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Essays on Population Ageing in Least Developed Countries

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PhD Dissertation in Economics

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Biographical note

N. Renuga Nagarajan was born on 18th November 1979, in Penang, Malaysia. Upon completing her high-school, she has enrolled in an undergraduate course in Business Management at University of Putra Malaysia (Malaysia) in year 2000 and graduated with a second class upper (honors) in the year 2003. She continued her studies by enrolling in a Master in Business Management (MBA) with Finance majoring in University Multimedia (Malaysia).

She was accepted to pursue her PhD studies in Economics at Faculty of Economics of University of Porto in the year of 2011. By the end of 2014, she managed to write, within her PhD thesis, a total of five essays on ageing and economic growth.

One essay of the present thesis was presented in the "3rd International Workshop on The Socio-Economics of Ageing" held in Lisbon, Portugal (in year 2013). Recently, an essay of her PhD thesis was accepted for publication in *Singapore Economic Review* (indexed in ISI WoK).

She has a great interest in research and worked as research assistance in several projects. Her current research interest include economic growth, ageing and human capital.

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Abstract

The process of demographic transition, mostly associated with increasing longevity and decreasing fertility, has led the world to the era of the 'ageing population'. The phenomenon of ageing was first felt among developed countries. Since there is no historical precedent on the existence of ageing, researchers and policy makers have been paying great attention in rectifying the impact of ageing on the economic performance of developed countries. However, not much attention was given to this phenomenon in least developed countries (LDCs). Hence, the aim of this dissertation is to identify determinants of ageing and the impact of ageing on the economic growth of LDCs.

In this context, the first and second essays of the dissertation are focused on reviewing the literature in detail, identifying: i) the main mechanisms through which ageing is expected to impact on economic growth; ii) the appropriate methodologies used in the related literature; iii) the type of countries that has been analysed in the literature.

Due to the perception of the lack of contributions related to LDCs, the third essay studies the demographic trend of ageing in LDCs in relation in comparison with developed and developing speed of ageing and the pace of 'convergence' of LDCs towards the developed and developing countries.

In order to identify the reasons for the increasing speed of ageing in LDCs in comparison with developed countries, an empirical analysis is developed in the fourth essay. The main purpose of this study is then to identify the main determinants of ageing and the speed of ageing on LDCs.

Finally, in the fifth essay, panel data estimations are carried out to examine the impact imposed by ageing and the speed of ageing on economic growth trajectories of LDCs.

Keywords: Ageing; Speed of Ageing; Economic Growth; Least Developed Countries

JEL-Codes: J10, O40

Resumo

O aumento da esperança média de vida e a queda na taxa de natalidade marcaram o arranque da era do envelhecimento da população à escala mundial. Os sinais de envelhecimento começaram por ser evidentes nos países desenvolvidos. Sem a existência de um precedente histórico sobre o fenómeno do envelhecimento, os investigadores e decisores políticos têm prestado especial atenção à necessidade de correção do impacto do envelhecimento sobre o desempenho económico nos países desenvolvidos. Contudo, a atenção sobre este fenómeno nos países menos desenvolvidos é relativamente escassa. Assim, o objetivo principal desta tese consiste em identificar os determinantes do envelhecimento e do impacto do envelhecimento sobre o crescimento económico dos países menos desenvolvidos.

Neste contexto, o primeiro e segundo ensaios da tese propõem uma revisão pormenorizada da literatura relevante, identificando: i) os principais mecanismos através dos quais se espera que o envelhecimento influencie o crescimento económico; ii) as metodologias que têm vindo a ser usadas na literatura; iii) o tipo de países tratados na literatura.

Face à escassez de literatura sobre o tema relativamente aos países menos desenvolvidos, o terceiro ensaio visa estudar a tendência demográfica do envelhecimento nos países menos desenvolvidos em relação aos países desenvolvidos e em desenvolvimento. Neste estudo descritivo, o principal objetivo consiste em calcular e analisar a velocidade do envelhecimento e do ritmo de "convergência" dos países menos desenvolvidos para os países desenvolvidos e em desenvolvimento.

Tendo em vista a identificação das causas para o aumento da velocidade do envelhecimento nos países menos desenvolvidos em relação aos países desenvolvidos, o quarto ensaio apresenta uma análise empírica cujo principal objetivo consiste então na identificação dos principais determinantes do envelhecimento e da velocidade do envelhecimento nos países menos desenvolvidos.

Finalmente, no quinto ensaio, são apresentadas estimações econométricas em painel desenvolvidas para analisar o impacto do envelhecimento e da velocidade do envelhecimento sobre o crescimento económico nos países menos desenvolvidos.

Palavras-chave: Envelhecimento, Velocidade do Envelhecimento, Crescimento Económico, Países Menos Desenvolvidos.
Códigos JEL: J10, O40.

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The impact of an ageing population on economic growth: an exploratory review of the main mechanisms

Abstract

Although a myriad of important theoretical and empirical contributions on ageing populations exist, these are diffuse and lack an integrated vision of the distinct mechanisms through which ageing populations impact on economic growth. This being the case, in this paper we survey the literature that provides insights regarding the ageing population and its effect on economic growth. In particular, we seek to uncover the main mechanisms through which ageing impacts on economic growth.

The literature review shows that the impact of ageing on a country's performance is intimately related to the selected mechanism. About 60% of the empirical studies that focus on the 'public social expenditure' mechanism show a negative impact of ageing on economic performance, whereas the majority (36%) of empirical studies that focus on 'human capital' fail to uncover any significant relationship. The positive impact is more closely related to the 'consumption and saving patterns' mechanism. Estimation methodologies also seem to be associated with distinct impacts of ageing on economic growth, with mathematical modelling and simulation. The bulk of the empirical evidence concerns developed countries, with most of the analysis indicating a significantly negative relation between ageing and economic growth. Given that developed, developing and even the least developed countries are/will be affected by the phenomenon of an ageing population, knowing the degree to which the impact of ageing varies among countries (including developing and least developed), and which mechanisms cause it to vary is essential for specifying sound public policies.

Keywords: Ageing; economic growth; consumption and saving patterns; public expenditure; human capital.

JEL Codes: J10, H50, O30, O40

1. Introduction

Many developed countries are approaching an era of ageing populations due to an increase in longevity and decrease in fertility rates (Harper and Leeson, 2009). The decline in population growth has been noticeable since the mid-1970s, when the adult working-age population in several countries overtook child population (Mason and Lee, 2011).

According to the World Health Organization (WHO),[1] the proportion of people aged 65 and above in Europe is predicted to increase from 14% in 2010 to 25% in 2050. Hence, it is expected that in the near future, the prime working age group will be smaller than the old age group.

The involvement of women in the labour force is also considered to be negatively related to the fertility rate (Becker *et al.*, 1990; Yong and Saito, 2012). In developed countries, more women have been actively participating in the labour market (Börsch-Supan, 2013). For instance, the growth rate of female employment in the Euro area (17 countries) increased from 1.3% in 1996 to 2.3% in 2007.[2] Considering this scenario, whether or not to have a child became a choice for female employees from the industrialized countries (Alders and Broer, 2004). As we know that human capital and the fertility rate are negatively correlated (Alders and Broer, 2004), the increasing trend among women to be better educated will in fact further decrease the fertility rate.

Alders and Broer (2004) further argue that the current demographic transfer faced by developed countries is no longer an exogenous shock. The authors stressed that the increase of female capital in the labour market has led to a decrease in the fertility rate. Given this critical situation, they further state that the altruistic behaviour of married couples will be a key factor in building future human capital. Furthermore, it is argued that the current financial crisis is not helping to promote altruistic behaviour in/amongst couples – which is essential.

A decline in the fertility rate leads to populations with many working age individuals and fewer children to succeed them (Weil, 2006; Lee *et al*., 2011; Alam and Mitra,

[1] World Health Organization, "Healthy Ageing", in http://www.euro.who.int/en/what-we-do/health-topics/Life-stages/healthy-ageing, accessed on 28th November 2012.

[2] European statistics (05.11.2012), "Employment growth by sex", in http://epp.eurostat.ec.europa.eu/tgm/refreshTableAction.do;jsessionid=9ea7d07d30dcf6332e333a1e44eaacb69590a71ad79c.e34MbxeSaxaSc40LbNiMbxeNb3qSe0?tab=table&plugin=1&pcode=tps00180&language=en, accessed on 17th December 2012.

2012; Navaneetham and Dharmalingam, 2012). For a highly developed country, the 'ideal' fertility rate is associated with the 2.1 replacement level (Nimwegen and Erf, 2010). In 2011, the fertility rates of almost all the European countries had fallen below the replacement level (*cf.* Figure 1.1). In particular, for Portugal, Spain, Italy, Austria and Greece, the fertility rate is now far below the replacement level. The average fertility rate for these five countries is below 1.5.

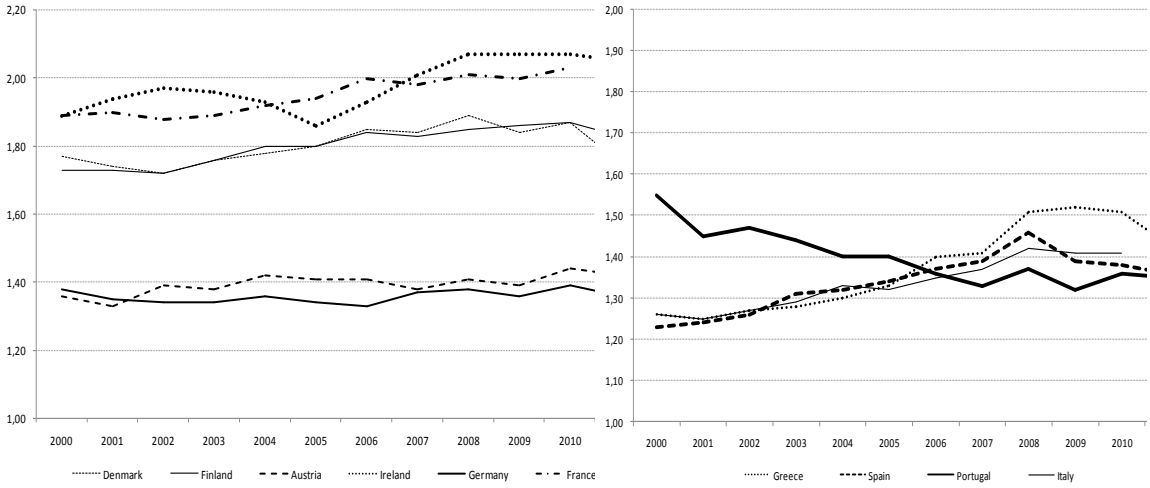

Figure 1.1: Fertility rates in European countries, 2000 – 2011
Source: European statistics (2012), "Total fertility rate", in http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&language=en&pcode=tsdde220&plugin=1, accessed on 17th December 2012.

It is important to note that a decrease in the fertility rate alone will not turn a country into an ageing country. Along with a lower fertility rate, a decrease in the mortality rate and increase in life expectancy have also played an important role (Dalgaard, 2012; Yong and Saito, 2012).

This structural ageing of the population has profound consequences on a country's economic growth. Most economists argue that a country with a higher proportion of inhabitants in the old age group tends to be associated with decreasing productivity levels, lower savings and higher government spending (Fougère *et al*., 2009; Bloom *et al*., 2010; Sharpe, 2011; Walder and Döring, 2012). The demographic transition makes room for an increase in the old age dependency ratio, meaning that the smaller working age group will be obliged to care for the older age group (Lindh, 2004; Navaneetham and Dharmalingam, 2012).

Although there are myriads of important theoretical and empirical contributions on the ageing population, these are diffuse and lack an integrated consensus of the various mechanisms through which an ageing population impacts on economic

growth. Thus, the main goal of this paper is to provide an in-depth literature survey on the interacting mechanisms between population ageing and economic growth.

Our paper is structured as follows. In Section 2, we provide a general overview of the literature on population ageing and economic growth, giving an account of the main mechanisms through which this influence occurs. Section 3 details the empirical studies in the area and Section 4 offers some concluding remarks.

2. The impact of an ageing population on economic growth: main mechanisms

2.1. An overview of the interaction between ageing and growth

Often in the past, demographic transition was considered to have a positive effect on economic growth as the proportion of the active working age group was higher than the non-working group (Lee *et al*., 2011). However, more recently, many authors have revealed that the working population group has become smaller than that of retired people. As a result, this situation has transformed most countries into ageing countries (Weil, 2006; Bell and Rutherford, 2013; Börsch-Supan, 2013). Indeed, the European Commission (EC) (2006) highlights the fact that the majority of developed countries face a relatively higher proportion of inhabitants (especially retirees) in the non-working group than in the working group. According to Bloom *et al*. (2010), the current global life expectancy is 65 years, and this is projected to increase to 75 years by 2050. In fact, some authors have even revealed that life expectancy in Japan has been the highest in the world since 2000 (Weil, 2006; Lee *et al*., 2011).

Most of the literature argues that there is a negative relationship between population ageing and economic growth (Narciso, 2010; Bloom *et al*., 2010; Lisenkova *et al*., 2012; Walder and Döring, 2012). According to these authors, individuals' physical capacity, preferences and needs will change in line with their advancing age. Hence, the inequality in age structure (a higher proportion in the old age group) is believed to affect a country's productivity level. Even so, some authors, such as Prettner (2012) and Lee *et al*. (2011), claim that a positive interaction exists between ageing and economic growth. According to Prettner (2012), older individuals tend to save more. As a result, they provide more resources for investment, which impact positively on economic growth. In fact, a longer life span will lead to investment in Research and Development (R&D). Thus, the rise in longevity will positively influence investment, particularly in R&D, which is generally recognized as an engine for economic growth (Aghion and Howitt, 1992).

Figure 1.2 highlights the fact that the increase in the ageing population *via* medical advances and couples' less altruistic behaviour will affect economic growth mainly through three mechanisms: consumption and saving patterns, public social expenditure, and human capital (Bakshi and Chen, 1994; Tosun, 2003; Alders and Broer, 2004; Elmeskov, 2004; Lee and Mason, 2007; Mason and Lee, 2013; Meijer *et al*., 2013). The following section looks at these mechanisms in more detail. However, it is also important to acknowledge that a reverse causality exists between these two phenomena (in other words, economic growth may also influence the determinants of an ageing population).[3]

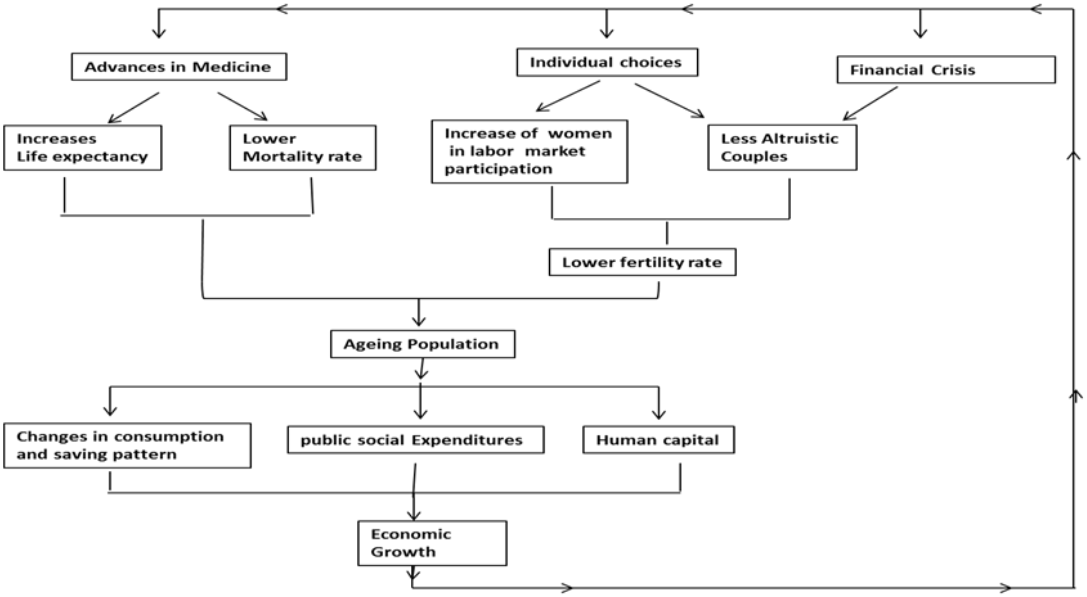

Figure 1.2: Main mechanisms through which an ageing population has an impact on economic growth

Source: Author's design

[3] Given that this paper focuses on the impact of ageing on growth, the important issue of reverse causality will not be developed. There are some contributions that study the causes of an ageing population (*e.g.*, Bloom and Williamson, 1998; Alders and Broer, 2004; Elgin and Tumen, 2010; Dalgaard *et al*., 2012).
Alders and Broer (2004) and Elgin and Tumen (2010) argue that a country's economic growth negatively affects its population growth and its fertility rate. Specifically, Alders and Broer (2004) show that the fertility rate tends to decline when there is a positive productivity shock - this shock increases the cost of having children and creates a substitution effect between children and the consumption of goods. Moreover, increasing returns on human capital will increase investment and raise labour force participation, inducing a decline in fertility rates, since couples now choose to allocate their time resource between child bearing, investment in human capital and work; this means fewer children. The international financial and economic crisis also has an important impact on demographic variables. The significant increase in unemployment rates and the income reduction observed during the crisis is contributing to a reduction in the fertility rate, especially for developed countries, since families have a greater role in supporting children than in supporting the elderly (Weil, 2006; Sobotka *et al*., 2010).

2.2. Consumption and saving patterns

The behaviour of households in terms of consumption and savings may differ substantially between individuals' working and retirement periods (Samuelson, 1958). The rise in population ageing will lead to changes in households' consumption patterns. Authors believe that ageing will to some extent change overall preferences and household needs (Walder and Döring, 2012; Velarde and Hermann, 2014). In fact, consumption patterns are alleged to be affected by ageing, through disposable income. Authors even stress that the increase in the elderly population will reduce the *per capita* income of all three generations (child, working group and retiree) and lead to a net decrease in the family's total consumption (Lee and Mason, 2007). To some extent, the increase in the old age dependency ratio is expected to reduce the disposable income of the working population and lead to a further decline in the fertility rate (Hock and Weil, 2012).

Despite these negative effects, authors such as Aguila (2011) argue that the personal retirement account (PRA) systems followed by many countries will enable retirees to be more independent. Using PRA instead of pay-as-you-go systems will provide financial sustainability for retirees. Hence, the rise in population ageing will not affect the total consumption of the family if the retirees have opted for the PRA system. In line with this argumentation, it is considered that the ageing population will not affect the consumption level of the working group in a family. Nevertheless, Davies and Robert III (2006) argue that the savings rate of retirees will decrease as savings become their source of spending. Thus, with the rise in life expectancy, PRA systems are unable to assure financial sustainability for retirees till the end of their lives.

Private consumption has a considerable influence on demand (Walder and Döring, 2012). Some authors believe population ageing will prompt changes in household demand for certain goods (Bakshi and Chen, 1994; Mérette and Georges, 2009; Aguiar, 2011; Walder and Döring, 2012). Changes in the demand for goods and services will undoubtedly influence the total productivity level of a country. In fact, the demand for goods and services is crucial for defining both the production structure and the labour market, which are directly influenced by the age composition of a country's population.

A country with an elderly population will face falling or stabilizing demand for property (housing) and higher demand in the stock markets, as older people are bigger risk-takers (Bakshi and Chen, 1994). Bakshi and Chen (1994) stressed that the retired age group will have less responsibilities as they are already in the later stages of life. Therefore, they will use their income to invest more heavily in risky assets.

Mérette and Georges (2009) argued that an ageing population will lead to higher demand for health services and a lower demand for housing. Even though a country with an ageing population tend to face in general a decline in the demand for housing, Chen *et al*. (2012) argue that in Scotland the problem of ageing is not yet seen as a main determinant for changes in house prices. Therefore, for countries like Scotland, there is no direct correlation between changes in the demand for housing and the rise in population ageing.

In addition to consumption of durable goods, households' consumption in relation to non-durable goods is also expected to drop significantly during the retirement and unemployment period (Aguiar, 2011). Among perishable goods, food expenditure is one of the major forms of expenditure that declines after retirement (Aguiar, 2011; Aguila *et al*., 2011). The authors stress that the expenditure on food eaten outside the home will fall once an individual leaves their employment. In fact, retirees will substitute their outside food consumption for home-cooked food as they have more leisure time after retirement.

There are some authors who are more positive about this ageing trend. They believe that population ageing will not affect consumption and household saving patterns, especially those of the working group (Alders and Broer, 2004; Hock and Weil, 2012). According to these authors, the decrease in the labour supply due to ageing tends to raise the wage rates of all generations and will increase the cost of having children. Therefore, in order to maintain its consumption level, the working age group must be willing to forgo in having children.

2.3. Public social expenditure

The old age dependency ratio is expected to increase in the near future (Díaz-Giménez and Díaz-Saavedra, 2009). The most common pay-as-you-go system is considered completely unsustainable due to the ageing phenomenon (Díaz-Giménez and Díaz-Saavedra, 2009; Aguila, 2011). Several authors predict that the current pay-as-you-go system will provoke an increasing deficit in government budgets (Tosun,

2003; Elmeskov, 2004; Díaz-Giménez and Díaz-Saavedra, 2009; Yong and Saito, 2012; Park-Lee *et al*., 2013). In fact, some authors consider that the rise in the government deficit has been due to the retirement of more educated workers (Díaz-Giménez and Díaz-Saavedra, 2009). For these authors, the more educated workers are, the higher the payroll taxes they pay during their working lives and the greater the pensions they will receive when they retire. Hence, a rise in retirement among educated workers is expected to double the government's expenditure on retirement. It largely depends on what types of retirement policies governments (or government agencies) adopt, as some policies may be able to offset the problem of increasing deficits in government budgets. In fact, Aguila (2011) suggests that by following the PRA (personal retirement account) retirement plan, it is possible to avoid many of the limitations of pay-as-you-go systems and even be able to reduce the budget deficit. Government agencies raise taxes to accommodate the rise in welfare expenditure on ageing societies. This is assumed to affect the disposable income of the working group to some extent, and thus tends to cause a decline in the fertility rate (Hock and Weil, 2012). Subsequently, this type of response will further enhance the ageing phenomenon. However, in the case of New Zealand, population ageing is believed to exert a positive influence on the government budget (Creedy and Scobie, 2002). Creedy and Scobie (2002) attest that the country's percentage of gross domestic product (GDP) is predicted to increase from 22.7% in 2001 to 31.0% by 2051 due to ageing. *Per se*, population ageing tends to cause significant changes in government budget allocations. However, Eiras and Niepelt (2012) and Lisenkova *et al*. (2012) argue that population ageing will increase the allocation of government spending more on social security than to education and infrastructure investment. According to these authors, the changes in government priority will ultimately impact (negatively) on the economic development of the country. Nevertheless, to some extent, the continuous rise in immigration will make it possible to mitigate the rise in government spending. Therefore, population ageing is believed not to have a negative impact on economic growth as long as there is a continuous flow of immigration (Blake and Mayhew, 2006).

As regards population ageing, some authors have even proposed postponing the retirement age of an employee (Finch, 2014; Díaz-Giménez and Díaz-Saavedra, 2009). To a certain degree, prolonging the working life of an individual is able to

overcome the pressure of the pension system. In fact raising the retirement age is considered to be one of the European Union's (EU's) policies (Finch, 2014).

Overall, the degree of negative effect of ageing on public expenditure depends on the type of government policy. Hence it is believed that the impact of population ageing makes it possible to mitigate the rise in public expenditure as long as retirement policies can be adjusted (by moving them to private pension schemes and raising the retirement age) and provided that the number of immigrant workers can be increased to compensate for the shortfall in the labour force.

2.4. Human capital

Rises in population ageing tend to decrease the weight of the working group (Alam and Mitra, 2012; Bell and Rutherford, 2013; Börsch-Supan, 2013; Wu, 2013). Fougère *et al*. (2009) argue that the decline in the working population in Canada was purely due to the ageing population. The huge baby boom population which emerged between 1947 and 1966 started to retire at the age of 65 in 2012, leading to a larger ageing population in Canada (Sharpe, 2011). However, authors claim that countries can sustain economic growth despite the ageing population problem. According to some authors, such as Bloom *et al*. (2010) and Peng and Fei (2013), the increase in the retirement age and immigration will in fact help to overcome the decrease in the labour force. Furthermore, Elgin and Tumen (2010) state that with a decline in human capital, the economy will switch from traditional production (that employs young workers) to new human capital oriented production (that employs elderly workers). Therefore, according to this line of argument an ageing population will affect neither production nor growth dynamics. Elgin and Tumen (2010) also stressed that modern economies rely more on machines than the labour force. Thus, a fall in the labour force will have no significant effect on productivity. According to these authors, labour can be replaced by machines. This means that a decrease in the young working group has no effect on economic growth.

However, Lisenkova *et al*. (2012) hold a contrasting view of this phenomenon. Even though an increase in the retirement age will help to overcome a decreasing labour market, workers of different ages are not perfect substitutes and so there will definitely be a decline in productivity *per* worker (Lisenkova *et al*., 2012). Thus, authors reveal that population ageing will decrease a country's stock of human capital and subsequently exert a negative influence on its economic growth (Narciso,

2010; Lisenkova *et al*., 2012). Furthermore, an ageing population expected to reduce the labour force, which is assumed to affect economic growth due to the lower productivity levels. Even though the higher participation of women in the labour force increases labour productivity, this participation will further lower the fertility rates, which will eventually lead back to the initial problem (Alders and Broer, 2004).

There is also the argument that, apart from the increase in the retirement age, higher immigration is unable to help much with overcoming public spending due to this problem of ageing, as immigrants will also have rights under the pension and health care system (Elmeskov, 2004). Despite the negative effect on human capital accumulation identified by Lindh (2004), Ludwig *et al*. (2011) and other authors in relation to the US economy, stressed that the increase in human capital investment will reduce the impact of an ageing population. The endogenous human capital acquired through formal schooling and on-the-job training programmes will positively influence human capital technology (Ludwig *et al.*, 2011). Hence in the case of the US, Ludwig *et al*. (2011) report that when we allow for endogenous human capital accumulation, the welfare losses in terms of lifetime consumption will be only about 8.7%, whereas when human capital is assumed as exogenous, these losses will rise to 12.5% (assuming that replacement rates to the pension system are constant).

3. Surveying the empirical studies which assess the impact of ageing on economic growth

3.1. Some brief methodological aspects

Although high quality empirical research on the impact of population ageing on countries' economic growth does exist, (this latter often proxied by GDP growth rates), such literature is still relatively scarce. The following section summarizes some of the most relevant studies in this area, highlighting the main mechanisms through which ageing impacts on economic growth: consumption and saving patterns, public social expenditure and human capital. The criteria for selecting the relevant papers involved an in-depth search within the blue ribbon journals (*The American Economic Review; Econometrica; The International Economic Review; The Journal of Economic Theory; The Journal of Political Economy; The Quarterly Journal of Economics; Review of Economic Studies; Review of Economics and*

Statistics), followed by an extensive search in specialized journals relating to ageing *(such as: The European Journal of Ageing; The Journal of Economics of Ageing; The Journal of Population Ageing; Research on Aging; Ageing International; The Journal of Aging and Social Policy*), and through a snowball method, some selected articles in other journals considered as well *(The Journal of Population Economics; Economic Modelling; De Economist; Applied Economics*). We used a time span of five years (2010 – 2014) in our search procedure for all the journals, except for *The Journal of Economics of Ageing, The Journal of Population Ageing, Economic Modelling and Applied Economics.* For *The Journal of the Economics of Ageing,* we carried out our search from the year 2013 – 2014, as their first volume was only published in 2013.

For *The Journal of Population Ageing*, and since there were few articles published between the year 2013 - 2014, we decided to consider a larger period, 2008 to 2014. The journals *Economic Modelling* and *Applied Economics* include a wide range of issues in the field of economics, and thus a vast amount of articles. Then the search was only undertaken from 2013 to 2014.

For all types, the search procedure involved the consideration of exclusive 'empirical studies' on 'economic growth' and 'ageing'. Particular attention was given to those articles assessing the possible distinct impact of ageing on economic growth by the main mechanism, estimation techniques and countries. From the search, 54 articles considered the impact of ageing on economic growth. Of the 54 articles, 23 focus exclusively on empirical studies (*cf.* Table 1.1).

From the identified articles, there were 7 instances of articles studying the impact of ageing on economic growth through consumption and saving patterns, 10 through public expenditure and 10 through human capital. In the following section, a further review will be carried out in relation to the empirical articles.

Table 1.1: Search procedure on number of relevant articles on ageing and economic growth

	Journal	Time span	Number of issues	No of articles	No (%) relevant articles	Empirical related article
Blue ribbon journals	American Economic Review	2010 - 2014	30	1001	1 (0.01)	1
	Econometrica	2010 - 2014	25	273	1 (0.4)	1
	International Economic Review	2010 - 2014	13	216	1 (0.5)	1
	Journal of Economic Theory	2010 - 2014	26	469	1 (0.2)	0
	Journal of Political Economy	2010 - 2014	25	130	1 (0.8)	1
	Quarterly Journal of Economics	2010 - 2013	17	180	0 (0)	0
	Review of Economic Studies	2010 - 2014	17	218	0 (0)	0
	Review of Economics and Statistics	2010 - 2013	17	375	2 (0.5)	2
Specialized ageing related journals	European Journal of Ageing	2010 - 2014	17	149	2 (1.34)	0
	The Journal of Economics of Ageing	2013 - 2014	3	11	8 (72.7)	6
	Journal of Population Ageing	2008 - 2014	17	90	9 (10)	3
	Research on Aging	2010 - 2014	24	123	0 (0)	0
	Ageing International	2010 - 2014	17	122	2 (1.64)	0
	Journal of Aging and Social Policy	2010 - 2014	16	109	2 (1.84)	0
Others journals	Journal of Population Economics	2010 - 2014	17	247	15 (6.1)	1
	Economic Modelling	2013 - 2014	9	696	3 (0.43)	2
	De Economist	2010 - 2014	16	84	7 (8.33)	6
	Applied economics	2013 - 2014	56	626	2 (0.32)	2

3.2. The effect that an ageing population has on consumption and saving patterns

Few empirical studies have addressed the impact of ageing on growth through consumption and saving patterns. Seven selected papers summarised in Table 1.1 have considered the influence of population ageing on both developed and developing countries. Since we know that the effect of ageing depends on countries' policies and household behaviour, the results (Table 1.1) show both positive (Kopecky, 2011; Mason and Lee, 2013) and negative (Nardi *et al*. 2010; Aguila *et al*. 2011; Ewijk and Volkerink, 2012; Hurd and Rohwedder, 2013) impacts on economic growth.

The needs and preferences of households will change depending on people's ages and their financial capacity. Analysing the expenditures of households from developed countries (such as the USA, the Netherlands and Germany), Nardi *et al*. (2010), Aguila *et al*. (2011), Ewijk and Volkerink (2012), Hurd and Rohwedder (2013) and Velarde and Hermann (2014) demonstrate a decreasing trend in the consumption patterns of the elderly. The fall in income after retirement has enabled households to adjust their consumption according to their financial capacity. Hence, an elderly household will alter his/her consumption substantially after retirement (*e.g*., Nardi *et al*., 2010; Aguila *et al*., 2011; Velarde and Hermann, 2014).

In the case of the USA, the empirical studies conducted by Aguila *et al*. (2011) and Hurd and Rohwedder (2013) shows similar results. According to these authors, the food consumption of a household will decline after the retirement of its members. In fact, considering a linear model, Velarde and Hermann (2014) also proved a similar result for households in Germany. According to the authors, retired members of German households behave in a similar way to those of USA households in terms of food consumption. Furthermore, their studies reveal that food expenditure will be the major category that is reduced after the retirement of inhabitants of these developed countries.

Nevertheless, in the case of the Netherlands, Ewijk and Volkerink (2012) find contradicting results. According to these authors, the rise in the elderly population in the Netherlands will increase the demand of non-tradable products (especially of services) in the long run. The authors believe that the consumption pattern of elderly households will only affect tradable goods. As a result of the ageing population, the Netherland's GDP share of the trade balance is projected to decrease to 4% in 2015. Moreover, Ewijk and Volkerink's (2012) simulation predict a 3% rise in the budget deficit when ageing reaches its peak for that country in 2040.

