume number) encountered during the completeness and quality of the content verification process." Besides retrieving multiple copies, GS also yields the most inconsistencies. Comparing the strengths and weaknesses of the three databases, Falagas *et al.* (2008) conclude that GS, although providing the retrieval of more information, is marred by inadequate, less frequently updated, citation information. They further add that, compared to WOS, Scopus covers a wider range of journals, including more articles, but is currently limited to recent articles (published after 1995). Focusing on the social sciences, Norris and Oppenheim (2007) demonstrate that when aspects related to functionality, the quality of record processing and depth of coverage are taken into account, Scopus has a significant advantage over WOS and GS, urging researchers to use Scopus as an alternative to WOS (and GS) as a tool to evaluate research impact in the social sciences. Based on the above arguments, we opted to use Scopus as our bibliographic database in this study.

The search keywords (in the fields "keywords", "article title" and "abstract") used were "ageing population", "aging population" and "demographic transition", limiting the search to articles written in English in the subject areas of "Economics, econometrics and finance" and "Business management and accounting".

This search yielded 605 articles published between 1975 and 2013. We downloaded the articles and analyzed each abstract (in some cases, the full paper). Following a preliminary assessment, 461 articles were removed from the analysis because, although highly relevant scientifically, they did not focus on topics related to ageing and economic growth/development, exploring rather topics such as: fertility and mortality trends; the altruistic behavior of couples and women labor force participation; demographic transition and its effects on the agricultural sector; the health care system and ways to overcome increasing medical expenditures; female education and fertility growth rates; and demographic transition processes.

After this preliminary assessment, a total of 144 articles had been selected, which seemed to serve the purposes of this study. They were then categorized according to their ageing-growth nexus mechanisms, type of methodology, unit of analysis, countries of analysis, and estimation methods.

With regard to the ageing-growth nexus mechanism, and following the literature briefly reviewed in Section 1, the articles can be classified into one of the following categories: (1) Consumption and saving patterns of households; (2) Public expenditure; and (3) Human capital.

The classification according to type of article (i.e., survey, empirical, empirical and appreciative, appreciative, formal and empirical and formal) follows the distinction proposed by Nelson and Winter (1982) in terms of "formal" and "appreciative" theorizing. In an attempt to clarify the difference between theoretical arguments that follow a mathematical logic and those that do not imply any modelization, these authors suggest that "formal" includes "logically structured theorizing", whereas "appreciative" comprises a

"more intuitive" form, based on "judgments and common sense" (Nelson and Winter, 1982, p. 9). Therefore, in the present paper, and following the elaboration made by Silva and Teixeira (2009) upon Nelson and Winter's contribution, the articles classified as "appreciative" included critiques, judgments, appreciations, appraisals or theoretical arguments. Likewise, the articles characterized as "formal" contained mathematical models or were based on an analytical or logical framework. If these formal articles also included the testing of data in the models used, they were classified as "formal and empirical". If the article was only (or substantially) concerned with the econometric or statistical testing of data, we classified it as "empirical". When the article contained an appreciation or a comment plus empirical data analysis, it was classified as "appreciative and empirical". Finally, the "survey" type of articles included articles, which involve the documentation of a comprehensive review of the published and unpublished work from secondary sources data in the areas of specific interest to the researcher.

Empirically-based articles were further examined in terms of the unit of analysis, which encompasses the individual (individual or household samples), regional and country levels.

To assess the specific trend associated to the methods used to analyze data, Malhotra *et al.*'s (2013) contribution was adapted by grouping methods into three categories: (1) univariate and bivariate analyzes; (2) multivariate analyzes; and (3) mathematical modeling (mainly involving simulation).

As the influence of ageing on growth may vary across countries, we identified the country(ies) that was(were) the target of empirical articles. More specifically, information was gathered on each country analyzed and then, following the World Bank's ranking, they were grouped into the categories "developed", "developing", and "least developed" countries.

3. Empirical Results

3.1. *General evolution of articles on ageing and economic growth*

The phenomenon of population ageing and its influence on the economic growth of countries has long been the focus of major concern for both governments and the scientific community. Economists have been actively involved in investigating the impact of ageing on economic growth. Overall the ratio of papers published on ageing and economic growth in total papers published on economic growth shows cyclical pattern. It is important to note that, within ageing related research economic growth constitutes a very small fraction. Thus, any variation in absolute terms in the number of papers on ageing and economic growth will entail huge variation in relative terms. As shown by the trend line depicted in Figure 1, the ratio of papers published on ageing and economic growth in total papers published on economic growth does not evidence a clear cut evolution that ratio's trend line being approximately constant (cf. Figure 1).

The ratio of papers published on ageing and economic growth in total papers published on economic growth reflects that ageing is attracting a steadily number of researchers within economic growth-related literature. The highest percentage of articles on ageing
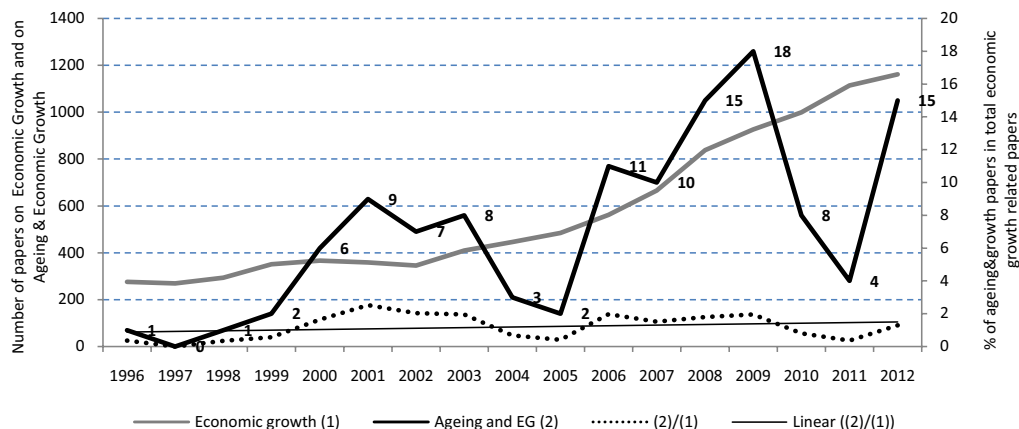
Note: Given that Scopus covers the literature after 1995, we opted to calculate the ratio of articles published on ageing and economic growth to all articles published on economic growth for each year after 1995. For the entire period, we considered 126 articles on ageing and economic growth and 10,254 on economic growth.

Source: Authors' computation based on articles gathered from the Scopus database (accessed on 4 February 2013).

Figure 1. The Evolution of the Number and Weight (in %) of Articles Related to Population Ageing in the Economic Growth Literature

related to economic growth was reached in 2001, accounting for 2.5% of the total papers on economic growth that explore ageing issues.

