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The Effects of Population Ageing on Household Consumption Expenditures in Central and Eastern Europe

DOCTORAL DISSERTATION

Social Sciences,
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CEE	–	Central and Eastern Europe
LCM	–	Life-Cycle Model
ODR	–	Old-Age Dependency Ratio
OLG	–	Overlapping Generations Model
PAYG	–	Pay As You Go
TFR	–	Total Fertility Rate

INTRODUCTION

Relevance of the topic. With the onset of long-term transformations in the demographic makeup of Central and Eastern European countries, the issue of their implications for the economy has become acute. The status quo of an ageing population coupled with growing life expectancy, low birth rates and no signs of imminent change is yet to be effectively addressed. Discussions covering these socio-economic changes span from developed countries like the USA and Japan to emerging economies such as India and China, a long way since Malthus' treatise (Jaimovich, Siu, 2009; Feyrer, 2007). For developing nations, the connection between demographics and the economy served as a basis for forward-thinking policy changes while other researchers made efforts to understand the aforementioned processes as they continue to manifest in their country or region.

The researchers' efforts resulted in an extensive debate regarding the effect of demographic variables on the economy and its components. Mankiw and Weil (1989) have spearheaded the attempt in combining population data with economic figures in the wake of the Baby Boom generation's expected steady withdrawal into retirement in the USA. Not all of their predictions have later been confirmed as accurate, but the study produced interest in a topic relevant to this day. Since then, the relationship between demographics and economics shifted from being questioned on a fundamental level to a branching area of research. The shift brought developments such as the International Monetary Fund (IMF), the World Bank and other international bodies providing insight on their understanding of the relationship between demographic and economic variables. Following the IMF's involvement in 2006, the topic expanded in scope and depth: research based on individual EU member states' data was published, while questions regarding the influence of ageing and its vectors of manifestation in the economy were raised.

With consumption highlighted as one of the vectors with a theoretical background, supported in part by Modigliani's Life-Cycle Theory, modern studies attempted to verify the connection in lieu of its importance to economies that rely on household consumption expenditures as the chief component of output. Empirical verification has become an ongoing challenge, regardless of research geography, as scholars struggle to develop a framework to correctly specify the influence of demographics, separating it from noise.

The CEE context raises more questions due to previous studies being much scarcer than in the USA or Japan, specifically, on the relationship between consumption and demographic shifts (Lindh, Malmberg, 2009). The body of literature is concerned more with Western European countries, leaving the CEE region with a smaller subset, dedicated to single-country case studies (Smrčka, Arltova, 2012; Bazhenova, Krytsun, 2013). On the one hand, an ageing population puts pressure on governments to look to long-term sustainability both economically and in terms of future population dynamics while necessitating short-term solutions, which results in erratic policymaking in the fledgling region, compounding the challenge in assessing the effect. Recent retirement policy reforms in Hungary and Poland, made with the intent to reduce the retirement age while increasing pensions, point to the possibility of distorting the often predictable short-term manifestation of demographics as a factor of economic activity (Fultz, 2012). Hence, there is potential utility in adapting a framework developed for the analysis of the Baby Boomer phenomenon in the USA or the Lost Decade in Japan to determine the empirical relationships between different variables used to represent ageing and the economy in CEE countries as the issue persists. The tools developed for the analysis of the ageing phenomenon in other regions may be helpful in the CEE context.

The problem and research object. The effects of demographic transformations in CEE countries on economic growth through household consumption expenditures, their magnitude and vectors of manifestation notwithstanding, are the prime concern of this thesis. With studies made to suit the USA or Asian context and dominating their European counterparts both quantitatively and qualitatively, additional research has merit in providing region-specific conclusions for countries experiencing the rapid ageing phenomenon and in search of appropriate policy response.

Goal and objectives. The purpose of this work is to identify, quantify and propose solutions to the negative effects of processes such as the evolution of the population's age composition and life expectancy in CEE countries on the economy through household consumption expenditures. This, in turn, provides insight to identify policy areas necessitating remedial action and suggest changes. In order to achieve the goal, the following objectives are formulated:

1. Assess the modern demographic and household consumption expenditure trends in CEE countries.
2. Provide a comprehensive review of relevant research and chief interpretations.
3. Build a theoretical model stemming from the literature review to analyse relationships outlined in the goal and verify the defended statements.

4. Adapt the theoretical model to study the empirical data of CEE countries.
5. Summarise research results and provide recommendations for policy and further research.

Methods used. A comparative analysis of demographic and consumption trends in CEE countries lays the groundwork for the adaptation of theoretical findings to enable compatibility with empirical data analysis. A broad comparative base is established for the empirical literature subsection, sourcing studies from regions that have experienced major demographic transformations, including the USA (Mankiw, Weil, 1989), Japan (Ohtake, Saito, 1998) and China (Gomez, Lamb, 2013). Further methodological guidance regarding age group-specific issues is taken from Poterba (2001) and Macunovich (2012).

The proposed econometric model hinges on the theory of rational expectations and lifetime utility maximisation, a variant of the Life-Cycle Model (LCM), per Modigliani (1966) and the more recent adaptation by Bloom et al. (2003), a time-dependent consumption curve, per McKinsey Global Insitute (2004), and a number of controls, selected on the basis of their prominence in literature and theoretical appropriateness. Panel regression analysis and statistical tests are applied in the empirical section.

Defended statements:

1. Population ageing and life expectancy trends have a non-linear effect on household expenditures in CEE countries.
2. Population ageing and life expectancy variables have overlapping effects on household consumption expenditures.
3. Retirement reforms in CEE countries did not have a statistically significant effect on household consumption expenditures over the analysed period.

Theoretical significance and scientific novelty of the research. Albeit demographics are a staple of research, studies pertaining to their relationship with the economy represent a more recent development. Having been largely ignored as a factor for economic growth until the emergence of the Baby Boomer phenomenon, demographic trends presently generate an increasing amount of interest. As such, there is no consensus view on the issue, with conclusions of theoretical studies ranging from outright dismissal of demographic variables having an effect on the economy to attributing a significant portion of volatility in output and household consumption expenditures. Such opposing views are juxtaposed and evaluated in this thesis to build a foundation for an analytical framework that addresses common pitfalls and attempts to identify relationships.

Due to its reliance on established tools, namely, LCM and OLG models, this thesis contributes to the discussion mainly through adaptation by allowing life expectancy to be affected by consumption and adding a lifetime consumption curve that allows for the simultaneous study of the effect along all age groups while reducing the burden for empirical analysis. This, in turn, permits the inclusion of a number of controls, including exogenising the aforementioned demographic trends through the exclusion of healthcare expenditures as well as considerations for changing retirement benefit schemes, which reduces the disconnect between the proposed model and real scenarios. In addition, the theoretical framework allows for a degree of flexibility in treating ageing and life expectancy variable groups as equivalents as well as discussing the benefits and risks of relying on these groups.

Practical significance of the research is highlighted by the problem's relevance in CEE countries and the geographic fragmentation of works dedicated to the phenomenon. Previous studies have either focused on a single country or oversimplified the question by enforcing limitations while ignoring the issue of endogeneity, endemic to demographic trends. Assessing the pending processes of ageing in CEE countries allows the quantification of the associated costs for the economy, the identification of vectors of manifestation and ways to address the issue.

Moreover, the study assesses the region's disposition towards dynamic retirement policymaking to determine deficiencies and isolate their effect from that of demographic trends, avoiding misspecification. The addition of a number of controls previously not used in concert contributes to the framework's robustness and broadens its application geography as well as utility.

Difficulties and limitations experienced in this dissertation stem from the modern nature of recording demographic transformations in CEE countries. Specifying an empirical model that covers the entire population pyramid and the effect various age groups have on household consumption expenditures reduces the number of control variables due to insufficient degrees of freedom and limited time series length. The issue of frequent policy reforms in the CEE region adds difficulty to examining the effects of population ageing. Topical literature is dedicated to the study of ageing in other regions without consideration for regional or cultural differences playing a role in the studies' explanatory power. Empirical analysis is conducted on samples that experience ageing, and it has not been tested with populations that are not ageing or becoming younger due to the aforementioned challenges in finding comparable data.

Main sources. Demographic and macroeconomic figures are taken from Eurostat and the World Bank database. Methodological guidance is attributed to Modigliani (1966) for the introduction of the LCM approach, as well as Arnott (2012) and Macunovich (2010), considering their input on working with time series limitations. The literature review is supplemented with a number of regional sources for contrast and comparison to address the issue of fragmentation in methods and geography.

Structure of the thesis is poised to present a bottom-up approach. It begins with a list of definitions dedicated to essential terminology, complemented with descriptive statistics and comparisons to detail the severity of the issue in the region. Then, the theoretical and empirical background of the relationship between consumption and demographic trends is presented. Conclusions stemming from previous research are collated and compared, including those rejecting the claim for demographic trends having an effect on consumption. The literature review is followed by a methodological framework to be adapted for empirical analysis, concluded with a list of research findings and suggestions.

Discussion and dissemination of research results took place in six peer-reviewed articles in academic journals, conference proceedings and were presented over the course of six international and national conferences.

1. AN OVERVIEW OF MODERN DEMOGRAPHIC AND CONSUMPTION TRENDS IN CENTRAL AND EASTERN EUROPE

The purpose of this section is to provide an overview of the modern demographic and consumption trends in CEE countries to highlight the criticality of these phenomena and their unprecedented pace. It is also to demonstrate a common issue in the 11 countries traditionally attributed to the region: Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia. Examples from other regions help compare the trends across the globe.

Furthermore, the section explains the logic behind using a particular set of variables to characterise population ageing and the methodological differences to their utilisation in an econometric model. The population median age, population pyramid, old-age dependency ratio, life expectancy at birth and total fertility rate are covered. In addition, this section describes past consumption trends to illustrate the importance of consumption as a component of output.

Besides CEE countries, this section presents data from the USA and Japan, two countries that have received a lot of attention in literature, notably due to the Baby Boomer phenomenon in the former and the Lost Decade in the latter. Japan's demographic trends are also considered as a template for ongoing ageing processes across the globe in the light of the populations' longevity and high proportion of retirees.

The section is concluded with a chronological summary of each selected CEE country's policy responses to economic challenges posed by ageing. With be benefit of hindsight, the policies are compared to not only illustrate the status quo, but also explain how the current policy toolkit came to be and provide a basis going forward.

1.1 Terms and definitions

While there have been attempts to use demographics to explain macroeconomic issues, the overlap of these two fields entails technical terms that can be misunderstood. To prevent that and make subsequent sections easier to read, the following terms are defined. The source is The World Bank metadata glossary, unless stated otherwise.

The **Life Cycle Model** is a model that strives to explain the consumption patterns of individuals. The model stipulates that individuals plan their economic behaviour over their lifecycle, smooth consumption and retire, per Modigliani (1966). The model involves a time-dependent pattern of consumption and enables the possibility of describing this pattern with a lifetime consumption function.

Life Expectancy at Birth indicates the number of years a newborn infant would live, if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life. Life expectancy is estimated for other ages as well and it is smaller for older cohorts.

Old-Age Dependency Ratio is the ratio of older dependents–people older than the age of 64–to the working-age population, namely, ages 15–64. It is worth noting that this ratio refers only to the age without consideration for whether a person aged 65 is working or a dependent.

Replacement Ratio or **Replacement Level Fertility** is the Total Fertility Rate at which a population precisely replaces itself from one generation to the next in the absence of migration. The ratio is about 2.1 children per woman, varying slightly depending on mortality.

Total Fertility Rate represents the number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with age-specific fertility rates of the specific year.

1.2 Current Demographic Trends in Central and Eastern Europe

Growing life expectancy may be considered as a welcome sign of economic development. For poorer nations, increasing life expectancy is also a means of preserving human capital. However, when such demographic changes progress at an increasing pace in conjunction with dropping birth rates and growing old-age dependency, as it has been the case in CEE countries over the last 20 years, the outlook's sustainability becomes questionable. A detailed description of each of these elements pertaining to population ageing in CEE countries follows.

Demographic trends, given their slow-moving nature, are challenging to influence and the response can take many years to manifest. Therefore, it may take decades of data for a demographic trend to emerge. One such trend in CEE countries is life expectancy growth, usually derived from life expectancy at birth and measured in years. The values of life expectancy growth in Table 1 are separated into decade-long intervals. For illustrative purposes, Table 1 contains data from the Euro Area 19, Japan and the USA in addition to CEE countries, and this comparison is preserved throughout the subsection. A body of literature is available for Japan and the USA and they present contrasting global demographic outlooks. The Euro Area, on the other hand, adds local context to CEE demographics. While Japanese and American data in Table 1 shows a levelling off as time progresses, life expectancy in CEE countries grows at a quickened pace, which presents a planning challenge for economic actors. With other variables presumed fixed, it is evident that the propagation of the trend in the CEE region is likely to have a substantial effect on the right-hand side of the age spectrum, namely, retirees. Should the shift in life expectancy be accompanied by economic malaise akin to Japan's Lost Decade and increased indebtedness, it may further complicate the already dynamic policymaking in the CEE region.

***Table 1**. Growth of life expectancy at birth (years) in Central and Eastern Europe, Euro Area, Japan and USA at 10-year intervals*

	1975–1985	1985–1995	1995–2005	2005–2015
Central and Eastern Europe	1.4	0.6	1.9	3.2
Euro Area 19	2.6	2.2	2.5	2.1
Japan	2.6	1.9	2.4	1.9
USA	2.0	1.1	1.9	1.3

Source: Compiled by the author using World Bank data

Table 1 is supplemented with life expectancy figures at the age of 65 for the same periods and the same countries. While the USA exhibits small variance during the period, the figures for the CEE region and Euro Area are of concern, with Japan being an extreme case for longevity. The CEE context appears to show a trend in longevity growth, which, depending on the country in question, can mean an increase life expectancy at the age of 65 by more than 30% over the period, as is the case with Czech Republic.

The information in Tables 1 and 2 is incomplete without the inclusion of the old-age dependency ratio, which covers those over the age of 65, traditionally referred to as retirees. The World Bank calculates the figure for each of the selected CEE countries. One issue with relying on the old-age dependency ratio, however, is that its definition can be misleading in the sense that it is anchored to age, a static number that disregards the actual timing of an individual's retirement from work. As such, individuals who are still in the labour market upon reaching the age of 65, which coincides with the retirement age in Lithuania, are a part of this ratio.

Table 2. *Growth of life expectancy at 65 years in Central and Eastern Europe, Euro Area, Japan and USA at 10-year intervals*

	1975–1985	1985–1995	1995–2005	2005–2015
Central and Eastern Europe	0	0.6	1.1	1.7
Euro Area 19	1.4	0.6	1.9	1.1
Japan	2.1	1.5	2	1.2
USA	0.7	0.8	1	1

Source: Compiled by the author using Eurostat, OECD data

Another criticism levelled at the old-age dependency ratio has to do with the left-hand side of the age spectrum, namely, the youth. For developing countries, an influx in life expectancy may spur difficulties in accommodating the associated reduction in infant mortality, adding to care costs for both the young and the elderly. The CEE context currently allows for the dismissal of this criticism, as the region has already gone through the transition from a high-birth, high-mortality state to low-birth, low-mortality.

Reviewing changes in the old-age dependency ratio (ODR), presented in Table 2, reveals a steady increase in ODR over time in each case: CEE, Japan and the USA. It is worth noting that the values are in the shape of percentage points and present a squeeze on the relative share of other age groups in the population. This is especially evident in Japanese data, which exhibits a jump from 2.4 to 6.4 p. p. in the last decade. USA figures show that this is a reversible process despite the overall trend being towards ODR growth, decade on decade.

Table 3. *Change in the old-age dependency ratio (p. p.) in Central and Eastern Europe, Euro Area, Japan and USA at 10-year intervals*

	1975–1985	1985–1995	1995–2005	2005–2015
Central and Eastern Europe	-0.4	2.1	2.2	2.4
Euro Area 19	-0.8	3	3.5	4.4
Japan	2.4	4.2	5.4	6.4
USA	1.4	0.5	-0.4	2.3

Source: Compiled by the author using World Bank data

Combined with data from Table 1, the issue of age versus economic behaviour can be mooted through the increase in the proportion of the population over the age of 65 living longer. This is especially evident in Japan, which, in addition to the old-age dependency ratio, calculates the proportion of those over the age of 85, the fastest-growing portion of its population. CEE countries are behind the Euro Area in terms of ODR growth over the period 1975–2015, but the accelerating rate of change is evident in both regions. 2005–2015 saw the largest increase in ODR for all four regions.

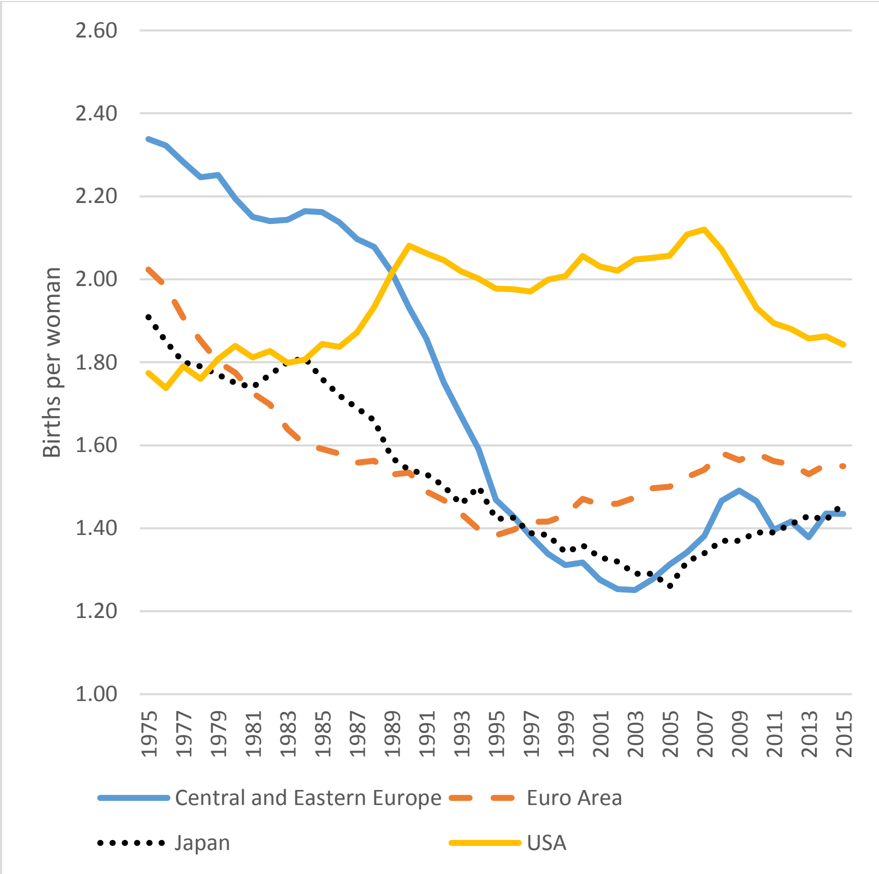

Figure 1*. Total Fertility Rate in Central and Eastern Europe, Euro Area 19, Japan and USA in 1975–2015*

Source: Compiled by the author using World Bank data

Another important element for the understanding of the demographic trends in CEE countries is the total fertility rate (TFR), or the number of births per woman. The TFR for a stable population stands at 2.1, which puts the USA close to a sustainable path, unlike CEE and Japan, as depicted in Figure 1. While the reasons behind the collapse of the TFR are not within the scope of this dissertation, the current unsustainable level experienced by the latter two countries, despite a jump from over 1.2 to 1.4 between the years of 2000 and 2010, suggests a difficult path forward. The repercussions of a prolonged period of a low TFR explain the rise ODR, with smaller cohorts on the left-hand side unable to mitigate its effect on the population as a whole. Taking into account net migration trends in the CEE region, which, according to World Bank data, have been negative for the last 20 years and do not show signs of abating, unlike the persistently positive Japanese and American net migration figures, another natural source of the effect's compensation is unavailable, further complicating the matter by withdrawing mobile individuals from the population.