Unlike Velarde and Hermann (2014), Hurd and Rohwedder (2013), Ewijk and Volkerink (2012) and Aguila *et al*. (2011), the empirical studies undertaken by Mason and Lee (2013) and Kopecky (2011) demonstrate a positive impact of ageing on economic growth through consumption and savings. Analysing 34 countries (including developed and developing), Mason and Lee (2013) justify this positive relationship in mathematical terms.

Table 1. 2: Studies on the impact of an ageing population on economic performance through consumption and savings

Sample	Time Period	Methodology	Dependent (in case of econometric model) / Endogenous (in case of simulation) variable	Independent (in case of econometric model) / Exogenous (in case of simulation) variable	Effect on dependent variable	Inferred effect of ageing on economic growth	Author
Germany	2001 /02 Survey	Double hurdle model	Food production at home [1]	Age	No Effect	No Effect	Velarde and Hermann, 2014
			Participation in food consumption away home[2]		Negative		
			Shopping[3]		Negative		
			Food production at home	Retired Group	Positive		
			Food consumption away home		Negative		
			Shopping		Positive		
		Linear model	Food consumption at home [4]	Age	Positive		
			Food consumption at home	Retired group	Positive		
34 countries	1994 - 2009	Conceptual accounting framework	Lifetime effective consumption	Life expectancy (at birth)	Positive	Positive	Mason and Lee, 2013
United States	1992 - 2004	Panel data - median regression	Total spending	After retirement	Negative	Negative	Hurd and Rohwedder, 2013
			Non-durable		Negative		
			Food		Negative		
Netherlands	2010 - 2040	Mathematical modelling, Simulation	Consumption of non-tradable product	population on average is older group	Positive	Negative	Ewijk and Volkerink, 2012
United States	1980 - 2000	Simple linear regression. Difference-in difference approach (Panel data)	Expenditures on non-durables product[5]	Transition from working to retirement	No Effect	Positive	Aguila *et al*., 2011
			Expenditures total food[6]		Negative		
			Expenditures on food at home[7]		Negative		
			Expenditure of non –food (non-durables)[8]		No Effect		
			Expenditures on non-durables product	Retired labour	Positive		
			Expenditures total food		Positive		
			Expenditures on food at home		Positive		
			Expenditure of non –food (non-durables)		Positive		
United States	1850 - 2000	Mathematical modelling, Simulation	Wealth index	Age above 60	Negative	Positive	Kopecky, 2011
United States	1994 - 2000	Mathematical modelling, Simulation	Assets	Age above 70	Negative	Negative	Nardi *et al*., 2010
			Consumption by income	Age above 70	Negative		
		Fixed effect	Medical expenses	Age above 74	Positive		

[1] Male (-); Unemployed (+); Non_working (+); poor_health (0); High_school (0); HHsize (-); Monetary_poor (0); West (-); Weekend (+); Unusual_day (-); [2] Male (+); Unemployed (-); Non_working (-); poor_health (0); High_school (0); HHsize (-); Monetary_poor (-); West (0); Weekend (0); Unusual_day (+); [3] Male (-); Unemployed (+); Non_working (+); poor_health (-); High_school (+); HHsize (-); Monetary_poor (0); West (0); Weekend (-); Unusual_day (0); [4] Male (0); Unemployed (+); Non_working (+); poor_health (+); High_school (-); HHsize (+); Monetary_poor (0); West (0); Weekend (+); Unusual_day (-); [5] Re-entered in the labour (0); transition from working to retirement (0);[6] Re-entered in the labour (0); transition from working to retirement (+); [7] Re-entered in the labour (+); transition from working to retirement (+); [8] Re-entered in the labour (0); transition from working to retirement (0).

According to these authors, a rise in life expectancy will prolong the capacity of an individual to continue in the labour market. Hence, theauthors stress that extending a person's working life will increase a household's income and consumption. In analysing the relationship between the wealth index and the elderly (the over-sixty), Kopecky (2011) proved that there was an increase in the consumption of retirees in the US from 1850 - 2000. According to the author, the total savings of an old age group will decline as its members' consumption on leisure activities increases upon retirement. In fact, the author stresses that men aged 65 and above spend approximately 43% more time on recreation than men aged 25–54. Nardi *et al*. (2010) believe that to some extent households' medical expenses grow throughout their lives. The higher the survival rate, the higher the medical expenses. For these authors, US households above the age of 70 face a decrease in their savings and income in order to compensate for their rising health care expenses. Hence, increase in life expectancy will augment households' medical expenses and decrease their savings.

3.2. The effect of ageing on economic growth through public social expenditure

Ageing populations affect the government's earning and expenditure in many ways. Empirical analysis has been carried out to identify the influence of ageing populations through social expenditure (Thiébaut *et al*., 2013 and Okumura and Usui, 2014), GDP (Bettendorf *et al*. 2011; Tobing, 2012 and Lugauer, 2012), taxation (Planas, 2010) and the financial sector (Narayana, 2011 and Imam, 2013).

In a similar manner to households, the rise in population ageing is believed to influence the expenditure pattern of government agencies. Using France as a sample for their analysis, Thiébaut *et al*. (2013) underline the fact that the rise in the elderly population will increase demand for health care. As a result, this will increase the government's budget allocation to health care expenditure. Unlike Mason and Lee (2013), Thiébaut *et al*. (2013) argue that the rise in life expectancy will not guarantee a healthy old age group unless there is continuous demand for medical consumption. Therefore, in the case of France, Thiébaut *et al*. (2013) stress that a healthy ageing scenario will not be 'cost-saving'. Hence the authors project that a rise in the number of elderly will not be able to support the country's economic growth.

Along with Thiébaut *et al*. (2013), there are still authors who provide empirical evidence that ageing has a negative impact on economic growth through public

social expenditure. Bettendorf *et al*. (2011) showed that the rise in life expectancy will negatively affect the percentage contribution of income tax to the GDP of the Netherlands. The authors stress that the rise in population ageing will reduce the tax income of the country. Even though the ageing population negatively affects income tax, the rise in the capital taxation is believed to positively affect the GDP of a country (Planas, 2010).

In fact, Planas (2010) demonstrates that the rise in the population ageing is expected to increase the capital taxation of the US. According to the author, younger decisive voters tend to support a higher tax rate on capital. The current demographic transition will lead voters to increase their saving and thereby shift the political preferences against capital taxation. In fact, in the case of the US, authors have proved that the imbalance in age structure will provide a reduction in business cycle fluctuations (Lugauer, 2012). According to the author, the rise in the percentage of the old aged population and the decline in the percentage of the youth population will lead to GDP volatility in that country. Using standard panel data with lagged birth rates as an instrument, Lugauer (2012) finds a strong statistical relationship between the percentage of youth and GDP volatility for the United States.

Narayana (2011) also demonstrates that apart from the developed countries, the rise in the old age population will negatively affect the public net transfer of India. According to the author, government spending on the elderly population is greater than the payment for previously accumulated public debt and interest. Nonetheless, Tobing (2012) believes that the rise in life expectancy will increase the gross domestic saving rate. For the author, the lower fertility rate and higher survival rate will increase household savings. The changes in households' behaviour regarding savings are expected to increase the percentage contribution of savings to GDP.

Even though ageing increases the gross domestic saving rate, authors such as Imam (2013) feel that the rise in the ageing population will affect the banking industries. The author stresses that the rise in the proportion of the old age population will lead to financial instability for the banking sectors.

Table 1. 3: Studies on the impact of an ageing population on economic performance through public expenditure[s]

Sample	Time Period	Methodology	Dependent (in case of econometric model) / Endogenous (in case of simulation) variable	Independent (in case of econometric model) / Exogenous (in case of simulation) variable	Effect on dependent variable	Inferred effect of ageing on economic growth	Author
Japan	2007, 2008 and 2009	OLS method	Expected pension claiming age[(1)]	Age 55 - 59	Negative	Positive	Okumura and Usui, 2014
			Retired age[(2)]		Positive		
			Expected pension claiming age	Age 60 - 65	No Effect		
			Retired age		Positive		
144 countries (*e.g.*, Japan, USA, France, Italy)	1990 - 2007	Panel data - fixed effect	Bank's return on assets[(3)]	Old age dependency ratio	Negative	Negative	Imam, 2013
France	2004 - 2029	Simulation	Drug expenditures	Old age population (65 and above)	Positive	Negative	Thiébaut *et al.*, (2013)
		OLS method	Health care expenditures (re-imbursement medicine)		Positive		
United States	1977 - 2008	OLS method	GDP volatility	Youth Share	Positive	Negative	Lugauer, 2012
109 countries (*e.g.*, China, France, Bangladesh , Australia)	1980 - 2000	Mathematical modelling, Simulation	Gross domestic saving rates	Fertility rate	Negative	Positive	Tobing, 2012
				Survival rates	Positive		
Netherlands	2008 - 2040	Generational accounting	% changes of GDP (income taxes)	Longer life expectancy	Negative	Negative	Bettendorf *et al.*, 2011
United States	1992 and 2004 cohort	Simulation	Labour force participation	Age 60 till 68	Positive	Positive	Hurd and Rohwedder, 2011
United States	1850 - 2000	Mathematical modelling, Simulation	1850 - 2000	Retirement rate age (65 and above)	Positive	Negative	Kopecky, 2011
India	2004 - 2005	Computational framework of National transfer account	Public net transfer	Total for elderly population	Negative	Negative	Narayana, 2011
United States	1965 - 2025	Mathematical modelling, Simulation	Capital income tax	Age structure	Positive	Positive	Planas, 2010

[(1)] Female (-); Less than high school (0); Junior college (+); University and over(+); Self-rated health: Good (-);Self-rated health: fair/poor (-); Married(0); Probability of survival until age 75 divided by life table (0); Currently working for pay (+); Number of years worked (0); Assets (0);Income (0); EPI beneficiaries (-); [(2)] Female (-); Less than high school (+); Junior college (0); University and over (0); Self-rated health: Good (0); Self-rated health: fair/poor (0); Married (0); Probability of survival until age 75 divided by life table (0); Number of years worked (0); Assets (0); Income (-); EPI beneficiaries (-); [(3)] Growth (+); GDP per capita (+); Inflation (0); Young age dependency (+)

His simulation result shows a negative relationship between the old age dependency ratio and the banks' returns on assets. For the author, households tend to shrink their balance sheet once members are above a certain age, thus bringing about a negative wealth effect.

The US faced a continuous rise in the old age population (over 65) from 1850 to 2000 (Kopecky, 2011). However, Kopecky (2011) identified a continuous fall in the participation of the workers over 65 in the labour force during this period. According to the author, life expectancy did not increase the life span of the labour force. In fact the rise in life expectancy increased the life span of retirees.

Taking this into consideration, there are authors who believe that government policies as regards retirement play a vital role in enabling ageing employees to prolong their life span in the workforce (Okumura and Usui, 2014; Hurd and Rohwedder, 2011). The Japanese pension reform in 1994 and 2000 has increased the pensionable age from 60 to 65 (Okumura and Usui, 2014). Furthermore, Okumura and Usui (2014) furnished empirical proof that in Japan, individuals in their late 50s and early 60s expected to retire at a later age. The authors also demonstrate that individuals with lower incomes and education levels who expect to survive until 75 will retire at a later age. Hence, the increase in government spending on public pensions is able to be mitigated through government policies such as pension plans. Like Okumura and Usui, (2014), even in the case of the US, Hurd and Rohwedder, (2011) have proved similar behaviour among elderly employees when there is a shift in the pension plan. The authors stressed that the shift in the pension plan from a defined contribution plan (DC[4]) to a defined benefit plan (DB[5]) will increase participation of older aged employees in the labour force and delay their retirement.

3.3. The effect of an ageing population on human capital

If workers of different ages are not perfect substitutes, in an ageing population the productivity level of any particular worker will be lower taking into account their diminishing physical ability to actively participate in the labour market (Dostie, 2011; Göbel and Zwick, 2012; Lisenkova *et al*., 2012; Mahlberg *et al*., 2013; Mason and Lee, 2013).

[4] Hurd and Rohwedder, (2011) defined DC as a stock of pension wealth at retirement. They do not focus on retirement at any particular age

[5] Hurd and Rohwedder, (2011) defined DB as a pension plans which provide an annuity in retirement. They typically focus on retirement at particular retirement ages.

The rise in the proportion of the elderly in a population is thought to decrease the labour supply of that country. Garau *et al*. (2013) emphasise that the rise in the proportion of elderly employees in relation to younger people will negatively influence the Italian GDP and employment conditions. The authors predict that, for Italy, in consequence of a demographic transition, the fall in GDP will be higher than that in employment.

Some authors feel that the changes in the retirement plan will prolong the participation of older employees in the labour force (Okumura and Usui, 2014; Hurd and Rohwedder, 2011). However, unconnected with the pension plan, Bell and Rutherford (2013) argued that the preference and willingness of the elderly employee to remain in the labour force is thought to be a reason for the rise in the retirement age. According to these authors, employed workers who prefer to work fewer hours are significantly more likely to retire than those who do not. In the case of the UK, the author proved that there is a significant increase in the proportion of older workers who are willing to works more hours. This means that older worker in the UK are willing to prolong their participation in the labour force.

However, Lisenkova *et al*. (2012) explain that, in general, regardless of the sector under scrutiny, the age-specific effect will influence productivity in Scotland. Their aim was to ascertain whether age-specific features significantly influence output productivity in Scotland. The authors predict Scotland's output level for the period 2006 – 2106, based on a simulation exercise. The results show that when age-specific features are not taken into account, the changes in the output level will be lower, whereas when age-specific effects are considered, these changes will be higher. According to these authors, given that the physical strength of human beings begins to decline as they get older, the increase in the retirement age will mean higher presence of more elderly people in the labour market, which will definitely have a negative effect on the productivity level. Furthermore, as an employee gets older, his/her average productivity will decline and possibly influence his/her standards of living (Dostie, 2011). Hence, the scenario could also have a negative impact on governments' ability to ensure the funding of pension systems.

Even both Göbel and Zwick (2012) and Lisenkova *et al*. (2012) agree that in general the impact of an ageing population on labour productivity is negative. Göbel and Zwick (2012), based on an empirical study, state that the influence of this effect will

differ according to the sectors analysed. Göbel and Zwick (2012) analysed the differences in the age productivity profiles between the metal manufacturing sector and the service sector in Germany, for the period 1997–2005. Using the generalised method of moments (GMM) as an estimation tool, the authors obtained results showing that for the 55–60 working age group, there is no significant effect on productivity in the metal manufacturing and service sectors. Hence, the study concludes that an increase in the old-age group in Germany has no effect on the productivity level of the metal manufacturing and service sectors. However, in the case of Austria, Mahlberg *et al*. (2013) obtain contradicting results in analysing the productivity level of elderly employees. Considering similar econometric methods (OLS, Fixed effect, Random effect and GMM for the time period 2002 to 2005), the authors stress that there is a significant effect for the manufacturing and service sectors.

The authors proved that the productivity level of old age employees for Austria in the manufacturing, financial intermediation, transport and communication sectors shows a negative effect. On the other hand, for construction, real estate, hotels and restaurants the productivity level of elderly employees of that country reveals a positively significant relationship. Taking into account the empirical result of these authors (Göbel and Zwick, 2012; Mahlberg *et al*., 2013), it is obvious that the productivity level of old aged employees varies among sectors and countries.

As with Scotland, the productivity level of old age employees in Portugal also shows a declining pattern. Even though the elderly employee makes a smaller contribution to the firm's productivity level, in the case of Portugal, Cardoso *et al.* (2011) stressed that the wages of more elderly employees still remain below their productivity level. Therefore, increasing the participation of elderly employees will not raise the production cost(s) of a firm (in terms of their wage).

Moreover, in the case of Canada, empirical studies demonstrate that the productivity level and the wage of a labourer over 55 were significantly positive during the period 1999 to 2005 (Dostie 2011). The empirical studies by Dostie (2011) not only demonstrate positive productivity levels among old age employees, but the author further proved that there is a huge gap between productivity and wages. Therefore, in hiring old aged workers, the firm will not face a rise in production costs (Ours and Stoeldraijer, 2011)

Table 1. 4: Studies on the impact of an ageing population on economic performance through human capital

Sample	Time Period	Methodology	Dependent (in case of econometric model) / Endogenous (in case of simulation) variable	Independent (in case of econometric model) / Exogenous (in case of simulation) variable	Effect on dependent variable	Effect ageing on economic growth	Authors
United Kingdom	2001 - 2008	Multinominal logistic	Retired [(1)]	Underemployment	Negative	Positive	Bell and Rutherford, 2013
				Overemployment	Positive		
United States	1840 - 1930	Mathematical modelling, Simulation	Schooling	Life expectancy	Positive	Positive	Cervellati and Sunde, 2013
			Life time labour hours		Negative		
Italy	2007 - 2067	Mathematical modelling, Simulation	2007 - 2067	Share of working age population	Negative	Negative	Garau *et al*., 2013
Austria	2002 - 2005	Panel data (multilevel regression)	Labour productivity (in manufacturing)	Share of old age employee	Negative	None	Mahlberg *et al*., 2013
			Labour productivity (Financial intermediation)		Negative		
			Labour productivity (Transport storage and communication)		Negative		
			Labour productivity (Hotels and restaurants)		Negative		
			Labour productivity (Wholesale and retail trade)		Positive		
			Labour productivity (construction)		Positive		
			Labour productivity (real estate, renting and business activities)		Positive		
34 countries	1994 - 2009	Conceptual cccounting framework	Lifetime effective labour	Life expectancy (at birth)	Positive	Positive	Mason and Lee, 2013
Germany	1997 - 2005	-Dynamic Generalized Methods of Moments (GMM)	Manufacturing (Productivity)[(2)]	Age [50 – 55) & Age [55-60) (labour productivity)	No Effect	No Effect	Göbel and Zwick, 2012
			Services (Productivity)[(3)]				
			Metal Working sectors (Productivity)[(3)]				
Scotland	2006 – 2106	OLG model. Simulation	Output per- person	With age specific features.	Changes In Output Is Higher	Negative	Lisenkova *et al*., 2012
			Output per- person	Without age specific features.	Changes In Output Lower		
Portugal	1986 - 2008	OLS, Fixed effect, GMM	Productivity	Age above 54	Negative	Negative	Cardoso *et al*., 2011
			wage				
Canada	1999 - 2005	OLS method	Wage[(5)]	Age above 55	Positive	No Effect	Dostie, 2011
			Productivity[(6)]		Positive		
Netherlands	2000 - 2005	OLS, GMM, First differences	Wage productivity gap[(7)]	Age 57 and above	No Effect	No Effect	Ours and Stoeldraijer, 2011

(1) Hourly wage (£) (+); Age (+); Age^2 (+); Female (+); Degree (+); **(2)** log capital (+);dummy variables for age [20,25) (-), [25,30) (0), [30,35) (+), [40 45) (0), [45,50) (0),[50,55) (-),[55,60)(-);women (-); Germans (0); Apprenticeships (+); unskilled (0); high skilled (0); white-collar (+); part time (+); good equipment (+); Age-dispersion (0); Export (+); number of workers (+); East Germany (-);dummy variables for cohort [1900,1930) (0), [1930,1940) (0), [1940,1950) (+), [1960,1970) (0), [1970,1980) (-), [1980,1900) (-); dummy variables for tenure [10,20) (0), [20,30) (+), [30,40)(0), [40, 50) (+); **(3)**log capital (+);dummy variables for age [20,25) (0), [25,30) (0), [30,35) (0), [40 45) (0), [45,50) (0), [50,55) (0), [55,60)(0); women (0); Germans (0); Apprenticeships (+); unskilled (-); high skilled (0); white-collar (+); part time (0); good equipment (+); Age-dispersion (-); Export (+); number of workers (0); East Germany (-); constant (+);dummy variables for cohort [1900,1930) (0); [1930,1940) (0); [1940,1950) (0), [1960,1970) (0), [1970,1980) (-), [1980,1900) (-); dummy variables for tenure [10,20) (0); [20,30) (0); [30,40)(0); [40, 50) (0); [4]Log capital (+);dummy variables for age [20,25) (0), [25,30) (0), [30,35) (0), [40 45) (0), [45,50) (-), [50,55) (-), [55,60)(-); women (-); Germans (0); Apprenticeships (+); unskilled (-); high skilled (0); white-collar (+); part time (0); good equipment (+); Age-dispersion (-); Export (+); number of workers (0); East Germany (-); constant (+);dummy variables for [1900,1930) (-);[1930,1940) (0); [1940,1950) (+), [1960,1970) (0), [1970,1980) (0), [1980,1900) (-); dummy variables for tenure [10,20) (0), [20,30) (0); [30,40)(0), [40, 50) (0); **(5)**Age] 35, 55[(+); **(6)**Age] 35, 55[(+); **(7)** Employment (-); Age share – 25 (+); 25 – 29 (0); 30 – 34(0); 40 – 44 (0); 45 – 49 (0); 50 – 56 (0); Female (0).

By no means all the empirical studies demonstrate that the rise in population ageing has a negative impact on labour productivity. Even though an increase in life expectancy is thought to exert a negative influence on public expenditure (Thiébaut et al., 2013), authors such as Mason and Lee (2013) believed that medical benefits provided by the government will improve the fitness of the old age group and prolong the period in which they are able to participate in the labour market. Hence, by applying a simple conceptual accounting framework for the period 1994 – 2009, Mason and Lee (2013) proved that life expectancy has extended the participation in the labour market in developed and developing countries. However, in the case of the US, Cervellati and Sunde (2013) discovered that the rise in the survival rate will lead to an increase in full time schooling and decrease in lifetime labour hours. According to these authors, an increase in the hours of schooling is associated with higher life time earnings.

4. Some final remarks on the relation between ageing and economic growth

The demographic dividend resulting from industrialization has improved the economic growth of developed countries (Bloom and Williamson, 1998). The imbalanced in age structure (a higher proportion of the old aged group in the population) has led to many developed countries being dubbed ‘ageing countries’ (Bloom and Williamson, 1998). Population ageing and its impact on economic growth through the main mechanisms has been extensively discussed above. The current ageing problem faced by many developed countries is unprecedented (Börsch-Supan, 2013). Therefore, these ageing impacts can be considered a new experience and challenge for the world.

Our review of the literature has led us to conclude that an ageing population has affected economic growth through three main mechanisms: consumption and saving patterns, public social expenditure, and human capital. This literature review shows that the impact of ageing on countries’ performances is intimately related to the mechanism. Indeed, almost all the empirical studies that have focused on ‘public social expenditure’ convey a negative impact of ageing, whereas the majority (36%) of empirical studies that focus on human capital do not find any statistically significant relationship between ageing and the economic growth proxy, while the positive impact is much more related to the ‘consumption and saving patterns’

mechanism (*cf.* Figure 1.2). In short, the mechanism seems to have a non-trivial impact on the estimated relationship between ageing and economic growth.

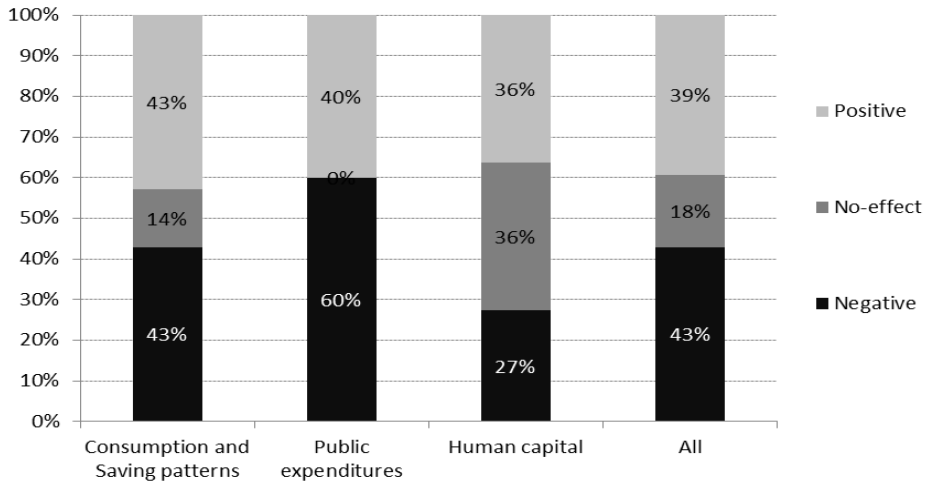

Figure 1. 3: Estimated impact of ageing on economic growth by main mechanism
Note: The analysis was based on 25 articles (56 occurrences) listed in Table 1.1.
Source: Authors' computations.

Estimation methodologies also seem to be associated with distinct impacts of ageing on economic growth. Indeed, Figure 1.3 shows that the most frequent empirical methods (*i.e.*, simulation, OLS and panel data) are most often associated with negative correlations, whereas the simple linear model, multinominal logistic model, dynamic generalized methods of moments (GMM) and double hurdle model are more likely to generate positive or no significant effects.

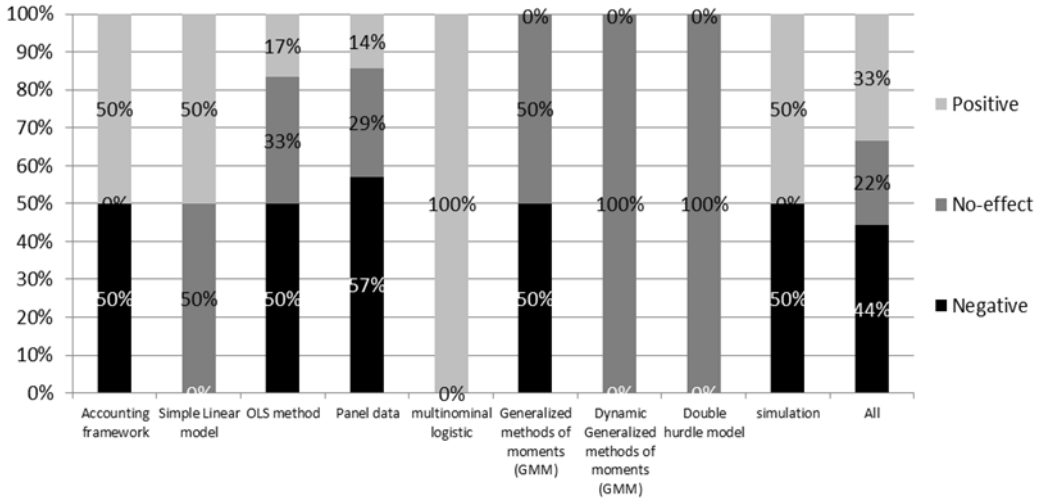

Figure 1. 4: Estimated impact of ageing on economic growth by main method of analysis
Note: The analysis was based on 25 articles (36 occurrences) listed in Table 1.1.
Source: Authors' computations.

The evidence gathered does little to help in assessing to what extent the impact of ageing on growth varies according to the mechanisms and countries analysed. The bulk of the empirical evidence is concerned more with developed countries.

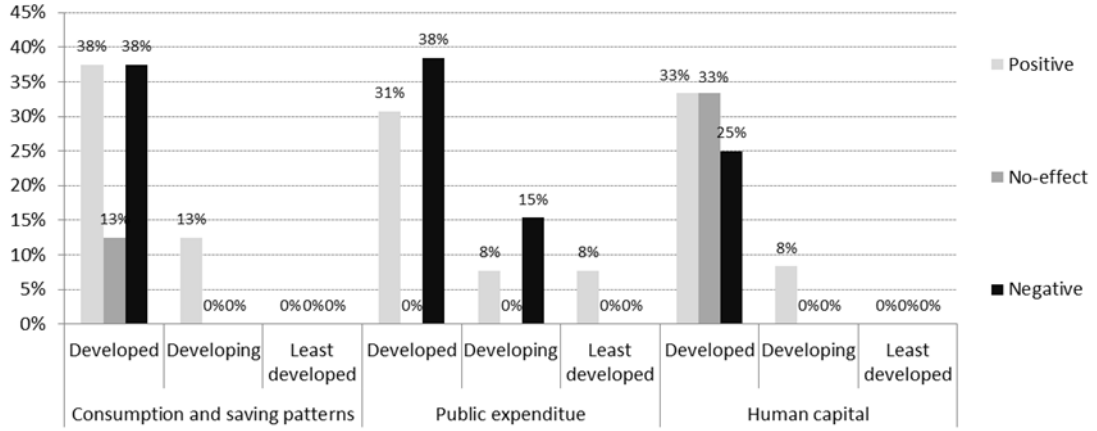

Figure 1. 5: Estimated impact of ageing on economic growth by main countries' blocks analysed

Note: The analysis was based on 25 articles (118 occurrences) listed in Table 1.1.
Source: Authors' computations.

Among the analyses, 'public expenditure' and 'consumption and saving pattern' mechanisms indicate more negative and significant relationships between ageing and growth. It is important, however, to acknowledge that developed, developing and even the least developed countries are affected by the ageing population phenomenon. As Börsch *et al*. (2002) state, ageing population patterns are similar in most countries; the only observable difference concerns the timing. Furthermore, an ageing population's influence on economic growth has been labelled 'remarkable', especially during the current financial and economic crisis (Lee *et al*., 2011). Several economic studies (*e.g*., Creedy and Scobie, 2002; Alders and Broer, 2004; Weil, 2006; Sobotka *et al*., 2010; Börsch-Supan, 2013) not only confirm the existence of ageing populations all over the world, but also document and analyse the mechanisms that influence economic growth, as well as proposing possible remedies for solving the problem.

The changes which both developed and developing countries are currently undergoing, leading to an era of global ageing populations, have their own consequences for economic growth dynamics through the distinct mechanisms detailed above: consumption and saving patterns (Fougère *et al*., 2009; Li *et al*., 2012; Walder and Döring, 2012; Mason and Lee 2013), human capital (Elgin and

Tumen, 2010; Sharpe, 2011; Göbel and Zwick., 2012), and public social spending (Creedy and Scobie, 2002; Tosun, 2003; Elmeskov, 2004; Hock and Weil, 2012; Yong and Saito, 2012).

Realizing the seriousness of the issues raised by population ageing, policy makers are desperate to find ways of tackling the issues. Policy implications such as the 'Blue card' system introduced by European countries to encourage foreign immigration in order to overcome labour shortages, increasing the retirement age so as to lower government expenditure, increasing the working group's income tax and social planning, whereby couples are encouraged to have more children, are considered to be the major ones. However, for some reason, general policy plans are not yet regarded as an effective way of solving the problem. Knowing the degree to which the influence of ageing varies from country to country, and through which mechanisms, is essential for identifying adequate policies.

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Essay 2: The impact of population ageing on economic growth: a bibliometric survey

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The impact of population ageing on economic growth: a bibliometric survey

Abstract

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. Considering the scientific contributions that have been published on the matter, it seems timely to take a comprehensive and objective account of this stream of the literature. Using bibliometric techniques we found that: 1) although ageing has increasingly attracted more researchers within economics literature, the relative weight of ageing & economic growth related papers does not evidence a clear positive trend; 2) more recently, studies have revealed the willingness of researchers to evaluate less immediate mechanisms relating ageing and economic growth, namely consumption and saving patterns, and human capital; 3) the visible increase in the use of empirical methods reflects a trend, within ageing research, to test economic phenomena with real–world data against the theory; 4) there are very few or a complete lack of studies on developing and less developed countries.

Keywords: Ageing population, Economic Growth, Bibliometrics, Less developed countries.

JEL Codes: 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 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 age 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 materialised, 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 analyse the main mechanisms underlying the influence of ageing on economic growth: consumption 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 (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 behaviour 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 labour supply and a decline in labour 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 labour force will be remarkably different (lower) from one with a younger labour 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) analyse 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) analyse and categorise 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 analysed (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 analyse 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).[6] Bibliometric studies are, in general, based on three main sources of data: the ISI Web of Science (WOS), Google Scholar (GS) and Scopus. 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 (2013:741) demonstrate that "Scopus performed better (surpassed) WOS and GS regarding inconsistencies (incorrect title, -author, -volume number) encountered during the completeness and quality of the

[6] Scopus is the world's largest search engine for abstract and citation databases of peer-reviewed articles. It has tools to track, analyse and visualise 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 February 4, 2013.

content verification process." Besides retrieving multiples 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 analysed 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 behaviour of couples and women labour 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 modellization, 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: 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 analyse data, Malhotra *et al.*'s (2013) contribution was adapted by grouping methods into 3 categories: 1) univariate and bivariate analyses; 2) multivariate analyses; and 3) mathematical modelling (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 analysed 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 2.1, the ratio of papers published on ageing and economic growth in total papers published on economic growth does not evidence a clear cut evolution with that ratio's trend line being approximately constant. (*cf.* Figure 2.1).