3.2. *Variations in the scientific importance of ageing-growth mechanisms*

Ageing influences economic growth primarily through three main mechanisms: consumption and saving patterns, public expenditure, and human capital. A country with a growing ageing population will lead to households with more individuals belonging to the old age group (Bell and Rutherford, 2013). The households' overall consumption and saving patterns change according to the individuals' age (Walder and Döring, 2012). Moreover, an ageing population is likely to influence a country's public expenditure (Lisenkova *et al.*, 2012). A rise in public expenditure, especially on public welfare, and a decline in tax revenue (higher number of pensioners and lower number of working age individuals) are assumed to increase the budget deficit of ageing countries. Finally, the impacts of ageing on labor productivity and human capital investment are also believed to influence economic growth as highlighted by Lisenkova *et al.* (2012) and Börsch-Supan (2013). According to these authors, a gradual decline in the labor force and a decline in public expenditure on capital investment will affect labor productivity.

Some of the papers analyzed focus on more than one mechanism (e.g., Hondroyiannis and Papapetrou, 2001; Cameron and Cobb-Clark, 2002; Guest and Mcdonald, 2003). Thus, the number depicted in Figure 2 represents the number of times each mechanism is referred to in the 144 articles analyzed in the given period, and not the number of articles.[2]

---

[2]From 1975 to 2013, four articles from the 144 are focused on "other" mechanisms (Technology; Agriculture; Agglomeration economies). Since the figure is residual, we decided to not include this group in Figure 2.
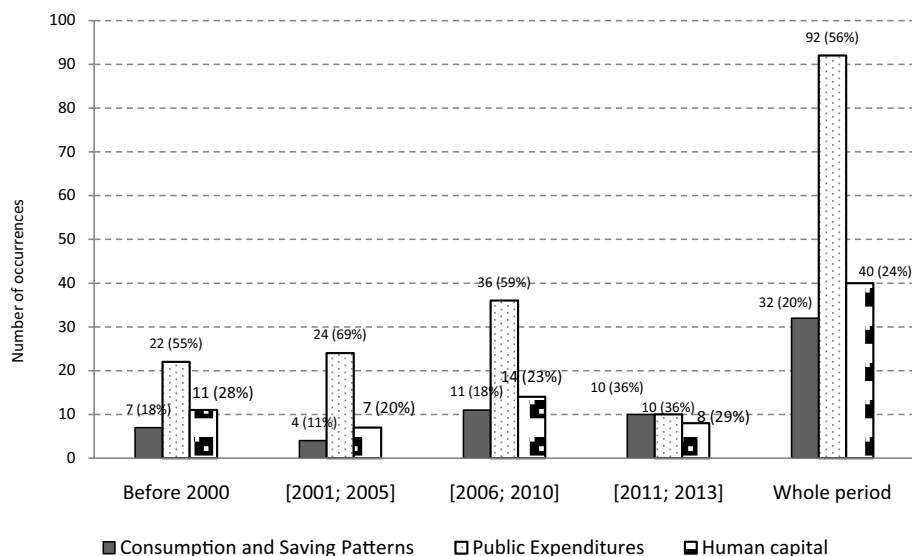
Figure 2. Evolution of the Distribution (in Number and %) of Occurrences on Ageing and Growth by Main Mechanism

For the entire period, the mechanism mentioned most often was "public expenditure", accounting for 56% of the total occurrences, followed at a distance by "human capital" (24%) and "consumption and saving patterns" (20%). According to Phillipson (2011), policy makers in OECD countries have confirmed that demographic changes influence public expenditure. The OECD and the European Commission's Working Group on Ageing Population have expressed their concerns over the long-term sustainability of current trends due to the ageing problem (Krugman, 2007). According to Maebayashi (2013), government budget deficits will rise due to increasing expenditures on social security benefits compared to public capital investment. The imbalances in the provision between capital investment and social security investment will affect economic growth. Tosun (2003) and Maebayashi (2013) further state that increases in spending on social security will reduce economic growth. Hence, an analysis of public policy centered on spending on social security benefits seems relevant for researchers (Maebayashi, 2013). Accordingly, research related to public expenditure was more prominent in the first years of the period under study, representing 69% of the total articles published in the period 2001–2005.

The dynamics of the relative scientific importance of the three mechanisms is clear from 2005 onwards, when the relative importance of "public expenditure" decreased substantially (from 69% to 36%) in favor of a remarkable rise in the "consumption and saving patterns" mechanism, which increased 25% points. From 2010 onwards, research published on ageing and economic growth seems to favor, in relative terms, consumption and saving patterns, reaching 36% of the total articles in 2011–2013. This seems a "natural"

trend as increases in tax revenue affect household incomes and decrease their average consumption (Alders and Broer, 2004). In fact, Pham (2009) argues that old people are less efficient in producing utility than young people and, therefore, they demand relatively more consumption. For example, Guest and Mcdonald (2003) estimate that the average person aged 75 years and above consumes 19% more than the average individual aged 25–39 years. Preferences and needs of households change with age, when the consumption preferences of the old age group become mainly related with health care services (Pham, 2009; Mason and Lee, 2013; Meijer *et al.*, 2013).

Thus, following the large amount of literature dedicated to the analysis of the public expenditure mechanism, studies in more recent years reveal the willingness of researchers to evaluate less immediate mechanisms relating ageing and economic growth, most notably consumption and saving patterns and human capital mechanisms.

3.3. *The evolution of research in terms of type of methodology*

For the period analyzed, about one third of the research was of the "formal + empirical" type. There is a striking balance between formalization and appreciative theorizing with the formal-type of papers representing half of the total articles published on this topic, whereas 44% are of the appreciative type (the remaining 6% cover "literature reviews") — cf. Figure 3.
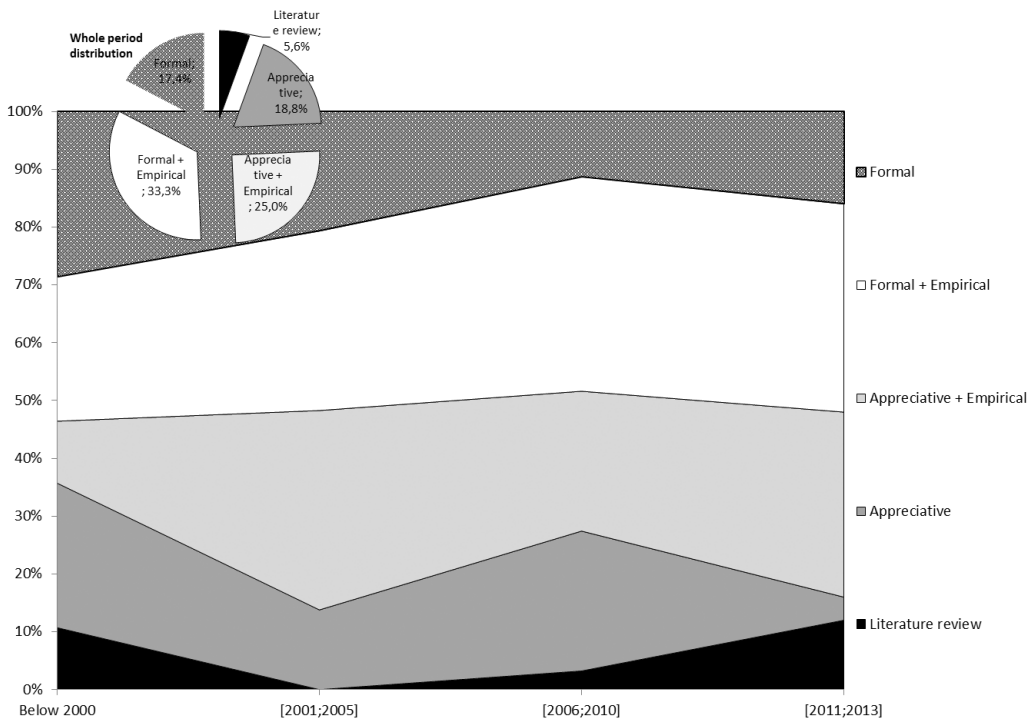
Source: Authors' computation based on 144 articles gathered from the Scopus database (accessed on 4 February 2013).