The demographic trends pertaining to ageing in CEE countries are, thus, defined by an accelerating growth of life expectancy, old-age dependents taking up an increasing share of the population, a shrinking youth cohort in absolute and relative terms due to low birth rates, and persistent negative net migration. The combination of these factors, absent remedial measures, leads to depopulation and potentially unfavourable conditions for the economy.

Consumption trends presented in the next subsection show a different if not outright contradictory picture about the macroeconomic effects of population ageing.

1.3 Evolution of Household Consumption Trends in Central and Eastern Europe

Contrary to the outlook presented by the CEE region's deteriorating demographics, consumption dynamics exhibit a level of resilience. Consumption is defined here as final household consumption expenditures, also known as final private consumption. It is one of the major GDP components when using the expenditure approach.

The motivation for using consumption for the purpose of this dissertation is in its proximity to demographics, i.e. households characterised by said demographic criteria and the consumption variable's prominence in output. The USA are renowned as a consumer economy, which is supported by Figure 2, placing household consumption expenditures between 64 and 70% of GDP, trending up from 1991 to 2015. Japan and CEE countries have a smaller portion of the economy covered by the aforementioned consumption, but the figure has remained above 50% for the last 25 years. This is notable in case of CEE countries, which have experienced a number of economic transformations during this period. Bearing in mind the non-transitory long-term significance of household consumption expenditures in GDP and their potential susceptibility to demographic trends, it is selected as the study object. Data availability and the presence of third-party research play a secondary role in opting for this variable.

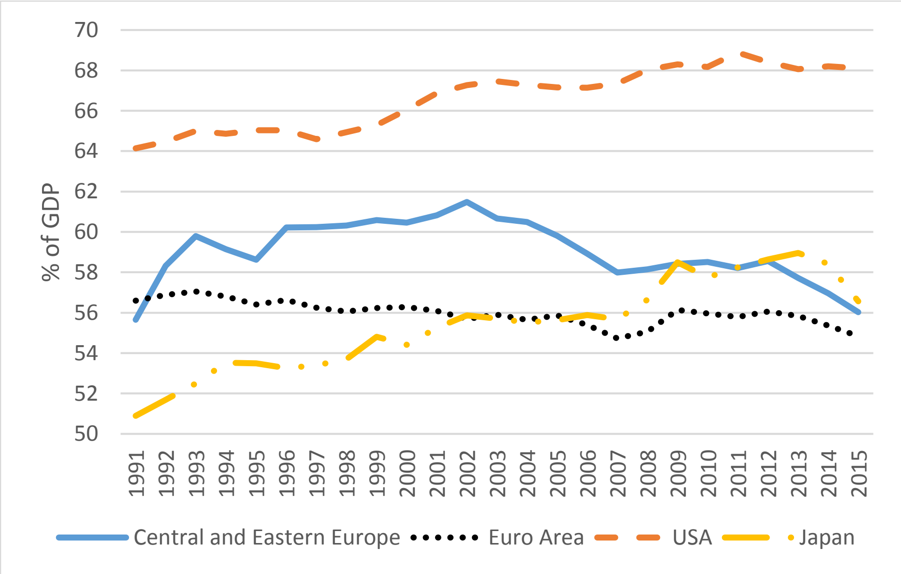

Figure 2*. Consumption expenditures of households in Central and Eastern Europe, Euro Area 19, Japan and USA as a percentage of GDP in 1991–2015*

Source: Compiled by the author using World Bank data

Another reason to the selection of consumption rather than output is its higher resilience to endogeneity. Changes in output are not only diluted by external factors, but also a degree of interdependency with demographics: changes in economic performance altering behaviour of the population and causing secondary changes in the economy. This effect is referred to in literature as a demographic dividend and its influence proves a challenge to correct model specification.

This challenge is further escalated bearing in mind the dynamics of consumption expenditures as shown in Figure 3, which depicts annual percentage changes of consumption expenditures at PPP. Contrasting with deteriorating demographic conditions, consumption growth in PPP terms has been positive since the end of 2009, which highlights the disconnect between intuitive empirical conclusions and empirics. Output volatility in the aforementioned countries has performed similarly to consumption expenditures over the period. Hence, the empirical relationship between demographic trends and consumption is not readily apparent.

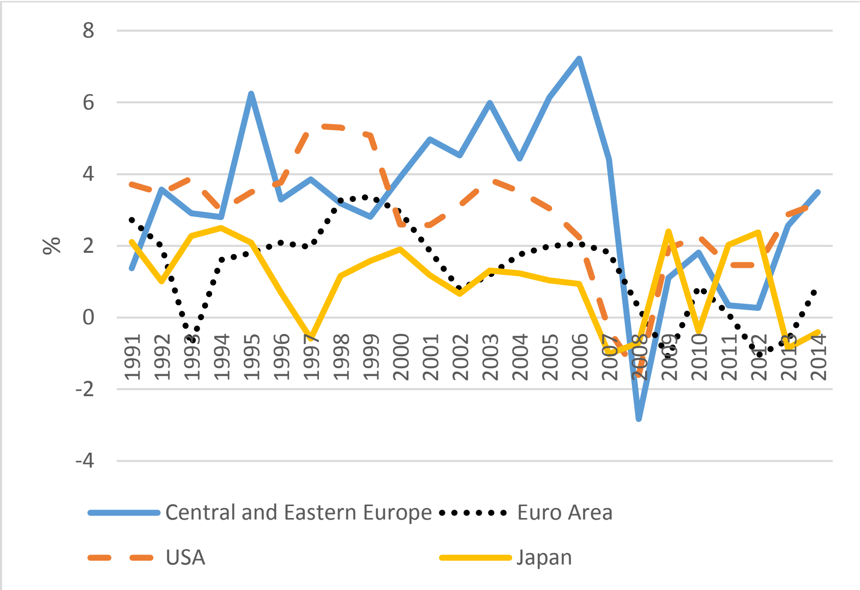

Figure 3*. Annual percentage change of consumption expenditures of households at PPP in Central and Eastern Europe, Euro Area 19, Japan and USA in 1991–2014*

Source: Compiled by the author using World Bank data

While consumption expenditures continue to grow in CEE, it is imperative that their relationship with demographics is understood, lest the region finds itself at the precipice of a Japanese-style Lost Decade with significantly worse starting conditions. The theoretical and empirical background of this scenario is covered in detail in Section 2, while chronological policy responses to population ageing trends are reviewed in the next subsection.

1.4 Retirement Policy Response to National Demographic Ageing Trends

Due to the shifts in the demographic makeup of CEE countries, each individual country has taken a number of steps to address the population ageing phenomenon. The focus is on changes on the right-hand side of the age spectrum with results assessable over the medium term. This subsection provides a concise chronological review of the measures taken, highlighting possible control variables and break points for the econometric model, providing material for subsequent verification of Defended statement 3 and providing an illustration of legislative activity in the region.

Following a shared prologue at the cusp of the twentieth century, the benefit of hindsight permits concluding that the paths of national policy response have diverged between CEE countries, unlike the general result in terms of demographics at the time of writing–an older population with a higher degree of old-age dependency. The measures taken in each of the CEE countries are reviewed in order to help understand what has already been done and how the policies have fared. Consequently, the insight derived from the review is to identify parameters related to policy changes as variables or controls, enable informed policy suggestions throughout the discussion of empirical findings in the Section 4. A stylized timeline of reforms is featured in Table 4.

Table 4. *Stylized Timeline of Major Retirement Reforms in CEE Countries*

	Bulgaria	Croatia	Czechia	Estonia	Hungary	Latvia	Lithuania	Poland	Romania	Slovakia	Slovenia
Contribution -based PAYG	1995	1993	1993	1993	1992	1996	1995	1999	1996	1993	1996
Introduction of private pension funds	2000	2002	2001	2002	1998	2001	2004	1999	2007	1996, 2003	2001
Scaling back of private pension funds	2015	2011		2018	2011		2013, 2019	2014			

Source: Compiled by the author

As shown in Table 4, retirement system reforms in CEE countries took a similar path. Upon becoming independent, governments tied the public PAYG pension to contributions, by mandating minimum employment terms and then tiering pensions passed on the size of annual contributions, per Pandurska

(2018), Guardiancich (2007), Potucek, Rudolfova (2015), Simonovits (2000), Domonkos (2015). At the cusp of the XXI century voluntary or mandatory two-to-three pillar private pensions were put in motion based on recommendations from The World Bank. The shift was gradual, yet resulted in a more complex pension system, namely tiered public pensions, variable degrees of participation in second, third pillars and the degree of government participation in providing funding or competing with private pension providers. This stage is covered by Nedelut (2013), Vidovicova (2014), Kulu, Reiljan (2004), Mistre, Muska (2011), Gudaitis (2009). Then, starting with 2011, retrenchment occurred that either allowed participants to freeze participation in pillars above PAYG, transfer their savings to PAYG or make withdrawals prior to reaching the retirement age. The case of Slovenia is notable during this period, as a reform permitting withdrawal of funds from pension funds after 10 years was frozen on its ninth year, putting in question the sustainability of the sustainability of retirement legislation, detailed by Dolenc (2011) and Polanec, Ahcan, Verbic (2013). The changes during this period coincided with governments struggling with the aftermath of The Great Recession. As of 2018, the retrenchment period does not appear to have ended. A parametric reform in Lithuania, scheduled for 2019, permits withdrawal from the second pillar for the second time. Discussions taking place in Estonia regarding the abolishment of a fixed retirement age in exchange for associating retirement with life expectancy also have the aim to include a flat PAYG pension, below current levels of funding. Poland is an outlier in this respect, as a 2017 law overturned the previous government’s decision from 2013 to gradually increase the retirement age to 67 for both sexes.

Throughout this timeline, the retirement age has increased in all countries to approximately 65, with minor differences for retirement based on sex and the presence of a path for future increases or passing laws for individual increases. This development is notable when assessing the life expectancy post-retirement.

2. THE BACKGROUND OF THE RELATIONSHIP OF DEMOGRAPHICS AND CONSUMPTION EXPENDITURES

This section is dedicated to the analysis of literature pertaining to the relationship of demographic trends and consumption. It covers a range of theoretical studies, establishing a background for the discussion, and produces examples of previous empirical research, their methods and conclusions to help build the methodological framework.

Due to the recent nature of the phenomena in question, this section describes chiefly American sources, which, along with Japanese researchers, have spearheaded the analytical effort. Additionally, this section features guidance from developing countries and a focus on the available European research.

2.1 Theoretical Studies

The theoretical justification of using demographics in macroeconomic analysis is not new. However, it has been relegated to a minor role while economists sought to explain consumption trends through other macroeconomic variables. Keynes' General Theory of Employment, Interest and Money avoids making direct references to demographics while discussing savings and, its remainder, consumption.

Samuelson's Overlapping Generations (OLG) theory and the eponymous model borrows from Keynes' approach and introduces an intertemporal element, through which agents undergo at least two different periods of life, notably, working-age and retirement. The addition of a finite lifespan facilitates the model's extensive use, as demonstrated in the next subsection, in empirical literature.

The standard OLG model's drawback is in its assumptions, precluding the possibility to analyse endogeneities and changes in population dynamics. The model assumes that the different stages in life (the so-called generations), are fixed, which imposes an unrealistic limitation in empirical studies.

Modigliani's (1966) Life Cycle Model (LCM) addresses this inflexibility by allowing adjustments to said periods as well as changes in consumption trends. LCM, therefore, encompasses a variety of realistic scenarios, including changes in the population and technological progress. The model's empirical origins can be credited for this property and its stated purpose – the study of consumption patterns coincides with the goal of the thesis.

Although LCM appears to have an advantage over OLG, its flexibility carries a flaw in that particular elements of an augmented model are left for the researcher to decide. The basic model consists of consumption, wealth, income, lifespan and retirement variables. It also suffers from rational expectations voiding the altruistic bequest motive and short-term behavioural anomalies. For LCM to be applicable in a realistic scenario, additional considerations need to be made in regard to control variables.

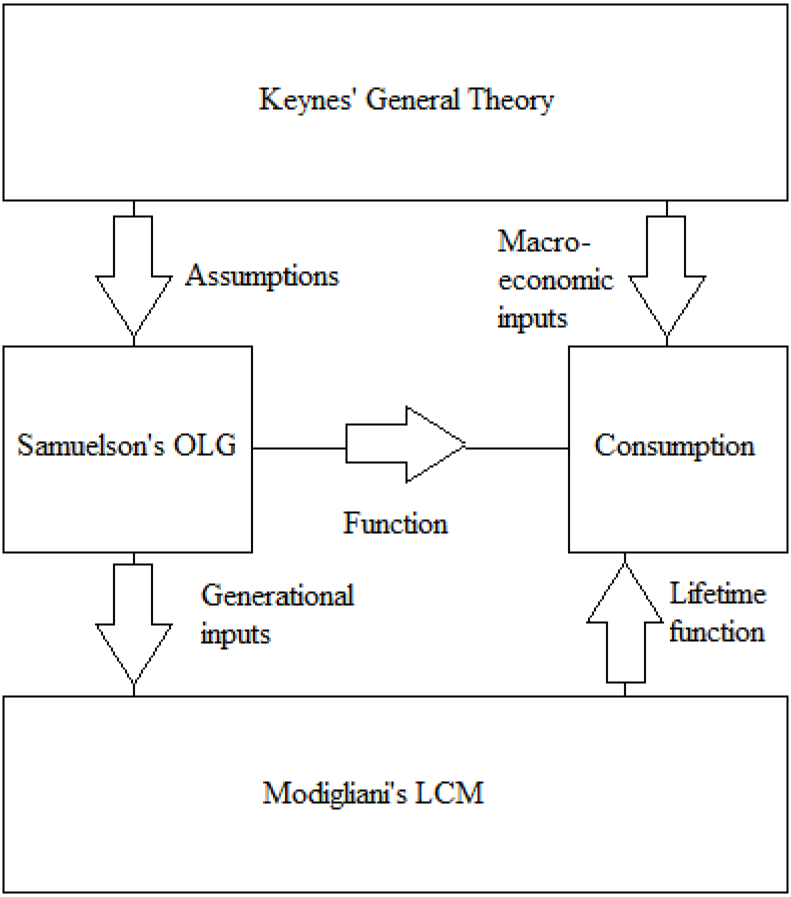

Figure 4. *Consumption and demographics in economic theory*
Source: Compiled by the author

Figure 4 provides a schematic explanation of how the aforementioned theories interact: through underlying Keynesian assumptions and the establishment of a consumption function, the assumptions for the OLG model, a division into work and leisure/retirement, and the introduction of behavioural anchors for consumption at different points in the lifetime. LCM and OLG share the idea of using generations to differentiate behaviours albeit their treatment is not identical. The inclusion of an old cohort in LCM necessitates additional controls.

The effect of ageing on consumption expenditures is not universally recognised. The question can be separated into two groups: mitigation and proxification. In the first case, natural checks and balances or active policy counter the effect of ageing, preventing it from manifesting in the real economy, while the second supplants ageing as a proxy for a different process, avoiding the question of demographics entirely by relying on macroeconomic variables.

Starting with mitigation, Muysken et al. (2013), Rowthorn (2008), Tyers (2007) and Zimmerman (2005) point to the absence of migration trends and their long-term effect on consumption from either OLG or LCM. Merette, Georges (2010) also refer to globalisation reinforcing the spillover effect conceptualised by Kenc, Sayan (2001). Kinsella, Philips (2005) take note of changing behavioural patterns of retirees, exemplified by Cigno (1993) in the notion of intergenerational transfers and altruism: rather than spend all of the accumulated capital in retirement, retirees transfer a part of their wealth to their offspring and in doing so compensate the loss of productivity after entering retirement. Silvertovs et al. (2011), Smrčka (2012) and Tabata (2005) add economy specialisation, referring to business sectors that benefit or experience losses from the increase in the share of old people in the population. With specialisation in mind, ageing may exert a positive, negative or zero cumulative effect on consumption.

Policy is another source of mitigation. Börsch-Supan et al. (2006), Heijdra et al. (2009) and Tyers (2007) detail various forms of possible government response to ageing, from managing welfare redistribution to pension reform. Hu (1995), Echevarria, Iza (2006) denote the issue of policy altering behaviour through retirement benefits. Heijdra et al. (2009), Razin (2007) warn about the limited practical effect of policy, considering the government's budgetary constraints and political alignment, yet its propensity to take action, Disney (2007) explains, that can produce a lasting effect and change the shape of the population pyramid.

Age-related variables act as an accessible behavioural anchor, which is assumed to be fixed. Increasing life expectancy challenges this assumption by shifting lifecycle phases in time. Minimum retirement age hikes and advances in healthcare throughout Europe facilitate people working and living longer. This trend also changes the concept of *young* and *old*, as detailed by Kinsella et al. (2005). Tyers (2007) points out the emergence of the old age participation ratio as a positive result of growing life expectancy, which age does not explain. Gonzalez-Eiras, Niepelt (2012) study changing life expectancy rather than age as an explanatory variable for economic growth. Gomez, Lamb (2013) explain that changes in life expectancy result in the fluidity of the "prime age," concluding that this stage is prolonged as life expectancy increases. Conversely, Chakraborty (2004) claims that short life expectancy, a frequent occurrence in a young society, is a negative factor for the economy, as human capital is not sufficiently accumulated. Tabata (2005) challenges this conclusion by focusing on healthcare costs in populations with greater life expectancy and refers to additional redistribution possibilities in a young society. While these two claims are difficult to reconcile in linear terms, Echevarria (2004) claims that life expectancy's effect on real output has an inverted U pattern, which contains a top threshold that is between 45 and 50 years. This is confirmed by Eggleston (2012) and corresponds to peak contribution ages detailed by Poterba (2001) and Goyal (2004).

Katz (2000), Magnus (2009) and Settersten Jr et al. (1997) conclude that it is what people do that matters and their decisions to partake in economic activity are not necessarily rooted in demographic metrics. Gollier, Zeckhauser (2002) put the notion of horizon length driven by an individual's expectations, albeit these are difficult to obtain in practice. The existence of a government is another issue, as growing live expectancy prompts a higher retirement age, which extends the life-cycle pattern and preserves the status quo over a longer time span (Bloom et al., 2003). As such, life expectancy theoretically addresses the inflexibility of age as a metric, but its effect remains susceptible to the same mitigation factors. In practice, it does not necessarily reflect individual horizon lengths and its explanatory power may be inferior to that of age. Hence, one of the hypotheses raised in the thesis is of an overlapping effect attributable to life expectancy changes and ageing represented by age groups.

In summary, while approaches such as the Overlapping Generations Model and Life Cycle Model permit the usage of population ageing variables either as fixed stages or transitions, their utility and application is not without criticism. Reliance on the models' assumptions and the relative novelty of using demographic trends to explain macroeconomic changes facilitate an ongoing discussion.

2.2 Empirical Literature

The mention of demographics in empirical research papers is not homogenous. While certain characteristics like age and gender may be considered intuitive anchors of economic behaviour, these are not necessarily included when an empirical paper deems its regressors *demographic*. Studies vary in scope, ranging from one variable to a system of variables, which leads to an equally broad range of conclusions. This is not unexpected, taking in mind the geographic fragmentation and data challenges for researchers in the field. In parts of the developing world, the papers in this review are the first of their kind, with a subset of countries having no publications on the topic. As such, there are difficulties in verifying persistence of third-party claims in time, compounded by the susceptibility of changes in demographic makeup in the long run due to exogenous shocks.