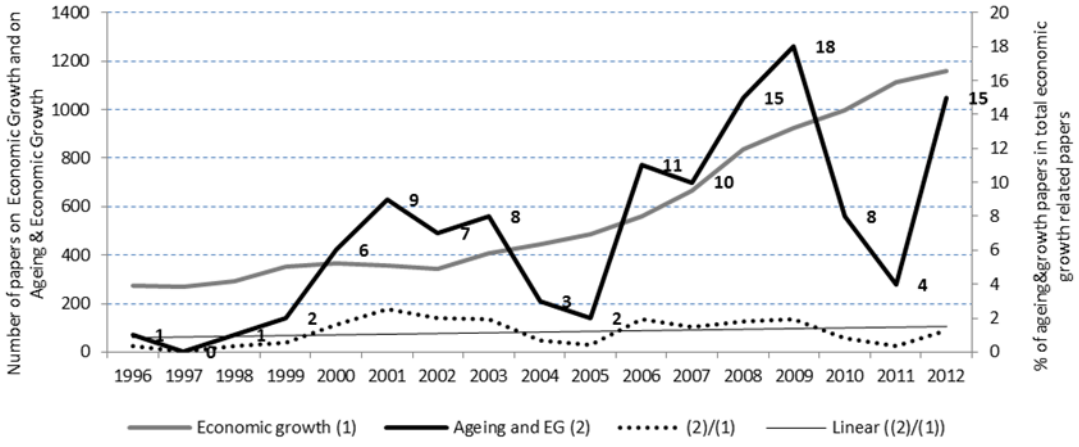

Figure 2.1: The evolution of the number and weight (in %) of articles related to population ageing in the economic growth literature

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 10254 on economic growth.

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

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 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 labour 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 labour force and a decline in public expenditure on capital investment will affect labour productivity.

Some of the papers analysed 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 2.2 represents the number of times each mechanism is referred to in the 144 articles analysed in the given period, and not the number of articles.[7]

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

[7] From 1975 to 2013, 4 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 2.2.

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 centred 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 favour of a remarkable rise in the 'consumption and saving patterns' mechanism, which increased 25 percentage points. From 2010 onwards, research published on ageing and economic growth seems to favour, 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).

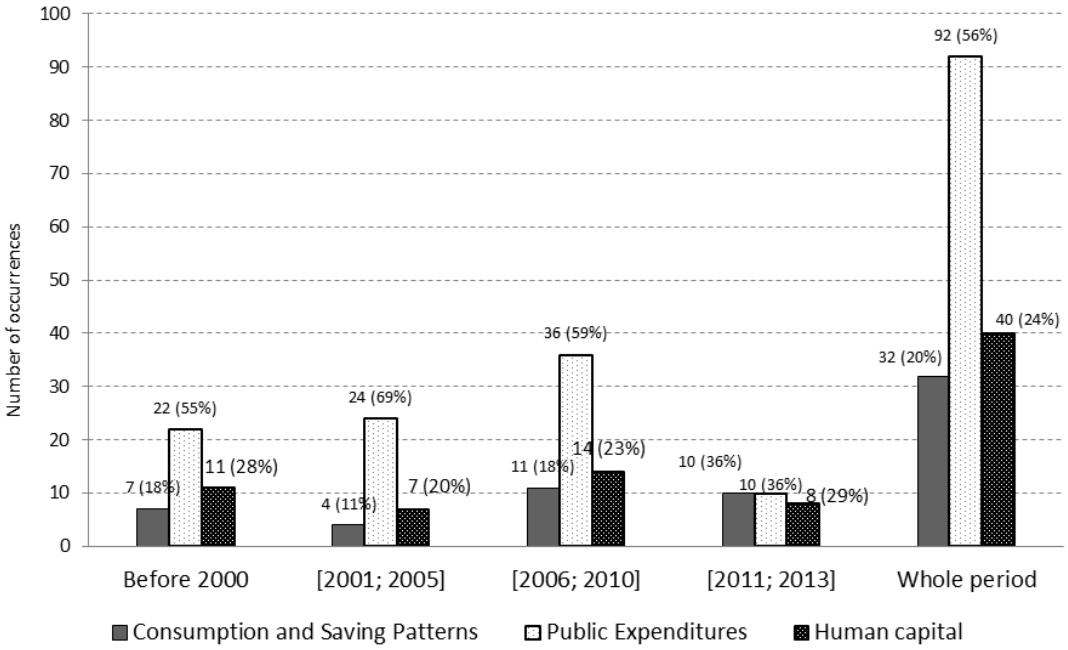

Figure 2.2: Evolution of the distribution (in number and %) of occurrences on ageing and growth by main mechanism

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

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 analysed, about one third of the research was of the 'formal + empirical' type. There is a striking balance between formalisation and appreciative theorising 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 2.3.

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 modelling and mathematical methods) is identified as the quest to increase 'rigor' (Cruz and Teixeira, 2010; Teixeira, 2013), a noticeable drop was detected in the use of the 'Formal' method between 2011 and 2013.

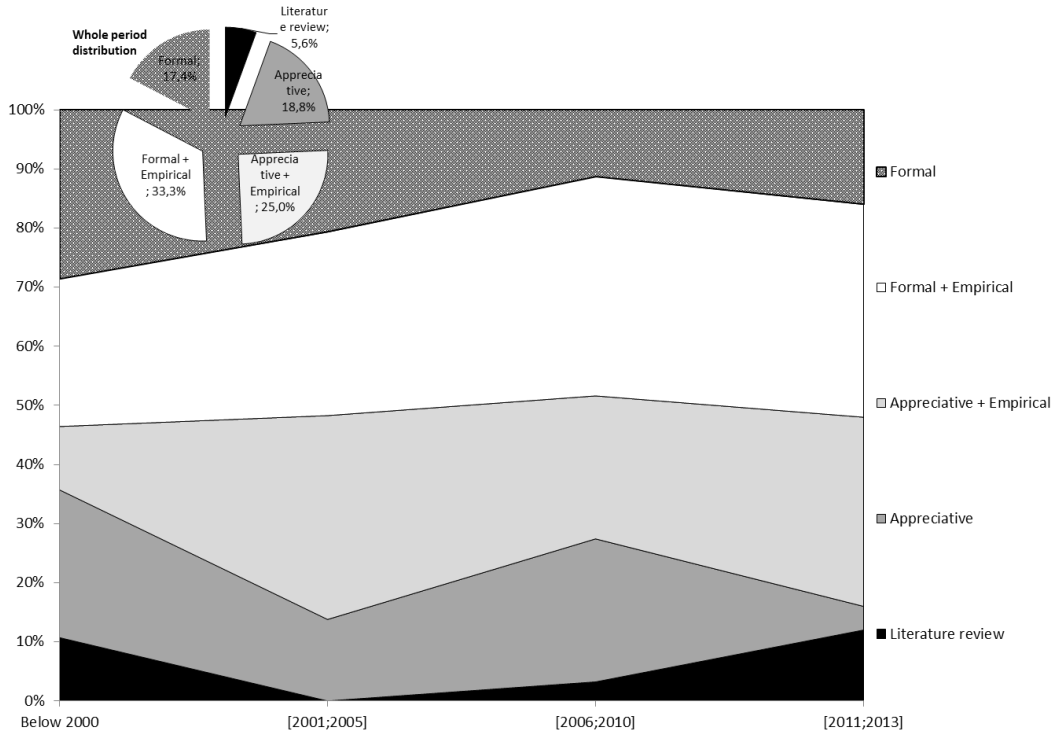

Figure 2.3: Evolution of the distribution of articles on ageing and growth by main methodology
Source: Authors' computation based on 144 articles gathered from the Scopus database (accessed on February 4, 2013)

Figure 2.3 highlights a perceptible rise in the use of 'Appreciative + empirical' and 'Formal + empirical' methods (increasing 21 percentage points and 11 percentage 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 2.4 represents the relative weight of the three main methodological types used to analyse data in empirical studies. It is shown that before 2000 the dominant type of empirical analysis was 'Mathematical modelling'. Between 2001 and 2010, 'mathematic modelling' 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 analyses 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).

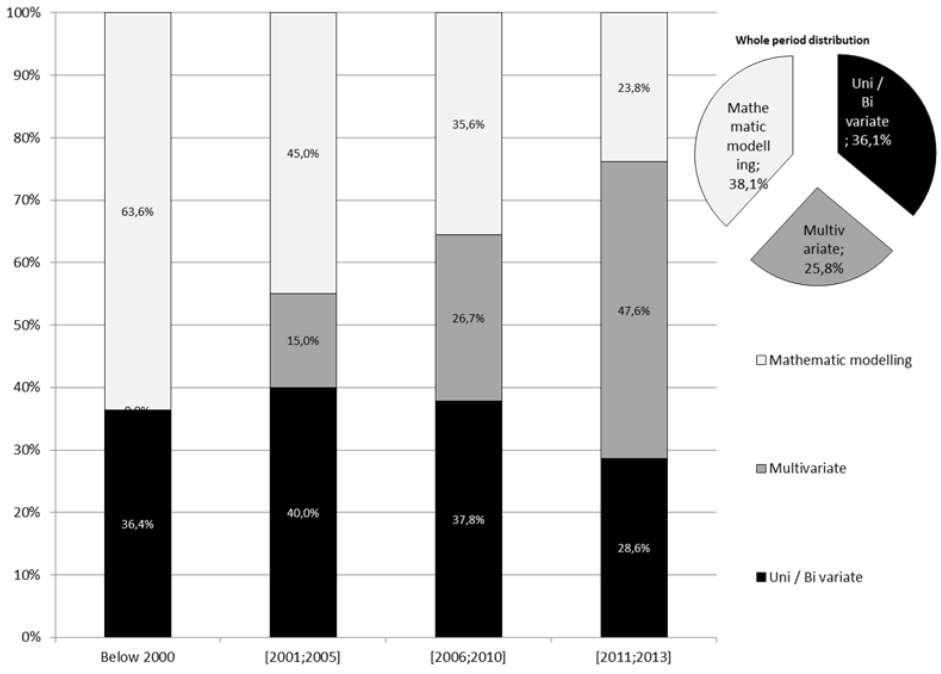

Figure 2.4: Evolution of the distribution of articles on ageing and growth using empirical estimation methods

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

Therefore, sufficient data were available to carry out 'Multivariate' types of empirical analysis. Figure 2.4 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 modelling'.

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 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 2.5) show that, in fact, the articles published have concentrated on specific methods to analyse each mechanism. More specifically, Figure 2.5 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 behaviour of households in terms of consumption and savings, since such behaviour 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 32.6% 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 analyse 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 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 labour force and analyses its effects on the basis of econometric methods (Ilmakunnas and Ilmakunnas, 2010; Göbel and Zwick, 2012; Ludwig *et al*., 2011).

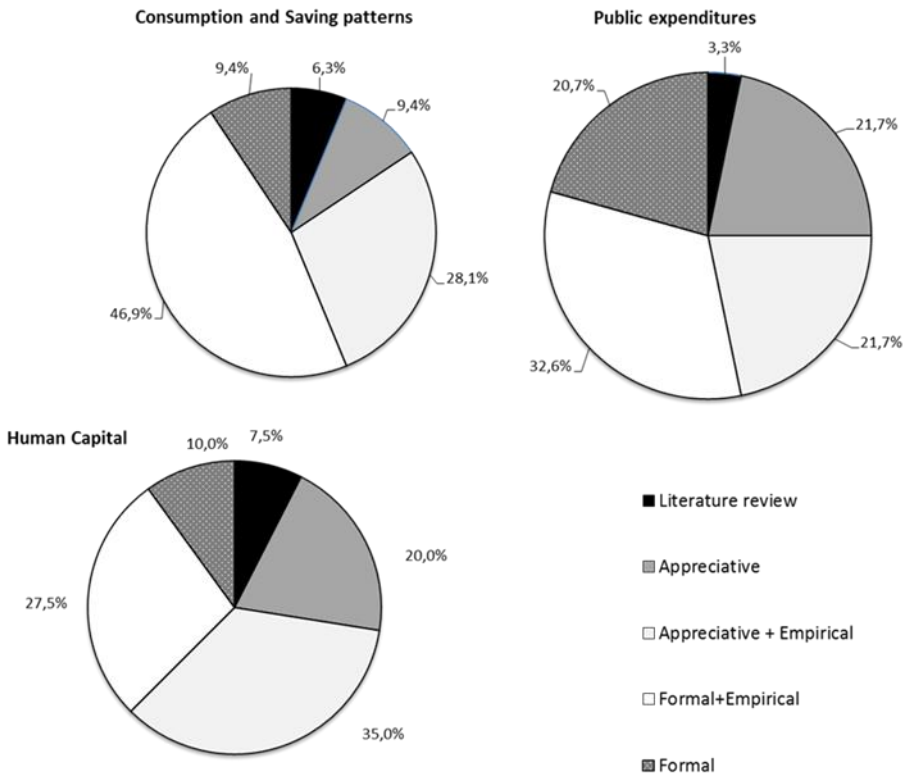

Figure 2.5: The interrelation between mechanisms and methodology
Source: Authors' computation based on 144 articles gathered from the Scopus database (accessed on February 4, 2013)

3.4. Main empirical methodologies to analyse 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 (*cf.* Figure 2.6). In general, regardless 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 centred 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 behaviour. Such behaviour 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 labour 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 2.6). 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 labour supply and labour productivity decline due to ageing (Alam and Mitra, 2012; Lisenkova *et al.* 2012; Börsch-Supan, 2013).

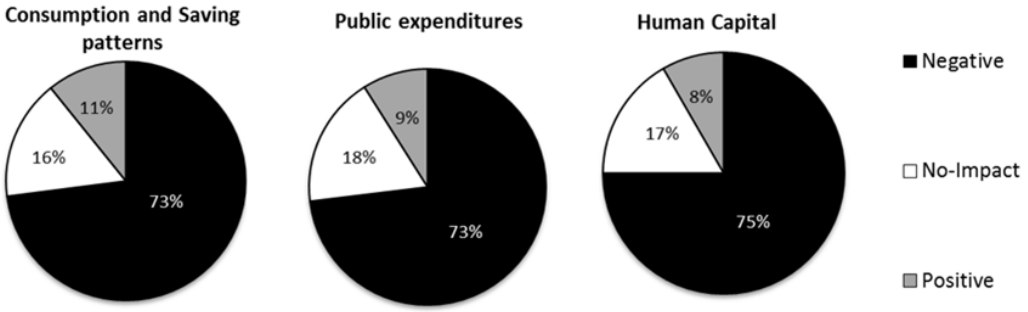

Figure 2.6: The impact of ageing on economic growth by main mechanisms
Source: Authors' computation based on 144 articles (161 occurrences) gathered from the Scopus database (accessed on February 4, 2013)

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 2.1, 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 analysed does not significantly influence the estimated impact of ageing on economic growth.

Table 2.1: 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)	
		WoS/ISI Impact Factor (in ln)			0.065 (0.073)			0.081 (0.076)
		Constant	-1.071 (0.340)	-1.022 (0.341)	-1.025 (0.346)	-0.457 (0.722)	-0.752 (0.761)	-0.211 (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 (p-value)	5.887 (0.207)	12.123 (0.146)	10.309 (0.172)	6.049 (0.534)	18.939 (0.008)	11.574 (0.115)
		% corrected	69.5	73.6	63.1	69.5	73.3	61.9

Legend: *** (**)[*] statistically significant at 1%(5%)[10%]; standard errors in brackets; grey cells are used to highlight significant estimates.

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 2.1) that the type of country influences the estimated impact of ageing on economic growth.

3.5. Countries and groups of countries analysed

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.

Most of the existing empirical studies have focused on developed countries regarding ageing and its impact on economic growth (*cf.* Figure 2.7). 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 analyses were performed based on data mostly from developed countries.

Among the developed countries, the US, Germany, Japan and the Netherlands were the most frequent analysed 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 2.8). As an industrialised 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).

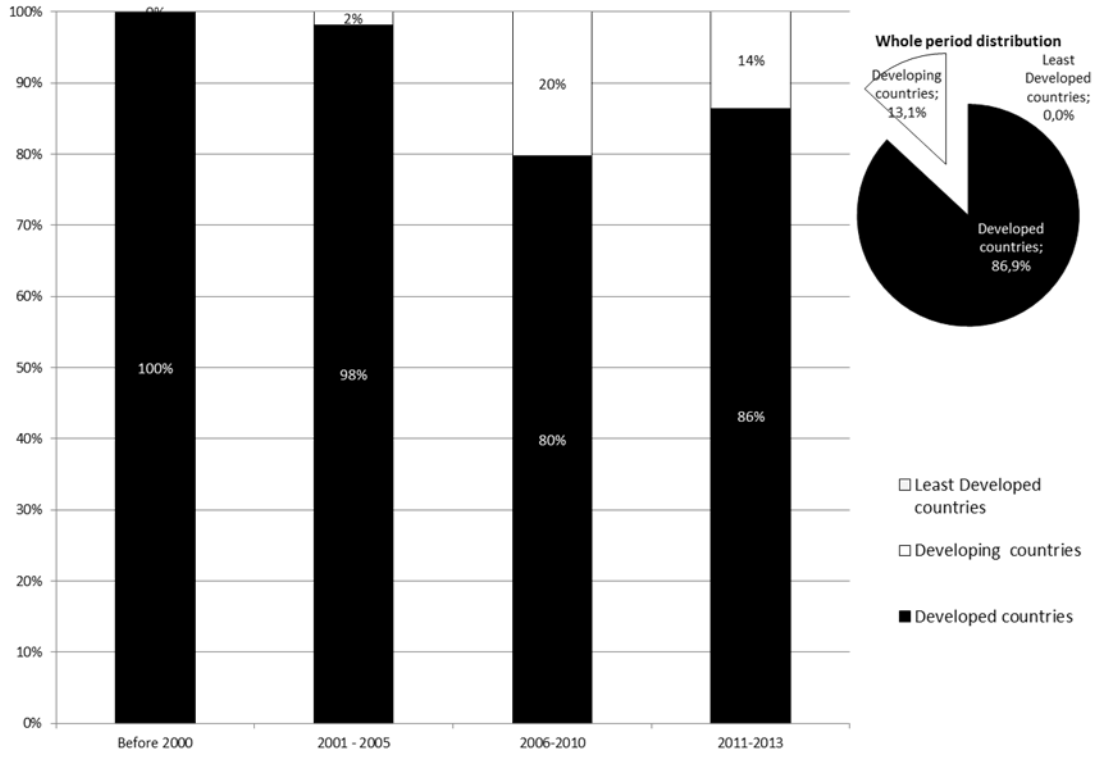

Figure 2.7: The evolution of the distribution of occurrences by the countries' level of development

Source: Authors' computation based on 144 articles (161 occurrences) gathered from the Scopus database (accessed on February 4, 2013)

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 labour force is predicted. In the case of Germany, empirical studies have tended to pay more attention to labour supply and labour 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, 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 analysed 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 analysed 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).

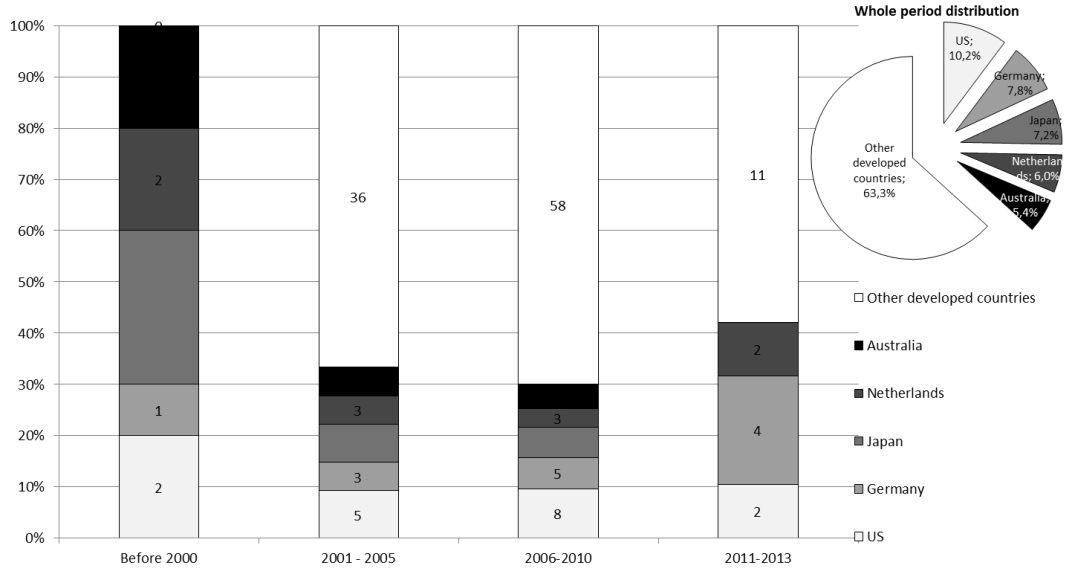

Figure 2.8: The evolution of the number/distribution of the occurrences for given developed countries

Source: Authors' computation based on 166 occurrences for developed countries gathered from the Scopus database (accessed on February 4, 2013)

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's report (DESA/PD, 2010), 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. Conclusion

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 (DESA/PD, 2010). 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 analyses 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-à-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 analysed, 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 favour of a noticeable rise in the 'consumption and saving patterns' mechanism, which increased 25 percentage 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 analysed 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; 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 *vs*. more sophisticated estimation methods) and the type of country in analysis (less developed *vs*. 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 (DESA/PD, 2010) reported that for less developed countries, the proportion of the population aged 60 years and over is projected to increase significantly over the next thirty 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.

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Essay 3: An in depth empirical analysis of the demographic trends in Least Developed Countries

Submitted and under review in *Ageing International*

An in depth empirical analysis of the demographic trends in Least Developed Countries

Abstract

The phenomenon of population ageing and its influence on economic growth has been a major concern among the scientific community, particularly as regards developed countries. Although ageing is a phenomenon almost exclusively related to developed countries, it is not an issue limited to developed economies alone. One key aspect of ageing is that it seems to be affecting the least developed countries even faster than it affected developed and developing countries. Using the ageing index and old age dependency ratio as ageing indicators, we ascertained the increase in the speed of ageing among the least developed countries. Our exploratory analysis established that the annual average growth rate of both the old age dependency ratio (OAD) and ageing index (AI) for least developed countries showed evidence of continuous acceleration, which was more striking when the AI was used. The increase in the speed of ageing affords a shorter time period for Least Developed Countries (LDCs) to overcome its consequences, so that they run the risk of becoming even poorer.

Data analysis revealed that the higher pace of ageing in LDCs is not only due to medical advances and couples' altruistic behaviour, but is mainly associated with the migration of LDC working groups and the role of international organizations (*e.g.*, WHO, UN, UNDAF, UNICEF) in improving the life expectancy of the inhabitants of LDCs.

Keywords: Demographic trend, Speed of ageing, Least Developed Countries.

JEL Codes: C62, D91, E13, J10

1. Introduction

The demographic transition experienced by many countries has introduced the world to ageing populations (Bloom and Williamson, 1998). The increase in longevity and decrease in fertility are considered to be major causes of the ageing problem (Harper and Leeson, 2009; Yong and Saito, 2012). An ageing population is believed to influence the economic performance of a country because individuals' preferences regarding labour force participation, productivity, education, consumptions, savings, investment and childbearing vary according to their age (Samuelson, 1958; Aguiar, 2011; Mason and Lee, 2011).

Although ageing is a phenomenon almost exclusively centred on developed countries, several authors (*e.g.*, Brooks, 2003; Mérette and Georges, 2009; Mason and Lee, 2013) are increasingly underlining that it is not an issue limited to developed economies alone. One key aspect of ageing is that it seems to be affecting Least Developed Countries (LDCs) even faster than it affected developed and developing countries (Lee, 2003). Developing and least developed countries' experiences have been rather neglected at the level of empirical studies on ageing.

In the present essay, we aim to provide an in-depth analysis of the demographic trends in LDCs in relation to developed and developing countries. In particular, we seek to compute and analyse the speed of ageing in these groups of countries and the pace of 'convergence' of LDCs towards the developed and developing countries.

Such an analysis will enable us to highlight, within LDCs' distinct histories and evolution, what will constitute a solid basis for future analysis of the possible mechanisms through which the speed of ageing is likely to impact on LDCs' economic growth. We go on to propose concrete public policies and recommendations to LDCs' government agencies so as to overcome or mitigate the negative effects of ageing on countries' potential economic performance/growth.

The paper is structured as follows. After the Introduction, Section 2 reviews the literature on the trend of population ageing in developed, developing and least developed countries, and analyses the type of ageing indicators used in the literature. Section 3 describes the methodology (AI and OAD) employed in analysing the speed of ageing. Section 4.1 details the results of the analysis, demographic trends between regions (more developed regions, developing countries and least developed countries), while the prime focus in Section 4.2 is to analyse the speed of ageing

(using the OAD and AI) between more developed regions and each of the LDCs. Finally, Section 5 concludes and offers some considerations regarding future research on this topic.

2. Review of literature on demographic trends and the indicators of ageing

2.1. Demographic transition process

The existence of ageing phenomena has created major concern among government agencies and scientific communities (Pammolli *et al*., 2011). The issue of an ageing population has its own role to play in influencing the economic growth of a country at different phases (Mérette and Georges, 2009; Bettendorf *et al*., 2011; Bloom *et al.*, 2011; Narayana, 2011). At the present time, the impacts of ageing are more prominent in more developed countries, although there is an evolving pattern of an increasing elderly population in some developing countries (Bloom *et al.*, 2011).

Authors stress that the issue of population ageing will affect the macroeconomic outcomes of a country (Acemoglu and Johnson, 2007; Bettendorf *et al*., 2011; Narayana, 2011; Wong and Tang, 2013). Changes in the age structure (where the proportion of elderly employees is higher than that of younger aged employee) will have a significant effect on the labour force and the productivity levels of many countries (Cardoso *et al*., 2011; Lisenkova *et al*., 2012; Mahlberg *et al*., 2013). Schmidt and Vosen (2013) further stress that the majority of continental European countries face a decline in the labour share due to the occurrence of the ageing problem. In the case of Germany, Börsch-Supan *et al*. (2002) state that population ageing will have a huge impact on the country's productivity. The authors project a 15% decline in the German labour force by 2035 in consequence of the ageing problem. In addition, the rise in the proportion of the ageing population is believed to influence the household consumption patterns (Velarde and Hermann, 2014; Hurd and Rohwedder, 2013; Thiébaut *et al*., 2013; Aguiar, 2011). Thiébaut *et al*. (2013) affirm that drug expenditure among the French is predicted to rise as life expectancy at the age of 60 will increase, on average, by 2 months every year. According to the authors, the rise in the elderly group will increase individuals' health consumption. This untainted effect of an ageing population is expected to raise France's drug expenditure to 43% by 2029 (Thiébaut *et al*., 2013).

Within developing countries, the majority of the extant studies focus on the Asian continent, in particular China, India, Korea and Pakistan (Kwack and Lee, 2005;

Choudhry and Elhorst, 2010; Li *et al*., 2012; Cheema, 2013). Choudhry and Elhorst (2010) reveal that at present China, India and Pakistan are experiencing significant economic growth compared to other Asian economies. According to these authors, the issue of the increase in old age dependency will be a barrier to the economic progress of these countries. The authors, further predict that the rise in the old age dependency ratio for China will be 0.38 in the year 2050 and is likely to generate a negative effect on that country' economic growth.

Although at this point the demographic transition process is mostly visible among developed rather than developing countries, this does not mean that the Least Developed Countries (LDCs) are not/will not face the ageing population problem in the future. Cutler *et al.* (2006) disclosed that the current LDCs have experienced massive expansions in life expectancy over the last half century, with the majority of African countries having experienced increases in life expectancy from the early 1950s to the 1980s, followed by a decline in life expectancy thereafter due to HIV/AIDS.

It is claimed that many health programmes conducted in LDCs by international organizations, such as the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF), have contributed to an improvement in the life expectancy of the populations of these countries (UNICEF and UNAIDS, 2013). According to the most recent WHO report (UNICEF and UNAIDS, 2013), 9.7 million people from low income countries have received HIV/AIDS treatment in 2012, and that number has tripled in the past five years. Additionally, HIV/AIDS education programs have also helped to prevent the populations of LDCs from succumbing to such diseases. As a result of these programmes, the United Nation (DESA/PD, 2010) predicted that between 2005 and 2010, about 3 in 5 of those born in LDCs would reach the age of 60. Regarding the total fertility rate, the same report (DESA/PD, 2010) revealed that in East Asia, South-east Asia, the Caribbean and Central and South America, the figure is already below 2.5.

The possible decline in the fertility and mortality rates (e.g. Duflo *et al*., 2006; DESA/PD, 2007; DESA/PD, 2010), is introducing the era of population ageing into the LDCs. In fact, at the present moment, the issue of population ageing in LDCs is already starting to attract certain researchers (*e.g*., Lee, 2003; Islam, 2009; Rahman and Ali, 2009; Bloom *et al*., 2011). According to the United Nations' (DESA/PD,

2007) report, rapid population ageing will take place in the LDCs, even though the level of economic development is still low. In line with this, Islam (2009) expects that the pace of ageing in LDCs will be faster than that experienced in the more developed countries. The United Nations' (DESA/PD, 2007) report adds that the impact of population ageing on LDCs will be severe, as they have a shorter period of time to adapt to the changes associated with population ageing. In line with this argumentation, Rahman and Ali (2009) state that the majority of the elderly in the LDCs will face low income and poor health. Moreover, the traditional family support mechanism (family support mechanism defined as an old aged couple living with their children and grandchildren as their dependants) will be unable to avoid the lowering of the family's average income incurred by the rise in the life expectancy of the family's elderly members (Rahman and Ali, 2009).

2.2. Demographic trends and their quantification: the type of indicators available

The existence of population ageing is due to the process of demographic transition in which the fertility rate and mortality rate decline from higher to lower levels. Generally, indicators such as the ageing index, old age dependency ratio, life expectancy, fertility rate, mortality rate, and population age group above 60 are used to measure the transition process (DESA/PD, 2001; Rahman and Ali, 2009; Bloom *et al*., 2011). Although in general these indicators adequately reveal demographic trends, the transition level may vary between the indicators (DESA/PD, 2001; Lee, 2003; Rahman and Ali, 2009; Choudhry and Elhorst, 2010; Bloom *et al*., 2011).

In Table 3.1, we synthesize the pros and cons of the use of the selected indicators for analysing population ageing trends. Among such indicators, the ageing index seems more precisely to explain the ageing trend (*cf.* Table 3.1). This indicator takes into account both life expectancy and the fertility rate, which are considered the primary causes of population ageing (DESA/PD, 2001). This index is also considered a useful tool in analysing the dynamics of population ageing.