Figure 3. Evolution of the Distribution of Articles on Ageing and Growth by Main Methodology

It is also apparent that over time there is a notable decrease in exclusively "appreciative" papers (dropping from 25% before 2000 to 4% in the most recent period, 2011–2013). In the early stage, many journal articles applied "Appreciative" and "Formal" methods. However, there is a substantial drop in the use of the "Appreciative" method between 2011 and 2013. Of the 25 articles published in this latter period, only one applied this method. This trend, also observed in other research areas (e.g., regional studies — Cruz and Teixeira, 2010; ecological economics — Castro Silva and Teixeira, 2011), clearly explains the difficulties researchers encounter in proving scientifically the real impact of the ageing problem exclusively through qualitative methods. Although the use of "formal" methods in economics (linked to formal modeling and mathematical methods) is identified as the quest to increase "rigor" (Cruz and Teixeira, 2010; Teixeira, 2014), a noticeable drop was detected in the use of the "Formal" method between 2011 and 2013.

Figure 3 highlights a perceptible rise in the use of "Appreciative + empirical" and "Formal + empirical" methods (increasing 21% points and 11% points, respectively, from the earlier period to the most recent one). Hence, these two combined types became central in the studies published from 2000 to 2013. This trend reveals a growing need in research to test economic phenomena with real-world data against the theory (Cruz and Teixeira, 2010). Furthermore, since the impact of population ageing on economic performance varies across countries (Lee *et al.*, 2011), empirical analysis is considered as vital in studying the impact of ageing on their economic growth (Börsch-Supan, 2013). For example, according to Lee *et al.* (2011), and unlike most Western countries, an ageing population positively influences economic performance in Asian countries. Therefore, in general, the total number of journal articles employing "Formal + Empirical" and "Appreciative + Empirical" methods more frequently has been on the rise. This result is in accordance with Kaldor's (1961) view on the relevance of empirics, as was previously highlighted. According to this author, any constructed model should be able to explain the typical features of economics that we find in reality.

Figure 4 represents the relative weight of the three main methodological types used to analyze data in empirical studies. It is shown that before 2000 the dominant type of empirical analysis was "Mathematical modeling". Between 2001 and 2010, "mathematic modeling" and "univariate" methods were the most prevalent. In particular, over this time frame, simulation methods, time series analysis and descriptive studies were used as primary tools to perform prediction on the ageing problem.

Multivariate analyzes have become more prominent since 2006. At least in part, this increase may be explained as the result of the increasing availability of data. In fact, from 2000 onwards, countries like Italy, Japan, Germany, France, the UK, Australia and Canada already had a larger proportion of people over the age of 65 and rich databases became available for empirical analysis (Eurostat, 2013). Therefore, sufficient data were available to carry out "Multivariate" types of empirical analysis. Figure 4 also shows a continuous rise in this type of empirical analysis since 2001. In contrast, there was a continuous fall in empirical analysis based on "Mathematical modeling".

As discussed in the introduction, distinct mechanisms have been identified underlying the ageing-economic growth nexus. Hence, it is interesting to quantify the weight of each
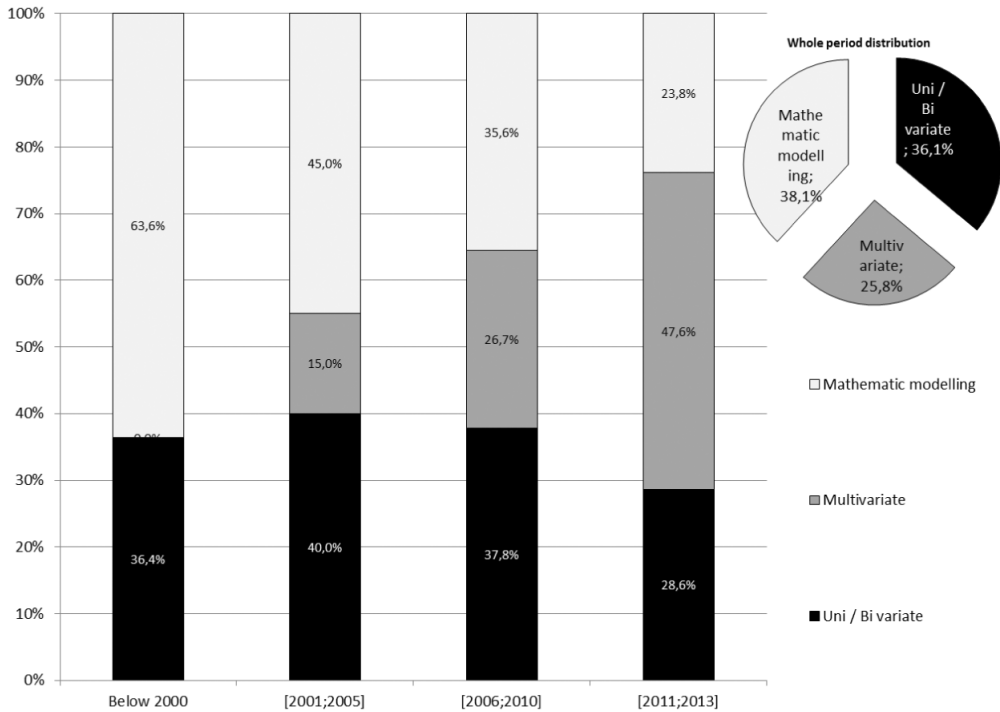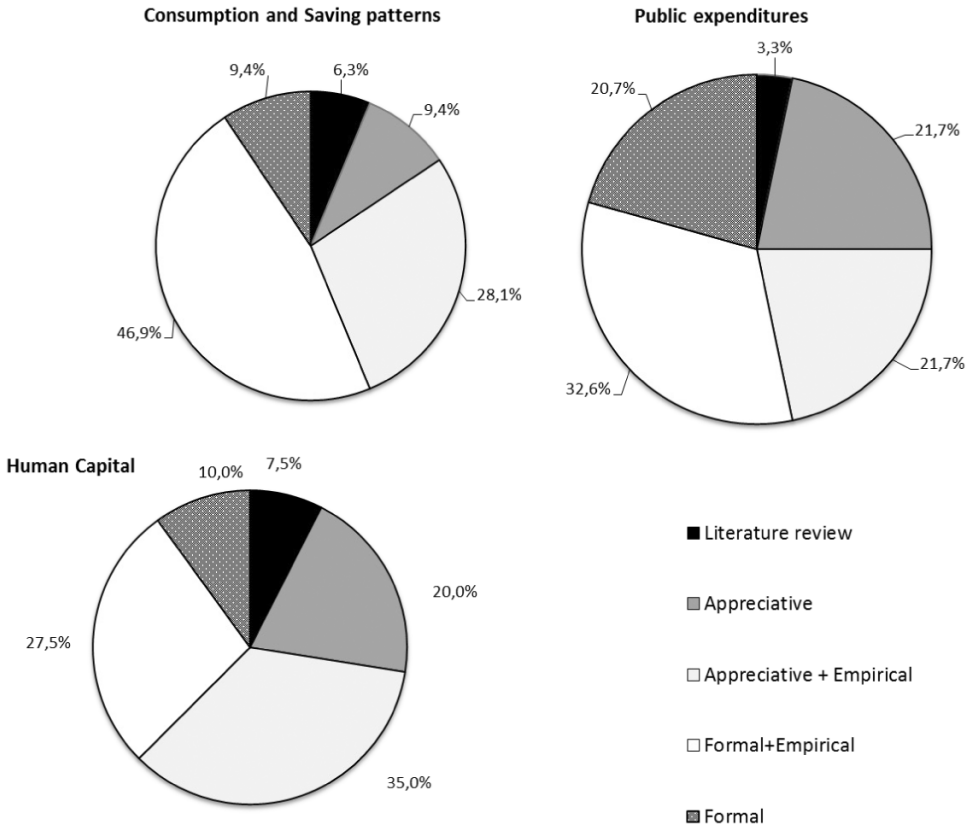
Figure 4. Evolution of the Distribution of Articles on Ageing and Growth Using Empirical Estimation Methods