Concerning the relationship of ageing and the economy, there are two camps, divided in their definition of ageing. The first camp interprets ageing as a change in the distribution of age groups in a population. The second camp, less numerous than the first, focuses on changes in the population's life expectancy instead. Each camp can be further divided based on geography and underlying methodology.

It is worth noting that studies point to both positive and negative effects of ageing on the economy, albeit the magnitude of these effects varies by a wide margin, depending on the source. Given that economic concerns stemming from population ageing are a recent development, initial research aimed to answer the question of whether ageing has a statistically significant effect. Alternatively, researchers dedicated their works to different parts of the population in search of demographic groups expected to tilt the balance towards a positive or negative outcome. Follow-up studies delved into the effect of ageing on different parts of the economy as well as forecasting the costs and benefits of this effect.

2.2.1. Population Age Structure Studies

Research in the connection between the population's age structure and the economy is related to life-cycle behaviour, formalised by Modigliani (1966). In essence, age is treated as a behavioural anchor, with young, middle-aged and retired people having a different effect on the economy through savings. Starting with the post-war generation in the US, often referred to as Baby Boomers, which has been of interest to economists for some time now, Mankiw and Weil (1989) present one of the earliest forays in the field connecting demographic trends and the economy. While their concern is mainly with the implications of a large cohort of consumers exiting from the workforce, later studies broaden the scope from soon-to-be retirees to different age groups and the whole population.

Numerous authors later found that consumers follow the same pattern over the life cycle and, depending on the population's age structure, effects from different stages take precedence (Bergatino, 1998; Bloom et al., 2003; Settersten Jr., Mayer, 1997; Attanasio et al., 1999; Hasan et al., 2011). Feyrer (2007) attributes 25% of differences in output in OECD countries over the period of 1960–1990 to differences in demographic structure. Gomez, Hernandez De Cos (2008), Krueger, Fernandez-Villaverde (2007) cite the explanatory power of the ageing phenomenon worldwide and in the US at over 50%, while projections by Guest, McDonald (2007), Jaimovich, Siu (2009) put it at 33%. Bloom, Williamson (1996), Choudhry, Elhorst (2010) and Pryor (2003) consider the relative size of the workforce in the population as the source of the differences in the strength of the effect. Börsch-Supan et al. (2006) conclude the significance of demographics in a European setting, namely, France, Germany and Italy. Floden (2003) highlights differences in aging behaviours in different regions. This is further touched upon by Choudhry, Elhorst (2010) in a panel of three countries: China, India, Pakistan. Results put the explanatory power, respectively, at 46%, 39%, 25%, with a smaller effect in predominantly youthful populations. Marattin, Salotti (2011) note that the effect is more pronounced in developed countries. Attanasio et al. (1999) offer an explanation that demographic effects, albeit slow to manifest in data, evolve over time. Higgins (1998) concludes that significance of the effect is to increase as ageing accelerates. In this respect, Europe's population dynamics make for a sensitive environment for the negative effects of ageing to manifest (Floden, 2003). Kenc, Sayan (2001) make the case for open economies experiencing spillover effects, making changes in real output caused by demographic trends difficult to isolate for neighbouring countries.

The case of demographic spillover does not apply to Japan due to its population's aversion to migration. Nonetheless, Japan-oriented studies point to the country's evolution from rapid output growth in the 1980s to a lost decade and a corresponding change in its age structure. Ohtake, Saito (1998) claim that 50% of GDP expansion in the 1980s can be attributed to demographics. However, the rapid rise in the share of working-age population proved unsustainable in later generations (Dekle, 2000; Mankiw, Weil, 1989). Bloom, Williamson (1996) warn about the economic instability caused by rapid changes in the population pyramid, forcing the economy to incur transformation costs, evident in depressed output growth rates. While Chomik, Piggott (2015) and Macunovich (2012) argue that Japan is a prologue to developments in other countries, Floden (2003) and Oliver (2015) show conceptual and empirical evidence to the contrary. Razin, Sadka (2007) highlight the issue of divergent social policy as a factor. While Japan is a stark example of old-age demographics, above reasons make considerations taken for Japanese empirical analysis difficult to apply directly when studying CEE countries.

Historical demographic trends show that they can have a positive effect on the economy. The Asian economic miracle is one such example, associated with a transition to a lower birth rate and higher life expectancy, resulting in a so-called "demographic dividend" (Cai, 2010; Gomez, Lamb 2013; Bloom, Williamson, 1996). A growing working-age share of the population leads to faster output expansion, with the eventuality of Asian economies converging with a value of GDP per capita comparable to that of the US (Ha, Lee, 2016), a positive demographic transition leading up to an economic transition (Cervellati, Sunder, 2015; Yang, 2014). Hu (1995) points to the continuous positive effect of ageing on the economy, provided it is not distorted by policy. Gomez, Lamb (2013) focus on demographic changes in China, crediting a growing of the relative share of age groups in the "prime" 30–54 years range and adding the possibility for this range to extend.

European research dedicated to population ageing exemplifies the phenomenon's importance across the region. Muysken, Ziesemer (2013) point out the negative effect of ageing on GDP in the Netherlands. Hondroyiannis, Papapetrou (2000) predict an economic downturn in Greece bourn from low fertility and increasing dependency ratios. Smrčka, Arltova (2012) reach a similar conclusion regarding the Czech Republic. Blake, Mayhew (2006) question the sustainability of the UK economy in an ageing, low-fertility scenario. Lindh, Malmberg (2009) determine a hump-shaped dependency of GDP growth on different age groups, associating stagnation with ageing in EU15.

The shape of the dependency is also referred to as an inverted U, representing net positive effects of age groups in the middle and depressive effects of children and retirees. A number of studies support the conclusions stemming from LCM and rely on support and dependency ratios. Ha, Lee (2016), Gomez, Lamb (2013), Guest, McDonald (2007), Tyers, Shi (2007), Pryor (2003) focus on the positive effect of the support ratio. Choudhry (2010), Hondroyiannis (2000) determine the negative effect of age groups caught in the dependency ratio. Going into further detail, Rojas (2005) distinguishes different age groups within the support ratio as having a different effect on output due to imperfect labour substitution. The addition of a population structure increases the model's predictive power more than the inclusion of dependency or support ratios. Poterba (2001) suggests the notion of "prime saving years" in the 40–64 years range, but admits reduced explanatory power of the said range, compared to theoretical calculations, when working with empirical data. Goyal (2004) shifts the groups with the highest positive effect to the 45–64 range, calling them “net contributors,” reiterating Poterba’s (2001) conclusion on predictive power. Gomez, Lamb (2013) suggest a 30–54 “prime age” range, while Attanasio et al. (1999) state the peak years are between 38 and 41. Macunovich (2012) adds the utility of the shrinking share of the population in the 15–24 years age range as a leading indicator of economic downturns.

A Romanian study by Nedelea, Slate (2008) contributes to the discussion by pointing out the material costs of transforming the economy to the needs of an ageing population. Dizard (2013) points out healthcare and financial sectors to be affected by demographic changes. Dizard also predicts that the increase of those over the age of 65 will reduce demand of youth-oriented consumer products and put pressure on stock valuations of related companies. Moreover, he expects gains of medical and care service providers to be modest due to restrictive government legislation and an increasing strain of public finances caused by the need to deliver the assumed amount of funding. Ghosh (2005) produces a similar assessment. Dizard introduces care homes as an example of a service in high demand that is not profitable enough for the private sector to fully satisfy the demand, a phenomenon seen both in the EU and the USA. Dizard stipulates the intransient nature of compensation mechanisms currently used by governments makes postponement too costly to consider. Taxing the productive, cutting opportunities for the youth and forming overly optimistic expectations about investment returns contrasts with Europe’s failing to meet inflation targets, a long-term challenge these measures are unable to tackle. The consequences are described as likely to increase tension about picking an alternative mechanism in the public sector poised to break the status quo. Jalal & Khan (2014) point out the wealth prerequisite for a country to be able to address the transformation costs. These costs, per Nankervis (2015), may need to be spread over a considerable period of time with government support.

Volatility in consumption levels is addressed by Gorbachev (2011) in a US case study. Her input contrasts the overall rise in income and lower volatility in US GDP dynamics during the 35-year period ending in 2004 with more volatile consumption trends. A number of demographic variables, including age, sex and education are considered significant to this change. The question of consumption volatility in the US is further covered by Twum-Barima (2015), who also references the Life-Cycle Hypothesis. Their input focuses on the way children affect household consumption, pointing out a negative correlation between the proportion of children in the US society and consumption. Conversely, consumption volatility decreases and becomes positive after reaching adulthood. Pope (2009) connects the notion of consumption volatility in the US with uncertainty under the permanent income hypothesis. Demographics, according to his paper, play a role in consumption and can be depicted with a U-shaped lifetime uncertainty curve. Since the opposite can be applied to consumption, it connects the notion made by Stampe et al. (2013) regarding retirement and Twum-Barima (2015) with reference to children.

Jensen (2013) and Magnus (2009, 2010) offer a consensual valuation of the state of affairs, but their views on a demographics-driven downturn are muted, in contrast to Dizard. Magnus argues that regions experiencing the demographic transition such as Europe or Japan are home to global businesses able to provide stability thanks to income generated in emerging markets. Such enterprises are not expected to fall under the lower returns trend. Moreover, they raise the issue of regional differences as significant, reducing the widely publicised Baby Boomer retirement threat in the USA with regards to Echo Boomers, the children of the post-WWII generation, as seen in Appendix 1. While this is relevant to the USA, Jensen admits that the EU does not have demographic dividends at the ready, only hoping that immigration initiatives will be effective.

Nonetheless, both Jensen and Magnus admit a doubling ODR is a problem the effects of which are largely unknown. As Magnus (2010, p. 1) puts it: “We actually have no template about what to expect because 21st century population aging is unique.” Japan’s experience may be even more unique for cultural reasons, but the implications of a lost generation happening in the EU deserve more attention than they currently get, Jensen concludes. A Japanese case study points to a temporary effect in the economy that lasted for ten years, where consumption levelled off instead of falling as the population aged. This was explained with savings made on less workforce being required along with reduced costs to equip it, leaving more funds available for consumption.

Macunovich (2010) uses examples from Latin America, Japan and the USA to explain that their economic downturns in the last 30 years were rooted in the countries’ demographic makeup. In the paper, he stresses the importance of the 15–24 age group rather than an increasing old age dependency ratio. He discovered that growing economic activity and GDP per capita correlated with an increase in the group’s relative weight while downturns occurred immediately after the period of the cohort’s peak size. This effect manifested itself in many countries across Europe, including Belgium, Sweden and Russia. Macunovich suggests examining the age structure as a polynomial to avoid omitting meaningful data, going as far as suggesting overestimating the number of degrees in the polynomial to begin with unbiased, if inefficient, estimates. However, he warns against combining countries with different types of age structures, as they indicate a different economic effect in the 65 and over age group due to the presence or absence of government aid schemes.

2.2.2. Life Expectancy Studies

Age acts as an accessible behavioural anchor, which is assumed to be fixed. This implies that a 65-year-old circa 2010 had anchored behaviour identical to a 65-year-old circa 2000. Increasing life expectancy challenges this assumption by shifting lifecycle phases in time. Minimum retirement age hikes and advances in healthcare throughout Europe facilitate people working and living longer. This trend also changes the concept of *young* and *old*, as detailed by Kinsella et al. (2005). Tyers (2007) points out the emergence of the old age participation ratio as a positive result of growing life expectancy, which age does not explain. Gonzalez-Eiras, Niepelt (2012) study changing life expectancy rather than age as an explanatory variable for economic growth. Gomez, Lamb (2013) explain that changes in life expectancy result in the fluidity of the “prime age,” concluding that this stage is prolonged as life expectancy increases. Conversely, Chakraborty (2004) claims that short life expectancy, a frequent occurrence in a young society, is a negative factor for the economy, as human capital is not sufficiently accumulated. Tabata (2005) challenges this conclusion by focusing on healthcare costs in populations with greater life expectancy and refers to additional redistribution possibilities in a young society. While these two claims are difficult to reconcile in linear terms, Echevarria (2004) claims that life expectancy’s effect on real output has an inverted U pattern, which contains a top threshold that is between 45 and 50 years. This is confirmed by Eggleston (2012) and corresponds to peak contribution ages detailed by Poterba (2001) and Goyal (2004). Stampe et al. (2013) present a log-linear approach to modelling the empirical connection between demographics and consumption based on Brazilian figures. Their findings suggest significant differences in sectoral consumption, which appears to be in line with the Life-Cycle Hypothesis. The authors stress changes in consumption levels post-retirement. Results of a more recent study by Tracey & Fels (2016) with US demographic data show this is also relevant in different regions.

Life expectancy is not without flaws when it comes to drawing conclusions about its effect on output growth. Katz (2000) and Settersten Jr et al. (1997) conclude that it is what people do that matters and their decisions to partake in economic activity are not necessarily rooted in statistical metrics. Gollier, Zeckhauser (2002) put the notion of horizon length driven by an individual’s expectations, albeit these are difficult to obtain in practice. The existence of a government is another issue for life expectancy as an effective variable, as growing live expectancy prompts a higher retirement age, which extends the U pattern and preserves the status quo over a longer time span (Bloom et al., 2003). As such, life expectancy theoretically addresses the inflexibility of age, but its effect remains susceptible to the same mitigation factors. In practice, it does not necessarily reflect individual horizon lengths and its explanatory power may be inferior to that of age.

2.2.3. Forecasts in Research

Rather than estimating relationships between demographics and the economy, a part of the body of literature is dedicated to forecasting demographic trends and modelling their effects. Accurate forecasts of this type have potential in helping develop forward-looking policy, a benefit in a region of dynamic policymaking like CEE. McKinsey Global Institute and the IMF produced ample topical research.

The McKinsey Global Institute (2004), the research arm of the McKinsey & Company management consultancy, presents a standardised approach towards polynomials as a representation of ageing effects in a publicised discussion on the upcoming *demographic deficit*. In their case study on Germany, Italy and the UK, among non-EU countries, they have used fifth-degree estimates of life cycle effects, reserving a different equation for every age cohort. The Institute details in the technical notes section: “in this type of synthetic panel specification, all trends in the data are captured by lifecycle and cohort effects. Linear time trends cannot be separately identified since age, time and cohort are linearly related. Any time effects are implicitly assumed to be orthogonal to the deterministic trends represented by age and cohort effects” (McKinsey Global Institute, 2004, p. 224).

It is predicted by the Institute that Germany will experience a gradual decline in net financial wealth in real terms until 2025, the study’s horizon, which is associated with the relative increase of the number of individuals aged over 55. The report does not mention the old-age dependency ratio directly despite showing an expansion in the 65+ age range. Rather, a reduction in new households being formed being responsible for downward pressure on growth. A decline in the prime savers cohort (those aged 40–50 in the model) increases the challenge in Germany.

The UK’s situation is described as unique, maintaining that growth “will be slightly lower than in the historical period but will remain at a robust level.” A slowdown is expected, but net financial wealth annual growth is to average on 3.2 percent, twice of the US equivalent derived from the same model. The Institute suggests taking a critical approach towards the estimate as a directional rather than a point valuation, as the model focuses on “the direction, timing and magnitude of the demographic pressure on household savings and financial wealth accumulation” (McKinsey Global Institute, 2004, p. 187).

The IMF dedicated an issue of *Finance and Development* to the matter of demographics and their effect on the economy. Bloom and Canning (2006) point out the current state is a result of more than 100 years of deviation from a historic trend, in which populations and age structures changed very little. The “upheaval,” according to the authors, caused a wave of “booms, busts, and echoes” referring to baby boomers, and the subsequent decline in fertility as they reach maturity and echo effects, maintaining that a generation’s influence manifests itself in waves.

Regardless of the looped effect and overall population increases, the IMF’s contributors pointed out the global total fertility rate dropped from 5 in 1950 to approximately 2.5 in 2006, projected to fall further to 2 by 2050. As such, birth rates in developing countries are not expected to remain as high as they are now. However, they have also noted a drop in infant mortality, down to a third of its value of 180 since 1950 in developing countries and from 59 to 7 in developed countries. This is accompanied by greater life expectancy worldwide, up by 15 years since 1950 to 65 in 2005. The increase has not been homogenous across the world, with disparity expected to rise due to AIDS hampering longevity in sub-Saharan Africa and failure to improve social infrastructure in certain Post-Soviet states (Bloom, 2006).

These developments are prone to challenging the health and pension systems as the demographic dividend of a baby boom, included in the ratio of working-age to non-working age population, expires. The modelled crash is acute in more developed regions while less developed regions are expected to see a fractional negative slope. The analysis assumes the second demographic dividend does not occur, which, if managed with assets accumulated by new retirees, may produce a different outcome. A Spanish case study omitting the second dividend reveals the country’s pension expenditures are to increase by 16 p. p. of GDP by 2050, more than twice of those projected by the European Commission. The general equilibrium effect suggests output has to increase for the scenario to be sustainable. However, more severe consequences may occur, should an increase in consumption tax be required to finance the state’s retirement costs (Catalán, 2007).

Challenges stemming from a large cohort entering retirement, provided behaviour is constant within age and sex groups, have potentially destructive consequences as described by Bloch in the beginning of this subsection. Conversely, the IMF paper notes a change in behaviour not accounted for in simpler studies such as more women participating in the workforce or active immigration, as stated by Magnus, will resist the downward pressure on real income.

The authors support their claim with the example of Ireland, the net migration rate of which has been negative since 1960 until 1990, amounting to 1 per cent per annum on average (not dissimilar from Lithuania), but changed with the onset of economic growth fuelled by policy and demography-based factors. The increase in female labour force participation and immigrants, those returning and foreigners, dampened the negative effect predictions based purely on historic data. Hence, the figure presented on the previous page not fully come to fruition, as it assumes a static "accounting" approach, present in a majority of situations modelled by previously referenced authors.

Focus on reforms is stressed throughout IMF's study. The government's role in assisting a smooth transition without harming the country's economic potential is considered important: "The ability of countries to realize the potential benefits of the demographic transition and to mitigate the negative effects of aging depends crucially on the policy and institutional environment" (Bloom, 2006). A unique feature of their view is the inclusion of unexpected events such as pandemics and emergence of new diseases capable of altering a country's age structure.

A production technology model encompassing the demographic transition in China and India employed by Chamon (2006) sheds light on the subject of challenges in utilising the benefits of the demographic dividend. The log-linear model takes changes in demographic makeup and the economic transformation process as exogenous variables, meaning that certain tasks can only be done in countries deemed "developed." It resulted in noteworthy conclusions, one of which was a development queue, allowing a certain country to develop only after a country ahead of it in the queue attains "developed" status. The authors also introduced criticality for long-term transformations, maintaining a scenario will continue indefinitely as long as external processes keep the population's demographic makeup above threshold. A country joining the developed world produces explosive growth, however, "transitions from the developing to the advanced economy group are rare" (Chamon, 2006, p. 11). Trade barriers are pointed out as a potential demographic dividend reductor. While the authors warn about the limitations of transferring regional experiences verbatim, they admit long-term predictions with borderline values are sensitive to changes, some of which do not depend on action within the country because "the same policies that make a country unattractive to foreign investors today may not discourage them from investing in the future if that country becomes one of the last places in the world where labour is still 'cheap'," which makes the case for keeping data from developing and developed countries in separate subsets (Chamon, 2006, p. 13).