Table 3.1: Ageing indicator computation formulas and their advantages and disadvantages for analysing ageing trends

	Formula	Advantages	Disadvantages	Studies
Ageing index	$\frac{\sum\ Old\ population(60\ yrs\ old\ or\ over)}{\sum\ Individuals\ aged\ under\ 15} \times 100$	It is able to show the dynamics of population ageing. This ratio is more able to explain the ageing phenomenon as the fertility rate, life expectancy and the mortality rate of the retired population are taken into account.	Does not take into account the possibility of changes in the working group. Imbalances in the age structure may also occur due to migration.	Rahman and Ali, 2009
Old age dependency ratio	$\frac{\sum\ Retired\ population\ (\ 65\ yrs\ old\ or\ over)}{\sum\ Working\ age\ population\ (15-64\ yrs\ old)} X100$	It shows the trend regarding the proportion of the old age population and their mortality level *vis à vis* the working age population. It is able to assess the changes in the working age population (especially due to migration).	Given that population ageing occurs due to a significant fall in the fertility and mortality rates, the trends in life expectancy and old age mortality alone are insufficient.	Lee, 2003; Rahman and Ali, 2009
Young age dependency ratio	$\frac{\sum\ Young\ population\ (0-14\ yrs\ old\ )}{\sum\ Working\ age\ population\ (15-64\ yrs\ old)} X100$	It is able to assess the trend in the growth of the young population relative to the working population. It is useful in assessing the fertility trend of the population.	The transition process of young age population alone is unable to assess the transition of the population ageing.	Lee, 2003; Choudhry and Elhorst ,2010
Dependency ratio	$\frac{\sum\ Population\ (0-14\ yrs\ old+65\ yrs\ old\ or\ over)}{\sum\ Working\ age\ Population\ (15-64\ years\ old)} X100$	Capable of tracking the trend between the working and non-working age population.	Does not clarify whether the rise in the dependency ratio is due to a young age population or a retired population. Not capable per se of showing the ageing trend.	Bloom *et al.* ,2011
Life expectancy at a given age	The average number of additional years a person of that age could expect to live if current mortality levels observed for ages above that age was to continue for the rest of that person's life.	Permits to reduce the uncertainty in the projection of life span. Is able to anticipate the rise in the average age group, trend in old age population and mortality rate.	Apart from life expectancy, the ageing problem occurs due to other factors as well. The indicator is unable to assess the evolution in the fertility rates and working age population.	Lee, 2003; Fehr *et al.*,2004(b); Fehr *et al.*,2008; Bloom *et al.*,2011
Fertility rate	Average number of children a woman would bear over the course of her lifetime if current age-specific fertility rates remained constant throughout her childbearing years (normally between the ages of 15 and 49).	Permits to show the speed and the timing of the changes in the fertility trend. Lower fertility rate evidences the decline in population growth, especially of the 0 – 14 years age group.	By itself it is unable to predict population ageing. This ratio is more appropriate for short term analyses.	Lee, 2003; Fehr *et al.*, 2004(b); Fehr *et al.*, 2008; Choudhry and Elhorst ,2010; Kurek, 2011; Bloom and Canning, 2011; Bloom *et al.*, 2011
Mortality rate	$\frac{\sum\ number\ of\ death\ occuring\ in\ a\ year}{1000\ population\ estimated\ at\ mid\ year}$	It allows us to study the life span of the population.	It is unable to explain the distribution of population age across age groups, especially of the young age population. Per se it is unable to provide a projection of the population growth	Fehr *et al.*, 2008; Choudhry and Elhorst, 2010
Proportion of retired population	$\frac{\sum retired\ population\ (age\ 65+)}{\sum population} X\ 100$	It enables us to predict the growth of the retired group in a population. It is a useful tool in exploring the life expectancy pattern and the mortality rate of the old age group.	Per se it is unable to express the trend of population ageing.	Rahman and Ali, 2009; Kurek, 2011

According to the United Nations' (DESA/PD, 2001) report, the ageing index is significantly higher in the more developed regions and will grow faster in the less developed regions. However, the obvious drawback of this indicator is that it does not take into account the changes in the working age population (especially those related to migration). As a result, Rahman and Ali (2009), in examining population ageing in Bangladesh, have used a combined set of indicators which include the ageing index and the old age dependency ratio.

The old age dependency ratio is defined as the number of old age dependants (aged 65 years and over) *per* one hundred members of the working age group (aged 15 to 64 years). According to Rahman and Ali (2009), the old age dependency ratio is able to address the changes in the working age population. However, only using the old age dependency ratio hampers us in determining the existence of population ageing, since the indicator does not include information on the fertility trend associated with the demographic transition. At some point, the young age dependency ratio was also used to analyse the demographic transition (Lee, 2003; Choudhry and Elhorst, 2010). The indicator measures the proportion between the younger aged population and the working age population.

The young age dependency ratio is considered by some (*e.g*., Lee, 2003; Choudhry and Elhorst, 2010) as an effective tool in identifying the growth pattern of the young age and working age population. To some extent, this ratio enables us to predict the number(s) of the future working and retired population. Nevertheless, the young and working age population alone are considered insufficient for assessing the exact transition of population ageing. Taking this limitation into account, Lee (2003) has combined young age and old age dependency ratios to measure the change in population ageing. At some point, the literature also used the total dependency ratio to assess the demographic transition process (*e.g*., Bloom *et al.*, 2011). This ratio is yet to be considered a good indicator for analysing population ageing trends as it provides only a rough approximation to the burden of the total dependency rate.

Apart from all the above mentioned indicators, life expectancy, the fertility rate, the mortality rate and the proportion of those of retired age were also used as measures to assess the rise in population ageing (Lee, 2003; Fehr *et al*., 2008; Choudhry and Elhorst, 2010; Bloom *et al*., 2011; Kurek, 2011). The declining trend in the fertility rate has been a primary determinant of shrinking populations, especially with regard

to the population group from 0 to 14 years of age (DESA/PD, 2001). In some instances, especially for short term analysis, the fertility rate can be considered an appropriate tool for the assessment of population ageing. However, this rate alone is insufficient for studying the dynamics of population ageing**.** Therefore, numerous studies have used life expectancy, the mortality rate and the proportion of senior citizens along with the fertility rate to assess the imbalances in age structure (Lee, 2003; Fehr *et al.*, 2004b; Fehr *et al*., 2008; Rahman and Ali, 2009; Choudhry and Elhorst, 2010; Bloom and Canning, 2011; Bloom *et al*., 2011; Kurek, 2011)

The review of the literature (*e.g*., Rahman and Ali, 2009; Choudhry and Elhorst, 2010; Bloom and Canning, 2011; Bloom *et al*., 2011; Kurek, 2011) reveals that using only one of the above mentioned indicators (*cf.* Table 3.1) to analyse population ageing may provide biased results. Therefore, taking into account the advantages and disadvantages of each of these indicators, we argue that the combination of the ageing index and the old age dependency ratio constitutes an adequate method for examining the ageing trends of the least developed countries.

3. Methodology

3.1. Data

To perform the analysis, data on total population by age was collected annually from the database of the United Nations´ Department of Economic and Social Affairs (UNDESA) Population Division, for the period from 1950 to 2050 for more developed regions, developing countries, and Least Developed Countries (LDCs). Within the LDCs we have also gathered data on total population by age for each individual country. According to UNCTAD/LDC's (2011) report, the economic and social performance of the LDC countries varies within the region. The report further reveals that most of the LDCs countries in Asian regions are economically better off than the other LDCs from other regions. Consequently, in our analysis we have categorized the 49 LDCs by region (Africa; Asia; Oceania; and America Caribbean).[8]

[8] The total numbers of LDCs referring to the United Nations are 49; we have removed Tuvalu from the analysis, due to the unavailability of data. The classification of region for the least developed countries was carried out by referring to the United Nations' classification. The Oceania region consists of countries from Melanesia (the Solomon Islands and Vanuatu), Micronesia (Kiribati) and Polynesia (Samoa and Tuvalu).

3.2. Method

As referred to in the previous section, for the analysis of the ageing trends we resorted to two indicators: the old age dependency (OAD) ratio and the ageing index (AI). As depicted in Table 3.1, the old-age dependency ratio is calculated as the number of persons aged 65 and over (the retired population) per one hundred persons 15 to 64 years (working age population), whereas the ageing index is calculated as the number of persons aged 60 and above (old age population) over per one hundred persons 0 – 14 years (young age population).

After assessing the demographic transition path for the region and countries, we furthered our analysis by studying the rate at which the population ages. To this effect, we calculated the growth rate for both the old age dependency ratio and the ageing index.[9] The rate of convergence makes it possible to examine the speed of convergence of ageing in the LDCs towards the most developed regions (MDR). The formulas used for both the OAD and AI ratio are:

$$Growth\ of\ OAD\ ratio_{LDC} - Growth\ of\ OAD\ ratio_{MDR} \quad \textbf{(1)}$$

$$Growth\ of\ AI\ ratio_{LDC} - Growth\ of\ AI\ ratio_{MDR} \quad \textbf{(2)}$$

4. Empirical results

A comparative study was carried out to visualize the pattern of old age dependency ratio and ageing index between the More Developed (MD) countries, Developing Countries (DCs) and Least Developed Countries (LDCs). The prime focus is to analyse the speed of ageing (using OAD and AI) between the most developed region and each of the LDCs.

4.1. Demographic trends between regions

At the initial stage, the three regions show a rise in the growth rate for the OAD (see Figure 3.1). The growth rates of the OAD ratio during 1950 – 1960 are positive for the most developed region and negative for both developing countries and least developed countries. Throughout this period, the less developed regions have

[9] In computational terms:

$Annual\ Growth\ of\ OAD\ ratio_r = \left(\frac{OAD_{t+1}}{OAD_t}\right)^{\frac{1}{1}} - 1$

$Annual\ Growth\ of\ AI\ ratio_r = \left(\frac{AI_{t+1}}{AI_t}\right)^{\frac{1}{1}} - 1$ ***r** denotes* by region /country and ***t*** denote by year.

experienced a demographic dividend with the numbers in the working age group outstripping the numbers in the old age group.

However, from 1960 onwards, the growth rates of the OAD ratio for both developing and least developed countries are positive. The annual average growth rate of the OAD ratio for developing countries converges towards the more developed countries during the period 2010 to 2020. In the case of LDCs, the OAD ratio is predicted to converge towards the most developed region between 2030 and 2040. The rise in OAD for both developing countries and LDCs was mainly due to the decline in the working age group. According to Malmberg *et al.* (2006), migration plays an important role in changing the population pattern of LDCs.

The OAD ratio for more developed and least developed countries is anticipated to diverge from the equilibrium point from 2040 onwards. From 2040, the annual growth rate of the OAD ratio for more developed countries illustrates a declining trend, whereas the LDCs experience continuous acceleration. This means that from 2040 onwards, a rise in the working age group for more developed countries and a continuous fall for the LDCs is expected.

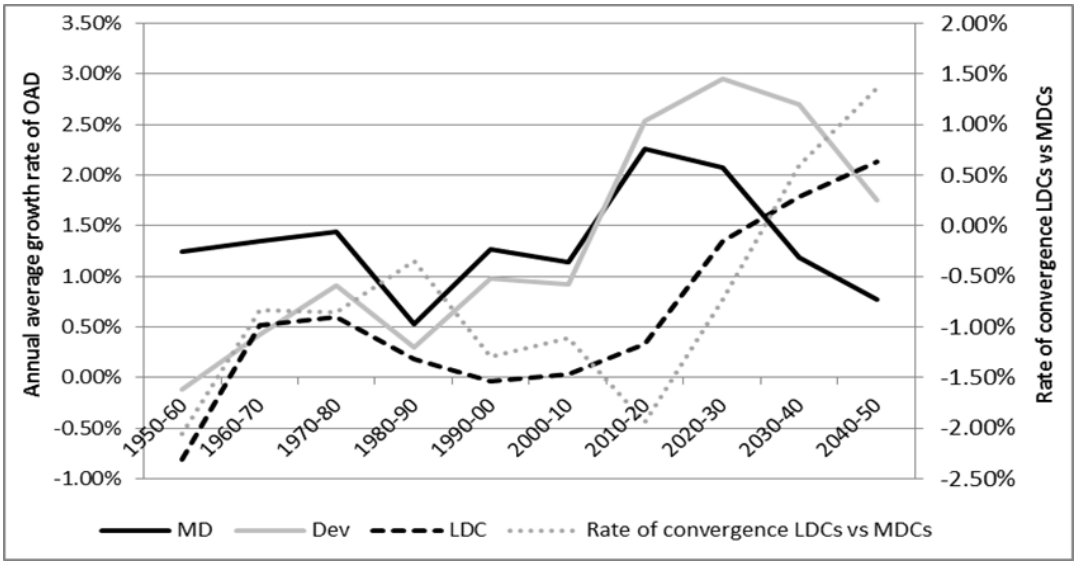

Figure 3.1: The evolution of OAD by regions (annual average growth rates, %)
Source: Own computations based on data from UNDESA population division

As regards the Ageing Index (AI), Figure 3.2 reveals a similar pattern to that observed for the OAD. When measured by AI, compared to the OAD, the speed of convergence for LDCs towards MD is even faster (being particularly significant between 2000 and 2010). During this period, LDCs faced a significant drop in the

fertility rate. Between 2000 and 2010, for LDCs, the average percentage of the young group (age 0-14) was below 35%. The fall in fertility was the main reason for the decrease in the young age group. The fall in the fertility rate among LDCs was due to the decline in infant mortality rates, greater levels of female education, increased labour market opportunities and the provision of family planning services (Malmberg *et al.*, 2006). LDCs converge towards the MD from about 2010 to 2020 (*cf.* Figure 3.2). From 2020 onwards, LDCs and MD diverge in terms of the AI. From this point onwards the annual growth rate of LDCs is higher than the MD.

Throughout this period, the AI shows continuously higher growth rates for developing countries than for LDCs, and is predicted to be 3.73% from 2020 to 2030. It is interesting to note that from 1950 to 2050, there is a continuous decrease in the fertility rate for developing countries, the prediction being that, from 2001 to 2050, the fertility rate of developing countries is expected to decrease from the rate of 6.02 to 2.09.

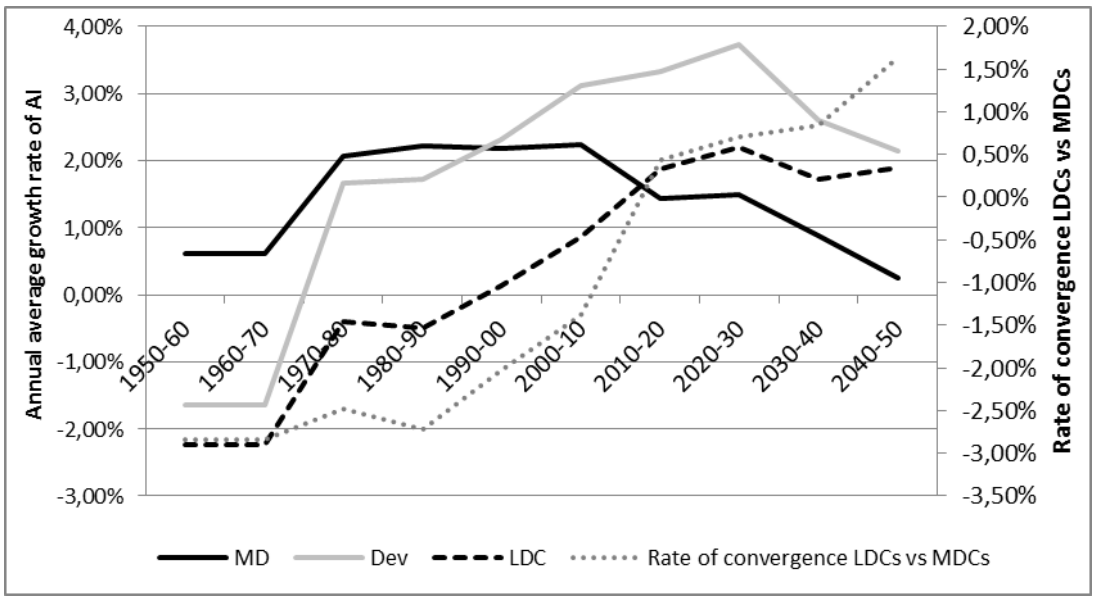

Figure 3.2: The evolution of the AI by regions (annual average growth rates, %)
Source: Own computations based on data from UNDESA population division

When compared to the OAD ratio, the annual average growth of the AI for the developing countries is higher over the period in analysis. This means that the fall in the fertility rate will have less impact on the future working age group in developing countries. According to UNCTAD/LDC's (2011) report, almost half of the emigrants from LDCs are migrating to developing countries.

In general, the speed of ageing in LDCs is higher than for the MD. Overall, the pace of ageing in relation to LDCs from the Asian region is higher compared to Africa, Oceania and America Caribbean. Specifically, Asian countries such as Afghanistan, Bangladesh, Bhutan and Timor-Leste (see Figures A.3.1 and A.3.5 in the Appendix) have the highest annual average growth rate of OAD and the AI. It is evident that both OAD and the AI for LDCs have different converging processes towards MD. The speed of ageing for LDCs varies within the region.

4.2. Demographic trends of LDCs within regions

Among the LDCs in the Asian region, Bangladesh has the fastest pace of ageing. Hence, Bangladesh has the greatest tendency to become an ageing country in the near future. The highest annual average growth rate of the AI for Bangladesh is 5.1%, which will be attained by 2020 – 2030. The country is facing a continuous fall in the young age group and a constant rise in the retired age group. Basing our findings on the WHO (2009), we can reveal that assistance from international organizations (*e.g.*, WHO, UN, UNDAF) was the main reason for the increase in life expectancy and reduction in the fertility rate of that country.

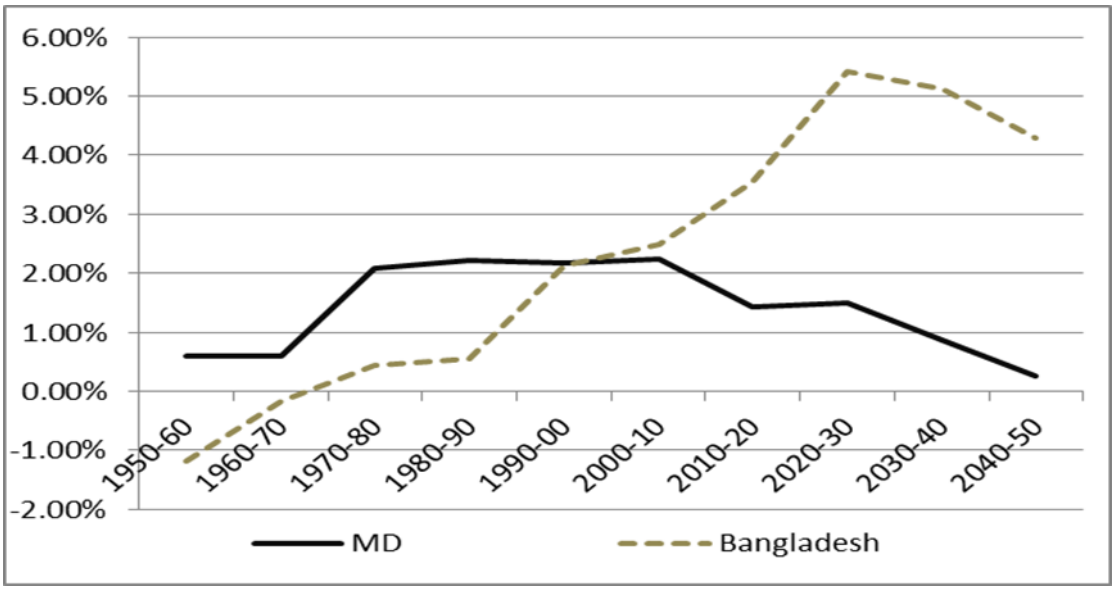

Figure 3.3: The evolution of the AI of Bangladesh (annual average growth rates, %)
Source: Own computations based on data from UNDESA population division

Using the OAD ratio, it is also clear that Bangladesh experienced the highest speed of ageing among the LDCs (see Figures A.3.5 in Appendix). The constant rise in the old age group has increased the OAD ratio of that country. The proportion of the retired group in relation to the total population is expected to rise by 15% from 2000

to 2050. Apart from that, the rise in migration of the working group has also influenced Bangladesh's OAD ratio.

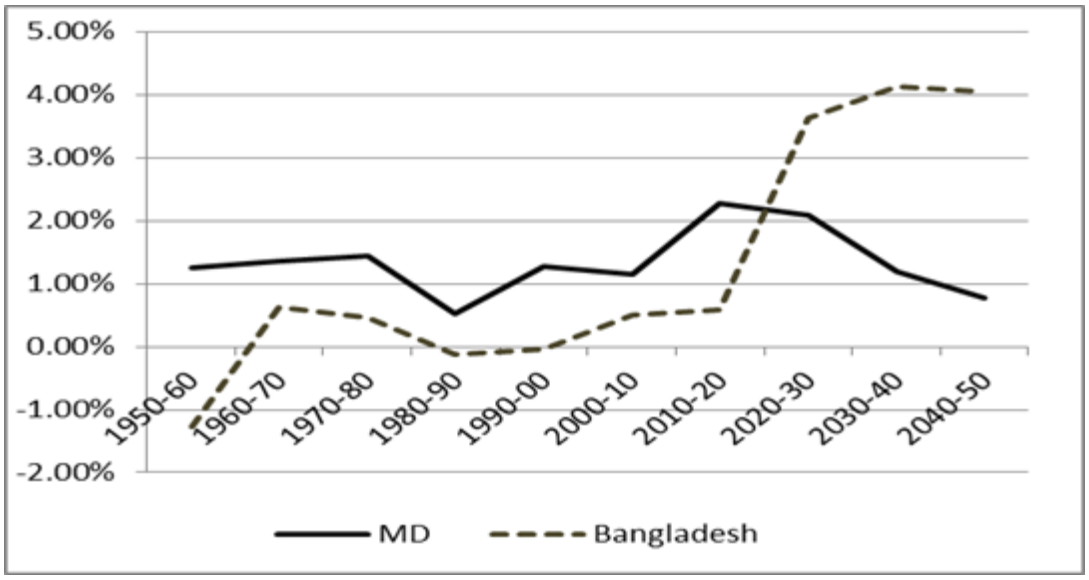

Figure 3.4: The evolution of the OAD of Bangladesh (annual average growth rates, %)
Source: Own computations based on data from UNDESA population division

The rate of the demographic transition for Bangladesh is faster than that of the MD region from 2010 onwards (*cf.* Figure 3.4), converging towards the MD region between 2020 and 2030. From 2020 onwards, there is a huge gap in the speed of ageing between Bangladesh and the MD region. During this period, the growth of OAD in Bangladesh is higher than for the MD region.

LDCs from the African region also face an increase in the rate of ageing. In particular, countries such as Eritrea, Djibouti, Ethiopia and Mozambique show a sharp increase in the growth of AI. The fall in the mortality rate for the majority of the LDCs in the African region has been due to the treatment of chronic diseases (*e.g.*, HIV/AIDS, malaria) (WHO, 2009). Moreover, the involvement of UN agencies in development and humanitarian assistance has also contributed to the improvement in the health systems of these LDCs. Such health improvement has had a positive impact on the life expectancy of the African countries.

Figure 3.5 shows the rise in the average growth rate of the AI for Eritrea. From 2000 to 2020, the growth rate of AI for Eritrea is almost similar to that of the MD region. From 2020 onwards the growth rate of AI will be higher than that of the MD region. The rise in the growth rate has been due simply to the increase in life expectancy and the fall in the fertility rate. Since its independence in 1991, Eritrea has experienced

improvements in its health infrastructure. The country has been treating infectious diseases such as tuberculosis and HIV/AIDS free of charge (WHO, 2009). As a result, life expectancy there has been gradually improving.

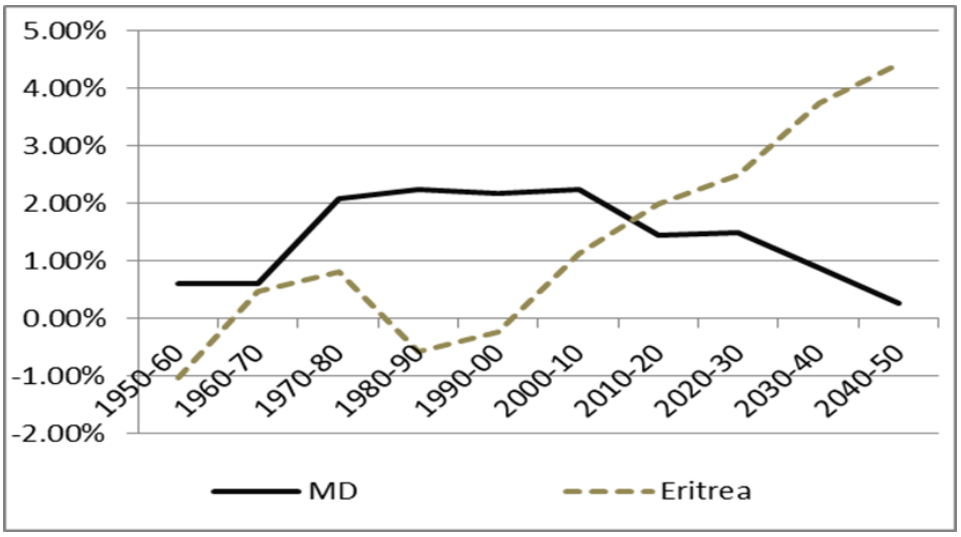

Figure 3.5: The evolution of the AI of Eritrea (annual average growth rates, %)
Source: Own computations based on data from UNDESA population division

In fact, the HIV/AIDS awareness programme organized by UN agencies such as UNDAF[10] has reduced that country's fertility rate.

The OAD ratio for Eritrea shows a similar trend to that of the AI. Unlike Bangladesh, the AI and OAD ratios of Eritrea will attain their highest growth rate in the same period (2040 – 2050). In fact the OAD ratio of Eritrea converged towards that of the MD region in the early 1990s. From 2000 to 2010 the annual growth rate of the OAD ratio for Eritrea underwent a deceleration (*cf.* Figure 3.6), though this occurred within a short period of time. From 2020 onwards, the OAD of Eritrea shows continuous growth and converges again towards the MD region.

Along with the Asian and African region, LDCs from Oceania also face increases in the speed of ageing. All the LDCs from Oceania (the Solomon Islands, Vanuatu, Kiribati and Samoa) show a continuous rise in the annual average growth rate of the AI. Furthermore, from 1990 onwards, the LDCs from Oceania have shown a positive growth rate of the AI.

[10] UNDAF stands for United Nation Development Assistance Framework.

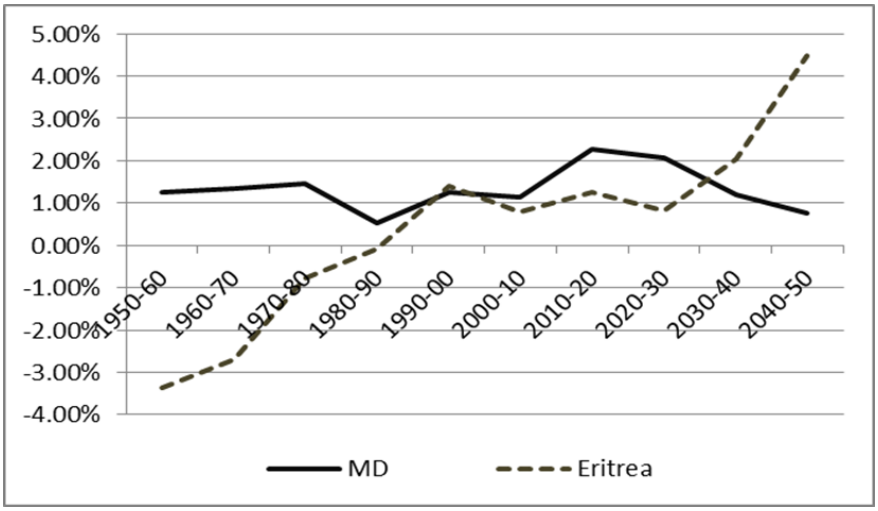

Figure 3.6: The evolution of the OAD of Eritrea (annual average growth rates, %)
Source: Own computations based on data from UNDESA population division

The Solomon Islands have shown a constant rise in the growth rate of the AI since 1990 (*cf.* Figure 3.7). This growth rate is projected to converge towards the MD region between 2000 and 2010. Figure 3.7 shows that from 2010, the growth rate of the AI for the Solomon Islands is higher than that of the MD region. The rise in the rate of the AI has been due to the continuous fall in the young age group (0 – 14). From 1950 to 2050, the young age group of the Solomon Islands is expected to have declined from 42.5% to 28.4%. Improvements in the health care system and awareness of HIV/AIDS programmes organized by the international and national NGOs have reduced the fertility rate of the country (SINAC, 2012). According to the Global AIDS Response Progress Report (SINAC, 2012), the life expectancy of the Solomon Islands' population is expected to increase, since the country is identified as a low HIV prevalence country.

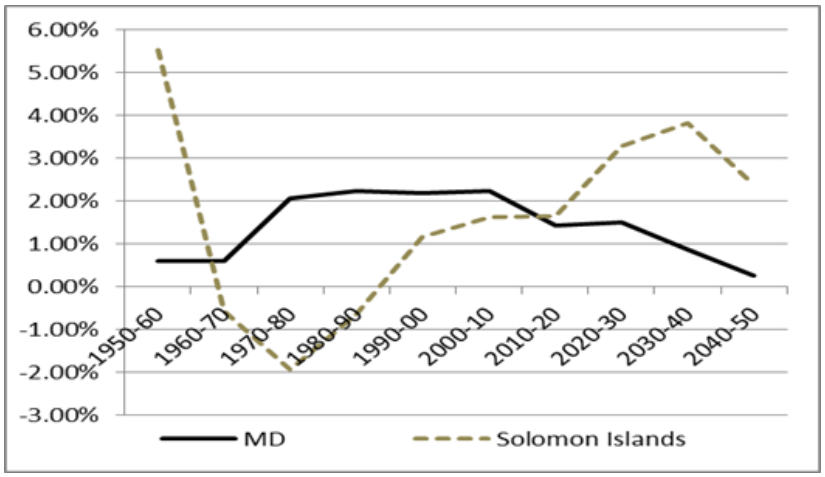

Figure 3.7: The evolution of the AI of the Solomon Islands (annual average growth rates, %)
Source: Own computations based on data from UNDESA population division

Unlike the AI, the annual average growth rates of the OAD ratio for the Solomon Islands from 1950 to 2010 show an irregular pattern (*cf.* Figure 3.8). This is due to the uneven trend in the proportion of the working group. Competitions for jobs and political instability have affected the migration of the working age group of that country (IMI/NIDEA, 2013). According to Global Migration Futures (IMI/NIDEA, 2013), the Solomon Islands face a rise in the migration of the working group towards countries such as Australia and New Zealand. Economic development and the issue of population ageing in Australia and New Zealand have increased the demand for skilled and semi-skilled workers from LDCs (mainly from the Solomon Islands).

Due to the irregular pattern in the proportion of the working age group, the annual average growth OAD ratio of the Solomon Islands converges towards the MD region more than once. Figure 3.8 shows that the speed of OAD growth for the Solomon Islands is higher from 2010 onwards. The annual growth rate of the OAD ratio was 5.96% in 2013 and is predicted to rise to 11.62% by 2050.

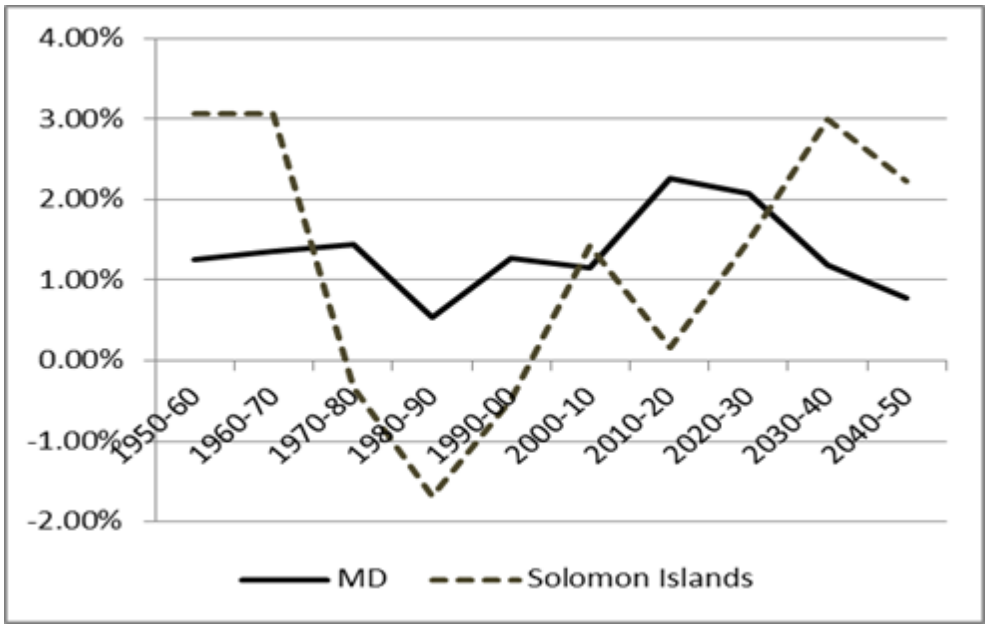

Figure 3.8: The evolution of the OAD of the Solomon Islands (annual average growth rates, %)
Source: Own computations based on data from UNDESA population division

Like the Asian and African regions, the Latin American Caribbean also faces a demographic transition process. In the early 21st century, Latin American countries such as Haiti faced a decline in their population growth due to lower fertility rates (Brea, 2003).