analytical method used to specifically address each mechanism. Cross tabulation analysis was applied to study the interrelation between the mechanisms and the methods. The results (cf. Figure 5) show that, in fact, the articles published have concentrated on specific methods to analyze each mechanism. More specifically, Figure 5 illustrates that the "Formal + Empirical" types were more frequently used in the articles related to the "Consumption and saving patterns" mechanism (46.9%). From our knowledge of the related literature, it is possible to state that an important stream of this literature has been using a framework of analysis based on Overlapping Generations (OLG) models to address the behavior of households in terms of consumption and savings, since such behavior may differ significantly between individuals' working and retirement periods. OLG models take into consideration the time preferences (Samuelson, 1958), thus, the majority of the studies has applied these models to project the impact of an ageing population on "Consumption and saving patterns". For the "Public expenditure" mechanism, the "Formal + Empirical" type is also dominant although less expressively (with 29.7% of the total occurrences) whereas the "Appreciative + Empirical" type accounts for 22% of the total occurrences.

In the early period of our analysis (1975–2000), the "Formal + Empirical" method was more frequently used to analyze the impact of ageing on "Public expenditure". To a certain extent, this analytical choice may be understood if we bear in mind that, until 2000, the

Consumption and Saving patterns

Public expenditures

Human Capital

- Literature review
- Appreciative
- Appreciative + Empirical
- Formal+Empirical
- Formal

Source: Authors' computation based on 144 articles gathered from the Scopus database (accessed on 4 February 2013).

Figure 5. The Interrelation Between Mechanisms and Methodology

impact of population ageing on public expenditure was not yet evident in many countries and, therefore, the impact of ageing was mainly presented through projection methods (Ogawa, 1982).

Our bibliometric results also show that, for the "Human capital" mechanism, the most common type of articles has been the "Appreciative + empirical" (with 35.0% of the total occurrences), higher than the "Formal + Empirical" (accounting for 27.5%). Generally, most of the literature on the influence of population ageing through "Human capital" is mostly focused on the labor force and analyzes its effects on the basis of econometric methods (Ilmakunnas and Ilmakunnas, 2010; Göbel and Zwick, 2012; Ludwig *et al.*, 2011).

3.4. *Main empirical methodologies to analyze the data*

The empirical analysis accomplished in the published articles reveals that the impact of population ageing on economic growth does not essentially vary according to the main mechanism through which ageing impacts on growth (c.f. Figure 6). In general, regardless
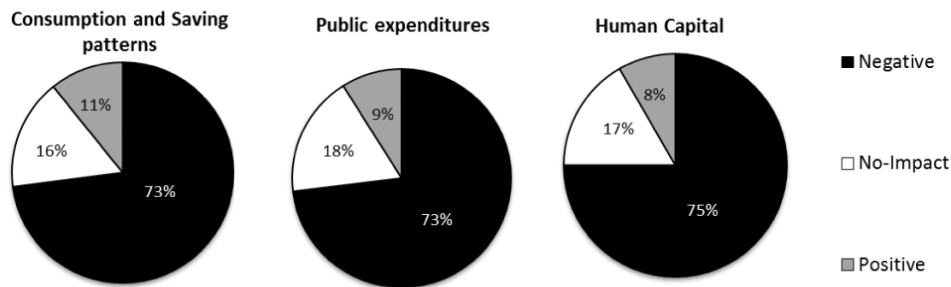
Figure 6. The Impact of Ageing on Economic Growth by Main Mechanisms

of the mechanism (consumption and saving patterns, public expenditure, and human capital), the predominance of the negative effects of ageing on growth is apparent (covering over 70% of the total occurrences).

According to Braun *et al.* (2009), a decline in the households' savings rate due to the ageing problem is associated to a concurrent decline in the after-tax real return on capital or after-tax real interest rate, which is believed to negatively affect economic growth. Although in a considerably lower proportion (11% of the corresponding total), some empirical studies centered on the impact of ageing on economic growth through consumption and savings have found a positive relation between these variables. An anecdotal example can be found in the Chinese case. Chinese economic growth has been occurring along with a rise in the old age dependency ratio. Li *et al.* (2012) and Peng and Fei (2013) report that China's increasing old age group is required to take measures to ensure their own welfare, which means this group will continue to be pressured to engage in a savings behavior. Such behavior in turn positively contributes to China's economic growth.

With regard to the articles in which ageing failed to impact on economic growth through the consumption and savings mechanism (a finding for 16% of the total occurrences), Hock and Weil (2012) and Mason and Lee (2013) argue that a rise in the ageing population will increase the burden on the working age group, i.e., working age individuals will have to expend a larger share of their income on the elderly (Wu, 2013). Thus, in order to maximize consumption at the steady state, the working age population may opt to have fewer children (Hock and Weil, 2012). Consequently, the ageing population will have a greater influence on the fertility rate than consumption and saving patterns.