Batini et al. (2006) use a dynamic intertemporal general equilibrium four-country model to project the effects of demographic transformations as far as 80 years into the future. They have discovered the outcomes are differ between regions, with Japan undergoing the most extreme change in capital flows. Developed countries are expected to boost their developing counterparts' growth over the next 20–30 years, exploiting their demographic dividends. Moreover, a rise in productivity by 0.1 per year was projected as sufficient to offset half of Japan's aggregate GDP's fall attributed to demographic changes. The model inspects GDP per capita growth rates as well, concluding a decrease in industrialised nations due to ageing whilst those of developing countries are expected to increase as long as additional labour is used effectively. Long-term forecasting, the authors admit, is subject to shocks unaccounted for in the model as well as different changes in productivity. They conclude the paper with the following words: "Our understanding of how demographic change will affect economic performance is far from complete" and give the example of external balance receiving feedback from private saving behaviour.

Kim (2010) stresses the presence of coping mechanisms stemming from demographics as a means to smooth consumption in a period of perceived economic hardship. Japan's experience may be even more unique for cultural reasons, but the implications of a lost generation happening in the EU deserve more attention than they currently get, Jensen concludes. Magnus' Japanese case study pointed to a temporary effect in the economy that lasted for ten years, where consumption levelled off instead of falling as the population aged. This was explained with savings made on less workforce being required along with reduced costs to equip it, leaving more funds available for consumption. This is not predicted in an earlier study conducted by Dekle (2000).

The geography of old-age dependency ratio dynamics is elaborated on by Lee, Mason (2010a, 2010b, 2011). While the US may avoid a part of the negative pressure from ageing in the medium term due to having a replacement-level birth rate, the long-run dynamics, the authors conclude, approach those of Japan and Spain at 1% annual age-adjusted aggregate consumption declines. Projections for developing countries such as Kenya and

India show a more positive development until their eventual transition into low fertility, long life expectancy dynamics.

Magnus (2010) and Bloch (2006) support their claim with the example of Ireland, the net migration rate of which has been negative since 1960 until 1990, amounting to 1 percent per annum on average (not dissimilar from Lithuania), but changed with the onset of economic growth fuelled by policy and demography-based factors. The increase in female labour force participation and immigrants, those returning and foreigners, dampened the negative effect predictions based purely on historic data.

Their claims are supported by multiple empirical studies conducted in the Indian theatre. Lee & Mason (2011) broaden the number of statistically significant regressors to gender, age and introduce the measure of subjective expectations. This is partially supported by Shalini (2013), whose regression and ANOVA analysis found age and marital status significant while dismissing the effect of gender in the light of other non-demographic variables acting as proxies. Charness (2012) reaches a similar conclusion, advising against far-reaching conclusions due to the possibility misspecification. Franchi (2013) builds upon the effects of age and the economy in the US as a lagged regressor, associated with behaviours of different age groups.

With regards to policy and implementation, it is important to distinguish between cyclical and long-term structural changes. A simulation exercise run as part of the IMF Working Paper initiative underpinned capital export into developing Asia with demographic processes happening in Europe and Japan (Lueth, 2008). While there have been speculations about capital flows in 2007 stemming from loose monetary policy, the author suggests that demographic change is behind the current, “making a sudden reversal less likely” (Lueth 2008, p. 15).

The research problems analysed and breadth of conclusions reached from data derived from different regions across the globe highlight both the weaknesses and strengths of using demographics to address macroeconomic questions. While population data is relatively easy to obtain, the limitations noted in third-party research due to regional differences and the usage of control variables makes robustness testing a challenge. However, the various methods developed to address this difficulty in different conditions related to geography, population dynamics and quality of data provide sufficient options to start with. Notable queries include the possibility of the lifespan being endogenous to consumption expenditures through healthcare services, the time-path and smoothing of consumption due to changes in lifespan length and the provision of sufficient degrees of freedom and level of detail. In addition to this, the role of government in changing consumption behaviour through legislation is worth considering.

Both age structure and life expectancy research have arguments in favour of using a specific interpretation of ageing. While the appeal of using age as a behavioural anchor is understandable, changes in longevity also give credence to life expectancy. As these two interpretations are not mutually exclusive, it is possible to adapt a framework to analyse and compare the effects of both, individually and jointly.

Insight taken from the works laid out in this section is used as a basis to formulate the methodology to be used for the theoretical model and its empirical adaptation in verifying the defended statements.

3. ESTABLISHING THE METHODOLOGICAL FRAMEWORK

This section features the methodology for the analysis of the effects of population ageing on household consumption expenditures. It begins with a description of the conceptual framework of the thesis, followed by the formalisation of an econometric model to be used in empirical analysis. The model is then examined in reference to the Defended statements.

Table 5. *Conceptual Approach to Methodology*

1. Model Framework Selection	1.1. Identifying approaches used to assess the effect of population ageing on household consumption expenditures
	1.2. Comparing the identified models and making a selection
	1.3. Adapting selected models for further analysis
2. Variable Selection	2.1. Identifying different representations of population ageing
	2.2. Selecting an appropriate measure of household consumption expenditures based on Model Selection
	2.3. Selecting additional control variables
	2.4. Performing transformations for empirical analysis
3. Econometric Model Specification	3.1. Formalising the Selected Models with Selected Variables
	3.2. Preparing Empirical Data of Selected Variables
	3.3. Running the Selected Models with Selected Variables
	3.4. Adjusting Selected Models based on statistical tests
	3.5. Comparing results between Selected Models and their iterations
	3.6. Verifying research results with an out-of-sample data set
4. Concluding Research Results	4.1. Making conclusions based on Research Results
	4.2. Making suggestions and recommendations for further study

Source: Compiled by the author

The conceptual process to the methodological approach of the thesis is described in Table 5. It consists of four parts: Model Framework Selection, Variable Selection, Econometric Model Specification, Concluding Research Results. This section describes the first three parts and provides the logic for the steps necessary to complete the objective of each of the three parts. These objectives are derived from the Goal and Objectives laid out in the Introduction. The aforementioned sequence of tasks is constructed based on methodological guidance from the literature review and encapsulates a schematic for the rest of the thesis. Model Execution and Testing is defined in this section while the presentation of research results takes place in Section 4.

3.1 Model Framework Selection

Part 1 of the Conceptual Approach, following the literature review, consists of three steps: Identifying approaches used to assess the effect of population ageing on household consumption expenditures, Comparing the identified models, Adapting selected models for further analysis. Because Steps 1.1. and 1.2. have been covered in detail in Section 2, this subsection provides a very brief overview of the two to make the rest of the section more accessible and easier to reference, focusing attention on Step 1.3.

Table 6. *Comparing Approaches to Population Ageing and Household Consumption*

Name of Approach	**Overlapping Generations Model**	**Life-Cycle Model**
Notable Traits	Distinctive generations with fixed criteria: working-age and retired	Flexible number of demographic groups
	Fixed lifespan	Lifespan is not fixed
	Widely used	Lifetime effect can be defined with a function
		Additional control variables required

Source: Compiled by the author

Table 6 shows the two main approaches to the relationship of population ageing and household consumption expenditures. The Overlapping Generations Model is widely used in literature, as demonstrated in Section 2, and its notable traits help explain its appeal to researchers, namely, the distinct and intuitive generations as well as a fixed lifespan. The Life-Cycle Model, on the other hand, leaves these two matters to the researcher to decide. The flexibility of LCM, however, adds responsibility to the researcher to provide motivation for making a particular choice in determining the lifespan or the number of demographic groups or cohorts to be considered. Furthermore, the lifetime consumption function that can be defined by force-fitting coefficients to adhere to a particular function complicates the model while the need for control variables is another complication that is becomes evident in empirical analysis, due to limited degrees of freedom.

Of the two approaches, LCM is selected for analysis in the subsequent steps. The motivation for doing so is as follows: the model allows a more realistic representation of the effect of ageing on household consumption expenditures. In addition to this, the possibility to include changes to the lifespan length and defining the effect of demographic variables on household consumption during the lifetime with a function also play a role. Prior research by Kasnauskienė, Michnevič (2015, 2017) into the use of this approach to model the effects of demographic transformations on the economy show its utility despite LCM being considered less frequently than OLG.

LCM specification in the next steps is related to the Defended Statements, detailed in the Introduction. Defended Statement 1 stipulates the use of ageing and life expectancy as variables, as well as a non-linear effect on household consumption expenditures. This statement deals with the issue of oversimplifying the macroeconomic effect of population ageing and its vectors of manifestation. Defended Statement 2 points to the effects of population ageing having overlapping effects on household consumption expenditures, which pertains to the need to use different, competing methods of representing demographic ageing and comparing results. Defended Statement 3 necessitates the inclusion of controls related to retirement reforms. With these specific considerations in mind, the approach moves on to the next part.

3.2 Variable Selection

This subsection details the logic behind variable selection for the econometric model. The starting point to selecting variables to the estimation of the effect of population ageing on household consumption expenditures is addressing the question of population ageing. There are several representations of population ageing, as laid out in Section 2.2. Their brief description is shown in Table 7.

__Table 7.__ Comparing Approaches to Population Ageing

Name of Representation	Age Group Distribution	Life Expectancy Distribution	Dependency Ratios
Notable Traits	Widely used	Uncommon	Widely used
	Grouping by age cohorts, proportions	Life expectancies based on year of birth	Grouping by wide age cohorts
	Up to 18 narrow age groups in CEE	Up to 85 cohorts, annual	Up to 3 ratios available

Source: Compiled by the author

Dependency ratios such as ODR or aggregates like the median age are less informative than the population's age composition or population pyramid. Despite this fact, these aggregates are intuitive, commonly used to supplement models with a demographic component. However, the Goal and Defended Statements necessitate the use of more detailed metrics of population ageing, like those pertaining to Population Age Structure and Life Expectancy, per Section 2.2.

The Age Group Distribution can be defined as the building blocks of the population pyramid, the relative weight, proportion or relative size that each cohort has in the population. Life Expectancy Distribution, for the sake of comparison, defines the life expectancies of cohorts in the Age Group Distribution. While these two are treated as different ways population ageing manifests, a contentious issue in literature, in this thesis they are to be analysed separately and jointly, so as to address Defended Statement 2 pertaining to their overlapping effects.

Moving on to household consumption expenditure specification, there are three points to consider:

1. This thesis assesses the effect of population ageing on household consumption expenditures rather than GDP because it aims for a macroeconomic measure more closely associated with the underlying population demographics.
2. The measure of household consumption is to exclude consumption of healthcare services, which have an effect on life expectancy.
3. Exogenous shocks to household consumption like the Great Recession are to be taken into account.

By adhering to the above points, the macroeconomic variable is to reflect the consumption of households and free of outliers caused by exogenous shocks to the macroeconomic variable. The exclusion of consumption of healthcare services from the consumption metric addresses a secondary effect that causes endogeneity: the lifespan being dependent on consumption. It is worth noting that life expectancy studies rarely address this issue and is a contribution of this thesis.

Additional control variables are required per LCM stipulations. However, Defended Statement 3 regarding reforms to the retirement system makes an additional argument to their inclusion. Given that retirement reforms are a common occurrence in CEE countries, as detailed in Section 1.4., with changes to the retirement age, the size of the pension, the presence of pension funds and participation rates being main categories of change, they represent the additional controls. With these variables, the prospect of pinpointing statistically significant behavioural anchors is increased. Addressing differences between countries are fixed effects.

The variables selected for the LCM model have different units of measurement. This needs to be addressed along with their susceptibility to the time trend. As such, the measure of using the variables' logged form and differencing the values is taken prior to inputting them into the model. The stationarity of the variables is further assessed in Section 4.

3.3 Econometric Model Specification

Sourced from guidance detailed in the literature review, a model with a small open economy is considered. The economy is populated with heterogeneous cohorts of households, the behaviour of which adheres to LCM assumptions, per Modigliani (1966), facing health and time-dependent mortality risks. A short summary of selected models and their main characteristics is presented in Table 8.

Logged and differenced aggregate household consumption expenditures at period *t* are denoted as C_t. Each cohort of households *i* contributes $c_{i,t}$ to the total – those are each cohort's household consumption expenditures. The purpose of this exercise is to make inferences and estimate $c_{i,t}$ for every CEE country.

$$C_t = \sum_{i=1}^{N} c_{i,t} \tag{1}$$

Since cohort-specific $c_{i,t}$ coefficients cannot be estimated directly, given the absence of regular household surveys in the CEE region, proxies are used. Each cohort *i* has the following two demographic properties: relative cohort size (proportion) in the population in each *t* period $d_{t,i}$, the *i* cohort's life expectancy in each *t* period $l_{t,i}$. The coefficients for the effect that cohort size and cohort's life expectancy have on consumption are β_i and φ_i respectively.

The above can be written as follows, for age groups:

$$C_t = a + \beta_1 d_{t,1} + \beta_2 d_{t,2} + ... + \beta_N d_{t,N} \tag{2}$$

(2) contains two reasons for the usage of LCM over OLG: the ability to analyse *N* number of cohorts and the possibility of describing them with a lifetime consumption function. Household consumption expenditures have an effect on life expectancy and, consequently, the size of each cohort. The direct manifestation of this are health-related expenditures H_t, which are subtracted from consumption prior to logging and differencing, as seen in (3).

$$C^*_t = C_t - H_t \tag{3}$$

(3) withdraws consumption of healthcare services and aims to address heterogeneity, through which the dependent variable would have effected the independent demographic variables. After substituting C_t with C^*_t and subtracting the effect of the Great Recession, in (4), the issue of time-dependent mortality of each cohort *i* can be addressed.

Per defended statement 3, the model is to feature variables pertaining to the retirement system. For ease of use, they are represented as $r_{m,t}$ with coefficient γ_m, in which *m* represents the index number of the retirement system variable. The variables, averaged for sexes where applicable, are as follows:

$r_{1,t}$ - retirement age;

$r_{2,t}$ - life expectancy at retirement age;

$r_{3,t}$ - median real retirement pension;

$r_{4,t}$ - presence of private pension funds, a dummy variable;

$r_{5,t}$ - proportion of participants in private pension funds in the country's population.

All five variables pertaining to the retirement system target a different part of reforms described in Section 1.4. Variables $r_{1,t}$ and $r_{2,t}$ look at retirement not just as a question of age, but also life expectancy. $r_{3,t}$ addresses the changes in the size of the pension while $r_{4,t}$ and $r_{5,t}$ relate to private pension schemes qualitatively and quantitatively. With the addition of these variables, (2) transitions to (4).

$$C_t^* = a + \beta_1 d_{t,1} + \beta_2 d_{t,2} + ... + \beta_N d_{t,N} + \\ + \gamma_1 r_{1,t} + \gamma_2 r_{2,t} + \gamma_3 r_{3,t} + \gamma_4 r_{4,t} + \gamma_5 r_{5,t} \tag{4}$$

Equation (4) is used in the Peak Consumption Model. It is referred to this way because it is an LCM variant that often results with demographic coefficients the values of which are similar to an upside-down or inverted U, with a clearly defined peak and downward sloping arms. Equation (4) without the retirement system variables is referred to as Peak Consumption Model 1, Without Controls as a special consideration to demonstrate the effect of demographic variables without additional macroeconomic regressors in the equation. This is also used as a basis for comparison with the Benchmark Model, which also features only demographic variables.

The Peak Consumption Model does not fully adhere to LCM assumptions because the effects cannot be described with a lifetime consumption function. The problem lies in $d_{t,i}$ cohort data. Since $\sum_{i=1}^{N} d_{t,i} = 1$, it results in perfect multicollinearity in their coefficients β_i and (4) becomes impossible to estimate without remedial measures. Based on prior research by Kasnauskienė, Michnevič (2015), with the use of the BACKWARDS procedure, it is possible to pinpoint the demographic group most likely to have the lowest statistical significance and removing it from the equation based on that assumption. In this case, $i = 1$ is removed. Hence, the equation used in the Peak Consumption Model 1 is as follows:

$$C_t^* = a + \beta_2 d_{t,2} + ... + \beta_N d_{t,N} + \\ + \gamma_1 r_{1,t} + \gamma_2 r_{2,t} + \gamma_3 r_{3,t} + \gamma_4 r_{4,t} + \gamma_5 r_{5,t} \tag{5}$$

Considering that the Defended Statements mention both life expectancy and age group variables, a second regression with life expectancy variables is necessary. This is referred to as Peak Consumption Model 2. The model is defined with (6). Note that $l_{t,i}$ is the life expectancy of cohort *i* at period *t*, φ_i is its coefficient, ρ_m is the coefficient for the retirement system variable *m*, and $r_{m,t}$ is the value of the retirement system variable *m* at period *t*. Since Peak Consumption Model 2 features life expectancies of all age groups, unlike Model 1 it adheres to LCM assumptions. The equation describing Peak Consumption Model 2:

$$C_t^* = z + \varphi_1 l_{t,1} + ... + \varphi_N l_{t,N} + \\ + \rho_1 r_{1,t} + \rho_2 r_{2,t} + \rho_3 r_{3,t} + \rho_4 r_{4,t} + \rho_5 r_{5,t} \tag{6}$$

In order to address Defended Statement 2, it is not enough to estimate (5), (6) and compare them. Whether the effects of life expectancy variables and age group variables overlap is determined by empirically assessing the sum of (5) and (6), a model with both groups of demographic variables. The joint model is referred to as Peak Consumption Model 3. This is the most taxing model in terms of required degrees of freedom. Based on prior empirical research by Kasnauskienė, Michnevič (2015), the cohort size is described as 10-year age groups, namely, ages 0-9 for $i = 1$, followed by 10-19, 20-29, ... ,70-79, 80 and above. The last cohort is broader and includes all ages starting with 80 years old in consideration to statistical data reporting standards, where cohorts starting with 90 years old are included in either the cohort of 80 years old and above or 85 years old and above

Per LCM stipulations, β_i coefficients in (4) follow a pattern when moving from cohort to cohort. Therefore, this pattern allows the coefficients to be described with a lifetime consumption function – a curve that explains how each cohort affects household consumption expenditures, without excluding any cohort on the researcher's discretion. However, the Peak Consumption Model does not offer a solution to this with the age group variable block. The objective in this case is to estimate (4) without removing any age groups.

This can be accomplished by attempting to describe (4) with a lifetime consumption function with restricted coefficients and transforming them accordingly. Per Macunovich (2010), McKinsey Global Institute (2004), an nth-degree polynomial can be used for this task. Based on the literature review and the Peak Consumption Model assumptions, the degree of the polynomial should be sufficiently high to pass the Wald restricted coefficients test, at least one degree higher than the correct model specification. The conclusions from empirical and theoretical research suggest that the hump shape, per Lindh, Malmberg (2009), or inverted U, per Echevarria (2004), are of the 2nd or 3rd degree. Hence, the starting polynomial should be at least of the 4th degree, subject to the aforementioned Wald test.

Since the procedure involves force-fitting the coefficients next to demographic cohorts in (4), to differentiate it from the other approach, it is referred to as the Force-Fitted Polynomial Model. This model is not applicable to life expectancy variables as in (5) because life expectancy data $l_{t,i}$ does not have the same sum every time as with $d_{t,i}$. The remedial measure can be described with the following four Procedures:

1. Specify a restriction for β_i coefficients to avoid multicollinearity with the intercept term a.

2. Perform transformation of β_i coefficients based on the specified restriction

3. Rewrite (4) with transformed β_i coefficients.

4. Specify a means of reverting transformed coefficients back to the original β_i coefficients upon completing Step 3.3. laid out in Table 5.