The results show that from 1950 to 2000, for Haiti the proportion of inhabitants in the young age group is higher than that of those in the old age group. During this

period, the country faced a rise in the fertility rate since it experienced a continuous decline in the infant mortality rate (Brea, 2003). According to Brea (2003), improvements in medical facilities have increased the survival rate of new born children. In fact, from 2000 onwards, the average annual average growth rate of the AI for Haiti showed an accelerating trend. Over this period the proportion of the population in the old age group is higher than that in the young age group. Moreover, Haiti's AI converged towards the MD region early in 2010. During this period, Haiti experienced decreases in its fertility rate. The increase in women's education and their participation in the labour force were the main reasons for the decrease in that country's fertility rate (Brea, 2003).

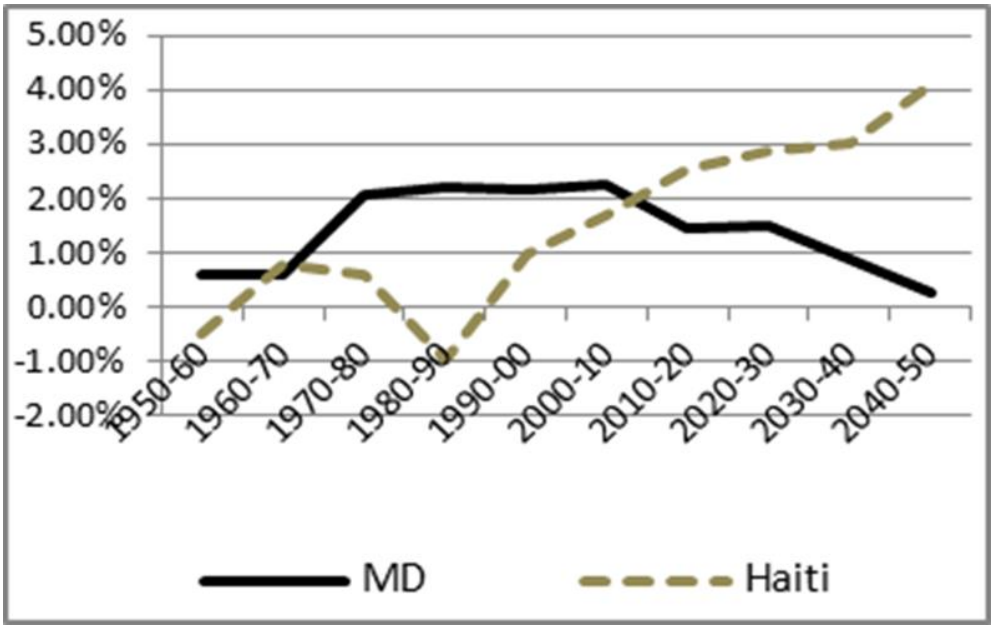

Figure 3.9: The evolution of Haiti's AI (annual average growth rates, %)
Source: Own computations based on data from UNDESA population division

As with the AI, Haiti's OAD ratio also showed an increase in the old age group and a fall in the working age group from 2000 onwards. From that year, the annual average growth rate of Haiti's OAD ratio showed a constant rise.

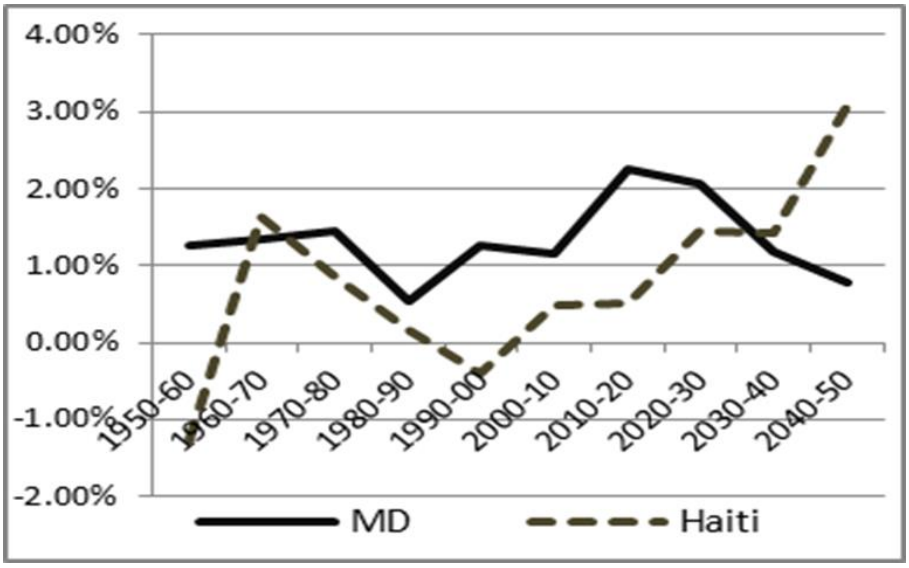

Figure 3.10: The evolution of the Haiti's OAD (annual average growth rates, %)
Source: Own computations based on data from UNDESA population division

Haiti's OAD ratio converged towards the MD region early in 2030. From 2040, Haiti and the MD region diverged in terms of their OAD. From then on the annual growth rate of Haiti's OAD ratio will become increasingly higher than that of the MD. However, Haiti's population is considered to be young age, and now, early in the 21st century, almost 70% are under 30 (Daumerie and Hardee, 2010). According to these authors, the destruction caused by Hurricane Jeanne in 2004 and the 2010 earthquake have affected the country's economic growth. Even though a higher percentage of its population belonged to the young age group, the effects of the natural disaster and the country's economic conditions increased the volume and rate of migration among the working age group (Brea, 2003).

5. Conclusion

The current ageing problem has created a new subject for economists and demographers to work on. The rise in the proportion of older people has resulted from the significant developments in the economic, social and medical fields. These developments have provided an opportunity for people to live longer and healthier lives, which is unprecedented in our history. Hence, these ageing impacts might be considered a new experience for the world. Medical advances and the altruistic behaviour of couples have led many developed countries to become 'ageing countries' (Bloom and Williamson, 1998). Since 2007, the average life expectancy

for countries such as Luxembourg, Spain, Germany, Portugal, Austria, France and Italy has risen to over 80 years of age.[11]

The processes of demographic transition towards an ageing population have also taken place in developing countries (Bloom *et al*., 2011). Even though at present the phenomenon of population ageing in the least developed countries may not yet be visible, it is not an issue limited to developed and developing economies alone. One key aspect of ageing is that it is taking place in LDCs even faster than it occurred in developed and developing countries.

In this paper, through descriptive analyses, we have been able to identify and confirm the increasing speed of ageing among LDCs. Overall; our analysis shows that this is much more pronounced in LDCs than in the DC and MD region. This increasing rate of change results in LDCs experiencing an ageing population trend in a shorter period of time. Our results demonstrate that the annual average growth rate of the ageing index (AI) and old age dependency ratio (OAD) for the LDC are converging towards the MD at the present time, in the case of the AI, or will do so within 20-30 years, in the case of the OAD. From 2010, in the case of the AI, and 2040 in the case of the OAD, we can observe a declining trend for more developed countries and a continuously accelerating trend for LDCs.

Furthermore, we found that the speed of convergence towards the MD among the LDCs within the corresponding region varied considerably. To be more precise, the LDCs from the Asian region experienced a more rapid rate of convergence towards the MD. This is in part explained by the higher economic dynamics of Asian LDCs. Compared to the African countries, (whose highest AI and OAD growth rate is on average below 4%), the highest AI and OAD growth rate of the majority of Asian LDCs is above 5%.

It is interesting to note that unlike that in the developed countries, the higher speed of ageing for LDCs seems to be due to more than medical advances and altruistic behaviour of couples. Indeed, during our research, we found that the rise in the speed of ageing is mainly associated with the migration of LDC working groups and the interference of international organizations such as the WHO, the UN and the UNDAF.

[11] 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.

The involvement of UN agencies in development and humanitarian assistance has contributed to the improvement in the health systems of these LDCs (WHO, 2009). Such significant health improvement has had a positive impact on life expectancy in the LDCs. Moreover, the HIV/AIDS awareness programmes organized by the UN have reduced the fertility rate of LDCs. As a result of these international aid programmes, LDCs have undergone an increase in the speed of ageing.

Another important factor accounting for the increasing rate of ageing in LDCs is migration. According to UNCTAD/LDC's (2011) report, the majority of the working age group from LDCs are migrating to DCs. It is estimated that half of all migrants from LDCs are migrating to DCs (UNCTAD/LDC, 2011). As a result, compared to LDCs, the rise in population ageing will have less of an impact on the OAD of DC(s).

The UNCTAD/LDC (2011) report underlines the fact that Asian countries such as India, China, Malaysia, Taiwan and Singapore play a prominent role in increasing the speed of ageing in Asian LDCs. Moreover, it reveals that there is a greater possibility of Asian LDCs becoming ageing countries before African ones.

Considering the rise in the speed of ageing for the LDCs, as measured by the AI and the OAD ratio, rapid population ageing will take place in LDCs even though the economic growth of these countries is still low compared with that of developed countries. The inequality in the age structure will have an impact on the economic growth since the proportion of those in the non-working group is expected to be higher than those in the working group (Lee and Mason, 2007; Aguiar, 2011; Aguila *et al.,* 2011; Navaneetham and Dharmalingam, 2012; Bell and Rutherford, 2013; Meijer *et al*., 2013). Therefore, compared to developed countries, the impact of population ageing is likely to be more severe for LDCs, as they have a shorter period of time to adapt to changes.