Moreover, an ageing population is assumed to influence growth negatively by means of government revenue and positively by means of government expenditure (Tosun, 2003). According to Tosun (2003), a rise in the ageing population tends to decrease government revenue through labor income tax and increase government spending through pension and health care expenditures. Notwithstanding, Pammolli *et al.* (2011) report that, over the past 30 years, the health care expenditure of OECD countries has increased more rapidly

than their GDP. Such an ambiguity is also found in our bibliometric analysis, although the general findings of the existing empirical research point to the prevalence of the negative impacts of ageing on economic growth (see Figure 6).

The lack of impact ("No impact") of ageing on economic growth is slightly more evident in studies that address the public expenditure mechanism (18% of the total empirical papers published focusing on this mechanism). According to Blake and Mayhew (2006), the rise in government spending due to an ageing population bares no effect on economic growth as long as there is a continuous rise in immigration.

With regard to the human capital mechanism, the vast majority of the empirical studies surveyed (75% of all occurrences) shows that ageing impacts negatively on economic growth as labor supply and labor productivity decline due to ageing (Alam and Mitra, 2012; Lisenkova *et al.*, 2012; Börsch-Supan, 2013). More specifically, Ilmakunnas and Ilmakunnas (2010) contend that ageing negatively affects the economic growth of a country when more senior workers are less productive compared to their younger counterparts. Thus, productivity differentials among the distinct age cohorts may explain the disparate impacts that the existing empirical literature has encountered.

It is important to note that the empirical studies on the impact of ageing on growth through the distinct mechanisms have employed different estimation methods and, consequently, part of the divergent effects encountered (negative, positive or no effect) may derive from the use of different methodological approaches. Indeed, as shown in Table 1, regardless the mechanism, the type of country, year of articles' publication or the scientific "quality" of the journal where the article was published, empirical studies based on simple econometric estimations (i.e., OLS), as compared to more complex methods such as the GMM, dynamic least squares, multinominal, and panel data, tend to be more associated with negative impacts of ageing on countries' economic growth.

When controlling for a set of factors that are likely to influence the impact of ageing on economic growth (e.g., the estimation method used, the type of country in analysis, the year of publication of the article, and the scientific "quality" of the journal where the article was published), the mechanism analyzed does not significantly influence the estimated impact of ageing on economic growth. The same can be said for the year of publication of the article, and the scientific "quality" of the journal where the article was published. In contrast, when the countries in analysis in the selected papers are developing countries (by comparison with developed countries), the impact of ageing on economic growth tend to be negative. Thus, other factors remaining constant, on average, ours results convey (cf. Table 1) that the type of country influences the estimated impact of ageing on economic growth.

3.5. *Countries and groups of countries analyzed*

Countries have been experiencing the demographic transition at different paces since 1970 (Mérette and Georges, 2009). According to Mason and Lee (2011) and Börsch-Supan (2013), countries cannot rely entirely on their past experience as changes in population age structure in any given country may be occurring for the first time.

Table 1. Logistic Models Estimation (the Dependent Variable is a Dummy Variable that Takes the Value 1 when the Impact of Ageing on Economic Growth is Negative and 0 Otherwise)

| Determinants	Variables	Indicator/proxy	Model IA	Model IIA	Model IIIA	Model IB	Model IIB	Model IIIB
Estimation method	OLS	Dummy variable that assumes the value 1 when the estimation method used was less sophisticated (OLS) and 0 if the method is more sophisticated (GMM)	1.057** (0.471)	1.349*** (0.519)	1.064** (0.471)	0.908* (0.496)	1.253** (0.570)	0.856* (0.498)
Mechanism (default: Public expenditures)	Consumption	Dummy variable that assumes the value 1 when the focused mechanism is consumption	0.604 (0.532)	0.403 (0.553)	0.659 (0.540)	0.472 (0.550)	0.359 (0.560)	0.504 (0.555)
	Human capital	Dummy variable that assumes the value 1 when the focused mechanism is human capital	0.748 (0.500)	0.349 (0.542)	0.818 (0.521)	0.629 (0.520)	0.384 (0.550)	0.750 (0.537)
Type of country (default: developed)	Developing	Dummy variable that assumes the value 1 when the countries under analysis are classified as developing	0.981* (0.576)	1.034* (0.588)	1.052* (0.578)	0.930* (0.570)	0.981* (0.591)	0.981* (0.580)
Year of publication	Years	Number of years since publication of the corresponding paper (in ln)				−0.279 (0.293)	−0.119 (0.316)	−0.362 (0.300)
Journal's scientific 'quality'	Journal's Impact factor	Scimago Journal Ranking (in ln)		−0.425 (0.267)			−0.412 (0.286)	

Table 1. (*Continued*)

Determinants	Variables	Indicator/proxy	Model IA	Model IIA	Model IIIA	Model IB	Model IIB	Model IIIB
		WoS/ISI Impact Factor (in ln)			0.065			0.081
					(0.073)			(0.076)
		Constant	−1.071	−1.022	−1.025	−0.457	−0.752	−0.211
			(0.340)	(0.341)	(0.346)	(0.722)	(0.761)	(0.758)
		N	105	105	105	105	105	105
		Negative impact	45	45	45	45	45	45
		Other	60	60	60	60	60	60
Goodness of fit		Hosmer and Lameshow test	5.887	12.123	10.309	6.049	18.939	11.574
		(*p*-value)	(0.207)	(0.146)	(0.172)	(0.534)	(0.008)	(0.115)
		% corrected	69.5	73.6	63.1	69.5	73.3	61.9