The restriction (7) to avoid multicollinearity with the intercept a, per Arnott (2012), as laid out in Procedure 1 above, can be described as: the sum of all unrestricted β_i coefficients equals zero.

$$\sum_{i=1}^{N} \beta_i = 0 \qquad (7)$$

With this restriction, the coefficients next to each demographic variable can be transformed as (8), per Procedure 2 above. It is worth noting that the transformation also reduces the number of coefficients D_j to estimate from the number of cohorts, totalling *N*, $i = 1,...,N$ to the order of the polynomial describing the lifetime consumption function, denoted as k, $j = 1,...,k$, $k < N$. The reduction in the number of coefficients to estimate allows additional degrees of freedom in empirical analysis and avoids bias from having to remove one of the demographic age groups, as with the Peak Consumption Model.

$$\beta_i = D_0 + D_1 i + D_2 i^2 + \ldots + D_k i^k \tag{8}$$

Once the replacement process is repeated with every β_i, (4) is rewritten as (9), per Procedure 3. Note that the index for the order of the polynomial in (4b) is *j*.

$$C_t^* = a + \left(\sum_{j=0}^{k} D_j 1^j \right) d_{t,1} + ... + \left(\sum_{j=0}^{k} D_j N^j \right) d_{t,N} + \\ + \gamma_1 r_{1,t} + \gamma_2 r_{2,t} + \gamma_3 r_{3,t} + \gamma_4 r_{4,t} + \gamma_5 r_{5,t} \tag{9}$$

Note that in (9) the number of sums $\left(\sum_{j=0}^{k} D_j i^j \right) d_{t,i}$ is equal to *N*, which is the maximum value of the index *i*. This can be rewritten as *k* number of sums and taking D_j in front of each sum (10).

$$C_t^* = a + D_0 + D_1 \left(\sum_{i=0}^{N} i \right) d_{t,1} + D_2 \left(\sum_{i=0}^{N} i^2 \right) d_{t,1} + ... + D_k \left(\sum_{i=0}^{N} i^k \right) d_{t,N} + \\ + \gamma_1 r_{1,t} + \gamma_2 r_{2,t} + \gamma_3 r_{3,t} + \gamma_4 r_{4,t} + \gamma_5 r_{5,t} \tag{10}$$

For (8) to hold true, D_0 is specified in (11):

$$D_0 = -\frac{1}{N} \left(D_1 \sum_{i=1}^{N} i + D_2 \sum_{i=1}^{N} i^2 + \ldots + D_k \sum_{i=1}^{N} i^k \right) \tag{11}$$

In (10) and (11), the i index, representing the cohort number, spanning from 1 to N, is raised to the power from 0 to k. Defended statement 1 entails that $k > 1$, which can be verified by assuming that households maximise utility and that marginal utility of consumption in older cohorts falls due to mortality or statistically through mortality tables. Conversely, at the beginning of the lifespan, as mortality risks fall in the transition from infancy to adulthood, the marginal utility of consumption increases, precluding a linear trend with a negative slope from the left-hand side.

After the coefficient transformation and after the inclusion of D_0 as shown in (11), the expanded form of (4), with consideration for (10), can be described as (12), the Force-Fitted Polynomial Model.

$$C_t^* = a + D_1 \sum_{i=1}^{N} \left[i d_{i,t}^i - \frac{i}{N} \right] + D_2 \sum_{i=1}^{N} \left[i^2 d_{i,t}^i - \frac{i^2}{N} \right] + \ldots + D_k \sum_{i=1}^{N} \left[i^k d_{i,t}^i - \frac{i^k}{N} \right]$$
$$+ \gamma_1 r_{1,t} + \gamma_2 r_{2,t} + \gamma_3 r_{3,t} + \gamma_4 r_{4,t} + \gamma_5 r_{5,t} \tag{12}$$

(12) presents the solution to time-dependency of consumption by making an assumption about the functional form, based on prior empirical research, without specifying the order of the polynomial, thus maintaining a degree of flexibility in assessing the data. (12) is used only in the Force-Fitted Polynomial Model and represents Procedure 4.

While (12) considers the elements frequently omitted from LCM-based studies, namely, the inclusion of all cohorts, consideration of endogeneity and retirement variables, the statistically significant restricted coefficients D_j estimated via regression analysis, seen in Appendix 1, do not answer the question of how the demographic variables affect household consumption expenditures. To reach the answer, these coefficients must be transformed back through (8). The equation features the restricted coefficients and the index of the cohort raised to a degree, up to the order of the polynomial. Note that the order of the polynomial is determined by running statistical significance tests, per Econometric Model Specification in Table 5.

In addition to running statistical tests pertaining to BLUE panel least squares coefficient estimation, Step 3.5 includes a secondary test aimed at reducing the risk of spurious regression. Step 3.5. features verification of empirical results obtained in the previous steps via a secondary out-of-sample panel regression. This verification is referred to as the Benchmark Model. The Benchmark Model is described in (13).

$$C_T^* = g + \varpi_2 W_{T,2} + ... + \varpi_N W_{T,N} \tag{13}$$

The Benchmark Model relies on a reduced form (5), without pension reform variables. It entails a different set of countries with age group data, a different, longer period *T* and intercept *g*. The secondary panel comprises of Western European countries that do not share a border with CEE countries in order to limit spillover effects, yet are on the same continent (in consideration to the risk of cultural differences playing a significant role) and have a longer available time series. The countries in the Benchmark Model are: Belgium, Denmark, Spain, France, Netherlands, United Kingdom. Their period is from 1977 to 2011. This results in a panel of a similar size to that of CEE countries, but with reduced overlap. The Benchmark Model's purpose is to verify the statistical significance of demographic variables and compare the values of statistical tests with those obtained from the panel of CEE countries.

Table 8. *Selected Models and Main Characteristics*

Selected Model	Main Characteristics
Peak Consumption Model 1, Without Controls	Demographic age shares. Based on Equation (5), without retirement system control variables
Peak Consumption Model 1	Demographic age shares. Based on Equation (5)
Peak Consumption Model 2	Life expectancy variables. Based on Equation (6)
Peak Consumption Model 3	Combination of Model 1 and Model 2. Used to test overlap of effects of life expectancy and age shares
Force-Fitted Polynomial Model	Demographic age shares. Based on Equation (12)
Benchmark Model	Demographic age shares of a secondary data panel. Based on Equation (13)

Source: Compiled by the author

Hence, the dissertation features the following six models, as laid out in Table 8: Four Peak Consumption Models, the Force-Fitted Model and the Benchmark Model. The Peak Consumption Model 1 contains coefficients derived directly as described in equation (5), but excludes a part of the population age structure to obtain them. The Peak Consumption Model 1, Without Controls, is a simplified version of Model 1 without retirement system variables to be used for comparison with the Benchmark Model. The Peak Consumption Model 2, the life expectancy model described with (6) is followed by the joint model that is a sum of (5) and (6), Peak Consumption Model 3. The Force-Fitted Polynomial Model follows equation (12), the transformed coefficients of which can be inserted into (4). Results are then verified with (13), the Benchmark Model with a secondary time series from a panel of Western European countries. Differences between countries are addressed with the inclusion of fixed effects, subject to statistical significance testing.

Per Defended statement 2, the aforementioned demographic proxies of household cohort size and life expectancy have overlapping effects. An example of this can be an increase or decrease of life expectancy, which leads to the addition or removal of an age cohort. Conversely, the addition or removal of an age cohort suggests changes in life expectancy. Furthermore, Defended statement 2 does not require that $\beta_i = \varphi_i$ because coefficients for the entire lifecycle are meant to be studied jointly. Of interest are the differences in the adjusted R-squared value in each model as well as any overlap in the index numbers of statistically significant cohorts.

With regards to Defended statement 3 and the statistical significance of retirement reforms for household consumption, the CEE context of a small open economy is important. This entails limitations to the budget of policy response, policies being overturned quickly demographic conditions changing slowly. The addition of a new old-age cohort at period t $d_{t,N+1}$ requires government forecasting and budgeting allotments at $t-1$ in order to mitigate the cohort's effect. However, such an example is a reaction to a symptom rather than a sustainable solution. Policy related to the reduction of ageing through an increase of the birth rate and new entrants into the labour force require decisions to be taken more than a decade prior to the current period, which would severely limit empirical analysis. Hence, policy variables in the model are limited to retirement reforms and their immediate effects.

In practice, estimates obtained via LCM provide a simplified view of an otherwise complicated relationship between population ageing and the economy. Minor differences between countries, their retirement systems as well as long-term social care schemes depend on the model's inclusiveness and the researcher's assumptions about these variables' significance. Likewise, demographic variables and the ways of representing or grouping them pose another open methodological issue, partially due to the theoretical assessment of a particular representation of demographic ageing as well as empirical constraints, be it data availability or available degrees of freedom: depending on the available inputs, different proxies may be used, which may in turn affect research results. It is also due to these constraints that the methodology proposed in this thesis as well as the literature review does not take account residual long-term effects of demographic change. The slow evolution of demographic variables helps avoid the addition of their lagged terms, but this is not necessarily the case for policy aimed at producing an effect after a considerable amount of time. The dynamics in CEE policymaking and the number of decisions taken in each country in the region pose a different challenge, but the opposite may be applicable in other regions. As such, the model may have to be retooled in consideration of regional differences when used outside the CEE scope.

4. EMPIRICAL EVALUATION OF THE EFFECTS OF DEMOGRAPHIC AGEING ON HOUSEHOLD CONSUMPTION EXPENDITURES

The purpose of this section is a discussion of the empirical evaluation of the effects of demographic ageing on household consumption expenditures in CEE countries based on the methodology laid out in Section 3 and guidance derived from the Section 2. The section is structured to begin with a specification of empirical data to be used in competing econometric time-series models pertaining to the relevance of different forms of representing population ageing. Following a discussion of results stemming from each model, including tests for adherence to BLUE (Best Linear Unbiased Estimator) assumptions, robustness checking and out-of-sample benchmarking, the Defended statements outlined in the introduction are addressed, forming a basis for policy suggestions. The section covers steps 3.2. to 3.6. laid out in Table 5 and produces a foundation for Steps 4.1. and 4.2., to be concluded in the next section.

4.1 Empirical Data Considerations

This subsection weighs in on the available empirical alternatives, compares and contrasts them to justify each empirical data choice, per Step 3.2. To begin with, the methodology laid out in the previous section is tooled for the analysis of time series. At the junction of macroeconomic and demographic data, a contending list of variables is to address issues posed by vanilla time trends and business cycle volatility. The inclusion of dependencies as defined by (4) further increases the need to transform secondary data as reported by each country's statistics authority to Eurostat, the source of empirical information throughout this section unless stated otherwise. As such, the geographic area of interest, traditionally referred to as Central and Eastern Europe, most of which became EU members in 2004, includes a list of eleven individual countries: Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia. These countries exhibit a degree of commonality in economic, demographic and retirement reform trends as well as similarities in history, which defines the period of analysis.

Individual countries are taken to form a panel using methodological guidance from Lindh et al. (2009), Cervellati et al. (2015), Plumper et al. (2005). Minor differences between countries are addressed through the inclusion of fixed cross-section effects, prior tested with the redundant fixed effects test, resulting in each country having a different intercept term.

The length of the time series is determined by data availability, spanning over 18 years from 1996 to 2013. Bloom et al. (1996) and Lindh et al. (2009) consider this amount of time sufficient for robust estimation of the long-term effect of demographic variables. The relative magnitude of the demographic changes involved, as shown in Section 1, supports this.

The dependent variable is the logarithmic, differenced value of annual real household consumption expenditures per capita in each country, ie. the rate of change of the growth of real household consumption expenditures per capita. The long-term focus makes the case for the usage of annual rather than quarterly data, with an adjustment for the outlying 2009 crisis. While the annual percentage change of household consumption expenditures is more common in studies of this type, its use requires remedial measures due to non-stationarity and base issues. Another adjustment is made for expenditures on healthcare, prior to the differencing and logarithmic transformation, per equation (3).

For the demographic variables, selection is motivated by structure. Ratios, such as the old-age dependency ratio are less demanding in terms of degrees of freedom, but they withhold information about the labour force by aggregating it in the support ratio. For the Peak Consumption Model and Benchmark Model, I propose dividing the population pyramid into 10-year age intervals and measuring the values of the independent variables in each age group directly, starting with ages 0–9 and ending with 80 and over, nine age groups in total. In this case, per equation (4), $N = 9$. To maintain consistency, the same grouping is done with life expectancy. The division allows for sufficient degrees of freedom in the joint life expectancy and age group model while retaining the information to compare the findings to prior research. Excluding the first group, per equation (5), is necessary to avoid perfect multicollinearity of the estimated coefficients. The first group is selected due to the ageing and life expectancy trends manifesting on the right-hand side of the time scale. The levels of age group sizes are data points observed on January 1st of the year in question. The European statistical authority website does not offer a look into quarterly or monthly observations. While short-run effects may have potential utility, the slow rate of change makes annual data the more feasible alternative. Although distribution by sex is available, it is not analysed in the scope of this thesis, considering the aggregate nature of the dependent macroeconomic variable.

Each ten-year age group takes the form of the share it has in the population of the particular country in the particular year. As such, the values range from zero to one. To avoid susceptibility to time trends, the demographic variables are logged and differenced.

Macunovich (2012) and Arnott (2012) criticise this approach as ad hoc and suggest force-fitting the age structure into an *n*-th degree polynomial. Their alternative, however, produces inefficient estimates due to multicollinearity and assumes a smooth transition between age groups, precluding the “hump shape” obtained by Attanasio et al. (1999) and Lindh (2009). Both approaches are considered per Section 3.3.

It is worth noting that the Force-Fitted Polynomial Model is a special case. This approach allows for more degrees of freedom due to coefficient restriction (7) and their reduced number, per (8). Therefore, the original eighteen 5-year age groups as reported to Eurostat can be included, namely, ages 0-4, 5-9, … 80-84, 85 and over. This model does not feature the life expectancy variable block as this variant of the Peak Consumption Model does not necessitate such variable restrictions.

For the retirement reform-related variables, there are five differenced logged control variables considered. The variables are as fllows: the gender-weighted old-age pension retirement age, the life expectancy upon reaching the old-age retirement age, the median inflation-adjusted old-age pension, the presence of private pension funds, the proportion of participants in private pension funds in the country’s population. These controls are selected based on Section 1.4. and are a part of the Conceptual Approach to Methodology as described in Table 5.

4.2 Modelling the Effects of Demographic Ageing on Consumption Expenditures

In this subsection, both of the previously laid out approaches, the Peak Consumption Model, which deals with 10-year age groups, and the Force-Fitted Polynomial Model, pertaining to a transformed, restricted variant of eighteen 5-year age groups, are exercised and tested, followed by the Benchmark Model with a different time series. Each model is put through a range of statistical tests to determine the viability of its specification and adherence to BLUE assumptions. These tests cover statistical significance, ANOVA, normality, serial correlation, multicollinearity, heteroscedasticity, coefficient restrictions functional representation and an out-of-sample test. The above tasks are covered in Table 5 in the previous section and they cover Steps 3.3. to 3.6.

4.2.1. Peak Consumption Model

With this approach, all except the first 10-year age group are taken into the initial model, denoted as Model 1. The model's representation is found in Figure 5. Albeit the model in Figure 5 pertains solely to the demographic variables, without control variables related to the retirement system, it is used as a basis for statistical significance of demographic variables and a purely demographic comparison for the Benchmark Model.

The model in Figure 5 is statistically significant at a 5% significance level with an F value of 5.9 and it explains 43% of variance, represented by the determination coefficient, which is in line with previous research by Kasnauskienė, Michnevič (2015b). The Adjusted R-squared is 0.35. Going over the variables, each demographic age group is annotated with the letter β_i and the index of the respective age range, in which . β_2 refers to the differenced logarithmic share of those aged 10 to 19 in the population of each country in a given year. The model also features an intercept term.

The purely demographic regressor-based Peak Consumption Model 1, Without Controls, contains a few statistically insignificant variables at a 5% significance level. This development is to be expected, per Poterba (2001). These apply to the age ranges outside the peak productivity years, up to 29 and ages 60 and over. This is in line with expectations, as the effect in each cohort is not equal. This also supports Defended statement 1 regarding the non-linear nature of the effect of population ageing on household consumption expenditures. Of note is the positive sign of each coefficient, growing steadily until ages 50–59, which coincides to the last pre-retirement group across the CEE region. The current median age in CEE countries lies within 40–50 years range, which corresponds to β_5 in Figure 5. On the one hand, it suggests that the median age in CEE countries, as the population is ageing, is climbing towards the peak value in cohort β_6 and remedial measures are unnecessary in the immediate future. On the other hand, the precipitous drop in the following cohorts cautions against allowing the ageing trend to continue. In addition to this, the distribution of the coefficient values plays a role, considering that cohorts in ODR are growing faster than the other cohorts and their coefficient values are negative. The cohorts climbing to higher coefficient values as they transition from, for example, β_3 to β_4 are less numerous than cohorts entering retirement. As such, the effect is both from the increase of the size of the cohort with a negative coefficient value and decrease of those with a high positive coefficient value.

Coefficient	Value	Std. Error	t-Statistic	Prob.
a	0.04	0.01	3.95	0.01
β_2	3.12	1.82	1.72	0.09
β_3	2.39	1.94	1.24	0.22
β_4	7.8	2.65	2.95	0.01
β_5	8.95	2.66	3.37	0.01
β_6	9.29	3.08	3.02	0.01
β_7	3.01	4.01	0.76	0.46
β_8	-2.76	2.95	-0.94	0.36
β_9	-2.03	2.04	1.2	0.24
Effects Specification				
Cross-section fixed (dummy variables)				

R-squared	0.43	Mean dependent var	0.04
Adjusted R-squared	0.35	S.D. dependent var	0.03
S.E. of regression	0.02	Durbin-Watson stat	1.21
Sum squared resid	0.09		
Log likelihood	337		
F-statistic	5.86		
Prob(F-statistic)	0.00		

Figure 5*. Peak Consumption Model 1, Without Controls, Representation and Test Statistics*

Source: Compiled by the author

The slightly positive coefficient value of β_7, the 60–69 age group, can be explained with the current effective retirement age in most CEE countries falling into that range. The negative coefficients next to the 70–79 and 80 and over groups suggest their negative effect on household expenditures. However, they are statistically insignificant at a 5% significance level. Furthermore, another issue with Peak Consumption Model 1, Without

Controls, is first-order serial correlation, as highlighted by the Durbin-Watson statistic of 1.2.

The transition from Model 1, Without Controls, to Model 1 is done via the BACKWARDS procedure by removing statistically insignificant variables without violating the reasoning behind the approach. Upon doing so, economic variables, namely the variable for the median pension and the variable for life expectancy upon reaching the retirement age, the median pension, the presence of private pension funds, the participation in private pension funds as a proportion of the population are added. The model is further corrected by subtracting the error term, lagged once to address the issue of first-order serial correlation.

Coefficient	Value	Std. Error	t-Statistic	Prob.
a	0.53	0.25	2.17	0.04
β_4	3.83	1.64	2.35	0.03
β_5	6.15	2.57	2.4	0.02
β_6	7.08	1.46	4.88	0
r_2	-8.16	2.18	-3.76	0.01
Effects Specification				
Cross-section fixed (dummy variables)				
R-squared	0.53	Mean dependent var	0.045	
Adjusted R-squared	0.46	S.D. dependent var	0.033	
S.E. of regression	0.02	Durbin-Watson stat	1.90	
Sum squared resid	0.06			
Log likelihood	318			
F-statistic	8.28			
Prob(F-statistic)	0.00			

Figure 6. *Peak Consumption Model 1 Representation and Test Statistics*
Source: Compiled by the author

As a result of the remedial measures described above, the number of estimators, as displayed in Figure 6, has decreased in half. The model's significance has also increased, with an F value of 8.3 and the determination coefficient suggesting that the model now explains 53% of variance, an increase of 10 p.p. compared with Peak Consumption Model 1, Without Controls. While reviewing the second representation, it becomes evident that ages 30 to 59 remain, with a pronounced peak, or upside-down U shape in coefficient values. However, the inclusion of β_4 pertaining to ages 30-39 suggests that the arms of the upturned U are not identical and there is a negative skew to the distribution – a gradual rise followed by a precipitous drop. While this finding partially contradicts Poterba (2001), it remains in line with LCM stipulations in the first half and OLG assumptions at the cut-off to retirement. Further highlighting the OLG component is the presence of the retirement age variable, the only statistically significant variable of retirement-related variables selected for this exercise. Denoted as r_2 in Figure 6, it shows that a positive growth rate of life expectancy post-retirement has a negative effect on the dependent variable of household consumption expenditures. This finding can be explained by the need to smooth out consumption, leading to a more platykurtic distribution of effects throughout the lifetime. A schematic of the change in distribution as time moves on, based on Model 1, Without Controls, can be seen in Figure 7.