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Appendix

Ageing Index

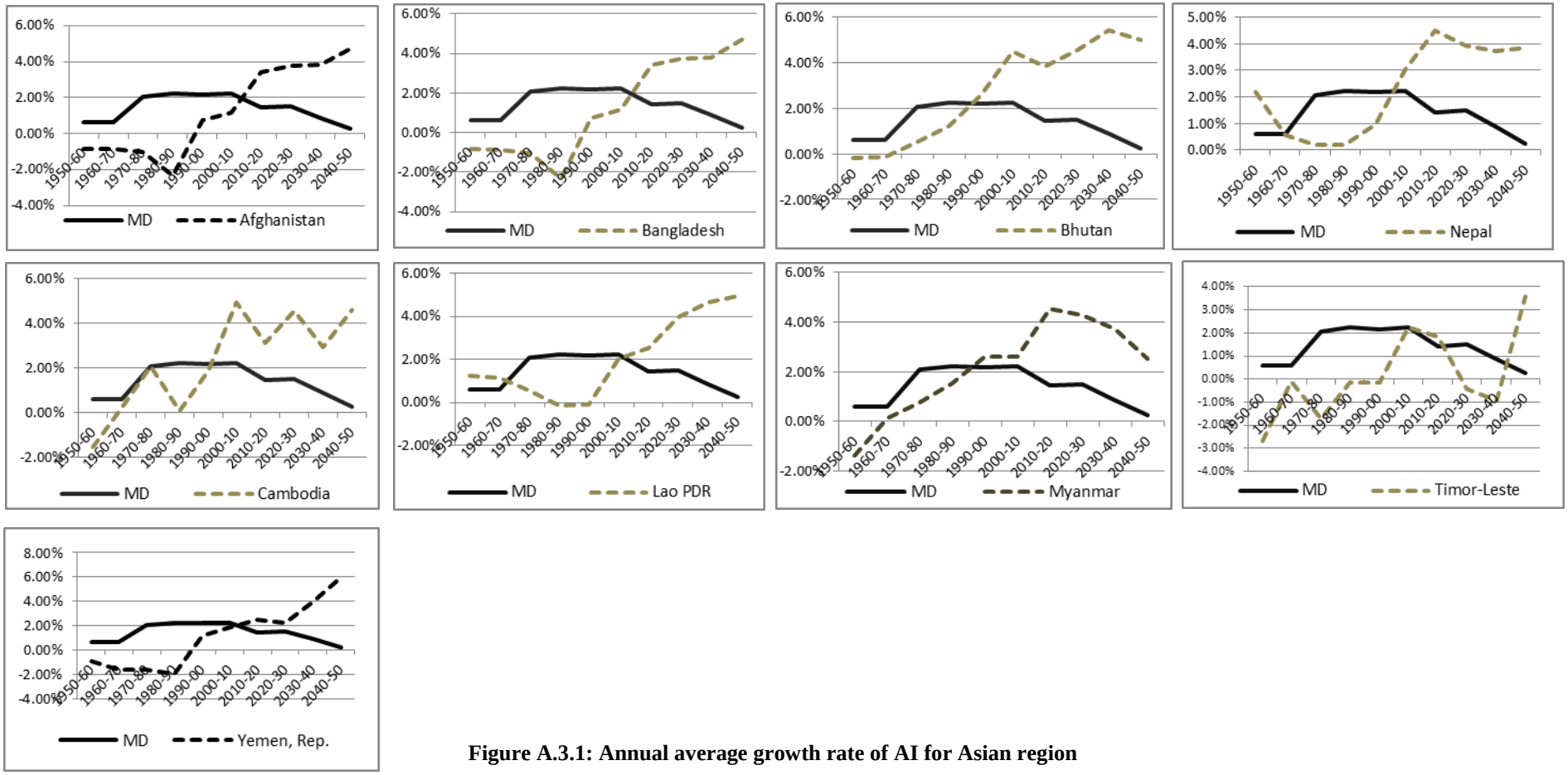

Figure A.3.1: Annual average growth rate of AI for Asian region

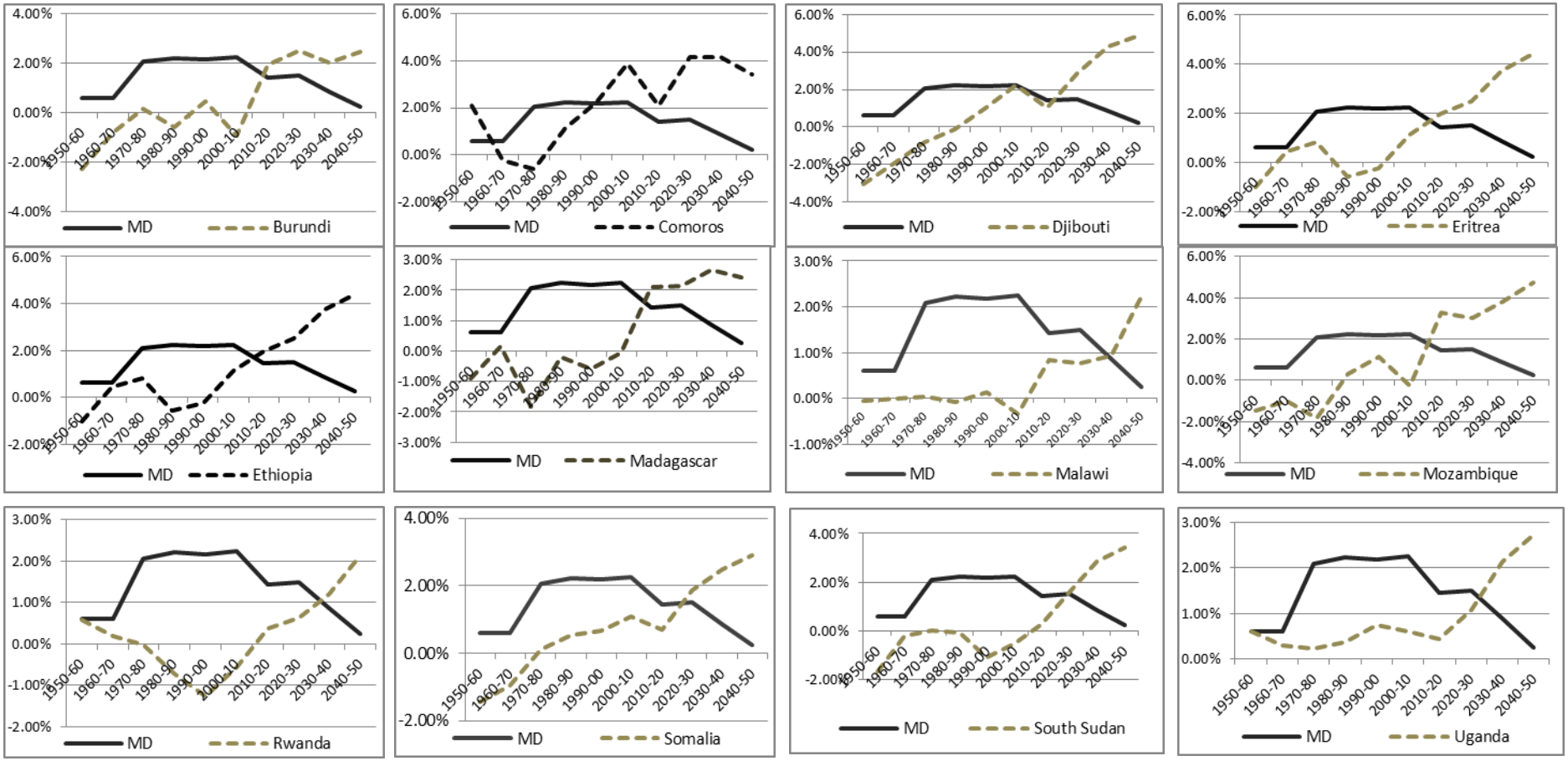

Figure A.3.2: Annual average growth rate of AI for African region part 1

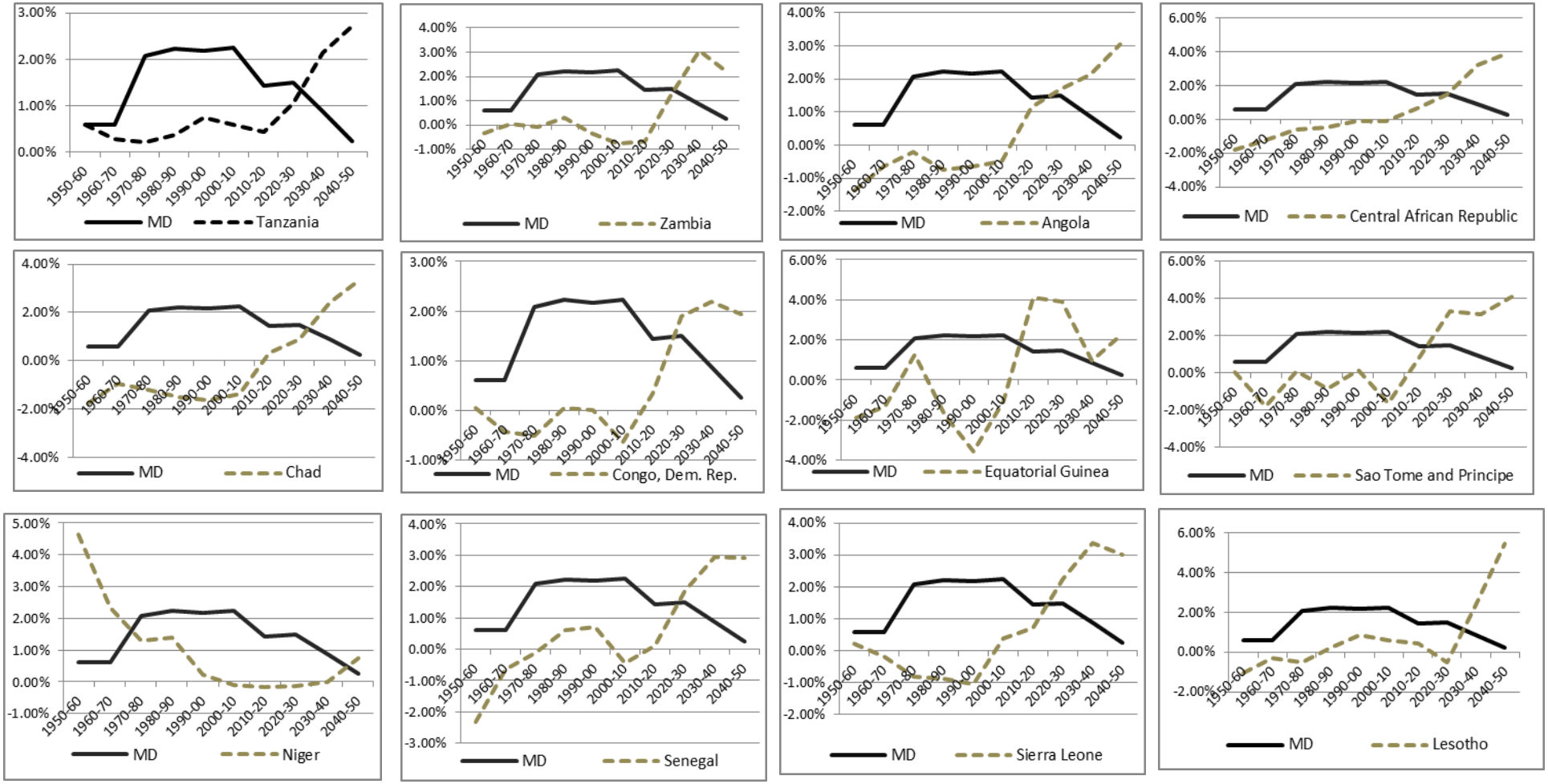

Figure A.3.2: Annual average growth rate of AI for African region part 2

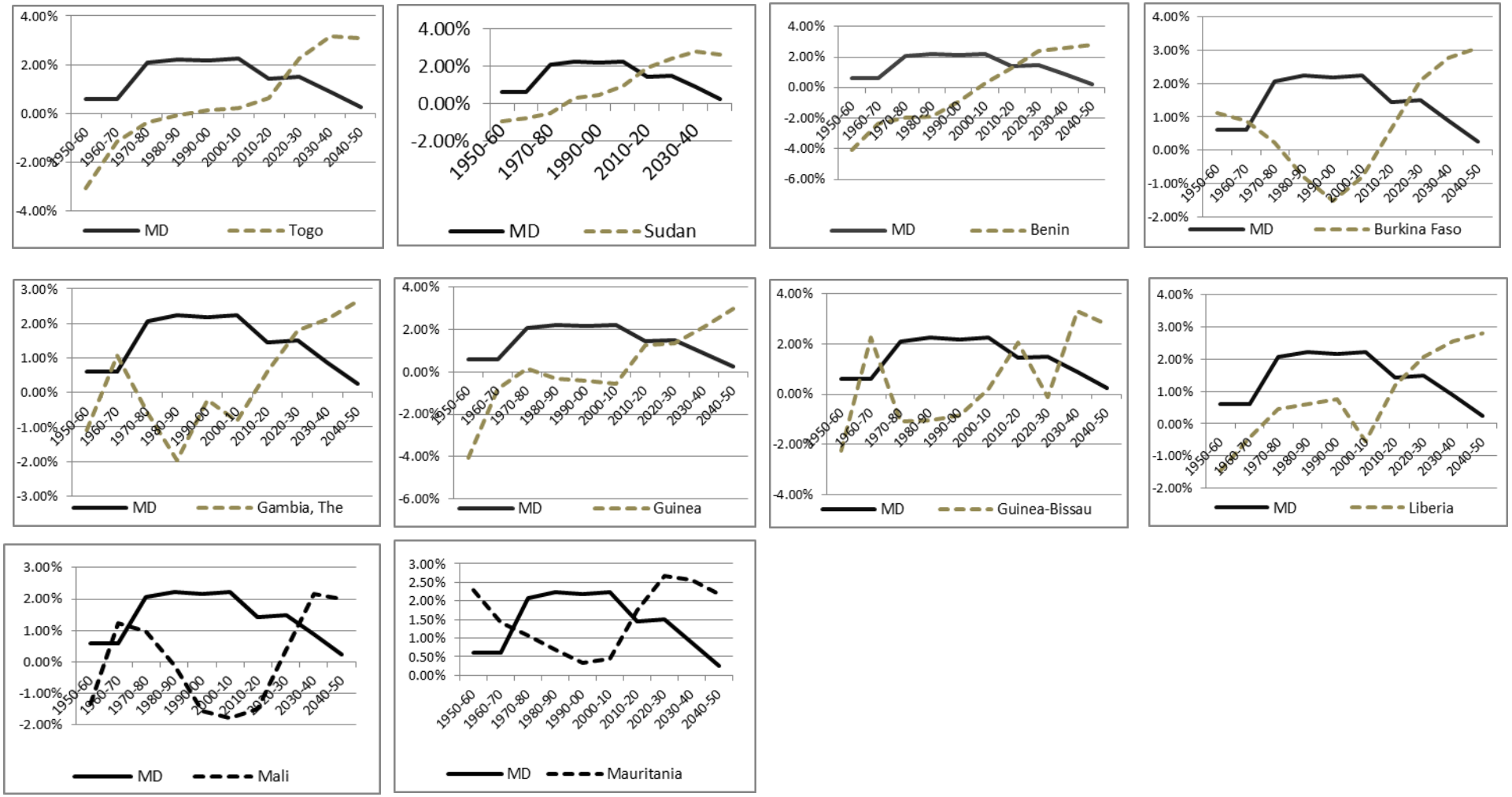

Figure A.3.2: Annual average growth rate of AI for African region part 3

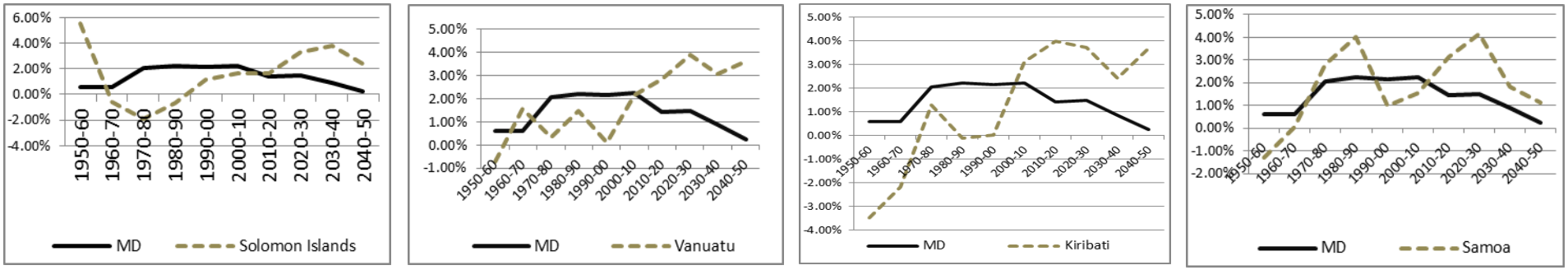

Figure A.3.3: Annual average growth rate of AI for Oceania region

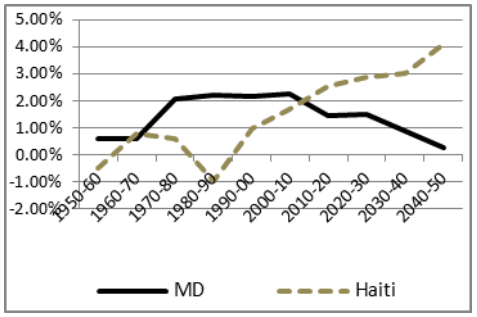

Figure A.3.4: Annual average growth rate of AI for America-Caribbean

Old age dependency ratio

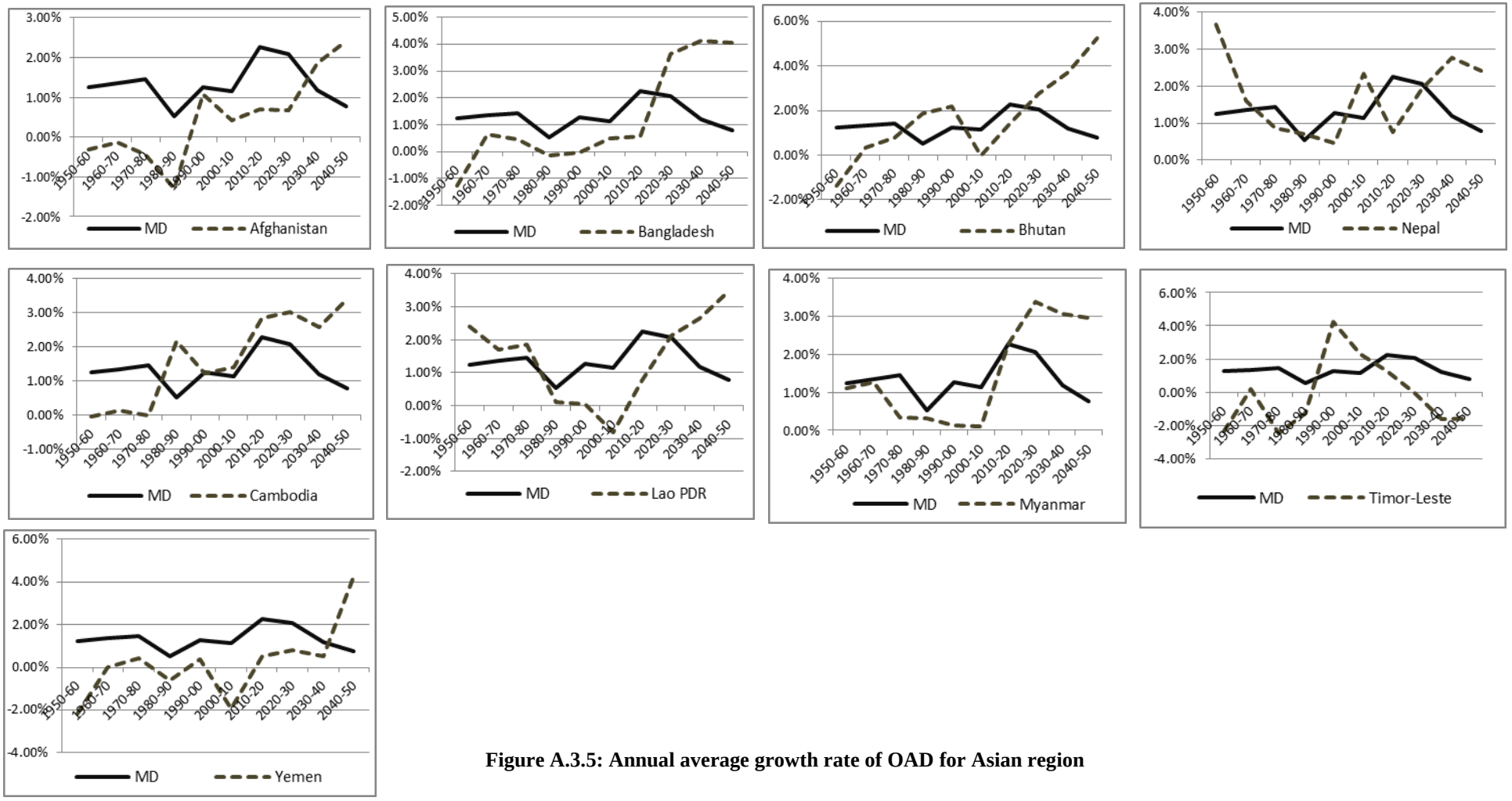

Figure A.3.5: Annual average growth rate of OAD for Asian region

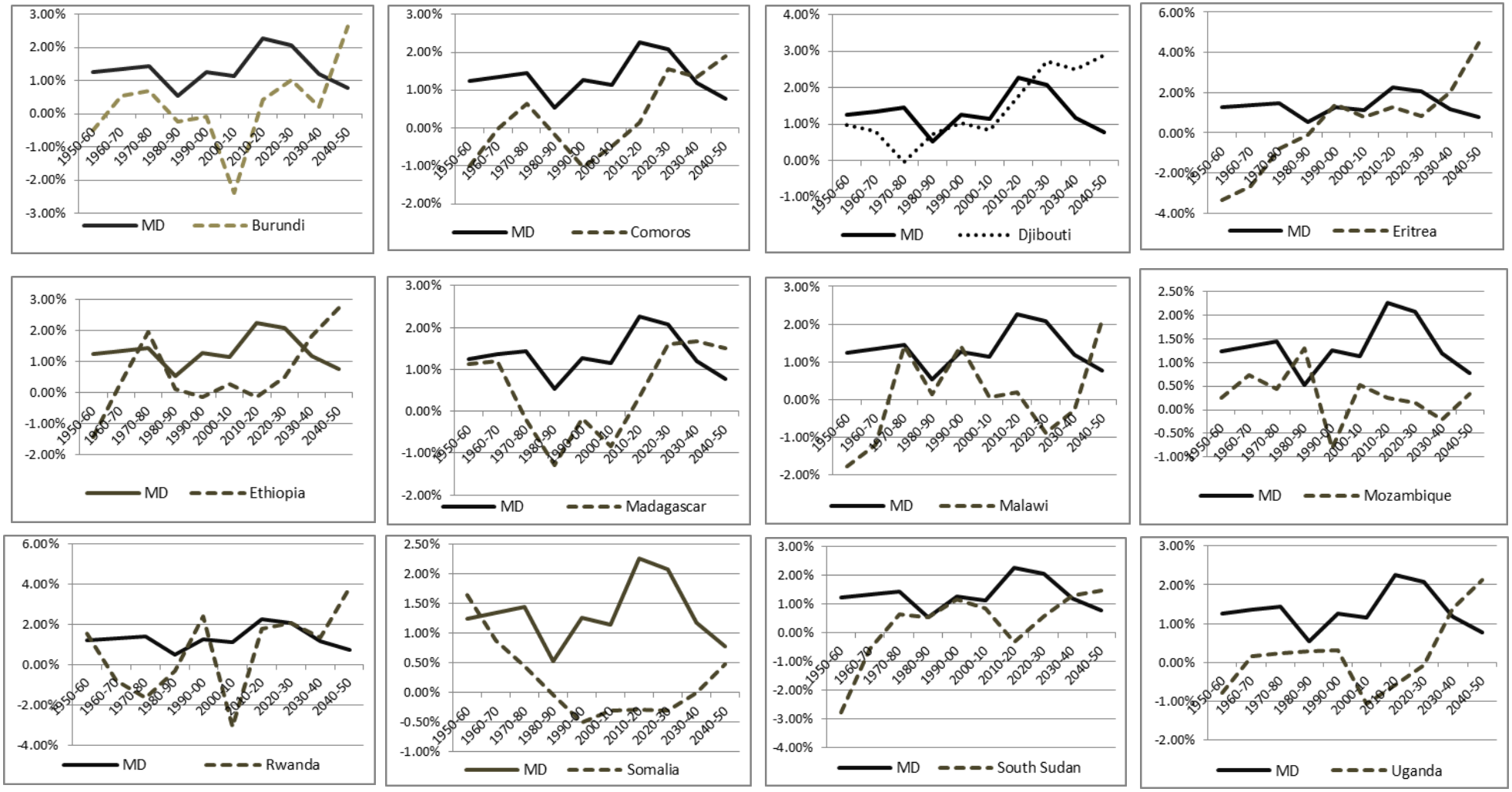

Figure A.3.6: Annual average growth rate of OAD for African region part 1

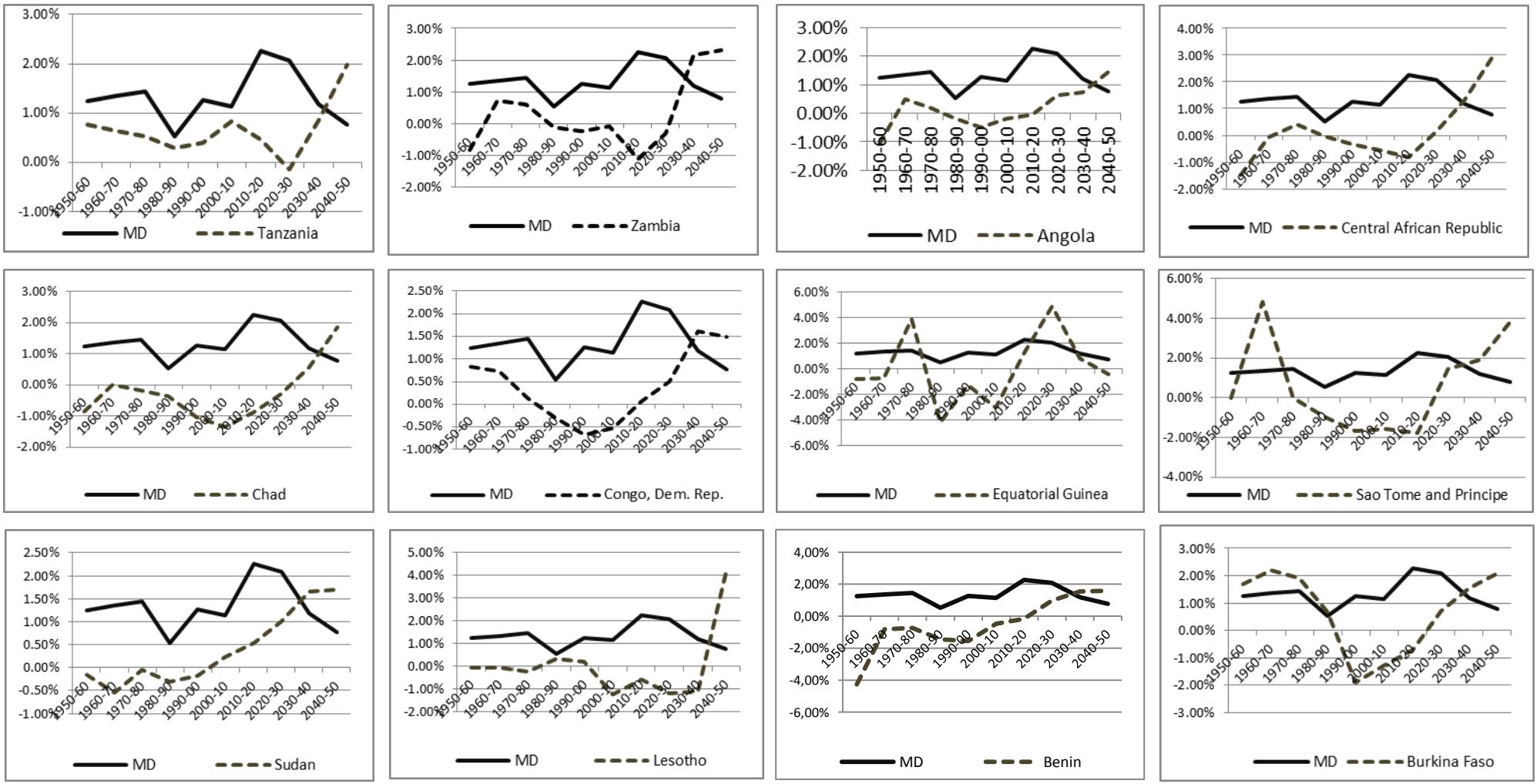

Figure A.3.6: Annual average growth rate of OAD for African region part 2

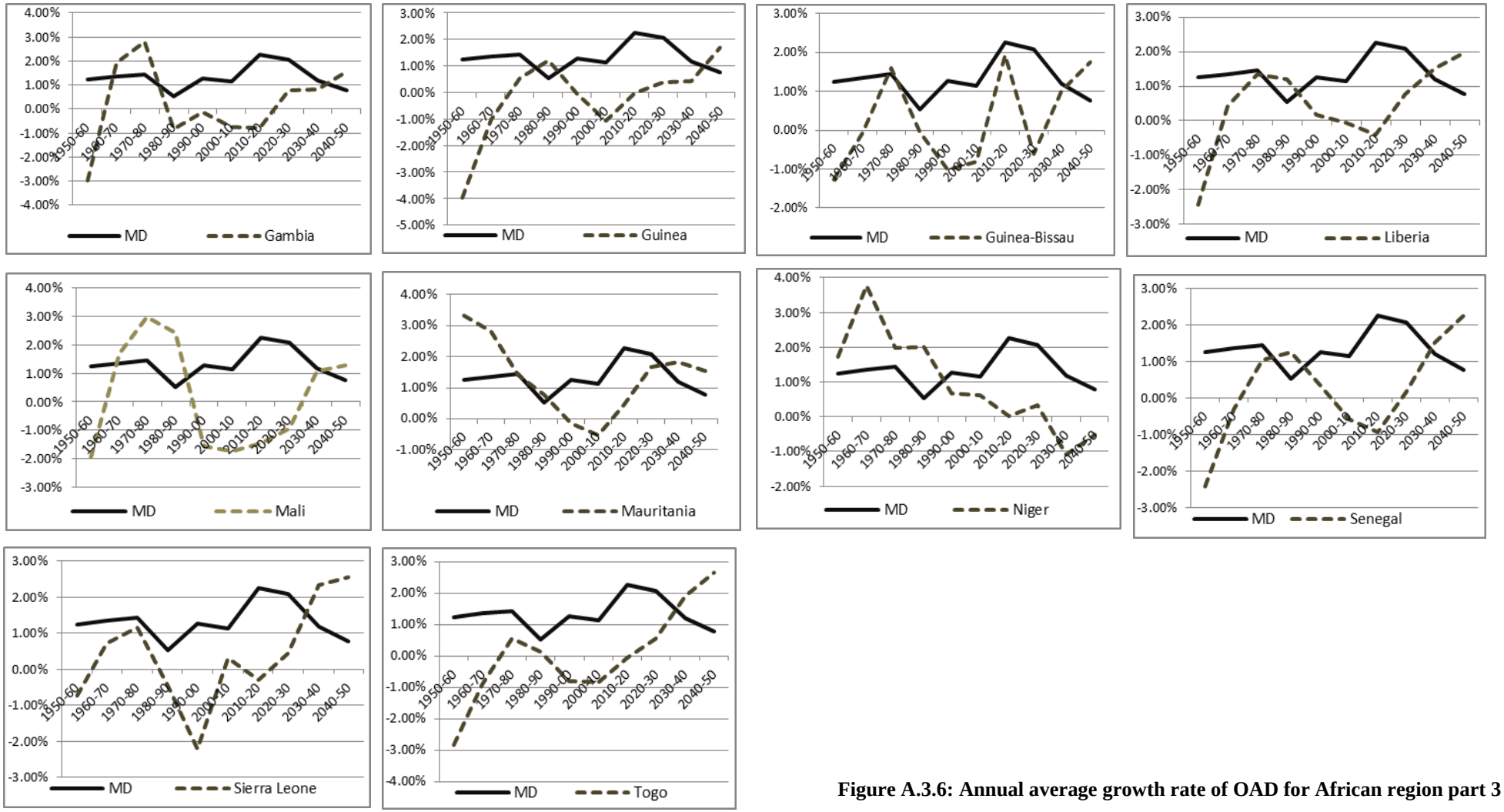

Figure A.3.6: Annual average growth rate of OAD for African region part 3

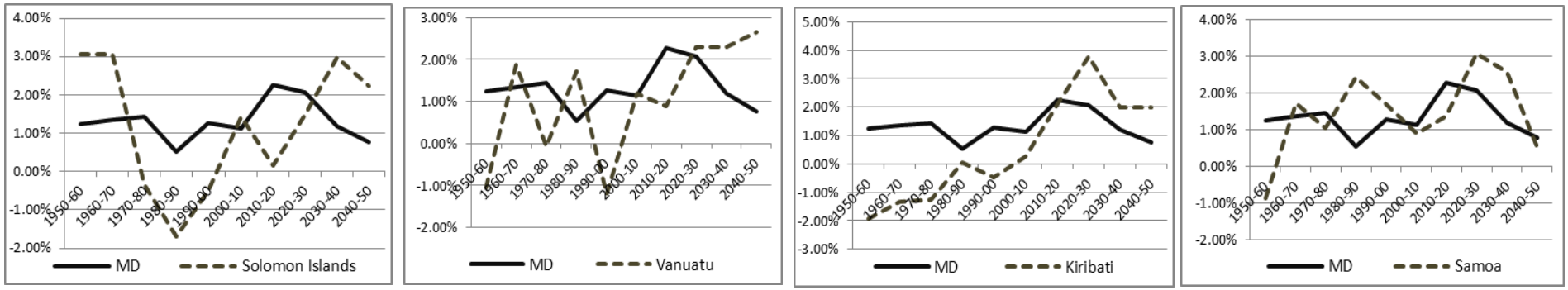

Figure A.3.7: Annual average growth rate of OAD for Oceania region

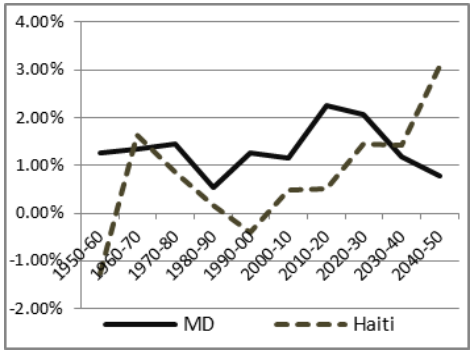

Figure A.3.8: Annual average growth rate of OAD for America-Caribbean

Essay 4: Are Least Developed Countries ageing yet? A panel data estimation of the determinants of ageing and the speed of ageing

Are Least Developed Countries ageing yet? A panel data estimation of the determinants of ageing and the speed of ageing

Abstract

The issue of population ageing is no longer exclusively centred on developed countries. Empirical studies have proven that the rise in the proportion of the old age group is already visible in Least Developed Countries (LDCs). The main concern of population ageing in LDCs is that, ageing approaching LDCs even faster than it approaching developing and developed countries. By means of panel data for 43 LDCs for a period of 23 years (1990 – 2012), we found that human capital and female labour market participation influences current and future ageing levels but not the future speed of ageing of LDCs. Additionally, GDP per capita, health expenditure per capita, net official development assistance and emigration evidence a positive influence on both the speed of ageing and the future level of ageing. Our empirical results suggest therefore that, differently from more developed countries, the phenomenon of ageing/speed of ageing in LDCs depends critically on the involvement of international bodies/international aid and the rise in emigration of working age group of LDCs to more developed countries.

Keywords: Determinant of ageing and speed of ageing; Panel data; Least Developed Countries.

JEL Codes: J11; O11; O19

1. Introduction

The phenomenon of population ageing has attracted increasing attention among political authorities and researchers. The rise in life expectancy and fall in fertility rates have accelerated the speed of ageing (Harper and Leeson, 2009; Yong and Saito, 2012). Ageing has a profound influence on the socioeconomic framework of most developed countries (Aguiar, 2011; Mason and Lee, 2011). To an extent, it is also considered a major determinant for a country's economic progress. Population ageing is believed to increase the retiree to worker ratios of many developed economies (Díaz-Giménez and Díaz-Saavedra, 2009; Mason and Lee, 2011)**.** As a result, many of the current unfunded pension systems (also known as pay-as-you-go system) are expected to face enormous losses (Díaz-Giménez and Díaz-Saavedra, 2009; Mason and Lee, 2011). Apart from this, the increase in the proportion of the old age group is believed to change the consumption pattern of households, whose preferences and needs vary according to their ages (Samuelson, 1958; Aguiar, 2011; Mason and Lee, 2011), and this is expected to have an impact on a country's economic growth.

Although not profoundly analysed, the processes of population ageing are also taking place in less developed countries (Bloom *et al*., 2011). Indeed, ageing in the Least Developed Countries (LDCs) is not as visible as in Developing Countries (DCs). However, some studies show that population ageing in LDCs is occurring at a more rapid pace than in the More Developed (MD) region (Lee, 2003; DESA/PD, 2007; DESA/PD, 2010). In this latter, the population issue did not gain prominence until people became rich (Bloom *et al*., 2011). But, for LDCs, it is understood that the issue of population ageing will occur even before they become rich (Bloom *et al*., 2011). In this context, we contend that ageing is not an issue limited to developed and developing countries alone.

Although extant empirical literature is relatively mute regarding this phenomenon, evidence shows that the speed of ageing in LDCs is much higher than in Developing Countries (DC) and More Developed (MD) regions. Figure 4.1 shows that the annual average growth rate of the ageing index for LDCs is converging towards the MD region within the time frame 2010 – 2020**.** Moreover, from 2020 onwards, the ageing index for the MD region shows a continuous decline. This increasing speed of ageing

in LDCs is likely to mean that these countries will have a shorter period of time in which to confront and overcome the impact of ageing.

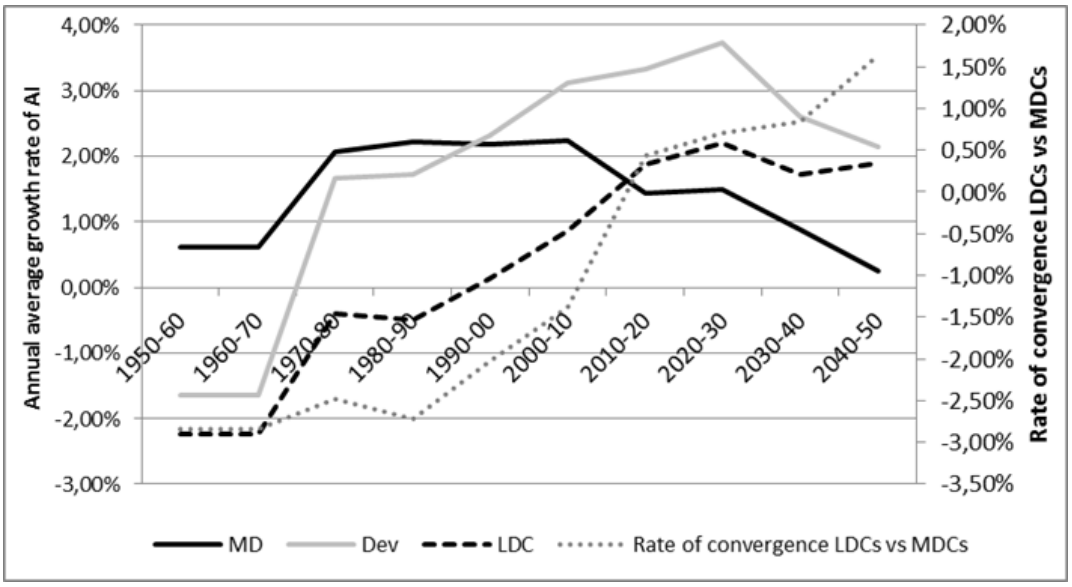

Figure 4.1: The evolution of the Ageing Index by regions (annual average growth rates, %)

Note: The ageing index is calculated as number of persons at age 60 and above per hundred persons under age 15

Source: Own computations based on data from UNDESA population division.

Given the scant information available on this theme, we argue that it would be helpful to gather evidence on the determinants of ageing and speed of ageing in LDCs. To the best of our knowledge, no study of the determinants of the speed of ageing involving LDCs exists. Thus, the present paper intends to fill this gap by presenting the estimations of panel data models encompassing 43 LDCs over a 23 year period (1990-2012).

This paper is structured as follows. After the Introduction, Section 2 reviews the determinants of ageing while at the same time seeking to establish a parallel for the determinants of the speed of ageing, and puts forward this study's main hypotheses. Section 3 describes the model specification and the most adequate proxies for the relevant variables. Section 4 details the results of the analysis**,** and finally Section 5 concludes and offers some considerations regarding future research on this topic.

2. Literature review on the determinants of ageing and the speed of ageing

2.1. A general overview

Though at this point the demographic transition process is noticeable mainly among developed rather than developing countries, this does not mean that LDCs will not face the ageing population problem in the future. In fact, there are numerous studies that have predicted a substantial fall in the fertility and mortality rates in LDCs (*e.g.*, Lee, 2003; DESA/PD, 2007; DESA/PD, 2010). Specifically, Lee (2003) discovered that the speeds of decline in the fertility rate for LDCs are faster than in developed and developing countries from 2000 onwards. Along with this, Cutler *et al*. (2006) also disclosed that current LDCs are experiencing massive expansions in life expectancy. According to the authors, the majority of African countries are facing increases in life expectancy due to the decline in HIV/AIDS - related illnesses. Hence, rapid population ageing will take place in LDCs, even though their economic growth is still low compared to that of developed and developing countries. The United Nations (DESA/PD, 2007) report further stressed that the impact of population ageing on LDCs will be profound in relation to developed countries, as they will have a shorter period of time to adapt to the changes associated with population ageing.

The rise in life expectancy and the decrease in the fertility rate are traditionally considered to be major causes for the existence of an ageing problem (Harper and Leeson, 2009). Moreover, advances in the medical sector and couples' altruistic behaviour are also considered relevant causes of population ageing (Alders and Broer, 2004). In the case of LDCs, however, the determinants of ageing no longer consist of advances in medical science medical advances and altruistic behaviour of couples alone (Lee, 2003). According to the United Nations report, migration of the working group from LDCs to developed and developing countries will create imbalances in these countries' age structure (with the proportion of the old age group overtaking that of the working group) (UNCTAD/LDC, 2011). Besides, it is understood that many health programmes conducted in LDCs by international organizations, most notably by the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF), have improved people's life expectancy (WHO, 2013). Likewise, some authors (*e.g.*, Meier and Werding, 2010; Brinker and Amonker, 2013) maintain that improvements in health care, education, and

modernization, along with better access to family planning information and services, have played a vital role in lowering fertility and increasing life expectancy in LDCs. The next section details the mechanisms through which these factors impact on economic growth.

2.2. Mechanisms through which relevant factors impact on (the speed of) ageing main hypotheses

Economic performance

Many authors consider ageing to be an important factor in a country's economic growth (Hondroyiannis and Papapetrou, 2001; Nardi *et al*., 2010; Aguila *et al*., 2011; Hurd and Rohwedder, 2011; Fanti *et al*., 2013). However, several authors stressed the reverse causality understood as the possibility that economic growth might in fact be one of the reasons for population ageing (Bloom and Williamson, 1998; Hodgson, 1988; Alders and Broer, 2004; Elgin and Tumen, 2010). According to Hodgson (1988) and Hoffman (2011), the economic development of a country will change the social culture of households and lead towards a fall in the fertility rate. The authors stress that the needs and preferences of households change due to the economic progress of their country. In fact, a rise in the fertility rate is supposed to reduce households' real per capita income (Becker *et al*., 1999; Hoffman, 2011). Consequently, a rise in the cost of living tends to reduce the possibility of females having more children (Becker *et al*., 1999; Alders and Broer, 2004; Murtin, 2013). Furthermore, economic development will raise households' standards of living and lead to healthier lives and longer life expectancy (Alders and Broer, 2004). Thus, we suggest that:

H1: *Countries' higher economic performance is associated with increases in ageing and the speed of ageing*

Human capital

Several authors argue that improvements in the education system contribute to a rise in life expectancy and a fall in the fertility rate (Angeles, 2010; Krupp, 2012; Murtin, 2013). Furthermore, Angeles (2010) identified education as a cause of reduction in the fertility rate. Education has been considered a main socioeconomic determinant for the demographic transition process. Educated individuals are more likely to practise more hygiene and have healthier life styles (De la Croix and Licandro, 2012)

and this expected to improve their life expectancy. The education level of women is also considered to be a strong reason for a decline in the fertility rate. According to Brea (2003) and Alders and Broer (2004), increases in women's education levels and their participation in the labour market lead to decreases in the fertility rate. These authors stressed that the rise in the number of years of schooling among females and their aim to be active in the labour market will delay the child bearing process. Apart from this, parents' investment in their children's education also influences the fertility rate, since the total cost of education increases in line with the number of children (Murtin, 2013).

According to Soares (2006), adult longevity has positive effects on schooling and negative effects on the fertility rate. In the case of Brazil, 80% of the effect of adult longevity and fertility comes from a direct link between mortality and fertility, while 20% comes from the indirect effect of the increase in educational attainment. In general, extant studies in this field stress that both education and income are expected to exert a significant influence on health transition and the fertility rate (Alders and Broer, 2004; Soares, 2006; Angeles, 2010; Murtin, 2013). In short, we find that most authors assert that education is a critical and influential factor in the demographic transition process (Brea, 2003; Alders and Broer, 2004; Soares, 2006; Angeles, 2010; Murtin, 2013). Drawing a parallel between ageing and the speed of ageing, we suggest that:

H2: Human capital increases is associated with increases in ageing and the speed of ageing

Labour market participation

As mentioned above, human capital plays a vital role in the demographic transition process, since the return on human capital production leads to a fall in the fertility rate (Becker *et al*., 1999; Elgin and Tumen, 2010). Furthermore, economic progress demands that more women actively participate in the labour market, and thus they can choose whether or not to have a child (Alders and Broer, 2004; Börsch-Supan, 2013). According to Alders and Broer (2004), the rise in the productivity shock will decrease the fertility rate. Hence, the rise in human capital derived from improved economic conditions will reduce the fertility rate. Literatures further underline that the greater participation of women in the labour market tends to reduce a country's fertility rate (Becker *et al*., 1999; Alders and Broer, 2004). Thus, we suggest that:

H3: Female labour market participation is associated with increases in ageing and in the speed of ageing

Government policies

Advances in medical treatment, along with the willingness of government agencies to allocate funds for medical care, increases life expectancy. In fact the WHO (2009) report stated that the majority of LDCs governments have started to treat infectious diseases such as tuberculosis and HIV/AIDS free of charge (WHO, 2009). The capability of government agencies to allocate more funds to public health expenditure has a positive influence on the life expectancy.

In addition, improvements in health systems provide proper nutrition intake and less exposure to infection, which is expected to increase the life span of an individual (De la Croix and Licandro, 2012). As a result of medical improvements, the United Nations (DESA/PD, 2010) shows that about 3 out of every 5 babies born in LDCs will reach the age of 60 between 2005 and 2010. It is thus obvious that medical advances have a positive impact on ageing.

Improvements in professional health assistance and the child immune system play an important role in life expectancy and the fertility rate (Brinker and Amonker, 2013). Medical developments are also expected to decrease the child mortality rate due to the reduction in chronic diseases (Owoo *et al*., 2014; Brinker and Amonker, 2013). This positive evolution, *i.e*. as regards the child mortality rate, will impact on women's fertility behaviour (*e.g.*, Owoo *et al*., 2014). According to Brinker and Amonker (2013), a fall in the child mortality rate will reduce the fertility rate, since for women the quality of children is more important than the quantity (Brea, 2003; Soares, 2006; Brinker and Amonker, 2013). As Owoo *et al*. (2014) explain, at the first stage, child mortality rates will start to fall and the fertility rate will remain high, due to medical developments; thus, in the short run, the rate of ageing will fall However, in the long run, women's behaviour (concerning the choice of quality *versus* quantity of children) will tend to produce a decline in the fertility rate and an increase in the ageing index. In addition to women's behaviour towards child bearing, certain government policies such as the 'one child policy' plan implemented by the Chinese government (documented by Porter, 2010) are likely to influence on ageing and the speed of ageing, since they affect the proportion of current young age group and the future working group.

Given that the impact of government policies, both in the short and long run are not unambiguous, we suggest that:

H4: Government policies targeting health care influence ageing and the speed of ageing.

International aid

The medical aid provided by international organisations plays a vital role in the evolution of both life expectancy and the fertility rate. Cutler *et al.* (2006) disclosed that the massive decline in life expectancy in LDCs was due to HIV/AIDS. Therefore, the HIV/AIDS awareness programs organized by the UN are expected to reduce the fertility rate of LDCs (WHO, 2013). Although such health improvements have a positive effect on LDCs, this type of international aid is expected to increase ageing and the speed of ageing in these countries. In support of this view, Bendavid and Bhattacharya (2014) stated that, instead of reducing the fertility rate, international aid tends to improve life expectancy and reduce child mortality under the age of five. These authors point out that many less developed countries will face a decline in the child mortality rate due to the influence of international aid devoted to the health sector. Thus, the literature reveals that the type of external aid received by the LDCs plays a vital role in determining ageing and the speed of ageing.

Given that international health aid might have two distinct impacts on ageing and the speed of ageing, we suggest that:

H5: The international aid allocated to health care influences ageing and the speed of ageing.

In the case of LDCs, the involvement of international organisations (such as the United Nations, the World Bank, UNICEF, WHO) plays a vital role in the increase in life expectancy and the reduction in the fertility rate (WHO, 2013). The contribution which international bodies make to LDCs in terms of development and humanitarian assistance is expected to improve the life expectancy in these countries (WHO, 2013). Hence, international aid is considered to be an important resource for helping LDCs to improve their economic growth. Authors such as Wamboye *et al*. (2013), stress that the quantity and quality of international aid are crucial for the sustainability of economic growth in African LDCs, especially when we consider the African economies' inability to replicate the growth of LDCs in Asia**,** which is far

ahead of that in African LDCs. In short, we expect that the international aid targeted at improving economic development levels in LDCs will influence the demographic transition in these countries.

H6: The international aid devoted to development is expected to influence ageing and the speed of ageing.

Net Migration

Migration is believed to have a significant influence on countries' demographic transition (Findlay and Wahba, 2013). The majority of the developed countries consider migrants an effective tool in tackling the issue of demographic transition (UNCTAD/LDC, 2011; Findlay and Wahba, 2013; Neumann, 2013). In fact, for a certain period of time**,** population ageing was not observed in certain developed regions due to the net migration gain. Neumann (2013), focusing on Germany, reveals that emigration from certain less developed regions is able to mitigate the problem of population ageing in that country. The increasing demand for the working group from LDCs to overcome the shortage of the working group in developed and developing countries have escalated the speed of ageing among LDCs (UNCTAD/LDC, 2011).

The UNCTAD/LDC (2011) report underlines that some Asian countries, such as India, China, Malaysia, Taiwan and Singapore, play a prominent role in the increasing speed of ageing among LDCs from the Asian region. The report further reveals that there is a higher possibility of Asian LDCs becoming ageing countries before those in Africa. Beyond the increasing demand for labour from LDCs, the rise in migration to more developed countries is also due to natural disasters and political tensions. According to Daumerie and Hardee (2010), the destruction caused by Hurricane Jeanne in 2004 and the Haitian earthquake in 2010 increased the volume and rate of emigration among the working age group in the most affected countries.

Thus, we suggest that:

H7: Emigration is associated with increases in ageing and the speed of ageing in LDCs.

3. Methodological considerations

3.1. The model's specification and the proxies for the relevant variables

Our empirical approach entails the estimation of population ageing and the speed of ageing. The primary aim is to study the determinants of ageing and the speed of ageing for LDCs. Hence, using panel data, we carried out the estimations for both population ageing and the speed of ageing, adopting the same set of determinants. Accordingly, the ageing and speed of ageing specifications are:

$$Ageing_{i(t+j)} = \alpha_i + \beta_1^A\, economic\ performance_{it} + \beta_2^A\, human\ capital_{it} + \beta_3^A\, labour\ market\ participation_{it} + \beta_4^A\, government\ policies_{it} + \beta_5^A\, International\ aid\ on\ health\ care_{it} + \beta_6^A\, international\ aid\ on\ development_{it} + \beta_7^A\, emigration_{it} + \varepsilon_{it} \quad \textbf{(1)}$$

Where subscript *i* denotes LDCs and with *j*=0, 5 and 10 to estimate the determinants of current (*j*=0) ageing, 5-years' time (*j*=5) and 10 years' time (*j*=10) ageing, respectively.

$$Speed_{i(t+10)} = \alpha_i + \beta_1^S\, economic\ performance_{it} + \beta_2^S\, human\ capital_{it} + \beta_3^S\, labour\ market\ participation_{it} + \beta_4^S\, government\ policies_{it} + \beta_5^S\, International\ aid\ on\ health\ care_{it} + \beta_6^S\, international\ aid\ on\ development_{it} + \beta_7^S\, emigration_{it} + \varepsilon_{it} \quad \textbf{(2)}$$

Where, *i* denotes 43 LDCs, and *t* stands for the year.

The analyses were carried out by considering the same set of regressors. Economic performance, human capital, labour market participation, government policies, international health care aid, international aid for development, and emigration from LDCs are the determinants of both ageing and the speed of ageing.
In a shorter version, the specifications are:

$$A_{it} = \alpha_i + X'_{it}\beta + \varepsilon_{it} \quad \textbf{(3)}$$

Where, again, subscript *i* denote LDCs, subscript *t* stands for the year, and *A* stands for the ageing index.[12]

$$SA_{i(t+10)} = \alpha_i + X'_{it}\beta + \varepsilon_{it} \qquad \textbf{(4)}$$

Where *SA* denotes the speed of ageing and is computed as the annual average growth rate of ageing index.[13] For this empirical analysis, we are assuming that the influence of the determinants on the speed of ageing (annual average growth rate of ageing index) will be visible in ten years' time.