Notes: Legend: *** (**) [*] statistically significant at 1% (5%) [10%]; standard errors in brackets; gray cells are used to highlight significant estimates.
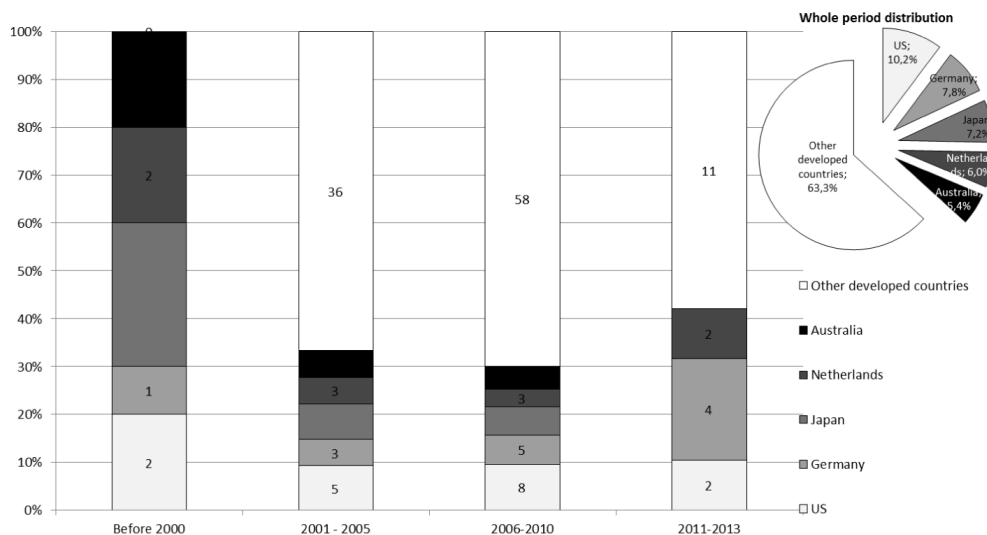
Most of the existing empirical studies have focused on developed countries regarding ageing and its impact on economic growth (cf. Figure 7). However, from 2006 to 2010, there was a substantial rise in the share of studies on developing countries (from less than 2% to over 20%). No published studies were found regarding the least developed countries on ageing and economic growth. Such an absence, although unfortunate, may be explained by the fact that the pace and timing of ageing are different between industrialized and developing countries (Brooks, 2003; Mason and Lee, 2013). Ageing was first experienced by developed countries (Mérette and Georges, 2009), thus it is to be expected that in the earlier periods (1975–2000), empirical analyzes were performed based on data mostly from developed countries.

Among the developed countries, the US, Germany, Japan and the Netherlands were the most frequent analyzed in the empirical studies in the area. During the period 1975–2013, the share of these four countries has been more or less stable (around 31% of the total occurrences for developed countries), albeit Germany's share observed a marked increase (cf. Figure 8). As an industrialized country, Germany faces the impact of ageing on economic growth. According to Bloom *et al.* (2011), although Germany has managed to solve the pension problem related to the ageing population, its scientific committees are currently more concerned with the impact of ageing on social policy (Börsch-Supan *et al.*, 2002). Börsch-Supan *et al.* (2002) state that Germany's ageing population will have a huge impact on production by 2035 as a 15% decline in the labor force is predicted. In the case of Germany, empirical studies have tended to pay more attention to labor supply and labor
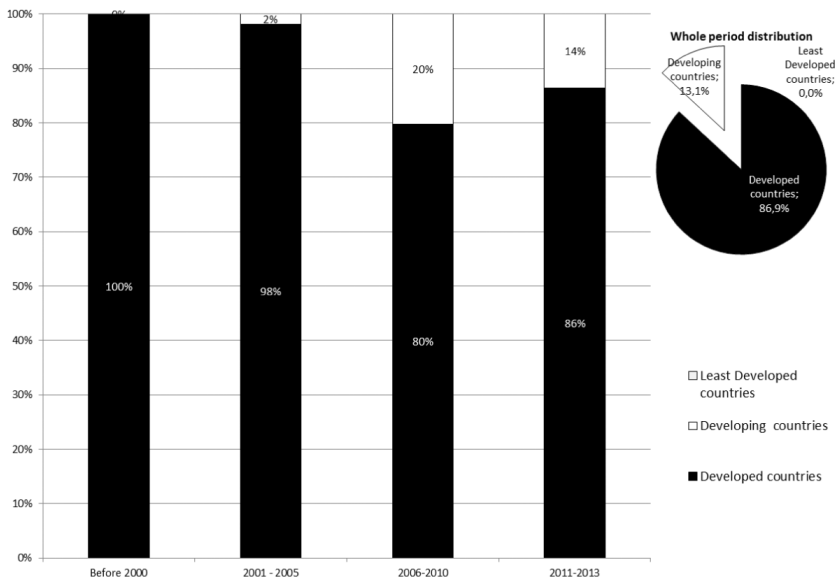
Source: Authors' computation based on 144 articles (161 occurrences) gathered from the Scopus database (accessed on 4 February 2013).

Figure 7. The Evolution of the Distribution of Occurrences by the Countries' Level of Development

Figure 8. The Evolution of the Number/Distribution of the Occurrences for Given Developed Countries

productivity, that is, the human capital mechanism (Börsch-Supan *et al.*, 2002; Göbel and Zwick, 2012; Börsch-Supan, 2013).

Ageing has also been considered a severe problem in countries such as the US, the Netherlands, and Japan. According to Ludwig *et al.* (2011), the US working-age population ratio is predicted to decrease from 84% in 2005 to 75% in 2050, whereas the old-age dependency ratio will increase from 19% in 2005 to 34% in 2050. In the case of the Netherlands, Van Ewijk and Volkerink (2012) state that the ageing population will tend to raise the consumption of non-tradable goods and diminish that of tradable goods. According to these authors, such changes in consumption patterns is likely to generate a decrease in the current account surplus from 7% of the GDP to 4% in 2025, eventually turning it into a deficit of 3% of the GDP by 2040 when ageing reaches its peak. In the case of Japan, Braun *et al.* (2009) project that the average value of Japanese savings rates will not exceed 5% for the rest of the 21st century.

Although showing a growing tendency, the number of studies on developing countries is still scarce, with Asia as the most frequently analyzed region (13 articles from a total of 25 on developing countries focus on Asian countries, corresponding to 52% of the occurrences). Within these regions, the most analyzed sub-regions are East Asia and the Pacific, especially in the period 2006–2010 (accounting for 38% of the total occurrences). The working age population has already started to decline in some East Asian countries (Lee *et al.*, 2011). Moreover, the proportion of the older population is increasing very rapidly in Asia as a whole, although there are distinct patterns within the region. For instance, South Asian countries still have relatively young populations while East Asian countries have seen their share of elderly increase substantially in the last few years (Lee *et al.*, 2011).

This increase largely justifies the fact that empirical studies have paid more attention to developing countries from East Asia and the Pacific. Interestingly, although China's population is ageing at a rapid pace (Wu, 2013), according to Fehr *et al.* (2005), given that this country is likely to become the world's largest saver over the next few decades, ageing will not negatively affect its economic growth.

Currently, the processes of demographic transition towards an ageing population take place in most of the developed and developing countries (Bloom *et al.*, 2011). Even though, at present, the demographic transition process in least developed countries may not yet be visible, given the lack of published empirical studies on these realities, this does not mean that ageing is not a relevant issue for these countries. According to the United Nation (2009), the growth rate of the older population in least developed countries is projected to continuously increase until 2040. The report further reveals that by 2045–2050, the population aged 60 years and over in the least developed countries is expected to grow at a rate of 3.5% per year, nine times higher compared to that of developed countries (0.4% annually).

4. Conclusions

Over the next four decades, global life expectancy at age 60 is expected to increase from 19.7 years in 2005–2010 to 22.4 years in 2045–2050 (United Nation, 2009). Besides the importance of ageing for scientific research, this issue is also the focus of major concern for policy makers (Tosun, 2003; Mason and Lee, 2011).