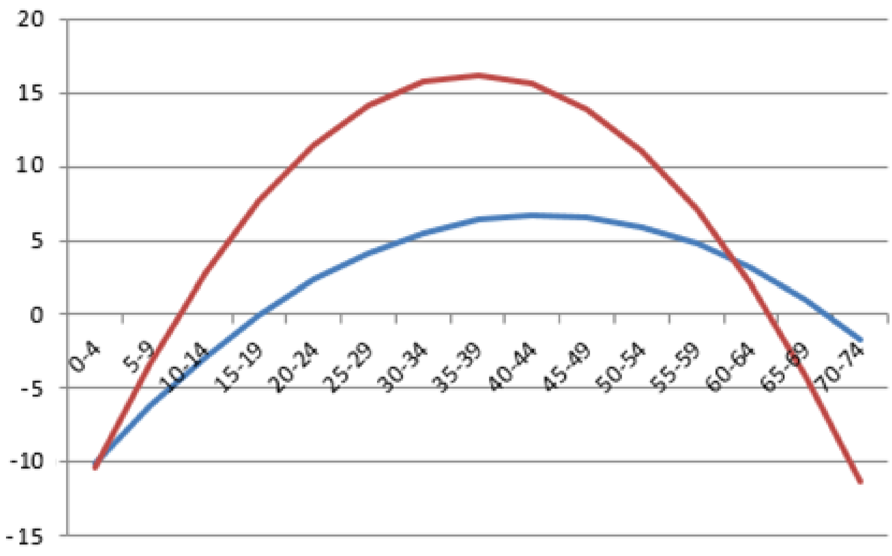

Figure 7. *Rate of Change of Consumption 1996–2004 (Red) and 2005–2013 (Blue)*

Source: Compiled by the author

Figure 7 shows that the effects the distribution of age groups in a population has on a country's household consumption expenditures in the CEE region evolve over time. While cutting the period in half to obtain the smoothed curves seen in the above figure significantly limits degrees of freedom, the resulting curves adhere to LCM assumptions and point to empirical data showing the upside-down U shape or hump shape mentioned in the literature review. Furthermore, the change of the distribution in the latter half of the analysed period, 2005–2013 shows that the overall positive effect defined as the surface area above the abscissas axis has decreased by more than half. While a part of this can likely be attributed to period effects, the significant reduction of the positive impact of demographics is concerning.

Following the transition to the Model 1, the representation shown in Figure 7 appears to have no first order serial correlation as determined by the Durbin-Watson statistic. Higher order serial correlation is verified through a correlogram with up to five lags and Ljung-Box test. The Q statistic value on each lag both for autocorrelation and partial correlation, shown in Figure 8, does not allow the rejection of the null hypothesis at a 5% significance level that there is no serial correlation. As such, the model is used as a basis for continuing the analysis.

The statistical insignificance of the median pension variable can be explained with the reactive nature of PAYG pensions that take up the majority of pensions in the region. It is further reinforced by indexation of pensions in countries such as Latvia. However, the length of time spent in retirement deserves further attention.

The coefficient before r_2 suggests that a shorter time spent in retirement would be beneficial to the growth of household consumption expenditures and, due to its weight in real output, the economy as a whole. It also puts the onus on time spent in retirement, not the retirement age itself. As such, instilling changes in the effective retirement age and, as a result, time spent in retirement, the government can influence the magnitude of the effect on economy over time.

An important caveat to this is that the retirement age and, by proxy, the amount of time spent in retirement is a sensitive political matter, as shown in Section 1.4.

Considering the prevalence of pension reforms in the region, as described in the Section 1.4, another experiment has been carried out, in the form of the addition of BIS-inspired private pension fund data. This has been included in calculations as a dummy variable, denoting the presence (1) or absence (0) of private pension funds and the number of people enrolled in private pension funds as a share of the overall population, logged, Appendix 2. A test case for the inclusion of such variables has been produced for a smaller sample by Kasnauskienė, Michnevič (2018).

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |. |	. |. |	1	-0.02	-0.02	0.03	0.87
.*|. |	.*|. |	2	-0.16	-0.16	2.56	0.28
. |. |	. |. |	3	-0.05	-0.06	2.82	0.42
. |. |	. |. |	4	0.01	-0.02	2.82	0.58
.*|. |	.*|. |	5	-0.01	-0.11	3.71	0.59

***Figure 8**. Correlogram of the Peak Consumption Model Model 1 Residuals*
Source: Compiled by the author

In relation to private pension funds, it has been determined that the existence of private pension funds alone is not statistically significant at a 10% significance level. On the other hand, the proportion of the population enrolled in private pension funds, as seen in Appendix 2, the precise contribution levels of which vary across countries (an intractable condition that warrants caution when drawing the conclusion), appears to be borderline significant, with statistical significance level of 4.8%. This borderline positive effect on household consumption would add grounds to explaining why countries engaged in frequent reforms of this part of the retirement system, both when increasing and decreasing contribution levels. However, the borderline significance excludes r_5 from further analysis in Model 1.

Model 1 does not appear to be possible to accurately specify in linear terms. At a certain point, this model would contradict OLG assumptions by straying from the population's aggregate indifference curve. The former notwithstanding, it is apparent that an increasing life expectancy post-retirement poses a challenge in funding consumption without changes to the working-age period. Figure 7 illustrates this point inasmuch changing the former invariably affects the latter: a longer retirement period *ceteris paribus* requires a longer period spent working. The shift in the effective retirement age during the period from high 50s to low 60s reflects that notion throughout the region.

Table 9*. Fixed Effects of Peak Consumption Model 1*

Num.	Country	Effect
1	Bulgaria	-0.002
2	Czech Republic	-0.009
3	Estonia	0.02
4	Croatia	-0.011
5	Latvia	0.017
6	Lithuania	0.027
7	Hungary	-0.024
8	Poland	0.009
9	Romania	-0.008
10	Slovakia	-0.014
11	Slovenia	0.002

Source: Compiled by the author

Further expanding on the negative coefficient value r_2 , it is worth noting that empirical data that would justify a higher-order function does not exist and is unlikely to come up. Given the political dynamics in CEE countries, a social experiment that would push the effective (as opposed to legal) retirement age and, by proxy, the length of retirement past the OLG threshold would be prohibitively difficult to carry out. While it is theoretically possible to raise the retirement age past the population's average life expectancy, it is more realistic that life expectancy growth would taper off or shift backwards in response to a natural disaster. Hence, the model's weakness is determined by its data, a one-directional shift towards an older society. Model 1 fixed effects are presented in Table 9. They have been tested with the Redundant Fixed Effects test.

Another test carried out for Model 1 is the Jarque-Bera normality test, coupled with a histogram. Both the histogram and the test statistic of 0.2 point to the normality assumption being upheld. The infeasibility of returning previously excluded variables to the model has also been verified with each separate variable individually, per STEPWISE regression.

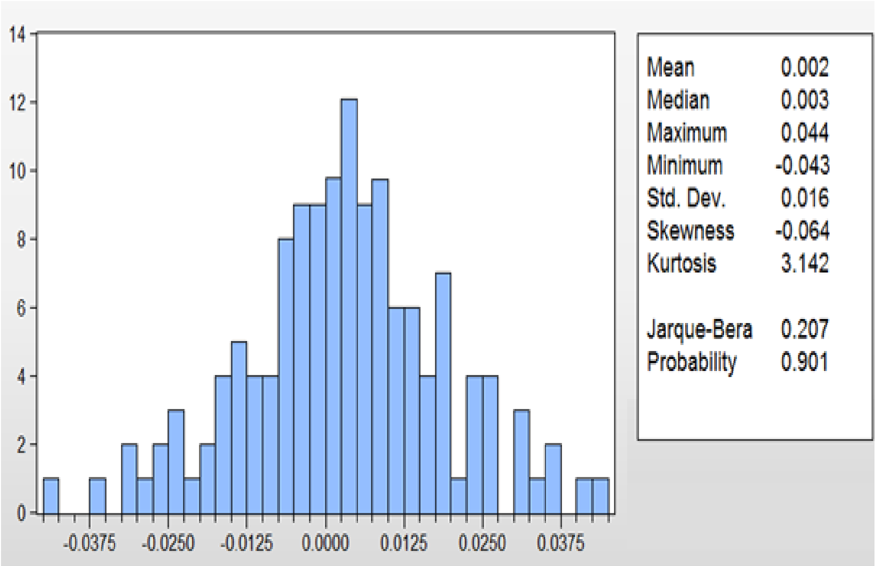

Figure 9. *Test Statistics and Histogram of Peak Consumption Model 1 Residuals*

Source: Compiled by the author

Regardless of the merits of Peak Consumption Model 1, the criticism fielded at the need to rely on the researcher's discretion in terms of selecting the age range for each group as well as the exclusion of one such group remains valid. Hence, the aforementioned model is to be juxtaposed and its results compared with that of a competing method.

Such a model is the Peak Consumption Model 2, which follows Equation (6). This model features life expectancy variables, which represent a separate field of interest, as demonstrated in the literature review, and a competing variable set for demographic age shares. While there is a discussion about the so-called true representation of demographic ageing, in this thesis Defended statement 2 claims that these two sets of variables exert an overlapping effect on household consumption expenditures.

It is worth noting that life expectancy models are less prevalent in empirical studies. While life expectancy has the theoretical appeal of a behavioural anchor, connecting consumption with the length of the lifespan, its empirical application can be challenging. This can be seen in Peak Consumption Model 2, in Figure 10.

Peak Consumption Model 2 is statistically significant, with an F-statistic of 11.6. It explains 55% of the regressand's variance. Despite benefiting from the inclusion of life expectancies of all eight cohorts, only two cohorts, namely

φ_3 for ages 20–29 and φ_9 for ages 80 and above remain statistically significant at a 5% significance level. Besides these two variables there is an intercept term *z*. It is worth noting that the Adjusted R-squared of 0.51 is 6 p.p. higher than that of Model 1.

Coefficient	Value	Std. Error	t-Statistic	Prob.
z	0.04	0.00	8.01	0.00
φ_3	2.61	0.53	3.96	0.00
φ_9	-0.33	0.10	-2.62	0.00
Effects Specification				
Cross-section fixed (dummy variables)				
R-squared	0.55	Mean dependent var		0.04
Adjusted R-squared	0.51	S.D. dependent var		0.03
S.E. of regression	0.02	Durbin-Watson stat		1.92
Sum squared resid	0.06			
Log likelihood	354			
F-statistic	11.6			
Prob(F-statistic)	0.00			

Figure 10. *Peak Consumption Model 2 Representation and Test Statistics*
Source: Compiled by the author

From the perspective of behavioural anchors, the inclusion of these two cohorts can be considered intuitive. The 20–29 age range represents entry into the workforce, while 80 years and above exceeds the life expectancy at birth in CEE countries. Hence, an increase in life expectancy in cohorts higher than the life expectancy at birth has a negative effect on household consumption expenditures. Since this model features life expectancy variables, the lack of statistical significance of the life expectancy post retirement variable is understandable. The coefficient values in Model 2 do not appear to contradict LCM assumptions or Defended statement 1. It is worth noting that the statistically significant cohorts in Model 1 and Model 2 are different. Ergo, different demographic groups allow the effect to manifest, but the strength of the effect is similar in terms of explaining the portion of the dependent variable's variance.

Coefficient	Value	Std. Error	t-Statistic	Prob.
a	0.04	0.01	7.45	0.00
β_4	3.65	1.21	2.69	0.01
β_5	5.86	0.99	5.91	0.00
β_6	3.96	1.84	2.14	0.03
φ_3	2.15	0.69	3.07	0.00
φ_9	-0.27	0.07	-3.53	0.00
Effects Specification				
Cross-section fixed (dummy variables)				
R-squared	0.62	Mean dependent var		0.04
Adjusted R-squared	0.57	S.D. dependent var		0.03
S.E. of regression	0.02	Durbin-Watson stat		1.99
Sum squared resid	0.05			
Log likelihood	366			
F-statistic	12.3			
Prob(F-statistic)	0.00			

Figure 11. *Peak Consumption Model 3 Representation and Test Statistics*
Source: Compiled by the author

In order to facilitate an effective comparison of Model 1 and Model 2, per Defended statement 2, and Step 3.5. there is utility in presenting a joint model. Referred to as Peak Consumption Model 3, the model combines statistically significant variables of Model 1 and Model 2, applies the BACKWARDS procedure until only statistically significant variables for the joint model remain. Coefficients and test values of Model 3 can be seen in Figure 11.

All demographic variables that were statistically significant in Model 1 and Model 2 are also present in Model 3. The value of the F-statistic is the highest so far, at 12.3. The model is statistically significant. Furthermore, it features the highest R-squared value of 0.62 and the highest Adjusted R-squared value of 0.57 of the three models. The transition from Model 2 to Model 3 exhibits an increase in the determination coefficient by 7 p.p. The Adjusted R-squared is higher by 6 p. p. This suggests a significant overlap of the effects exerted by the life expectancy trend and the age group distribution trend. Life expectancy variables alone appear to explain 10% more variance of household consumption expenditures than age group variables. However, the remainder appears to have a 90% overlap. This high overlap of explanatory power, despite differences in theoretical implications of each set of variables and zero common cohort numbers, points to the potential of using these variables interchangeably, depending on the data that is available. Given the necessity of the 80-and-above group for the life expectancy model and the relative novelty of calculating life expectancy, Model 1 shows more promise than Model 2 for developing countries. The utility of using Model 3, given the added requirements of degrees of freedom and limited increase of Adjusted R-squared, may also be lower than that of Model 1.

4.2.2 Force-Fitted Polynomial Model

This approach is favoured by McKinsey (2004), Arnott (2012) and Macunovich (2010) considering the slow-moving nature of demographic variables and their requirements for degrees of freedom. As demonstrated with the Peak Consumption Model, it is impossible to estimate coefficients for all eighteen 5-year age groups, per Eurostat reporting schedule, over the currently longest available time span of eighteen years, from 1996 to 2013 while taking into account for sufficient additional control variables and corrections. It is described in Equation (6).

A key element of the Force-Fitted Polynomial Model is the restriction of each coefficient to adhere to a polynomial function. This, in turn, assumes a smooth transition between from one age group to the next, but poses a challenge in interpreting the restricted coefficients as well as introducing multicollinearity, all of which are valid concerns. However, the necessity to restrict coefficients is data-driven, and equations (7), (8) address that problem. Moreover, since this approach permits the joint analysis of all coefficients pertaining to individual age group effects, the concern regarding adherence to LCM assumptions is rendered moot in this model. The calculation of these restricted coefficients is available in Appendix 1.

Coefficient	Value	Std. Error	t-Statistic	Prob.
a	-0.29	0.09	-3.39	0.01
D_1	46.64	18.45	2.44	0.03
D_2	99.79	22.32	3.08	0.01
D_3	-1.29	0.94	1.75	0.08
D_4	-0.05	2.42	-0.02	0.99
γ_2	-6.36	1.4	-3.57	0.01

Effects Specification			
Cross-section fixed (dummy variables)			
R-squared	0.49	Mean dependent var	0.04
Adjusted R-squared	0.42	S.D. dependent var	0.03
S.E. of regression	0.02	Durbin-Watson stat	1.92
Sum squared resid	0.06		
Log likelihood	289		
F-statistic	6.85		
Prob(F-statistic)	0.00		

Figure 12. *Force-Fitted Polynomial Model Representation and Test Statistics*

Source: Compiled by the author

A notable part of the procedure is the additional step of transforming blocks of demographic data for each cross section in each year into a smaller set, the size of which is not initially known. McKinsey (2004) finds that the starting position is to be at least one degree higher than the correct functional form. Moreover, previous work by Kasnauskiene, Michnevic (2015a) suggests that the 2nd or 3rd-degree polynomial can be expected as the functional form. Higher order functions carry the risk of volatility at extreme values. For the purpose of this exercise, the fourth degree is taken as the starting point. In case all restricted coefficients are statistically significant, it would be necessary to use the FORWARD procedure and increase the order of the polynomial.

The Force-Fitted Polynomial Model's coefficient values and test statistics are presented in Figure 12. It features an intercept, four restricted coefficients, one per degree, denoted respectively as D_1 to D_4 and the life expectancy upon reaching retirement variable γ_2 as in the previous approach. Other pension reform-related variables did not appear to be statistically significant at a 5% significance level.

Coefficient	Value	Std. Error	t-Statistic	Prob.
a	-0.29	0.09	-3.46	0.01
D_1	10.62	9.38	3.18	0.01
D_2	32.04	17.77	-2.29	0.02
D_3	-2.11	1.26	2.04	0.04
γ_2	-5.63	1.61	-3.02	0.01
Effects Specification				
Cross-section fixed (dummy variables)				
R-squared	0.49	Mean dependent var	0.04	
Adjusted R-squared	0.42	S.D. dependent var	0.03	
S.E. of regression	0.02	Durbin-Watson stat	1.92	
Sum squared resid	0.06			
Log likelihood	289			
F-statistic	7.41			
Prob(F-statistic)	0.00			

Figure 13. *Force-Fitted Polynomial Model Representation and Test Statistics with Statistically Significant Coefficients*

Source: Compiled by the author

Of note is the statistical significance of the model, with an F value of 6.85, with the model explaining 49% of variance. The estimation representation also shows that there is a statistically insignificant variable, D_4, pertaining to the fourth degree. Upon confirmation with the Wald restricted coefficient test, it is feasible to remove D_4 from further analysis as statistically insignificant.

The model without D_4, featured in Figure 13, is also statistically significant, with an F value of 7.4. Its explanatory power is identical to that of the previous representation at 49%. Albeit a lower value than that of the Peak Consumption Model 2, the difference is marginal. Hence, this model is used in further statistical tests.

It is worth noting that the borderline significant D_3 variable remains in the model due to its smoothing effect on the left-hand side, per LCM stipulations. Its exclusion would effectively reduce the function to a parabola with equal arms on both ends, which is not consistent with the underlying theoretical approach.

Table 10. *Implied Regression Coefficients of the Force-fitted Polynomial Model*

Age group	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44
Implied Regression Coefficient	-3.98	-3.06	-1.76	- 0.19	1.52	3.23	4.83	6.19	7.18
Age group	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+
Implied Regression Coefficient	7.67	7.54	6.68	4.93	2.19	-1.67	-6.79	-13.3	-21.3

Source: Compiled by the author

Since restricted coefficients need to be reverted back, via the procedure described in Section 3, prior to analysis, the step is taken and the result is displayed in Table 10. These coefficients have been obtained through transformation, which is why they are referred to as implied coefficients. As such, they follow a third degree polynomial function.

Upon taking a closer look at the coefficients, it is evident that ages significantly past the retirement age during the analysed period, starting with year 70, have a pronounced negative effect on household consumption expenditures. Conversely, ages prior to entering the labour market are also exhibiting a negative effect, albeit not as pronounced. Due to limitations of the polynomial function, the values at the start and end of the function should be carefully appreciated. The greatest positive effect in the Force-Fitted

Polynomial Model can be attributed to ages 45–54, over 7.5. This is a commonality with the Peak Consumption Model 1 and it highlights the limitations of broad grouping, suggesting that the age groups in the peak productivity range can be sliced further into smaller ranges to offer more detailed insight.