The X_{it} are regressors for the independent variables: economic performance, education, human capital, government policies, international aid devoted to health care, international aid devoted to development, and emigration.

The α_i corresponds to random individual specific effects, and ε_{it} is an idiosyncratic error. The α_i may be correlated with X_{it}, covariance $(X_{it}, \alpha i) \neq 0$. Considering fixed estimated effects,[14] we are assuming that the error terms ε_i in these two specifications will be decomposed into a time-invariant unobserved effect (α_i) and an idiosyncratic error term (u_{it}) (Wooldridge, 2010).

$$\varepsilon_{it} = a_i + u_{it} \qquad \textbf{(5)}$$

Independent variables are selected by taking into account the most relevant factors that emerge within economics, ageing and demographic literatures explaining the demographic transition.[15] We have used several proxies for these variables, based on extant literature in this area (*cf.* Section 2). The details are provided in Table 4.1.

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[12] The ageing index is computed as an AI ratio$_t$ = $\frac{\sum \text{Old population}_t \text{ (60 yrs old or over)}}{\sum \text{Individuals aged under } 15_t \times 100}$.

[13] Annual average growth rate is computed as: Growth of AI ratio$_{t+10}$ = $\left(\frac{\text{AI}_{t+10}}{\text{AI}_{t+9}}\right) - 1$.

[14] In fixed effects estimation independent variables are assumed to be fixed across observation units, with fixed effects being computed from the differences observed for each unit across time. Although random effects estimation produces more efficient estimates due to the inclusion of information across individual units and also across time periods, the consistency of these estimations is ensured only if unit-specific effects are not correlated with other explanatory variables. This is not the standard situation, so fixed effects estimation is a sound option choice (Greene, 2011). Note that, considering a random effect specification, for the Hausman test, hypotheses are: H_0: E (X_i, αi) = 0, where X_i = (X_{i1}, X_{i2}, X_{i3}… X_{it}); H_1: E (X_i, αi) ≠ 0, where X_i = (X_{i1}, X_{i2}, X_{i3}…X_{it}). The Hausman test states that, under the null hypothesis, the random effect estimator is consistent and efficient. Whereas, under the alternate hypothesis, the fixed effect estimator is considered consistent.

[15] There are other potential variables that are not included in this analysis due to the lack of data. In particular, certain policies such as transfer payments and tax deductions for children (Angeles, 2010) were not considered for LDCs due to this unavailability.

The ageing index is considered here as a proxy to measure ageing, as this variable takes into account the fertility rate, life expectancy and the child mortality rate. The speed of ageing is measured by computing the annual average growth rate of the ageing index.

In line with the literature, we consider real GDP per capita a proxy to measure countries' economic performance. Since education has a recognized impact in raising life expectancy and diminishing the fertility rate (Angeles, 2010; Murtin, 2013) we use the ratios of student enrolment in primary and secondary schools as proxies for the human capital variable. Besides student enrolment, the adult literacy rate could also be considered a proxy for human capital, as this indicator takes into account adults' understanding and ability to read and write simple statements in their everyday lives. However, since the available data for LDCs are limited, we have opted to use the student enrolment ratio in our analysis.

The participation of women in the labour market is, as explained above, a determinant of both ageing and the speed of ageing, since the involvement of females is expected to decrease the fertility rate of a country (Alders and Broer, 2004; Börsch-Supan, 2013). We use as proxy for this determinant the percentage of females aged 15 and above who are active in the labour force. Health expenditure per capita and the percentage of government spending on health care are considered to be appropriate proxies for government policies. The indicator health expenditure per capita covers the provision of health services, family planning activities, nutrition activities and emergency aid for households. The indicator public expenditure(s) on health care corresponds to government spending from its budget and borrowing for countries' health progress.

The amount of external resources for health care is the proxy for international aid, capturing the dimension that is most important to consider here: medical aid. These external resources for health come from international organizations and other countries through bilateral arrangements. The international aid provided for the development of LDCs is expected to increase the standard of living of their populations (Wamboye *et al.*, 2013). Hence, we assume that the financial aid provided by the Development Assistance Committee (DAC), multilateral institutions and non-DAC countries to promote the economic development of LDCs will

influence the speed of ageing. The variable log net official development assistance is used to measure the growth rate of the net official development assistance.

Table 4.1: Proxies for the determinants considered in the model

Variable	Description	Proxies	Studies
Ageing	Population ageing occurs due to a rise in life expectancy and a fall in the fertility rate. The ageing index is considered as a proxy for ageing. The variable measured by the ratio between the old age group (age above 60) and the young age group (age 0 -14).	Ageing index	Rahman and Ali, 2009
Speed of ageing	Annual growth of the ageing index is used as a proxy to identify the speed of ageing.	Annual growth of ageing index	DESA/PD, 2010
Economic development	A negative relationship between population growth and economic growth is expected. Thus, a rise in the level of economic development is expected to decrease the fertility rate.	Real GDP per capita (in log)	Hodgson, 1988; Bloom and Williamson, 1998; Becker *et al*., 1999; Elgin and Tumen, 2010
Human capital	An increase in the enrollment of students in primary and secondary schools increases life expectancy and reduces teenage pregnancy rates. Hence, a proper education system provides healthy life styles and reduces the (teenage) fertility rate.	Primary student enrolment ratio[1]	Brea, 2003;Angeles, 2010; Murtin, 2013
		Secondary student enrolment ratio[2]	
Labour market participation	The economic progress of a country promotes less altruistic couples. A rise in productivity levels increases the female participation in the labour force. As a result, the rise in the female labour force decreases the fertility rate.	% of total female participation in the labour force	Becker *et al*., 1999; Alders and Broer, 2004; Elgin and Tumen, 2010
Government policies	The rise in health care expenditures per capita indicates the accessibility of households in a country to medical facilities. The rise in the allocation of public expenditure to health care improves medical systems, leading to a reduction in the mortality rate.	Health expenditure per capita	De la Croix and Licandro, 2012; Brinker and Amonker, 2013
		% total government expenditure devoted to health care.	
International aid	International assistance in development for LDCs and the associated contribution to health care increases life expectancy and decreases the fertility rate.	% total external resources devoted to health care	Cutler *et al*., 2006; Porter, 2010;WHO, 2013
		Net official development assistance (in log)	
Migration	Migration of the working age population reduces the proportion of the working age group and the fertility rate of a country.	Total net migration value	UNCTAD/LDC, 2011; Findlay and Wahba, 2013

Notes: [1]Number of student enrolments in primary schools over the total population of official entrance age for primary education; [2]Number of student enrolments in secondary schools over the total population of official entrance age for secondary education.

Immigration has emerged as a temporary measure to overcome the shortages in the working age group due to the ageing problem, not only in developed but also in developing countries (UNCTAD/LDC, 2011). This has encouraged a significant fraction of the working age group in LDCs to migrate to developed and developing

countries, searching for a better standard of living. Hence, we consider that this tendency will be a determinant for the ageing problem in LDCs.

3.2. Data description and summary statistics

We use a panel data set with the ageing index/annual growth rate of ageing index as dependent variables and 10 regressors for 43 LDCs over a period of 23 years, 1990 – 2012. This data was gathered from the World Bank and the United Nations. Data on total annual population by age for LDCs from 1989 to 2012 was collected from the database of the United Nations Department of Economic and Social Affairs (UNDESA) Population Division.[16] Data on the primary and secondary student enrolment ratio for 1990 to 2012 was obtained from the UNESCO statistics database. The remaining data regarding constant gross domestic product (GDP) per capita based on purchasing power parity (PPP), health expenditure per capita (current US$), external resources for health (in % of total external expenditure on health), public health expenditure (in % of total public expenditure), female labour force (in % of total labour force) and the net official development assistance (current US$) for the period from 1990 to 2012 was obtained from the World Bank database. On average, for each of the 43 countries under analysis, the population of the old age group (60 and above) is about 11.3 times higher than that of the young age group**;** within 5 and 10 years that figure will be 11.8 and 12.6 respectively (see Table 4.2). In addition, the speed of ageing for the selected LDCs was 1.0% on average, whereas the mean value of the constant GDP per capita for these same countries is USD 2099.55 ($e^{7.32}$) per year.

From the population that should officially be enrolled in primary/secondary schooling on average only 87.0%/28.0% were in fact enrolled, taking the LDCs under analysis. Furthermore, from the total working population, on average 42.4% are females. Average health expenditure per capita corresponds to USD 36.24 per year, with an average of 10.2% of total government expenditure allocated to health care. The contribution of international bodies to medical aid and development of LDCs can be seen in the following table: on average, the contribution by external sources to health care is 20.1%, while net official development assistance (loans and

[16] The total number of countries considered to be LDCs by the United Nations is 49. From this group, we have removed six countries (Tuvalu, Somalia, South Sudan, Myanmar, Kiribati and Haiti) due to data unavailability. The regional classification for the LDCs followed the United Nations' classification.

grants) contributes an average of 521 million of USD ($e^{19.33}$) per year. Mean net migration is negative, confirming the outflow of workers from these countries.

Table 4.2: Descriptive statistics

Variable	Mean	Standard Deviation	Min	Max
Ageing Index (t)	11.34	2.95	6.07	24.58
Ageing Index (t+5)	11.8	3.7	6.07	29
Ageing Index (t+10)	12.55	4.79	6.76	35.25
Annual growth of ageing index	0.005	0.02	-0.05	0.06
GDP per capita, PPP (constant 2011 international $,in log)	7.32	0.67	4.96	10.6
Primary student enrollment ratio	0.87	0.33	0.04	1.96
Secondary student enrollment ratio	0.27	0.18	0.03	1.53
Female labour force (% total labour force)	42.43	9.38	13.86	56
Health expenditure per capita ($/year)	36.24	72.02	2.07	1138.24
Government expenditure allocated to health care (% total government expenditure)	10.24	6.55	1.12	95.82
External resources allocated to health care (% total external resources)	20.12	17.82	0.02	155.51
Net official development assistance ($/year, in log)	19.33	1.41	9.9	22.65
Net migration (value/year)	-14932.94	107424.1	-800462	818184

4. Empirical Results

In our analysis we studied the issue of ageing and the speed of ageing by considering 43 LDCs for the period 1990 – 2012. The Sargan-Hansen Statistic test was computed to identify the best option between the fixed and the random effect estimator. The Sargan Hansen test conveys a strong rejection of the null hypothesis for all the estimations. (*cf.* Table 4.3).[17]

[17] The Hausman test for the ageing $index_t$ shows p- values equal to 0.0001. While the Hausman test for the ageing index in 10^{th} year and annual growth rate of ageing $index_{t+10}$ demonstrate negative chi-square value. For the prospective ageing index in the 5^{th} year, the test shows that the random effect model is consistent. Since we are considering 43 LDCs as a sample of countries, the countries' specific effects should be taken into account. Hence, we have considered the Sargan -Hansen statistic in our analyses. The Sargan-Hansen statistic carried out to study the robust Hausman test (Arellano, 1993; Schaffer and Stillman, 2010). For the Sargan-Hansen test, under the null hypothesis the random effect estimator is consistent and efficient. Whereas, under the alternate hypothesis, the fixed affect estimator is considered consistent.

In general, our results show that the estimated impact of the independent variables on ageing (ageing index) and the speed of ageing (annual growth of ageing index) are distinct. The growth rate of GDP per capita has a positive and significant impact on the speed of ageing, whereas no significant evidence emerges regarding the impact on the current ageing index. This suggests that current GDP per capita of LDCs does not exert an immediate influence on life expectancy or the fertility rate. However, the results reveal that LDCs with higher development levels (measured by GDP per capita) are on average countries with higher ageing populations and correspond to countries which in 10 years' time will show signs of an increasing rate of ageing. Unlike the evidence gathered for developed countries (Hodgson, 1988; Bloom and Williamson, 1998; Becker *et al*., 1999; Alders and Broer, 2004; Elgin and Tumen, 2010), our results reveal that the influence of GDP per capita on population ageing only emerges from a dynamic perspective, through the impact on the speed of ageing.

Therefore, in short, *H1* (*Economic performance is positively associated with increases in ageing and the speed of ageing of LDCs*) is only partially corroborated by means of our data.

In the case of human capital, one of the proxies considered, the primary student enrolment ratio, fails to explain the impact on current ageing index and the speed of ageing speed. However, the results reveal that LDCs with higher ratio of student enrolment in primary schools are, on average, countries with higher ageing populations in 10 years' time.

The other proxy, the secondary student enrolment ratio, while not being statistically significant in terms of the speed of ageing of LDCs, nevertheless shows a significantly positive influence on the current and future ageing index (at time t, t+5 and t+10). This suggests that the effect of current enrolment of students in secondary schooling is associated with current and future ageing levels of LDCs. This is in line with the extant literature (*e.g*., Malmberg *et al.*, 2006; Angeles, 2010), which identifies education as an important determinant for the rise in life expectancy and reduction in the fertility rate that lead to ageing. This evidence was also gathered by Soares (2006), and further explained by the fact that the rise in human capital produces a significant fall in a country's fertility rate.

Hence, *H2* (*Human capital is positively associated with ageing and the speed of ageing*) is partially corroborated by our data.

Female labour force participation also emerges as positive and significant, in relation to ageing, but not to the speed of ageing.[18] To be precise, on average, a one per cent increase in female labour force participation leads to 0.17 times higher in the current population of the old age group (60 and above) of LDCs' than that of the young age group while all the other variable in the model are held constant.

Moreover, the current level of labour force participation among LDCs is estimated to influence future population ageing (in 5 and 10 years' time).

Concerning this point, our empirical analysis provides a result which is in line with the reasoning of Alders and Broer (2004) and Malmberg *et al.* (2006). These authors argued that the fall in the fertility rate was the joint result of the increase in female participation in the labour force and their higher education levels.

In short, *H3* (*Female labour market participation is positively associated with ageing and ageing speed of LDCs*) is partially corroborated by our data.

Variable health expenditure per capita is statistically significant for both ageing (in current and in 10 years' time) and the speed of ageing. However, the resulting estimates display distinct signs. To be precise, an increase in per capita health expenditure is associated with an increase in the future ageing and speed of ageing but with a decrease in the current ageing. We must recall that the majority of the current LDCs face a rise in the child mortality rate due to chronic diseases such as HIV/AIDS and malaria (WHO, 2009). Thus, the rise in nutrition, health and family planning activities will decrease the child mortality rate**,** which in the short term will have a positive impact on the young age group (from 0 to 14). As a result of this effect, the current ageing index in LDCs is expected to decrease. On the other hand, since per capita health expenditure covers services such as nutrition and family planning activities, the dynamic of these activities is expected to increase the speed of ageing in the medium to long term. Hence, for every US dollar allocated to per capita health care expenditure there will be an increase in the speed of ageing in LDCs.

[18] The trend of female participation in the labour force in LDCs is increasing over time but at a decreasing rate, which may, in part, explain the absence of a relation between female labour market participation and the speed of ageing.

The allocation of government expenditure to health care also impacts positively on ageing, although there was no significant evidence concerning a potential impact on the speed of ageing. It is a fact that allocation of public health expenditure to the curing of chronic illnesses in countries leads to increased life expectancy. As stated in the WHO (2009) report, the majority of LDCs started to treat infectious diseases on their own, as treatment was free for their citizens. The capability of government agencies to increase [the] public expenditure allocated to health thus exerts a positive influence on ageing, although not necessarily on the speed of ageing.

Hence, we find that *H4* (*Government policies targeting health care influence ageing and the speed of ageing.*) is partially corroborated by our data.

The empirical results show a negative relationship between external resources devoted to health care and ageing and the speed of ageing in LDCs. For a one per cent increase in the proportion of external resources allocated to health care, there is a decrease of 0.001% in the annual growth rate of ageing index and 0.021 times fall in the current ageing index. This means that the LDCs that have a higher proportion of external resources allocated to health care will experience an increase in the proportion of the young age group (0-14) instead of the old age group (60 and above). As a result, the rise in the proportion of external resources devoted to health care contributes to a fall in ageing and in the speed of ageing in LDCs. These results might be explained by the fact that many health programs conducted in LDCs by international organizations, such as the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF), have contributed to the improvement in life expectancy, especially in overcoming the problem of child mortality in LDCs (UNICEF and UNAIDS, 2013). Indeed, according to Bendavid and Bhattacharya (2014) and Brea (2003), improvements in medical facilities have increased the survival rate of the new born child.

Besides, it is also understood that improvements in the health service and the service and the awareness of HIV/AIDS programs organized by the international and national NGOs have reduced the child mortality rate of the country (SINAC, 2012).

In short *H5* (*The international aid allocated to health care influences the ageing and the speed of ageing*.) is corroborated by our data.

The development aid provided by the international bodies stands as an important determinant of the speed of ageing.

Table 4.3 : Regressions on ageing and speed of ageing (Fixed effect)

Hypotheses	Independent variables	Dependent variables			
		Annual growth rate of ageing index (t+10)	**Ageing Index (t)**	**Ageing index (t+5)**	**Ageing index (t+10)**
H_1:Economic performance	GDP per capita (log)	0.009***	0.277	0.995***	1.783***
H_2: Human capital	Primary student enrollment ratio	0.0007	0.118	0.339	0.837**
	Secondary student enrollment ratio	-0.0004	3.185***	3.93***	4.99***
H_3: Labour market participation	Female labour force participation (in percentage)	0.0003	0.174***	0.228***	0.307***
H_4: Government policies	Health expenditure per capita	0.00002***	-0.003***	0.00002	0.004***
	Total government expenditure allocated to health care as percentages)	-0.00001	0.0204***	0 .024***	0.036***
H_5: International aid on health care	Total external resources allocated to health care (in percentage)	-0.0001***	-0.021***	-0.027***	-0.032 ***
H_6: International aid on development	Net official development assistance (log)	0.0023***	0.199***	0.334***	0.394***
H_7: Migration	Net Migration (in value)	-1.37e-08***	-1.96e-06***	-2.39e-06***	-3.27e-06***
Constant		-0.117***	-2.598	-12.74***	--23.143***
Obs. (*no. of countries*years*)		43*23=989			
R^2		0.1699	0.222	0.316	0.444
F statistics		21.31 (0.000)	29.7 (0.000)	48.1(0.000)	83.27(0.000)
Sargan-Hansen statistics		25.412(0.0025)	21.098(0.012)	21.28 (0.012)	23.404 (0.005)

Note: The regressions were carried out for the period 1990 – 2012 for 43 LDCs. Estimated coefficients and the *p-values* are calculated using robust standard error. Significance levels*: *** (**)[*] 1%(5%)[10%]*

Indeed, net official development assistance shows a statistically positive influence on ageing and the speed of ageing. To be precise, our result demonstrates that for a one per cent increase in net official development assistance, there is a 0.00002 times increase in the speed of ageing (with a significant level of 1%).

In brief: *H6* (*The international aid devoted to development is expected to influence ageing and the speed of ageing*) is corroborated by our data.

In line with our expectations, results show that net migration exerts a significant influence on ageing and the speed of ageing. Thus, a rise in the number of emigrants (or fall in the number of immigrants) is expected to increase the proportion of the old age group and reduce the fertility rate in LDCs, which means an increase in ageing and the speed of ageing. These results are in line with Schou (2006), UNCTAD/LDC (2011) and Findlay and Wahba (2013). According to these studies, the increasing demand for members of the labour force from LDCs was meant to compensate for the decline in the labour force in developed countries due to the problem of population ageing. Hence, the policies to increase the inflow of immigrants from LDCs resulted in the fall in the proportion of the working age group in these countries.

This means that *H7* (*Emigration leads to increased ageing and speed of ageing*) is corroborated by our data**.**

5. Conclusion

Population ageing is no longer considered to be an issue faced only by developed countries. In fact, the demographic transition is also visible in developing countries (Bloom *et al*., 2011). Moreover, several studies have recently shown that the speed of ageing in LDCs is even faster than in developed and developing countries (Lee, 2003; DESA/PD, 2007; DESA/PD, 2010). Drawing on this evidence, in this paper we identified determinants and the associated mechanisms of ageing and the speed of ageing for LDCs, analysing a time period of 23 years (1990 – 2012). Our empirical results confirm that the phenomenon of an ageing population is not an issue limited to developed and developing countries. Moreover, results show that population ageing in LDCs results from other causes than economic growth, government policies regarding medical improvements and altruistic behaviour of couples. Contrary to what happens in developed countries, the phenomenon in LDCs not only

depends on the determinants that affect more developed economies, but also on the involvement of international bodies and the continuous rise in emigration.

Our results show that some selected determinants have a distinct impact on ageing and the speed of ageing. Specifically, human capital and female labour market participation influences current and future ageing levels but not the future speed of ageing of LDCs. The remaining variables - GDP per capita, health expenditure per capita, net official development assistance and emigration - have an estimated positive influence on both the speed of ageing and the future level of ageing.

Even though our estimation results do not show any evidence of the influence of GDP per capita on the current ageing problem, they do show that GDP per capita plays a significant role in determining future ageing in LDCs. Thus, results show that LDCs with a higher level of GDP per capita will face an increasing speed of ageing and future ageing.

Our analysis clearly shows the relevance of other causes of the ageing phenomenon in LDCs beyond those identified for more developed countries. Results support the view that the type of international aid and emigration from LDCs play vital roles in relation to ageing. The contribution that external resources make to health care increases the numbers in the young age group, as the main purpose of such resources is to overcome the child mortality rate in LDCs. Conversely, for international development assistance, our results demonstrate that the rise in international aid will reduce the numbers of the young age group while increasing those in the old age group. Meanwhile, some policy measures, such as those implemented by developed countries to increase immigration in order to overcome population ageing, have contributed to the reduction of the working age group in LDCs, and consequently have a negative impact on the ageing phenomenon observed in LDCs.

Overall, this empirical analysis has not only confirmed the existence of an ageing problem in LDCs but has also identified determinants of ageing and the speed of ageing in these countries. Contrary to what has been the case in developed countries, the issue of population ageing started to occur in LDCs when economic growth in these countries was still low. Hence, as argued in the related literature (Lee, 2003; DESA/PD, 2007 and DESA/PD, 2010), the impact of the population ageing on LDCs will be severe, as they have a shorter period of time to adjust to the related changes.

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Essay 5: Too poor to age so fast… On the impact of ageing and the speed of ageing on the economic growth of Least Developed Countries, 1990 – 2013

Too poor to age so fast… On the impact of ageing and the speed of ageing on the economic growth of Least Developed Countries, 1990 – 2013

Abstract

Although the issue of population ageing is considered a key factor in economic growth, its analysis has been mostly concentrated in developed countries. Notwithstanding, Least Developed Countries (LDCs) are reaching the transition process faster than those from developed regions, which renders the speed of ageing, beside ageing, a critical variable to explore in this context. Using econometric panel data for 40 LDCs, over a time period of 24 years (1990 – 2013), we assessed the impact of ageing and the speed of ageing on LDCs economic performance.

Our results show that the negative impact of ageing on growth takes time (5-10 years) to occur. Additionally, when we use the growth of the old age dependency ratio as a proxy for the speed of ageing or when we control for the contemporary and lagged levels of ageing, a significant and negative relation between the speed of ageing and the GDP per capita emerges. Such results emphasise the need for urgent public policies that might mitigate the imbalance in LDCs' age structure (higher proportion of the old age group, lower proportion of the young age group and lower proportion of the working age group) before the speed of ageing leads LDCs to become even much poorer.

Keywords: Economic growth, Ageing and speed of ageing, Panel data, Least Developed Countries.

JEL Codes: J11, J14, O40

1. Introduction

One of the greatest accomplishments of medical science in the twentieth century is the dramatic increase in the life expectancy of individuals (Bloom *et al.*, 2010; Lee *et al.*, 2011; Mason and Lee, 2011). However, the continuous rise in life expectancy has led to a growing concern about imbalances in the age structure, most notably, the increase in the proportion of the old age group (Bell and Rutherford, 2013; Börsch-Supan, 2013). Such concerns reflect the risk that some authors have pointed out (*e.g.*, Bloom *et al.*, 2010; Lisenkova *et al.*, 2012; Walder and Döring, 2012), that ageing might undermine the economic growth of countries. Thus, researchers and policy makers are constantly working on assessing the impact of population ageing on economic growth.

The constant rise in life expectancy and the fall in the fertility rate were at the root of a demographic transition (Lee *et al.*, 2011; Alam and Mitra, 2012; Navaneetham and Dharmalingam, 2012). A higher proportion of an older population is expected to impact on the economic growth of countries since individuals' needs, preferences and their physical capability change as they age (Bloom *et al.*, 2010; Lisenkova *et al.*, 2012; Walder and Döring, 2012). Besides, a slow population growth rate is also expected to increase the burden of the working group in terms of paying higher income taxes (Navaneetham and Dharmalingam, 2012). Furthermore, the rise in population ageing diverts government priorities in spending more on the health care system and pensions than on the country's development. As a result, countries with a more aged population tend to face restrictions in economic development (Lindh *et al.*, 2009).

Several studies have classified the majority of the developed countries as ageing countries (Lindh *et al.*, 2009; Bloom *et al.*, 2010; Lee *et al.*, 2011; Göbel and Zwick, 2012; Lisenkova *et al.* 2012). Moreover, Lindh *et al.* (2009) state that the imbalance in the age structure (higher proportion of the old age group and lower proportion of the working age group) in European countries will decrease the GDP per worker and, consequently, affect the overall GDP of the countries.

Although population ageing was initially visible only in developed countries (Harper and Leeson, 2009; Lee *et al.*, 2011), recent demographic studies have uncovered that such a trend is not limited to developed countries alone (Bloom *et al.*, 2010). There are a good number of studies (*e.g.*, Lee, 2003; DESA/PD, 2001; DESA/PD, 2007;

Rahman and Ali, 2009; Bloom *et al.*, 2010) that have highlighted, that the Least Developed Countries (LDCs) are becoming ageing countries at a faster rate than the developed countries. In fact, the United Nation's report showed that the constant medical aid received to overcome chronic illnesses like HIV/AIDS have improved life expectancy in the LDCs (UNICEF and UNAIDS, 2013). Hence, the rise in life expectancy and the fall in the fertility rate have begun to introduce LDCs to the era of an ageing population. Since the speed of ageing in LDCs is faster than that of developed countries (DESA/PD, 2010), and given its potentially negative consequences on the countries' economic growth, we argue that it is crucial to study the impact of ageing and the speed of ageing on the LDCs' economic growth. To the best of our knowledge, such an evaluation has yet to be performed.

In this paper, we aim to study the impact of ageing and speed of ageing on economic growth by considering a number of variables as proxies for ageing and speed of ageing. The paper is structured as follows. Following the Introduction, Section 2 reviews the literature related to the determinants of economic growth and puts forward the main hypotheses for this study. Section 3 presents the model's specification and the proxies for the relevant variables as well as the statistical description of the selected proxies. Section 4 presents the empirical analysis and discusses in detail the results of the analysis. Finally, Section 5 concludes and discusses the main contribution of this paper.

2. The determinants of economic growth and the role of (speed of) ageing: a review

The current demographic transition process is often considered as having a negative effect on economic growth as the proportion of the old age group is higher than the working and young age groups (Lee *et al.*, 2011; Lisenkova *et al.*, 2012; Bell and Rutherford, 2013; Börsch-Supan, 2013; Cuaresma *et al.*, 2014). In fact, Bloom *et al.* (2010) projected that global life expectancy is expected to increase from 65 years to 75 years by 2050. Numerous studies indicate that the ageing population is expected to influence the economic growth of countries through consumption and saving patterns (Mérette and Georges, 2009; Aguila, 2011; Hock and Weil, 2012; Walder and Döring, 2012; Velarde and Hermann, 2014), public expenditures (Tosun, 2003; Elmeskov, 2004; Díaz-Giménez and Díaz-Saavedra, 2009; Yong and Saito, 2012;

Park-Lee *et al.*, 2013), and human capital (Alam and Mitra, 2012; Bell and Rutherford, 2013; Börsch-Supan, 2013; Wu, 2013).

Consumption and the saving patterns of households is considered to have an extensive influence on the rate of economic growth (Nardi *et al.* 2010; Aguila *et al.* 2011; Ewijk and Volkerink, 2012; Hurd and Rohwedder, 2013). In fact, authors such as Samuelson (1958) and Aguiar (2011) have confirmed that the rise in consumption and saving patterns of households are distinct according to the individuals' working and retirement periods. These authors show that the preferences and needs of individuals vary according to their age and their financial ability. Hence, considering the continuous rise in the old age population, it is expected that the demand of households on goods and services may shift towards some specific sectors (*e.g.*, medical services).

Furthermore, in the case of the USA, Bernheim *et al.* (2001) empirically show significantly negative relationship between consumption and retirement. The authors found that between 1978 and 1990 there was extensive discontinuity in consumption at retirement. Therefore, they inferred that the rise in retirees negatively affected consumption and economic growth.

Moreover, researchers such as Lee and Mason (2007) reveal that the increase in old age dependency is likely to raise the tax burden of the shrinking working age group. As the consumption of the working age group is comparatively higher than the old age group, the rise in the tax burden tends to reduce their purchasing power and, consequently, impact (negatively) on economic growth.

Similarly to consumption, the savings patterns of working individuals and retirees are expected to fall due to the rise in the ageing population (Lee and Mason, 2007; Davies and Robert III, 2006). According to Davies and Robert III (2006), a rise in the old age population tends to reduce overall private saving since saving becomes the main source of spending for an individual during their old age period.

Overall, ageing is seen to change the consumption and saving patterns of households and expected to affect the rate of economic growth.

Eiras and Niepelt (2012) and Lisenkova *et al.* (2012) reveal that the rise in the ageing population has increased the need for public authorities to allocate more resources to the health care system than to the factors that are positively impact on the

development of countries. Thus, excessive allocation to health care due to the existence of an ageing population is expected to induce a substantial fall in the rate of economic growth (Bettendorf *et al.*, 2011; Thiébaut *et al.*, 2013).

Moreover, the rise in the ageing population is likely to reduce the tax revenue as the number of working group individuals (active income tax contributors) becomes smaller than that of the dependency group. In fact, countries that follow a pay-as-you-go system are considered to face a higher risk of having increasing deficits in government budgets (Tosun, 2003; Elmeskov, 2004; Díaz-Giménez and Díaz-Saavedra, 2009; Yong and Saito, 2012; Park-Lee *et al.*, 2013), which will eventually become completely unsustainable (Díaz-Giménez and Díaz-Saavedra, 2009; Aguila, 2011) and is expected to undermine the rate of economic growth.

Ageing is also likely to affect economic growth through human capital due to the fall in the proportion of the current and future working group (the fall in current fertility reduces the size of the future working group). Specifically, the fall in the working group reduces the productivity level of workers (Lisenkova *et al.*, 2012). Additionally, the priority of government agencies in allocating higher budgets to health care and social services rather than to education and skill training programs is expected to further decrease the workers' productivity level in the labour market (Lisenkova *et al.*, 2012). Authors such as Lisenkova *et al.* (2012) reveal that population ageing tends to decrease a country's stock of human capital and, subsequently, lead to lower economic growth.

However, authors such as Bloom *et al.* (2010) and Peng and Fei (2013) stress that the fall in the number of participation in the labour market may no longer be an issue if there is an increase in the retirement age or immigration. Besides, Bloom *et al.* (2010) further evidence that the rise in life expectancy due to better health will enable individuals to work for a longer period of time without facing a decrease in productivity level. Therefore, unlike some other authors (Cardoso *et al.*, 2011; Göbel and Zwick, 2012; Lisenkova *et al.*, 2012; Garau *et al.*, 2013), Bloom *et al.* (2010) stress that the rise in the retirement age of workers may not affect the productivity level of the labour force.

Despite the latter remark, we hypothesize that:

H1: Ageing will impact negatively on the economic growth of LDCs'

The process of demographic transition towards an ageing population is no longer limited to developed countries. In fact, there are a number of studies which have proved that less developed countries are reaching the transition process faster than those from developed regions (Lee, 2003; DESA/PD, 2007; DESA/PD, 2010). The rise in life expectancy and the fall in the fertility rate due to medical advancement and the altruistic behaviour of couples are considered as the main reason for ageing (Lee *et al.*, 2011; Alam and Mitra, 2012; Navaneetham and Dharmalingam, 2012). In addition, some authors believe (*e.g.*, Meier and Werding, 2010; Brinker and Amonker, 2013) that the improvement in the health care system, education, and modernization accompanied by access to family planning information and services, have played a vital role in lowering the fertility rate and increasing life expectancy of LDCs.