Given the relatively large amount of scientific literature on this topic, namely related to economic growth, it seemed timely to review this literature from a quantitative perspective.

Bibliometric analyzes are considered useful tools in uncovering potential gaps in the literature (Silva and Teixeira, 2009). Indeed, bibliometric methods are able to map a given scientific area and provide an assessment of the dynamics of its key topics and research methods (Cruz and Teixeira, 2010).

In this paper, based on bibliometric techniques, we were able to identify several dimensions of the main scientific contributions in the literature on ageing and economic growth. Some of our findings are worth highlighting, as they provide valuable insights into the extent to which ageing has affected the economic growth of countries.

First, our results show that papers on ageing and economic growth have been on the rise in absolute terms but not in relative terms (i.e., *vis-á-vis* papers related with economic growth) evidencing a steady share of the total papers published on economic growth.

Second, in terms of the main mechanisms, studies related to the public expenditure mechanism were more prominent in the first years of the period analyzed, representing 69% of the total articles published in the period 2001–2005. This is in line with the observation by Pammolli *et al.* (2011) that, in the past 30 years, the health care expenditures of countries increased more rapidly than their gross domestic product. From 2005 onwards, variations in the relative scientific importance of the three mechanisms (consumption and saving patterns, human capital, and public expenditure) is more clear-cut, with the relative importance of "public expenditure" decreasing expressively (dropping

from 69% to 36%) in favor of a noticeable rise in the "consumption and saving patterns" mechanism, which increased 25% points.

Third, the results reveal a growing need to test economic phenomena with real-world data against the theory, as testified by the substantial increase in the "Appreciative + empirical" and "Formal + empirical" type of papers.

Fourth, it was found that the impact of ageing on economic growth does not depend on the mechanism analyzed but rather varies according to the empirical methodology used and the countries in analysis. In general, the vast majority of the empirical studies found a negative effect of ageing on economic growth (Kenc and Sayan, 2001; Braun *et al.*, 2009; Ilmakunnas and Ilmakunnas, 2010; Bloom *et al.*, 2011; Lee *et al.*, 2011; Van Ewijk and Volkerink, 2012; Thiébaut *et al.*, 2013), although some occasional evidence points to the positive or neutral effects of ageing on economic performance (e.g., Blake and Mayhew, 2006; Cai, 2010; Li *et al.*, 2012). Such idiosyncrasies are to some extent related to the countries' institutional and social arrangements. Through econometric estimations, we showed that the type of methodologies used by original studies (less sophisticated versus more sophisticated estimation methods) and the type of country in analysis (less developed versus developed) tend, on average, to explain the estimated impact observed between ageing and economic growth. Specifically, articles whose estimation techniques rely more on less sophisticated methods (e.g., OLS) and on less developed countries tended to report more negative impacts of ageing on economic growth.

Fifth, there are few empirical studies on ageing and economic growth in developing countries and none on the least developed countries. This raises some concern as ageing is also a critical issue for less developed countries.

The United Nation (2009) reported that for less developed countries, the proportion of the population aged 60 years and over is projected to increase significantly over the next 30 years, with the working age population in these countries projected to decline to 49% by 2050. Therefore, there is an urgent need for empirical studies on ageing and economic growth in developing and least developed countries, which require more attention from researchers.

References

Adriaanse, LS and C Rensleigh (2013). Web of Science, Scopus and Google Scholar. A content comprehensiveness comparison. *The Electronic Library*, 31(6), 727–744.

Alam, M and A Mitra (2012). Labour market vulnerabilities and health outcomes: Older workers in India. *Population Ageing*, 5, 241–256.

Alders, P and PD Broer (2004). Ageing, fertility, and growth. *Journal of Public Economics*, 89, 1075–1095.

Bakshi, GS and Z Chen (1994). Baby boom, population aging and capital markets. *Journal of Business*, 67, 165–202.

Bell, DNF and AC Rutherford (2013). Older workers and working time. *The Journal of the Economics of Ageing*, 1–2, 28–34.

Blake, D and L Mayhew (2006). System in the light of population ageing and declining fertility. *The Economic Journal*, 116, 286–305.

Bloom, DE, A Börsch-Supan, P McGee and A Seike (2011). Population aging: Facts, challenges, and responses, PGDA Working Paper No. 71.

Bloom, DE, D Canning and J Sevilla (2001). The Demographic Dividend. A New perspective on the Economic Consequences of Population Change, A RAND program of Policy-Relevant Research Communication.

Bloom, DE and JG Williamson (1998). Demographic transition and economic miracles in emerging Asia. *The World Bank Economic Review*, 3, 419–455.

Börsch-Supan, A (2013). Myths, scientific evidence and economic policy in an aging world. *The Journal of the Economics of Ageing*, http://dx.doi.org/10.1016/j.jeoa.2013.06.001.

Börsch-Supan A, A Ludwig and J Winter (2002). Aging and international capital flow, MEA Discussion paper series 02010, Munich Center for the Economics of Aging (MEA) at the Max Planck Institute for Social Law and Social Policy.

Braun, RA, D Ikeda and DH Joines (2009). The saving rate in Japan: Why it has fallen and why it will remain low. *International Economic Review*, 50, 291–321.

Brooks, R (2003). Population aging and global capital flows in a parallel universe, IMF staff Papers, 50, 200–221.

Cai, F (2010). Demographic transition, demographic dividend and lewis turning point in China. *China Economic Journal*, 3(2), 107–119.

Cameron, LA and DA Cobb-Clark (2002). Old-age labour supply in the developing world. *Applied Economics*, 9, 649–652.

Castro Silva, M and AAC Teixeira (2011). A bibliometric account of the evolution of EE in the last two decades is ecological economics (becoming) a post-normal science? *Ecological Economics*, 70, 849–862.

Creedy, J and MG Scobie (2002). Population ageing and social expenditure in New Zealand: Stochastic projections, New Zealand Treasury Working Paper 02/28.

Cruz, S and AAC Teixeira (2010). The evolution of the cluster literature: Shedding light on the regional studies-regional science debate. *Regional Studies*, 44, 1263–1288.

Davies, BR and RR Robert III (2006). Population aging, foreign direct investment, and tax competition, SAID Business School, 1HPWP 07/10.

Eiras, MG and D Niepelt (2012). Ageing, government budgets, retirement and growth. *European Economic Review*, 56, 97–115.

Eurostat (2013). Life expectancy by age and sex, in http://epp.eurostat.ec.europa.eu/portal/page/portal/population/data/database, accessed on 25th March 2013.

Falagas, ME, EI Pitsouni, GA Malietzis and G Pappas (2008). Comparison of PubMed, Scopus, Web of Science, and Google Scholar: Strengths and weaknesses. *The FASEB Journal*, 22, 338–342.

Fehr, H, S Jokisch and LJ Kotlikoff (2005). Will China eat our lunch or take us out to dinner? Simulating the transition paths of the US, EU, Japan and China, NBER Working Paper No. 11668.