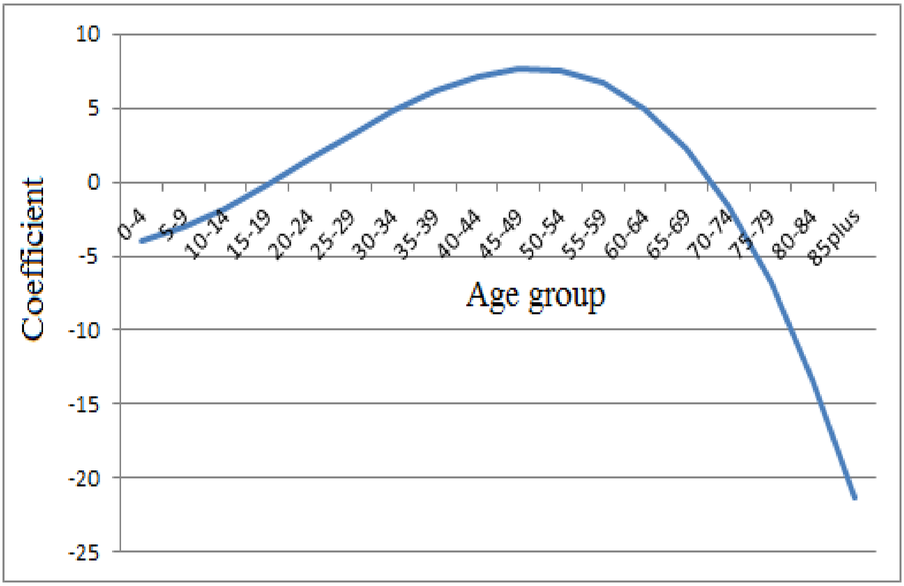

Figure 14. *Force-Fitted Polynomial Model Demographic Coefficient Curve*

Source: Compiled by the author

The Force-Fitted Polynomial Model's coefficients in Figure 14 appear in line with LCM assumptions. They also do not contradict prior research based on the general shape of the curve, namely, a peak around the middle years and crossing the horizontal axis at points of entry and exit from the workforce.

A notable difference in the models is the presence of a pronounced trough in the Force-Fitted Polynomial Model, which is partially covered by the life expectancy post retirement variable in the Peak Consumption Model. With the population pyramids changing in accommodation of a higher proportion of retirees living longer, the negative effects may cascade and become difficult to manage.

Considering the recent shift in retirement reform in countries such as Estonia, Lithuania and Poland, following a history of frequent changes to the retirement system, there is a need for future-proof legislation that would not be overwhelmed by the population ageing trend over the medium term.

4.2.3 Benchmark Model

Both the Peak Consumption Model and the Force-Fitted Polynomial Model use panel data over the same period. Albeit separation of the period of analysis is considered as a remedial measure for verification purposes, the subsequent reduction in accuracy is a problem in itself. Hence, a benchmark model, based on Equation (13), with empirical data from a different, longer period is considered. This is described in Step 3.6 in Table 5.

The requirements for the model, described in Section 3, are as follows: the analysis period should be different from the main regression, the countries involved should not have a border with the CEE sample in order to avoid spillover effects, the countries should not have significant cultural differences from the CEE sample.

Meeting the above requirements is challenging due to limited quality time series regardless of geography and the rapid population ageing phenomenon emerging in modern times. Notwithstanding the above, Western European countries appear to possess the required qualities, namely, time series from 1977 to 2011, a period of 34 years, twice as long as the main regression, with limited overlap. The six countries included in the analysis, alphabetically: Belgium, Denmark, Spain, France, Netherlands, United Kingdom, do not have a border with the CEE countries. Despite the smaller number of countries, because of the longer time period the resulting balanced panel retains its size and provides comparable degrees of freedom.

The Benchmark Model, as seen in Figure 15, contains the same variables and undergoes the same macroeconomic variable adjustments as in the Second Peak Consumption Model from Figure 11. Other than the 50–59 age group, the other variables retain their statistical significance at a 5% significance level. The model itself is also statistically significant, with an F-stat of 9.15 and R-squared of 0.39.

While the value of determination coefficient shown in Figure 15 (0.39) is lower than in models from the main panel regression, the relationship is statistically significant at a 5% significance level. The Benchmark Model's results, given that it lacks retirement reform controls, are comparable with Peak Consumption Model 1, Without Controls.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
g	0.02	0.01	4.52	0
ϖ_4	3.39	1.31	2.59	0.02
ϖ_5	4.39	1.33	3.32	0.01
ϖ_6	1.91	1.41	1.36	0.18

Effects Specification			
Cross-section fixed (dummy variables)			
R-squared	0.39	Mean dependent var	0.015
Adjusted R-squared	0.34	S.D. dependent var	0.02
S.E. of regression	0.01	Durbin-Watson stat	1.95
Sum squared resid	0.04		
Log likelihood	423		
F-statistic	9.16		
Prob(F-statistic)	0.00		

Figure 15. *Benchmark Model Representation and Test Statistics*
Source: Compiled by the author

Of note is the identical sign of coefficients of all variables. While coefficients of age groups exhibit lower explanatory power, life expectancy in retirement is more statistically significant than in Peak Consumption Model 2. This highlights that the effects of demographics are not equally spread across the globe, making comparative analysis challenging.

However, the distribution of demographic variable coefficients obtained from the Western European sample retains the distinctive hump (or peak) shape as in the CEE sample. Of note is the change in their importance over time, as coefficients for the 1996–2013 period, as shown in Appendix 3, are markedly higher in absolute terms, further suggesting that the issue of population ageing is a growing concern in the Western Europe sample, if not as acute as in CEE countries.

A comparison of F-test and Adjusted R-squared values of each model is presented in Table 11. The Benchmark Model benefits from the longer time series while its Adjusted R-squared value is nearly identical to that of Peak Consumption Model 1, Without Controls. The transition to Peak Consumption Model 2 illustrates the utility of using life expectancy variables while Peak Consumption Model 3 shows the effects of combining age group and life expectancy. The Force-Fitted Polynomial Model fares similarly. The small level of difference between the models and their significance explains why these – age group and life expectancy-based models – are competing approaches, since they yield similar results with empirical data despite having different methodological backgrounds. The statistical significance of all the presented models points to the utility of enhancing models with a demographic component. However, the test values also highlight why demographic variables are unlikely to be used alone, without additional macroeconomic control variables, to gauge trends in household consumption expenditures.

***Table 11**. Test Statistic Comparison of Peak Consumption, Force-Fitted Polynomial and Benchmark Models*

	Peak Consumption Model				Force-Fitted Polynomial Model	Benchmark Model
	1, Without Controls	1	2	3		
F-test	5.86	8.28	11.6	12.3	7.41	9.16
Adjusted R-squared	0.35	0.46	0.51	0.57	0.42	0.34

Source: Compiled by the author

A review of the results obtained through all six models provides a perspective on the Defended statements. Defended statement 1 pertains to the non-linear nature of the effect, which has not been contradicted by any of the models. Defended statement 2, regarding the overlap of the effects of age group variables and life expectancy variables is also not contradicted by research results. The overlap between the effects is significant, to the point that these variable groups can be used interchangeably for empirical models. Furthermore, per Defended statement 3, four out of five retirement reform variables appeared statistically insignificant in most models while all five of them were statistically insignificant in the life expectancy model variants. While the selected retirement reform variables do not represent the full scope of reforms conducted in 11 CEE countries, they match a significant amount of changes covered in Section 1.4. Additional controls may be necessary to further verify Defended statement 3.

Another caveat is the presence of intra-EU migration that is a potential spillover effect regardless of geography. An example of this is migration trend from countries like Lithuania and Poland to the United Kingdom that took place during the latter half of the analysed period, resulting in an effect of one country's demographics on another despite having no direct land or sea border.

While keeping the above in mind, the overall statistical significance of the 30–59 age range found in the main sample and the benchmark model points to the utility of adding demographic variables to enhance macroeconomic models for the analysis of household consumption expenditures. The next subsection lays out more practical ways how this study and the approaches contained therein can be of use for policymaking.

4.3 Policy Implications of Empirical Findings

As household consumption expenditures remain a significant component of real GDP in CEE countries, the factors that affect its growth are of potential interest to academia, businesses and policymakers. Having demonstrated the factor of population ageing and its two widely used empirical expressions in ongoing household consumption expenditure trends, ignoring its potential use in assisting the decision-making process related to the economy may be erroneous. Hence, the demographic variables can provide guidance for future policy in the CEE region.

To begin with, factors presumed to be natural compensators or mitigators to population ageing did not appear to function with sufficient significance during the period of 1996 to 2013 in CEE countries. Negative net migration, sub-replacement-level birth rates, economic specialisation and globalisation did not overturn the trend, as the populations of CEE countries are ageing at a rate previously seen in Japan during the Lost Decade, with a comparable increase in life expectancy. Furthermore, the effects of this process have been identified by both the Peak Consumption Model, the Force-Fitted Polynomial Model and then verified with the Benchmark Model.

Moreover, the ageing that results in an increasing share of old-age dependents, as described in Section 1.2. is not compensated with a proportional increase of entrants to the labour force or births. This creates a challenge, all else equal, both during the analysed period, at present and in the future as the skewness of the population pyramid continues to increase. The portion of age groups belonging to peak consumption years 30–59 that exerts a positive effect has been growing over the analysed period, but this is not a sustainable process, considering that these cohorts are not sufficiently replaced as they age. The movement towards greater concentration of middle age groups that generate the highest positive effect on household consumption expenditures may not necessarily stop at the peak. At the current rate of ageing, the populations of CEE countries will pass the span when the non-linear nature of the demographic variables' effect stays positive. The change comprises of two components: the reduction in the relative size of the cohorts that exert a positive effect on household consumption expenditures and the increase in the relative size of cohorts that exert a negative effect. In addition, the increase of life expectancy post-retirement is another issue with a negative effect on consumption, as determined in the Peak Consumption Model 1 and the Force-Fitted Polynomial Model.

In the absence of effective tools to reverse this trend, as evidenced in the empirical analysis and frequency of reform revisions, policy is reduced to reactively dampening the negative effects of population ageing as they manifest. Of these, the non-linear effect of population ageing on household consumption expenditures, per Defended statement 1, LCM stipulations and analysed models, is notable. There are two reasons for this: as the 30–59 age group takes a greater portion of the population due to population ageing, consumption increases, which obscures the problem, and then, as they enter retirement, the delayed negative effect manifests. By the time the negative effect from retirees becomes greater than the positive, in part because the cohorts entering the 30–59 age range are smaller than those exiting, the population pyramid has already undergone significant changes. It is therefore prudent to avoid entering such a situation or alter lifecycle behaviour of consumers, so the age range where consumption peaks shifts together with the population pyramid, i.e. smoothing consumption, as demonstrated in the halved Peak Consumption Model 1 in Figure 7.

Migration policy, cited by Muysken et al. (2013) and Magnus (2010) as a method of mitigating the negative effects of population ageing has theoretical appeal. However, the persistent negative net migration in the CEE region makes it difficult to confirm empirically. The frequent reforms described in Section 1.4. also raise the question of such policy being active long enough to have a statistically significant effect. The statistical insignificance of variables related to retirement reforms, per Defended statement 3, is of note.

The slow evolution of demographic ageing in CEE countries resulted in a growing problem of retirement benefits. This problem can be divided into two parts: part one, stemming from population ageing, and part two, policy shortcomings. Part one is straightforward in that an increasing share of old-age dependants and growing life expectancy results in individuals smoothing consumption. However, while the rate at which life expectancy grows on the right-hand side has been increasing in CEE countries over the analysed period, this smoothing appears insufficient, ending up with a shortfall – contrary to households in a model, real households cannot be expected to accurately gauge their life expectancy and its changes. However, this is not necessarily the case for governments acting in the households' stead.

Part two is closely related to the policymakers' ability to plan and assess the implications of population ageing. Biannual reforms of the retirement system, be it overhauls or parametric changes, consistently and repeatedly carried out throughout the CEE region is a concerning trend that is ongoing. Reforms such as private pension schemes that depend on participation rates to be effective, per Appendix 2, have been introduced and then rolled back, reducing the possibility of assessing them in the long run and limiting their statistical significance in the discussed models. Repeated hiking of the retirement age at a hastening pace without a reliable timeframe also puts the policymakers' credibility into question. The fact that reforms supposed to be long-term required retooling is counterintuitive in the context of population ageing. The ageing trend remained remarkably persistent despite the evolution of legislation, leaving the change of lifecycle behaviour as an option.

Despite the above criticism of pressing short-term reforms insufficient for the long run, empirical analysis demonstrated that a part of the reform package has had a positive influence on reducing the negative effects of population ageing on household consumption expenditures in the Peak Consumption Model 1. This may appear to be contrary to Defended statement 3, but the variable related to life expectancy post-retirement is statistically insignificant in Peak Consumption Models 2 and 3, which include life expectancy variables. Retirement reforms, the effect of which can be described as reducing life expectancy post-retirement exhibited a notable positive effect. This is achieved mainly through the increase of the old-age retirement age and, secondly, through consistent reduction of benefits for the effective retirement age to be derailed from the statutory retirement age. However, the pace of the changes, as evident from the number of increases, is lacking. Applying a fixed age to a phenomenon derived from life expectancy is a partial solution. A clear connection between old-age retirement and life expectancy may be necessary to address the growing length of time post-retirement.

Defended statement 1 claims that the effect of life-expectancy and population ageing is non-linear while defended statement 2 proposes treating their effects on household consumption expenditures as overlapping.

Empirical analysis gives credence to the aforementioned statements. The non-linear LCM traits of population ageing in CEE countries are demonstrated both through the Peak Consumption Models, the Force-Fitted Polynomial Model. It is also verified with Western European countries with the Benchmark Model. The effects explain nearly identical fractions of variance of the rate of change of household consumption expenditures, as evidenced in the change in the values of statistical tests between Peak Consumption Models 1 and 2.

Hence, retirement reform that aims to mitigate the negative effect of population ageing by haphazardly increasing the retirement age may not have the desired effect if changes to life expectancy are not accounted for. The factual caveat is that the retirement age is changed periodically, and only coarsely follows life expectancy growth. This allows for periods where increased life expectancy post retirement increases the negative effect of population ageing.

One solution to being consistently behind the curve is addressing the matter of life expectancy: the retirement age needs to tie closely to life expectancy post-retirement. In CEE countries this is a challenge because life expectancy differs between areas and between sexes, but it does not contradict the benefit of reworking the start of retirement by shifting from the statutory retirement age to statutory life expectancy post-retirement.

The suggestion for policymakers to transform the retirement age to retirement life expectancy is not without drawbacks. The main issue is that it relies on the policymakers' ability to predict life expectancy, which, as detailed above, has shown limited success. The second issue is the trust required to follow an algorithm by a legislator with the ability to change the algorithm.

CONCLUSIONS AND SUGGESTIONS

1. Demographic trends in Central and Eastern Europe are an ongoing concern in terms of the sustainability of household consumption expenditure growth. While increasing longevity should be considered evidence to the region's socioeconomic development, the challenges of increasing life expectancy also grow over time. The challenges are compounded by the total fertility ratio that remains below the replacement level, negative net migration and an accelerating increase of the old-age dependents in the population.

2. Historical economic transformations instilled by population ageing in other regions carried significant adjustment costs and a strain on public finances to cover the needs associated with increasing old-age dependency.

3. Findings in previous works emphasise the need for empirical data and precise demographic variable classification. Differences in methodology lead to analogous research methods obtaining contradictory results when conducted in different countries. Regional fragmentation and cultural differences make precise comparisons difficult to accomplish.

4. Previous empirical studies highlight the issue of demographic characteristics acting as proxies for other variables, including macroeconomic variables. This makes demographics-based models sensitive to bias. Such models feature control variables or filters for unrelated effects.

5. The policy response to challenges stemming from demographic ageing in CEE countries over the last twenty years has shown a reactive evolution of goals, an example of which is the introduction, broadening, scaling back and cancellation of private pension schemes. Success of long-term rules-based retirement reform enacted to lessen the effects of population ageing remains dependent on the election cycle.

6. Developments in the study of demographic variables as a source of information about consumption patterns focus on selecting age groups with the most influence, with young adults and retirees acting as the most frequent groups of research interest.

7. The application of methodological guidance from prior research leads to an adaptation of the LCM model augmented with OLG elements, in line with the Keynesian school. The proposed model considers the endogeneity problem in the relationship of household consumption expenditures and demographic trends, permits the inclusion of other macroeconomic variables and a lifetime consumption function.

8. The inclusion of both age group-related metrics and life expectancy variables in the proposed models allows the comparison and combination of

these two approaches towards explaining the relationship between demographics and household consumption expenditures.

9. Further expansion in the number of controls in the proposed model is expected to produce more reliable estimates, especially in relation to the economy adjusting to the changing demographic makeup in the population.

10. Empirical research in this dissertation highlights the statistical significance of life expectancy post-retirement as well as its negative effect on consumption expenditures of households.

11. The Peak Consumption Model 1 demonstrates a statistically significant positive effect in the 30–59 age range on household consumption expenditures. The significance of these age groups points to the ageing effect's non-linear nature and is in line with LCM assumptions. The process of demographic ageing while the 30–59 age range grows in relative weight in the population exhibits a demographic dividend. Conversely, a continuation of the ageing process leads to a decline in the weight of these age groups and a decline in the growth rate of household consumption expenditures.

12. The Peak Consumption Model 2 shows a statistically significant effect of life expectancy variables on household consumption expenditures. The effect is positive for the increase of life expectancy of the 20–29 age cohort and negative for the 80 years and above cohort.

13. The statistically significant effect exerted by demographic age group variables on household consumption expenditures is found via the Force-Fitted Polynomial Model. Using this approach, it is determined that ages 0 to 19 exhibit a marginal negative effect, followed by a hump shape peaking at ages 40–59. It is worth noting that the direction of the effect in each group coincides with labour market participation ages.

14. Population ageing appears to be beneficial to Central and Eastern European countries over the transitory period, while those in the 30–59 age range increase as a proportion of the population. In the absence of increasing supply within this age range this positive effect diminishes, giving way to the negative effect of growing life expectancy upon reaching retirement.

15. Should the proportion of those aged 30–59 begin to decrease with life expectancy continuing to increase post-retirement, it is likely that the current pace of gradually raising the retirement age to 65 for both sexes in most CEE countries may have to be sped up.

16. The effects of population ageing as described by the population pyramid and life expectancy on household consumption expenditures are determined as non-linear, described by a hump or inverted U shape when age group selection is allowed, or a third-degree polynomial when force-fitting, which is in line with Defended statement 1. The effects are considered as

overlapping, per Defended statement 2, as life expectancy and age variable groups explain only a marginally greater portion of variance in household consumption expenditures when assessed together in Peak Consumption Model 3.

17. In the absence of sufficient counteraction from policymakers, all countries in the CEE sample, despite their mutual differences, experience the effects of population ageing for household consumption expenditures, both positive and negative effects.

18. The Benchmark Model's performance in showing statistical significance of demographic variables, namely, the peak ages 30–59, over a longer period of time in a sample of Western European countries adds to the conclusiveness of the selected approach for CEE countries.

19. The author suggests closely and explicitly associating the retirement age with life expectancy post-retirement in the medium term in lieu of the metric's effect on household consumption expenditures.

20. It is suggested that reforms related to retirement in CEE countries take place over a protracted time period to reduce the possibility of the election cycle substituting long-term demographic policy with short-term goals, subject to subsequent revisions.