However, unlike developed countries, the determinants of an ageing population in LDCs do not include medical advancement and altruistic behaviour of couples alone (Lee, 2003; UNCTAD/LDC, 2011). The rise in the migration of the working group (UNCTAD/LDC, 2011) and the involvement of international bodies (WHO, 2013) are important explanatory factors for the rising speed of ageing in LDCs (cf. Essay 4). Furthermore, a United Nations report reveals that the migration of working group individuals from LDCs to developed and developing countries is expected to create a decreasing pattern for the working group (UNCTAD/LDC, 2011). The United Nations (DESA/PD, 2007) report further stressed that the impact of population ageing for LDCs will be more profound compared to that in developed countries as they will have a shorter period of time to adapt to the changes associated with population ageing.

We therefore assume that:

H2: The speed of ageing will influence the economic growth of LDCs.

Beside ageing and speed of ageing there are a myriad of other factors likely to influence the economic growth of countries. Indeed, Moral-Benito (2012) argues that there are more than 140 variables considered as key determinants of economic growth. Among these, the most commonly referred to as the main determinants of economic growth are: initial GDP (Barro, 1990; Moral-Benito, 2012), rates of human capital accumulation (Becker, 1974; Hanushek and Woessmann, 2012; Boccanfuso *et al.*, 2013), physical capital investment (Beck *et al.* 2000; Rousseau and Wachtel

2000; Beck and Levine 2004), institutions (Alesina *et al.*, 1996; Fatás and Mihov, 2013), public expenditures (Barro, 1990; Zhang 2014), and population growth (Becker *et al.*, 1990; Brueckner and Schwandt, 2014). In the present paper we consider these variables as control variables.

3. Methodological considerations

3.1. Model's specification and the proxies for the relevant variables

To capture the impact of ageing and speed of ageing on the economic growth of LDCs, we have chosen panel data estimation. This method serves to analyse a set of variables for a larger number of countries over a long period of time. In order to study the impact of ageing and speed of ageing on economic growth in 40 LDCs over the period from 1990 to 2013, we have developed three different models.

In the first model we test the impact of ageing on economic growth:

$$Economic\ growth_{it} = \alpha_i + \beta_1\ ageing_{i(t-j)} + \beta_2\ human\ capital_{it} + \beta_3\ physical\ capital_{it} + \beta_4\ institutions_{it} + \beta_5 public\ expenditures_{it} + \beta_6\ population\ growth_{it} + +\varepsilon_{it} \quad \textbf{(1)}$$

Where *i* denotes the LDCs and *t* stands for the year. With *j* represent 0, 5 and 10 to define the current (*j*=0) and lagged value of ageing (with *j*=5 represent 5-years' lagged and *j*=10 represent 10 years' lagged).

In the second model we analyse the impact of the speed of ageing on economic growth:

$$Economic\ growth_{it} = \alpha_i + \beta_1\ speed\ of\ ageing_{i(t-j)} + \beta_2\ human\ capital_{it} + \beta_3\ physical\ capital_{it} + \beta_4\ institutions_{it} + \beta_5 public\ expenditures_{it} + \beta_6\ population\ growth_{it} + +\varepsilon_{it} \quad \textbf{(2)}$$

Where, *i* denotes the LDCs and *t* stands for the year. With *j* represent 0, 5 and 10 to define the current (*j*=0) and lagged value for the speed of ageing (with *j*=5 represent 5-years' lagged and *j*=10 represent 10 years' lagged).

Finally, in the third model, we assess the impact of ageing and speed of ageing on economic growth:

$$Economic\ growth_{it} = \alpha_i + \beta_1\ ageing_{i(t-j)} + \beta_2\ speed\ of\ ageing_{i(t-j)} + \beta_3\ human\ capital_{it} + \beta_4\ physical\ capital_{it} + \beta_5\ institutions_{it} + \beta_6 public\ expenditures_{it} + \beta_7\ population\ growth_{it} + +\varepsilon_{it} \quad \textbf{(3)}$$

Where *i* denotes the LDCs, and *t* stands for the year. With *j* represent 0, 5 and 10 to define the current (*j*=0) and lagged value of ageing and the speed of ageing (with *j*=5 represent 5-years' lagged and *j*=10 represent 10 years' lagged).

In a shorter version, the specifications are as follows:

$$Y_{it} = \alpha_i + X'_{it}\beta + \varepsilon_{it} \quad \textbf{(4)}$$

Where, again, subscript *i* denotes LDCs, subscript *t* stands for the year, and *Y* stands for economic growth. The X_{it} are regressors for the independent variables and they are: ageing, speed of ageing, human capital, physical capital, institutions, public expenditures and population growth.

The α_i corresponds to random individual-specific effects and ε_{it} is an idiosyncratic error.

Using panel data with a fixed effects estimator, we are assuming that the error terms will be decomposed into a time-invariant unobserved effect (α_i) and an idiosyncratic error term (u_{it}) (Wooldridge, 2010).[19]

$$\varepsilon_{it} = a_i + u_{it} \quad \textbf{(5)}$$

The relevant proxies (both for the dependent and independent variables) were selected based on the extant literature (*cf.* Table 5.1).

[19] In fixed-effects estimation, independent variables are assumed to be fixed across observation units, with fixed effects being computed from the differences observed for each unit across time. A Hausman test was implemented to sustain the choice between the fixed and random effect models. In the Hausman test, the hypotheses are: H_0: E (X_i, αi) = 0, where X_i = (X_{i1}, X_{i2}, X_{i3}… X_{it}); H_1: E (X_i, αi) ≠ 0, where X_i = (X_{i1}, X_{i2}, X_{i3}…X_{it}). The Hausman test states that, under the null hypothesis, the random effect estimator is consistent and efficient, whereas, under the alternate hypothesis, the fixed effect estimator is considered consistent.

Specifically, to measure the dependent variable (country's economic performance), we consider the real GDP per capita based on purchasing power parity (PPP) (Acemoglu and Johnson, 2007). The ratio of student enrolment in primary and secondary school is used as proxies for the human capital variable in line with Alesina *et al.* (1996), Li and Zhang (2007) and Fatás and Mihov (2013). Gross capital formation is used as a proxy for physical capital investment (*cf.* Brander and Dowrick, 1994; Moral-Benito, 2012), which is considered a perfect representative of physical capital investment, as it takes into account fixed assets of the economy and inventories of goods owned by firms to meet temporary production (World bank, 2014).[20] For the institutional variables, we have considered the civil freedom index and political rights index from "Freedom House" (Moral-Benito, 2012). The civil freedom index and the political rights index reflect the quality of a country's institutions. They are measured using a scale from 1 to 7, with 1 being the highest freedom level and 7 the lowest freedom level. Thus, the freer and fairer a country, the lower these indexes will be and (hypothetically) the higher the economic growth performance of a country (Moral-Benito, 2012).

General government final consumption expenditure on GDP is taken as a proxy to study the influence of the weight of the government/state on the countries' economic performance, as the variable includes all current government expenditures for purchasing goods and services. Similar to several studies (*e.g.*, Moral-Benito, 2012; Coccorese and Silipo, 2014; Cuaresma *et al.*, 2014), population growth is computed as the annual relative variation in total resident population in a country.

Ageing (and the speed of ageing) is proxied by three distinct variables: life expectancy, the ageing index (AI),[21] and the old age dependency ratio (OAD).[22]

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[20] World Bank, (2014) "Gross capital formation (% of GDP)", in http://data.worldbank.org/indicator/NE.GDI.TOTL.ZS, accessed on 5th October 2013.

[21] Ageing index is computed as AI ratio$_{it}$ = $\frac{\sum \text{Old population}_t \text{ (60 yrs old or over)}}{\sum \text{young age Individuals}_t \text{ (aged 0 } -14)\times 100}$, while the annual average growth rate is computed as: Growth of AI ratio$_{it}$ $= \left(\frac{\text{AI}_{(t+j)+i}}{\text{AI}_{(t)+i}}\right) - 1$, with ***i*** denoting LDCs and ***t*** denoting the year..

[22] The old age dependency ratio is computed as OAD ratio$_{it}$ = $\frac{\sum \text{Old population}_t \text{ (60 yrs old or over)}}{\sum \text{working Individuals}_t \text{ (aged 15 } -64)\times 100}$, while the annual average growth rate is computed as: Growth of OAD ratio$_{it}$ $= \left(\frac{\text{OAD}_{(t+j)+i}}{\text{OAD}_{(t)+i}}\right) - 1$, with ***i*** denoting LDCs and ***t*** denoting the year.

Table 5. 1: Empirical studies on economic growth (selection of proxies for variables)

Studies	Period	Countries (#)	Estimation Method	Proxy for the dependent variable (*economic growth*)	Proxies for the relevant independent variables
Mankiw *et al.* (1992)	1960-1985	98 countries excluding oil exporters (Summers and Heston, 1988)	OLS regression	Logarithm of GDP per working age population 1960-1985	Human Capital: Working age population with secondary education (%) Physical Capital: Investment in physical capital (% GDP)
Brander and Dowrick (1994)	1961 - 1985	107 countries	Pooled OLS, Fixed effect and random effect	Growth rate of GDP per capita	Population growth: 5-year population growth rate, share of population of working age (15 – 64) Physical capital: Investment (% share of the GDP)
Alesina *et al.*(1996)	1950 - 1982	113 countries	Amemiya's generalized least squares technique (AGLS)	GDP per capita	Initial GDP: GDP per capita$_{(t-1)}$ Institution: Democracy (dummy variables), executive adjustment, government change Human capital: Percentage of school age population enrolled in primary school
Acemoglu and Johnson (2007)	1940 - 2000	47 countries	OLS regression Two stage least square (2SLS) regression	Log GDP	Ageing: Log life expectancy Initial GDP: Initial log GDP
				Log GPD per capita	
				Log GPD per working age population	
Li and Zhang (2007)	1978 - 1998	China	System GMM approach	First difference of Log GDP	Initial GDP: Five-year lagged Log GDP Human capital: Secondary-school enrolment Population growth: Birth rate and In-migration rate Ageing: youth dependency ratio and in-migration rate Physical capital: Investment share and Trade share Public expenditures: Government spending share (1983 – 1998)
Lindh and Malmberg (2009)	1950 - 2004	EU 15 (excluding Luxemburg)	Pooled OLS	Growth rate of real GDP per worker (divided by the country- and period-specific convergence term)	Initial GDP: initial level of GDP per worker Physical capital: log average investment share Ageing: population share of age group (65 and above)
				GDP per capita (1940 – 2000)	Ageing: Ln life expectancy, Ln life expectancy*Post-transitional and Ln life expectancy *Pre-transitional
Bloom *et al.* (2010)	1960 - 2005	Asian countries	OLS	Five- year growth rate of income per capita	Initial GDP: Log real GDP per capita Human capital: Average years of secondary schooling Population growth: Total fertility rate, Infant mortality rate Ageing: Old-age share, Life expectancy Institution: Freedom House Polity Index

(....)

Authors (year)	Period	Countries (#)	Estimation Method	Proxy for the dependent variable (economic growth)	Proxies for the relevant independent variables
Choudhry and Elhorst (2010)	1961–2003	70 countries	Fixed effect estimator	Growth rate of GDP per capita (constant PPP)	Initial GDP: Log initial GDP per capita Population growth: Growth differential between working-age population and total population Ageing: Log of old-age dependency ratio, Log of child dependency ratio
Cervellati and Sunde (2011)	1940 - 2000	47 countries (25 pre-transitional & 22 post-transitional)	OLS regression	GDP per capita (1940 – 1980)	Ageing: Ln life expectancy , Ln life expectancy*Post-transitional and Ln life expectancy *Pre-transitional
				GGDP per capita (1940 – 2000)	Ageing: Ln life expectancy , Ln life expectancy*Post-transitional and Ln life expectancy *Pre-transitional
Boccanfuso *et al.* (2012)	1970 - 2000	22 African countries	GLS regression, Fixed effect and random effect estimator	GDP per capita	Human capital: average number of years of schooling of those aged 25 years or older, average number of years of schooling at the primary level, average number of years of schooling at the secondary level, average number of years of schooling at the higher education level,
Hanushek and Woessmann (2012)	1960 - 2000	OECD countries	2 stage least square (2SLS)	Average annual growth rate of GDP per capita	Initial GDP: initial GDP per capita, Human capital: Initial years of schooling
Moral-Benito(2012)	1960-2000	73 countries	Bayesian averaging of maximum likelihood estimates	Growth rate GDP per capita	Initial GDP: Log initial GDP per capita Human capital: Secondary Education Population growth: Population, population under 15, Urban population, population density, population growth, population over 65 Physical Capital: Investment share, trade openness Institutions: Civil Liberties, Political Rights Ageing: Life Expectancy, population over 65 Public expenditure: Government consumption share
Fatás and Mihov (2013)	1970 - 2007	93 countries	OLS regression	Growth Rate of Output per Capita	Initial GDP: Initial GDP per capita Human capital: Primary enrollment Institution: policy volatility (log of the standard deviation of the policy residuals from 1970 to 2007) Investment: Investment price
Coccorese and Silipo (2014)	1960 - 2010	Italy	Least square estimation	Average compounded rate of growth of real value added (for each region and each sector)	Human capital: Education (high school student to population age 15 – 19) Population growth: Population growth Public expenditure: Log of per capita public consumption
Cuaresma *et al.* (2014)	1970 - 2010	European countries	Fixed effect estimator	Growth rate of GDP per capita 5-year period	Population growth: Population growth Physical capital: Physical Capital growth Ageing: prospective old age dependency ratio (POADR)
				Growth rate of GDP per capita 10-year period	Population growth: Population growth Physical capital: Physical Capital growth Ageing: prospective old age dependency ratio (POADR)
				Growth rate of GDP per capita 20-year period	Population growth: Population growth Physical capital: Physical Capital growth Ageing: prospective old age dependency ratio (POADR)

The AI is referred as a good proxy for analysing the dynamics of population ageing, since it takes into account both life expectancy and fertility rate, which was considered as a main causes of population ageing (Lee *et al*., 2011; Alam and Mitra, 2012; Navaneetham and Dharmalingam, 2012). To account for the speed of ageing, we compute the annual growth rate of the AI and of the OAD ratio.

It is important to recall that using only the growth rate of the AI, we would not be able to fully account for the effect of the speed of ageing on economic growth since the variable does not address the changes in the working age population. Unlike developed countries, the existence of population ageing in less developed countries is associated with the migration of the working age population (cf. Essay 4). Hence, along with the annual growth rate of the AI, the annual growth rate of OAD should be included in the analysis.

3.2. Data description and summary statistics

We use a panel data set with the GDP per capita as dependent variables and 16 regressors for 40 LDCs over a period of 24 years (1990 – 2013).[23] The data was gathered from the World Bank, United Nations and Freedom House database. To compute the AI and OAD, we have collected total population by age group (annually) from the database of the Population Division of the United Nations' Department of Economic and Social Affairs (UNDESA), from 1980 to 2013 for the LDCs.[24] Data on the primary and secondary student enrolment ratios were obtained from the UNESCO statistics database for the period from 1990 to 2013. The data on political rights and civil liberties were obtained from the database of Freedom House. The remaining data regarding constant gross domestic product (GDP) per capita based on purchasing power parity (PPP), capital formation on GDP, government consumption on GDP, population growth and life expectancy, were retrieved from the World Bank database for the period from 1990 to 2013.

[23] The independent variable initial GDP per capita were not considered in the analysis due to the unavailability of data for all the 40 LDCs.

[24] The regional classification for the LDCs followed the United Nations' classification. The total number of LDCs considered by the United Nations is 49. From this group, we have removed nine countries (Tuvalu, Somalia, South Sudan, Myanmar, Kiribati, Lao PDR, Samoa, Timor-Leste and Haiti) due to data unavailability.

The descriptive analyses show that the average GDP per capita for the 40 LDCs is USD 2089.86 ($e^{7.295}$) per year (*cf.* Table 5.2). In terms of life expectancy, the average life span of an individual born in the LDCs is 54 ($e^{3.986}$) years for the period from 1990 to 2013. The average population of the old age group (aged 60 years and over) is about 11.3 times higher than the young age group for each of the 40 countries, a value that is higher than the mean for the past 5- and 10-year periods (with an average of 11.0). The ageing index has been increasing annually over the period in analysis, on average, at a rate of 0.5%, whereas the annual average growth of the old dependency ratio is -0.2% for the past 5- and 10-year periods.

Table 5. 2: Summary statistics

Variable	Mean	Standard Deviation	Min	Max
GDP per capita, PPP (constant 2011 international $, in log)	7.295	0.677	4.956	10.601
Life expectancy (in log)	3.986	0.142	3.287	4.2758
Ageing index $_{(t)}$	11.255	2.973	6.073	25.389
Ageing Index $_{(t-5)}$	11.036	2.519	6.073	21.724
Ageing Index $_{(t-10)}$	10.999	2.38	6.073	21.947
Annual growth of ageing index $_{(t)}$	0.005	0.016	-0.049	0.062
Annual growth of ageing index $_{(t-5)}$	0.002	0.016	-0.051	0.062
Annual growth of ageing index $_{(t-10)}$	0.0002	0.015	-0.056	0.062
Annual growth of old age dependency ratio$_{(t)}$	-0.002	0.015	-0.066	0.092
Annual growth of old age dependency ratio$_{(t-5)}$	-0.002	0.015	-0.066	0.092
Primary student enrolment (in ratio)	0.861	0.336	0.036	1.956
Secondary student enrolment (in ratio)	0.264	0.171	0.029	1.533
Capital formation in GDP	0.231	0.202	-0.024	2.275
Political rights (1: the highest level…, 7: the lowest level)	4.666	1.7401	1	7
Civil liberties (1: the highest level…, 7: the lowest level)	4.513	1.325	1	7
Government consumption in GDP	0.159	0.122	0.021	1.386
Population growth	0.027	0.012	-0.073	0.108

In terms of human capital dynamics, the average primary/secondary school enrolment stands at 86.0%/26.0% of the total population that officially should be enrolled in those levels. Additionally, the average share of physical investment in GDP is, for the whole period in analysis, 23%. The quality of the LDCs' institutions shows an average of 4.7 for political rights and 4.5 for civil liberties.

This means that, according to the Freedom House classification, the average degree of freedom for the 40 LDCs might be considered "partly free".

The analyses also show that the average consumption by LDC governments was 16% of the total GDP. The average annual population growth in LDCs over the period in analysis was 2.7%, ranging from a minimum of -7.3% and a maximum of almost 11%.

4. Empirical results

4.1. General considerations

For the empirical analyses, we examined the impact of ageing and the speed of ageing on the countries' economic growth with three distinct groups of econometric specifications: A) impact of ageing on economic performance; B) impact of the speed of ageing on economic performance; and C) impact of ageing and the speed of ageing on economic performance.

Including the relevant control variables (lower part of Table 5.3) for each group of specifications, we first estimated a model for ageing (speed of ageing) with a set of proxies (Models A1 & A2, B1 & B2). Then, we estimated specifications by including both ageing and speed of ageing (Models C1 & C2).

Instead of Hausman Test, the Sargan-Hansen Statistic test was computed to identify the best option between the fixed and the random effect estimator.[25] The Sargan Hansen test for the three groups of specifications conveyed a strong rejection of the null hypothesis that the random effect provides a consistent estimator (*cf.* Table 5.3).

4.2. Empirical Results

In general, by observing the *F statistics* and respective *p-values* for all the estimated specifications, we can conclude that they are globally significant.

The estimates for the 40 LDCs show a significantly positive relationship when considering life expectancy as a proxy to test the impact of ageing on economic

[25] The chi-square result from the Hausman test yielded a negative value for majority of the analyses. Hence, we have considered the Sargan-Hansen statistic in our analyses. The Sargan-Hansen statistic carried out to test for the orthogonality condition (overidentifying restriction) for the panel data (Arellano, 1993; Schaffer and Stillman, 2010). The Sargan-Hansen test states that, under the null hypothesis, the random effect estimator is consistent and efficient, whereas, under the alternative hypothesis, the fixed affect estimator is considered consistent.

growth.[26] This means that, on average, all the remaining factors held constant, a country with high life expectancy tends to experience high economic growth. In concrete, the results show that for an additional increase of one per cent in life expectancy there will be an increase of 1.74% in the LDCs' GDP per capita. Unlike with the findings by Lisenkova *et al.* (2012), our results evidence that the participation of the old age population in the labour market will influence positively economic growth without jeopardizing their productivity level. Similarly to Bloom *et al.* (2010), we found that the rise in life expectancy (which might, at least partially, be explained by a better health system), has led the old age group to be actively engaged in the labour market and has thus contributed to an increase in the GDP per capita.

As such, when considering life expectancy as a proxy for ageing, *H1* (*Ageing will impact negatively on the economic growth of countries*) is not corroborated by our data.

Alternatively, when considering the ageing index as a proxy for ageing, we find that, although the impact of the current ageing index is positive, the lagged (5- and 10-year periods) values of the ageing index evidence significantly negative impact on the GDP per capita. Thus, in line with Alders and Broer (2004) and Bloom *et al*. (2009), the fall in the current fertility rate is expected to increase female participation in the labour market and subsequently influence (positively) economic growth. However the lagged values, reveals that the past (lagged five or ten years) rise in the proportion of the old age group and the fall in the proportion of the young age group tend to decrease the LDCs' current economic performance. Thus, similar to Weil (2006), Lee *at al*. (2011) and Alam and Mitra (2012), our result explains that the declining fertility rate may increase the present population with many working age individuals and decrease the future population with many working age individuals as the current young age group will be the successor of the future working age group. Thus, even though the changes in the current proportion of the old age group and young age group are expected to boost the economic growth of LDCs, the prolonged ageing over the past 5- or 10-year periods are expected to decrease the LDCs' current GDP per capita. Therefore, our result

[26] Since AI, growth of AI, OAD and growth of OAD take into account the life expectancy (old age population), in model C, we did not include the life expectancy variable in the analysis.

proved that, in the case of the LDCs, the negative impact of ageing is not contemporaneous but rather that it takes time to occur (5-10 years).

In short, *H1* (*Ageing will impact negatively on the economic growth of countries*) is partially corroborated by our data.

With regard to the specifications accounting for the impact of the speed of ageing on economic growth (Models B), the estimates associated with the current and 5-year lagged annual average growth rate of the ageing index yield a positive and significant result. Hence, unlike concerns in Lee (2003) and the United Nations reports (DESA/PD, 2007, 2010), by considering other variables held constant, on average, the LDCs that experiencing a higher speed of ageing (both contemporaneous and within a short period of time) tend to grow faster in economic terms.

Furthermore, these results are again in line with Bloom *et al*. (2009), who establish that the fall in the proportion of the young age group will tend to increase female participation in the labour market and consequently increase the productivity level of the country.

Interestingly, when considering a longer period of time (10 years), the lagged variable of the speed of the ageing index reveals a statistically significant and negative impact on GDP per capita. Our estimates convey that LDCs which experienced higher growth in the old age group and a fall in the fertility rate 10 years ago tend to observe a decrease in their present economic performance. In fact, this result is in accordance with the concerns of Lee (2003) and the United Nations reports (DESA/PD, 2007, 2010).

A significant and negative relation between the speed of ageing and the GDP per capita also emerges when we consider the growth of the old age dependency ratio (both in current and 5-year lags). This result emphasises that LDCs facing a fall in the working age group are those with declining growth performance. In fact, our result is in accordance with the arguments of Schou (2006), UNCTAD/LDC (2011), and Findlay and Wahba (2013), that the increasing demand from developed countries for the LDCs' labour force (*i.e*., emigration) negatively affects the participation of the working age group in LDCs and thus their economic growth. Hence, it is found that the labour force participation has a substantial influence on the economic growth of LDCs. Unlike the theory of Elgin and Tumen (2010), our

empirical result shows that the economic performance of the LDCs relies more on the working age group. As such, regardless of how we proxy the speed of ageing in model B, *H2* (*The speed of ageing will influence the economic growth of LDCs*) is corroborated by our data.

In general, the results described above do not significantly change the level of ageing when we estimate the third group of econometric specifications (*cf.* Model C) which include both the ageing and the speed of ageing variables. However, when we estimate specifications including the contemporaneous and the relevant lagged variables for speed of ageing, the annual growth of the $AI_{(t)}$ and the annual growth of the $AI_{(t-5)}$ reveal a significantly negative effect on economic growth, whereas the annual growth of the $OAD_{(t-5)}$ fails to yield a significant relationship. This result means that, when we control for both contemporary and lagged levels of ageing, the impact of the speed of ageing (Annual growth of $AI_{(t)}$ and Annual growth of $AI_{(t-5)}$) on economic growth will be negative. Therefore, unlike Model B and regardless of how we proxy the speed of ageing for Model C, *H2* (*The speed of ageing will influence the economic growth of LDCs*) is partially corroborated by our data.

Regarding the control variables, we found that investment in human capital at the level of secondary schooling positively impacts on economic growth. Our results are in line with findings by Becker (1974), in that investment in human capital provides talented and competent workers who will contribute positively to economic growth.

Similar to human capital, physical capital investment also proved to be an important factor for the economic growth of a country. For our sample, LDCs with high investment rates present, on average, lower economic growth (when represented as GDP per capita). Such an unexpected significantly negative relation between investment share/capital formation in GDP per capita might be due to inefficiencies in the investment decisions in these countries (Badunenko *et al*., 2014; Caballe and Santos, 2014). Although the political rights variable fails to show a significant influence on the GDP per capita, civil liberties (where lower values represent a higher level of freedom) estimates emerge as statistically significant reflecting that freer LDCs are more likely to experience higher economic performances.

Table 5. 3: **Estimation of the impact of ageing and the speed of ageing on economic growth (dependent variable: GDP per capita (in log)) (Fixed effect)**

		Ageing		Speed of ageing		Ageing and speed of ageing	
Variable	**Proxy**	**Model A1**	**Model A2**	**Model B1**	**Model B2**	**Model C1**	**Model C2**
Ageing	Life expectancy (in log)	1.740***					
	Ageing index (t)		0.177***			0.241***	0.183***
	Ageing Index (t-5)		-0.183***			-0.125***	-0.184***
	Ageing Index (t-10)		-0.095***			-0.220***	-0.099***
Speed of ageing	Annual growth of ageing index (t)			6.606***		-2.229**	
	Annual growth of ageing index (t-5)			5.352***		-7.572***	
	Annual growth of ageing index (t-10)			-1.826**		-6.061***	
	Annual growth of OAD (t)				-1.815**		-3.088***
	Annual growth of OAD (t-5)				-1.429**		-0.840
Human Capital	Primary student enrollment (in ratio)	-0.369***	-0.097*	0.050	-.0640	-0.029	-0.106**
	Secondary student enrollment (in ratio)	0.629***	0.651***	0.636***	0.846***	0.611***	0.637***
Physical capital	Capital formation on GDP (in proportion)	-0.357***	-0.012	-0.193***	-0.257***	-0.015	0.013
Institution	Political rights (1: the highest level…, 7: the lowest level)	0.005	-0.016*	-0.010	0.013	-0.016*	-0.013
	Civil liberties (1: the highest level…, 7: the lowest level)	-0.099***	-0.069***	-0.070***	-0.09***	-0.056***	-0.068***
Public expenditure	Government consumption on GDP (in proportion)	-0.132	-0.049	-0.314***	-0.232***	-0.089	-0.019
Population growth	Population growth	-5.818***	-2.324***	-2.922***	-3.844***	-2.332***	-1.728***
Constant		1.194**	8.735***	7.670***	7.666***	8.678***	8.684***
	Obs. (*no. of countries*years*)	960	960	960	960	960	960
	R^2	0.323	0.446	0.296	0.212	0.478	0.461
	F statistics	54.31 (0.000)	73.13 (0.0000)	38.16 (0.0000)	27.28 (0.0000)	63.81 (0.0000)	64.78 (0.0000)
	Sargan-Hansen statistic	52.09 (0.0000)	64.837 (0.0000)	41.599 (0.0000)	42.061 (0.0000)	70.664 (0.0000)	69.126 (0.0000)

Notes: The regressions were carried out for the period 1990 – 2013 for 40 LDCs. Estimated coefficients and the *p-values* are calculated using robust standard error. Significance levels*:* *** (**)[*] 1%(5%)[10%]

Finally, for government consumption, our results evidence statistically significant and negative relation for Model B and insignificant relationship for Model A and C. In fact, the negative relation obtained in Model B aligned with the argumentation by Barro (1991). According to the author, higher public consumption may create market distortions and crowding out effects on private investment yielding negative effects on economic growth.

The population growth variable shows a negatively significant relationship for GDP per capita in all 6 models. The result reveals that an increase in population growth

is associated to a decrease in economic growth. Related to this point, our empirical analysis provides a result which is similar to findings by Bloom *et al.* (2001) and Brueckner and Schwandt (2014). Hence, it is expected that countries with a higher population growth will experience lower economic growth due to scarcity in food supplies and natural resources.

Conclusion

Ageing and the problems related to ageing have been more widely studied in developed countries. However, it has recently become clear that ageing is no longer limited to developed countries alone (Mason and Lee, 2013). Currently, the issue and the impact of ageing are already visible in developing and underdeveloped countries. Hence, focusing on the issue of ageing and speed of ageing in LDCs and their consequences on economic growth, we have carried out empirical analyses for 40 LDCs for the year 1990 to 2013.

For this empirical study, we have considered a number of proxies for ageing (life expectancy, $AI_{(t)}$, $AI_{(t-5)}$, $AI_{(t-10)}$) and speed of ageing (annual average growth of $AI_{(t)}$, annual average growth of $AI_{(t-5)}$, annual average growth of $AI_{(t-10)}$, annual average growth of $OAD_{(t-5)}$, annual average growth of $OAD_{(t-10)}$). In general, our results are in line with much of the literature on the matter (Lee, 2003; Fougère *et al*., 2009; Bloom *et al*., 2010; Sharpe, 2011; Lisenkova *et al*., 2012; Walder and Döring, 2012), namely that ageing and speed of ageing have a significant impact on economic growth.

Among the selected proxies for ageing, the life expectancy variable shows a positively significant relationship. The estimation concludes that, regardless of the change in fertility rate, the rise in the life expectancy of individuals in LDCs increases the growth rate of the country. Hence, it is concluded that countries with a higher life expectancy experience higher economic growth. However, the result is not similar when the proportion of the old age group and the young age group over the past five- and ten-year periods are taken into account. Our results reveal that the rise in the old age group and the fall in the young age group over the past 5- and 10-year periods are likely to slow down the economic growth of LDCs. This means that ageing is expected to influence negatively the economic growth of a country in a five-year timespan if an adequate method is not taken into account to mitigate the

imbalances in the existing age group (higher proportion of the ageing group and lower proportion of the young age group).

Apart from ageing, the current speed of ageing in LDCs is faster compared to developed countries (Lee, 2003). Focusing on the consequence of the speed of ageing on LDCs, we tested the annual growth of the AI with current values, lagged five years and ten years. Our result concludes that the annual average growth rate of the current AI and the AI lagged five years is likely to enhance economic growth. However, the economic growth of LDCs due to the growth of the AI only occurred over a short period of time.

Nevertheless, for the speed of ageing, the empirical analyses showed that the continuous rise in the annual growth rate of the AI for a ten-year period seems to slow down economic growth. Knowing the immigration pattern of the LDCs, our empirical analyses also revealed that the imbalance in the growth of the working group and the old age group seems to influence the economic growth of the countries as well.

In general, we conclude that ageing at current rates boosts the economic growth of LDCs. However, the current rates of ageing are expected to undermine the economic progress of the LDCs in the future (in five and ten years' time). Hence, ageing at current rates is only considered a blessing for economic growth for a short period of time.

In fact, we found that the majority of the selected proxies for the speed of ageing revealed a statistically significant impact on economic growth (represented as GDP per capita). Thus, in accordance with Lee (2003) and the United Nations reports (DESA/PD, 2007, 2010), we believe that the speed of ageing will have a profound impact on the economic growth of LDCs. Hence, government agencies should implement appropriate policies to mitigate the imbalance in age structure (higher proportion of the old age group, lower proportion of the young age group and lower proportion of the working age group) before the speed of ageing leads LDCs to become much poorer.

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