Göbel, C and T Zwick (2012). Age and productivity: Sector differences. *De Economist*, 160, 35–57.

Guest, RS and IM Mcdonald (2003). Vintage versus homogeneous capital in simulations of population ageing: Does it matter? *Applied Economics Letters*, 10, 149–153.

Hock, H and ND Weil (2012). On the dynamics of the age structure, dependency and consumption. *Journal of Population Economics*, 25, 1019–1043.

Hodgson, D (1988). Orthodoxy and revisionism in American demography. *Population and Development Review*, 4, 541–569.

Hondroyiannis, G and E Papapetrou (2001). Demographic changes, labor effort and economic growth: Empirical evidence from Greece. *Journal of Policy Modeling*, 23, 169–188.

Ilmakunnas, P and S Ilmakunnas (2010). Work force ageing and expanding service sector: A double burden on productivity? *The Service Industries Journal*, 30, 2093–2110.

Kaldor, N (1961). Capital accumulation and economic growth, in *The Theory of Capital*. FA Lutz and DC Hague (eds.), pp. 177–222. New York: St. Martins Press.

Kenc, T and S Sayan (2001). Demographic shock transmission from large to small countries, An overlapping generations CGE analysis. *Journal of Policy Modeling*, 23, 677–702.

Krugman, P (2007). *The Conscience of a Liberal*, New York: W.W. Norton and Company.

Lee, HS, A Mason and D Park (2011). Why does population aging matter so much for Asia? Population aging, economic security and economic growth in Asia, ERIA Discussion Paper Series, ERIA-DP-2011–04.

Li, X, Z Li and MWL Chan (2012). Demographic change, savings, investment and economic growth, a case from China. *The Chinese Economy*, 45(2), 5–20.

Lisenkova, K, M Mérette and R Wright (2012). The Impact of population ageing on the labour market: Evidence from overlapping generations computable general equilibrium (OLG-CGE) model of Scotland, Discussion paper in Economic, Strathclyde, 12–13.

Ludwig, A, T Schelkle and E Vogel (2011). Demographic change, human capital and welfare. *Review of Economic Dynamic*, 5, 94–107.

Maebayashi, N (2013). Public capital, public pension, and growth. *International Tax and Public Finance*, 20, 89–104.

Malhotra, NK, L Wu and J Whitelock (2013). An updated overview of research published in the International Marketing Review 1983 to 2011. *International Marketing Review*, 30, 7–20.

Mason, A (2005). Demographic Transition and Demographic Dividends in Developed and Developing countries, United Nations Expert Group Meeting on Social and Economic Implications of Changing Population Age Structure, UN/POP/PD/2005/2.

Mason, A and R Lee (2011). Population aging and the generational economy: Key findings, In *Population Aging and the Generational Economy. A Global Perspective*, R Lee and A Mason (eds.), pp. 3–31. Cheltenham, UK and Northampton, MA, USA: Edward Elgar.

Mason, A and R Lee (2013). Labor and consumption across the lifecycle. *The Journal of the Economics of Ageing*, 1 – 2, 16–27.

Meijer, C, B Wouterse, J Polder and M Koopmanschap (2013). The effect of population aging on health expenditure growth: A critical review. *European Journal of Ageing*, 10(4), 353–361.

Mérette, M and P Georges (2009). Demographic Changes and the Gains from Globalisation: A Multi-Country Overlapping Generations CGE Model, Department of Economics Working Papers No. 0903, Local: University of Ottawa.

Mincer, J (ed.) (1974). *Age and Experience Profiles of Earnings*. New York: Columbia University Press.

Navaneetham, K and Dharmalingam, A (2012). A review of age structural transition and demographic dividend in South Asia: Opportunities and challenges. *Population Ageing*, 5, 281–298.

Nelson, RR and Sidney GW (1982). *An Evolutionary Theory of Economic Change*. Belknap Press/Harvard University Press: Cambridge.

Norris, M and C Oppenheim (2007). Comparing alternatives of the Web of Science for coverage of the social sciences' literature. *Journal of Informetrics*, 1, 161–169.

Ogawa, N (1982). Economic implications of Japan's ageing population, a macro-economic demographic modelling approach. *International Labour Review*, 121, 17–33.

Pammolli, F, M Riccaboni and L Magazzini (2011). The sustainability of European health care systems: Beyond income and aging. *European Journal of Health Economics*, 13, 623–634.

Peng, D and W Fei (2013). Productive ageing in China: Development of concepts and policy practice. *Ageing International*, 38, 4–14.

Pham, HX (2009). Optimal investment, education, and consumption under demographic changes for a small-open economy. *The Singapore Economic Review*, 54, 41–59.

Phillipson, C (2011). Extending working life and re-defining retirement: Problems and challenges for social policy. In *Older Workers in a Sustainable Economy*, R Ennals and RH Salomon (eds.), Frankfurt am Main: Peter Lang, 233–243.

Samuelson, AP (1958). An exact consumption-loan model of interest with or without the social contrivance of money. *Journal of Political Economy*, 66(6), 467–82.

Silva, S and AAC Teixeira (2009). On the divergence of evolutionary research paths in the past 50 years: A comprehensive bibliometric account. *Journal of Evolutionary Economy*, 19, 605–642.

Sobotka, T, V Skirbekk and D Philipov (2010). Economic Recession and Fertility in the Developed World Literature Review, European Commission, Directorate-General Employment, Social Affairs and Equal Opportunities Unit E1 — Social and Demographic Analysis.

Teixeira, AAC (2014). Evolution, roots and influence of the literature on national systems of innovation: a bibliometric account. *Cambridge Journal of Economics*, 38(1):181–214.

Thiébaut, SP, T Barnay and B Ventelou (2013). Ageing, chronic conditions and the evolution of future drugs expenditure: A five-year micro-simulation from 2004 to 2029. *Applied Economics*, 45, 1663–1672.

Tosun, SM (2003). Population aging and economic growth political economy and open economy effects. *Economics Letters*, 81, 291–296.

Tyers, R and Q Shi (2007). Demographic change and policy responses: Implication for the Global economy. *The World Economy*, 30, 537–566.

United Nation (2009), World Population Ageing, United Nations Department of Economic and Social Affairs, Population Division.

Van Ewijk, C and M Volkerink (2012). Will ageing lead to a higher real exchange rate for the Netherlands? *De Economist*, 160, 59–80.

Walder, BA and T Döring (2012). The effect of population ageing on private consumption — a simulation for Austria based on household data up to 2050. *Eurasian Economic Review*, 2, 63–80.

Weil, ND (2006). Population Aging, NBER Working Paper No. 12147.

Wu, L (2013). Inequality of pension arrangements among different segment of the labor force in China. *Journal of Aging and Social Policy*, 25, 181–196.

Yong, V and Y Saito (2012). National long-term care insurance policy in Japan a decade after implementation: Some lessons for aging countries. *Ageing International*, 37, 271–284.