21. It is suggested that CEE countries communicate their demographic policy transparently and responsibly, in a manner that allows outside scrutiny and assessment. While this need not apply to value-based policy, parametric reforms should contain analytical justification open to input.

22. Empirical analysis of time series from countries experiencing population ageing may benefit from the inclusion of demographic variables to supplement established macroeconomic models. The determination of the two-way relationship of household consumption expenditures and life expectancy is an example of demographics adding explanatory power to and reducing noise from macroeconomic data. However, the demographic variables alone have insufficient explanatory power to explain more than 50% of changes in household consumption expenditures.

23. The rollback or freezing of participation to private pension funds, in the absence of alternatives with goals similar to those that resulted in the introduction of private pension funds, should be reviewed in the light of their effect in reducing the consequences of population ageing for household consumption expenditures.

Recommendations for further study

Population ageing and its various forms have been a subject of discussion for decades, but it is thanks to the latest trend of sub-replacement-level fertility, negative net migration and growing old-age dependency that the topic garnered increased attention. The fragmentation of third-party studies and quality of secondary data in CEE countries limited the scope of this dissertation, yet these challenges pose opportunities for new studies.

The possibility of broaching the topic in the field of comparative studies carries significant prospects, both in terms of reducing geographic fragmentation and testing the conclusions reached in this dissertation, including regarding the utility of adding demographic variables to a macroeconomic model. The complicated data-generating process between demographics and the economy may not be limited to household consumption expenditures.

Besides adding new control variables and analysing the effects of population changes on other macroeconomic variables, there is potential utility in repeating the study in other regions, with consideration for the regional and cultural differences. Furthermore, this enables verification of the methodological framework with empirical data from countries, the population of which is not ageing or has other social conditions contrasting with CEE countries.

The study of retirement reforms in CEE countries warrants additional attention. Rather than viewing each reform in isolation, it may be prudent to analyse their cumulative effects in hindsight, comparing them to alternatives chosen in other countries.

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Appendix 1. *Restricted Coefficients for the Force-Fitted Model*

Year	Country	D1	D2	D3	D4
1996	Bulgaria	-1,25	-29,01	-555,57	-10025
1997	Bulgaria	-1,21	-28,49	-549,15	-9949
1998	Bulgaria	-1,17	-27,93	-542,24	-9863,5
1999	Bulgaria	-1,12	-27,24	-532,51	-9718,6
2000	Bulgaria	-1,08	-26,47	-520,69	-9532,5
2001	Bulgaria	-1,03	-25,74	-509,07	-9343,5
2002	Bulgaria	-0,92	-23,63	-475,63	-8822,1
2003	Bulgaria	-0,88	-22,95	-465,32	-8662,3
2004	Bulgaria	-0,84	-22,26	-454,63	-8497
2005	Bulgaria	-0,8	-21,5	-442,36	-8296,5
2006	Bulgaria	-0,76	-20,82	-431,15	-8111,9
2007	Bulgaria	-0,65	-18,78	-399,1	-7620,1
2008	Bulgaria	-0,61	-18,02	-386,46	-7414,8
2009	Bulgaria	-0,57	-17,23	-373,31	-7202,4
2010	Bulgaria	-0,53	-16,41	-359,43	-6975
2011	Bulgaria	-0,49	-15,58	-345,53	-6750,3
2012	Bulgaria	-0,46	-14,97	-334,72	-6569,4
2013	Bulgaria	-0,43	-14,42	-325,1	-6410,4
1996	Croatia	-1,22	-27,66	-521,4	-9263,2
1997	Croatia	-1,19	-27,13	-513,4	-9143,5
1998	Croatia	-1,16	-26,59	-505,26	-9023,3
1999	Croatia	-1,12	-26,03	-496,78	-8897,2
2000	Croatia	-1,09	-25,46	-487,62	-8754,9
2001	Croatia	-1,06	-24,87	-478,02	-8600,8
2002	Croatia	-1,03	-24,33	-469,47	-8467,4
2003	Croatia	-1	-23,84	-461,94	-8354,5
2004	Croatia	-0,97	-23,33	-454,02	-8235,2
2005	Croatia	-0,94	-22,75	-444,1	-8073,3
2006	Croatia	-0,92	-22,28	-435,73	-7927,7

2007	Croatia	-0,9	-21,8	-427,11	-7779
2008	Croatia	-0,88	-21,31	-418,38	-7628,2
2009	Croatia	-0,86	-20,97	-411,72	-7510,1
2010	Croatia	-0,85	-20,56	-404,13	-7378,6
2011	Croatia	-0,85	-20,55	-403,09	-7350,3
2012	Croatia	-0,83	-20,2	-396,73	-7239,1
2013	Croatia	-0,82	-19,84	-390,29	-7131,1
1996	Czechia	-1,56	-34,67	-641,64	-11267,8
1997	Czechia	-1,5	-33,83	-630,29	-11111
1998	Czechia	-1,45	-33,01	-619,21	-10959,7
1999	Czechia	-1,39	-32,13	-607,14	-10792,7
2000	Czechia	-1,34	-31,21	-594,3	-10608,2
2001	Czechia	-1,29	-30,46	-584,31	-10475,2
2002	Czechia	-1,23	-29,42	-568,95	-10250,5
2003	Czechia	-1,18	-28,51	-555,53	-10055,6
2004	Czechia	-1,13	-27,66	-543,34	-9882,6
2005	Czechia	-1,07	-26,73	-529,31	-9671,9
2006	Czechia	-1,02	-25,91	-516,74	-9478,4
2007	Czechia	-0,97	-25,03	-502,47	-9252,2
2008	Czechia	-0,94	-24,43	-492,47	-9090,3
2009	Czechia	-0,91	-23,82	-482,1	-8921,3
2010	Czechia	-0,88	-23,12	-470,26	-8732,7
2011	Czechia	-0,85	-22,39	-457,54	-8525,7
2012	Czechia	-0,8	-21,51	-442,72	-8286,7
2013	Czechia	-0,76	-20,65	-428,03	-8050,4
1996	Estonia	-1,51	-33,11	-612,18	-10792,2
1997	Estonia	-1,45	-32,12	-597,24	-10566
1998	Estonia	-1,39	-31,18	-583,04	-10350
1999	Estonia	-1,35	-30,47	-572,81	-10197,3
2000	Estonia	-1,27	-29,44	-559,17	-10006,2
2001	Estonia	-1,22	-28,63	-547,12	-9823,1
2002	Estonia	-1,17	-27,71	-532,69	-9598,5
2003	Estonia	-1,12	-26,85	-519,1	-9385,3
2004	Estonia	-1,08	-26,06	-506,74	-9189,5

2005	Estonia	-1,03	-25,22	-493,16	-8974,5
2006	Estonia	-0,99	-24,37	-479,31	-8752
2007	Estonia	-0,94	-23,45	-463,29	-8483,5
2008	Estonia	-0,91	-22,66	-448,93	-8234,6
2009	Estonia	-0,88	-22,01	-437,13	-8031,2
2010	Estonia	-0,85	-21,29	-424,45	-7817,3
2011	Estonia	-0,82	-20,56	-411,22	-7591,4
2012	Estonia	-0,78	-19,59	-393,76	-7292,3
2013	Estonia	-0,74	-18,63	-376,67	-6999,8
1996	Hungary	-1,39	-31,42	-589,42	-10467,4
1997	Hungary	-1,36	-30,89	-582,02	-10362
1998	Hungary	-1,32	-30,25	-572,6	-10221,6
1999	Hungary	-1,27	-29,55	-562,45	-10072,4
2000	Hungary	-1,23	-28,77	-550,77	-9895,7
2001	Hungary	-1,18	-27,89	-537,28	-9686,7
2002	Hungary	-1,14	-27,23	-527,42	-9536,3
2003	Hungary	-1,11	-26,56	-516,94	-9374,1
2004	Hungary	-1,07	-25,89	-506,84	-9221
2005	Hungary	-1,02	-25,11	-494,5	-9026,9
2006	Hungary	-0,98	-24,43	-483,61	-8850,9
2007	Hungary	-0,94	-23,75	-472,72	-8674,7
2008	Hungary	-0,91	-23,12	-462,32	-8504,7
2009	Hungary	-0,87	-22,45	-451,12	-8321,6
2010	Hungary	-0,83	-21,77	-439,95	-8142,5
2011	Hungary	-0,79	-20,98	-427,32	-7943,2
2012	Hungary	-0,71	-19,77	-410,61	-7730,8
2013	Hungary	-0,68	-19,07	-399,26	-7551
1996	Latvia	-1,5	-32,86	-608,24	-10733,7
1997	Latvia	-1,44	-32,01	-596,3	-10561,3
1998	Latvia	-1,38	-31,07	-582,73	-10360,4
1999	Latvia	-1,32	-30,21	-570,59	-10183,6
2000	Latvia	-1,26	-29,34	-558,11	-10000,3
2001	Latvia	-1,21	-28,57	-546,7	-9828,1
2002	Latvia	-1,16	-27,69	-533,32	-9625

2003	Latvia	-1,11	-26,78	-519,11	-9401
2004	Latvia	-1,06	-25,96	-506,02	-9191,6
2005	Latvia	-1,01	-25,12	-492,82	-8985,7
2006	Latvia	-0,97	-24,27	-479,07	-8764,8
2007	Latvia	-0,92	-23,36	-463,92	-8515,6
2008	Latvia	-0,89	-22,66	-451,85	-8311,7
2009	Latvia	-0,85	-21,7	-434,95	-8028,5
2010	Latvia	-0,78	-20,28	-411,28	-7647,8
2011	Latvia	-0,7	-18,75	-385,92	-7240,6
2012	Latvia	-0,64	-17,52	-365,21	-6899,3
2013	Latvia	-0,6	-16,56	-348,78	-6626
1996	Lithuania	-1,8	-37,79	-680,59	-11766,5
1997	Lithuania	-1,75	-37	-669,46	-11607,7
1998	Lithuania	-1,69	-36,16	-657,17	-11428,5
1999	Lithuania	-1,64	-35,31	-644,42	-11238,3
2000	Lithuania	-1,59	-34,48	-632,18	-11056
2001	Lithuania	-1,54	-33,82	-624,07	-10958,2
2002	Lithuania	-1,44	-32,28	-600,02	-10586,3
2003	Lithuania	-1,36	-30,92	-579,32	-10269,1
2004	Lithuania	-1,28	-29,49	-556,91	-9918,3
2005	Lithuania	-1,2	-28,18	-536,65	-9604,3
2006	Lithuania	-1,11	-26,57	-511,29	-9208,6
2007	Lithuania	-1,04	-25,4	-492,64	-8911,4
2008	Lithuania	-0,98	-24,29	-474,52	-8616,1
2009	Lithuania	-0,93	-23,3	-457,99	-8343,9
2010	Lithuania	-0,88	-22,17	-439,14	-8039,2
2011	Lithuania	-0,78	-20,23	-406,62	-7516,6
2012	Lithuania	-0,71	-18,86	-383,48	-7140,3
2013	Lithuania	-0,67	-17,8	-365,36	-6841,4
1996	Poland	-2	-42,01	-750,16	-12873,4
1997	Poland	-1,95	-41,26	-740,36	-12742,8
1998	Poland	-1,89	-40,43	-729,13	-12587,2
1999	Poland	-1,83	-39,52	-716,68	-12412,2
2000	Poland	-1,78	-38,52	-701,64	-12188,2

2001	Poland	-1,71	-37,55	-687,71	-11984,1
2002	Poland	-1,65	-36,51	-672,88	-11768,6
2003	Poland	-1,58	-35,44	-657,33	-11540,9
2004	Poland	-1,52	-34,37	-641,96	-11316,7
2005	Poland	-1,45	-33,28	-625,76	-11073,2
2006	Poland	-1,39	-32,18	-609,09	-10817,5
2007	Poland	-1,32	-31,05	-591,63	-10547,7
2008	Poland	-1,27	-30	-575,23	-10293,6
2009	Poland	-1,22	-29,03	-559,78	-10052,5
2010	Poland	-1,17	-28,12	-545,36	-9828,4
2011	Poland	-1,13	-27,28	-532,2	-9627,5
2012	Poland	-1,07	-26,21	-514,84	-9353
2013	Poland	-1,02	-25,18	-498,3	-9093,7
1996	Romania	-1,82	-38,61	-699,71	-12154,1
1997	Romania	-1,78	-38,02	-691,7	-12039,3
1998	Romania	-1,73	-37,31	-682,05	-11903,9
1999	Romania	-1,67	-36,63	-672,9	-11776,6
2000	Romania	-1,62	-35,82	-661,29	-11603,3
2001	Romania	-1,57	-35,01	-649,38	-11422,8
2002	Romania	-1,49	-33,59	-627,33	-11086,3
2003	Romania	-1,37	-31,54	-597,48	-10656,8
2004	Romania	-1,31	-30,65	-584,53	-10464,5
2005	Romania	-1,25	-29,51	-567,01	-10194,9
2006	Romania	-1,19	-28,49	-551,31	-9950,1
2007	Romania	-1,13	-27,52	-536,05	-9709,5
2008	Romania	-1,03	-25,55	-504,52	-9219,5
2009	Romania	-0,96	-24,4	-485,79	-8921,4
2010	Romania	-0,91	-23,39	-468,92	-8648,2
2011	Romania	-0,87	-22,54	-454,8	-8418,5
2012	Romania	-0,82	-21,73	-442,14	-8224,1
2013	Romania	-0,84	-21,78	-440,11	-8160,1
1996	Slovakia	-2,11	-43,69	-773,67	-13187,6
1997	Slovakia	-2,05	-42,95	-764,23	-13062,7
1998	Slovakia	-2	-42,2	-754,7	-12938,7

1999	Slovakia	-1,95	-41,44	-745,01	-12810,5
2000	Slovakia	-1,89	-40,58	-733,42	-12646,9
2001	Slovakia	-1,83	-39,78	-723,54	-12529,9
2002	Slovakia	-1,8	-39,26	-717,19	-12447,1
2003	Slovakia	-1,73	-38,25	-703,27	-12254,6
2004	Slovakia	-1,67	-37,26	-689,95	-12072,2
2005	Slovakia	-1,61	-36,25	-675,6	-11866
2006	Slovakia	-1,55	-35,3	-662,04	-11673,6
2007	Slovakia	-1,48	-34,3	-647,52	-11462,3
2008	Slovakia	-1,43	-33,32	-633,16	-11252
2009	Slovakia	-1,37	-32,37	-619,02	-11044,6
2010	Slovakia	-1,32	-31,45	-605,07	-10838,8
2011	Slovakia	-1,27	-30,5	-590,7	-10628,3
2012	Slovakia	-1,22	-29,59	-576,63	-10417,8
2013	Slovakia	-1,17	-28,61	-561,47	-10190,5
1996	Slovenia	-1,56	-35,31	-658,02	-11579,9
1997	Slovenia	-1,5	-34,28	-643,7	-11379,8
1998	Slovenia	-1,43	-33,21	-628,23	-11158,6
1999	Slovenia	-1,36	-32,07	-611,35	-10910,3
2000	Slovenia	-1,3	-31,03	-596,2	-10686,5
2001	Slovenia	-1,24	-29,99	-580,54	-10451,4
2002	Slovenia	-1,17	-28,81	-562,68	-10183,6
2003	Slovenia	-1,1	-27,6	-543,95	-9899,9
2004	Slovenia	-1,04	-26,46	-526,4	-9633,4
2005	Slovenia	-0,98	-25,3	-507,92	-9343,8
2006	Slovenia	-0,92	-24,24	-491,06	-9077,6
2007	Slovenia	-0,86	-23,11	-472,33	-8775,9
2008	Slovenia	-0,8	-21,85	-451,2	-8433,8
2009	Slovenia	-0,77	-21,2	-439,62	-8236,7
2010	Slovenia	-0,73	-20,44	-426,53	-8019,7
2011	Slovenia	-0,69	-19,46	-409,15	-7731,5
2012	Slovenia	-0,64	-18,46	-391,61	-7441,8
2013	Slovenia	-0,6	-17,54	-375,14	-7165,5

Source: Compiled by the author

Appendix 2. *Peak Consumption Model 1 with Pension Fund Membership Representation and Test Statistics in 1996–2013*

Variable	Coefficient	Std. Error	t-Statistic	Prob.
a	-0.41	0.712	-0.574	0.568
β_4	7.70	3.11	2.47	0.016
β_5	10.3	2.61	3.95	0.000
β_6	6.32	3.01	2.30	0.021
r_2	-6.92	3.22	-3.89	0.000
r_5	0.033	0.015	2.02	0.048

Effects Specification			
Cross-section fixed (dummy variables)			
R-squared	0.582	Mean dependent var	0.046
Adjusted R-squared	0.454	S.D. dependent var	0.033
S.E. of regression	0.027	Durbin-Watson stat	1.93
Sum squared resid	0.033		
Log likelihood	142.93		
F-statistic	4.58		
Prob(F-statistic)	0.000		

Source: Compiled by the author

Appendix 3. *Benchmark Model Representation and Test Statistics in 1996-2013*

Variable	Coefficient	Std. Error	t-Statistic	Prob.
g	0.012	0.007	1.77	0.078
ϖ_4	3.317	1.477	2.24	0.027
ϖ_5	7.152	2.960	2.41	0.017
ϖ_6	3.743	2.320	1.61	0.110
Effects Specification				
Cross-section fixed (dummy variables)				
R-squared	0.388	Mean dependent var		0.011
Adjusted R-squared	0.320	S.D. dependent var		0.022
S.E. of regression	0.017	Durbin-Watson stat		2.016
Sum squared resid	0.028			
Log likelihood	272.3			
F-statistic	5.770			
Prob(F-statistic)	0.000			

Source: Compiled by the author

LIST OF PUBLICATIONS

In peer-reviewed academic journals:

1. Kasnauskienė, G.; Michnevič, K. (2017). Does life expectancy and ageing influence GDP growth in Central and Eastern European countries? *Моніторинг, моделювання та менеджмент емерджентної економіки* (*Monitoring, modelling and management of the emergent economy),* p. 8-11.
2. Kasnauskienė G., Michnevic K. (2017). Contribution of increased life expectancy to economic growth: evidence from CEE countries. International Journal of Economic Sciences, Vol. VI(2), pp. 82-99, 10.20472/ES.2017.6.2.005.
3. Michnevič, K. (2016). The Effects of Ageing on Household Consumption in Central and Eastern Europe, *Economy & Business: Journal of International Scientific Publications*, 10(1), p. 273-287.
4. Kasnauskienė, G.; Michnevič, K. (2015). Demographic shifts and their consequences for the investment funds in the European Union, *Ekonomika*, 94(3), p. 1-14.
5. Kasnauskiene G., Michnevic K. (2015).The effects of demographic trends on economic growth in the European Union. European Scientific Journal. June 2015 /SPECIAL/ edition Vol.2 , p.70-85 ISSN 1857- 7431.

In peer-reviewed conference proceedings:

6. Kasnauskienė G.; Michnevič, K.; Belinskaja, L. (2018). Pension reform as a countermeasure to the effects of population ageing in the Baltics. *XIX International scientific insurance conference proceedings*, Nr. 2, p. 94-99.

Presentations in national and international conferences:

1. Kasnauskienė, G., Michnevič K., Belinskaja L. Pension reform as a countermeasure to the effects of population ageing in the Baltics. *XIX International scientific insurance conference*. Joshkar-Ola, Russia, June 5-8, 2018.
2. Kasnauskienė, G.; Michnevič, K. Contribution of increased life expectancy to economic growth: evidence from CEE countries. International conference: "33rd IISES International Academic Conference." Vienna, Austria, August 28-31, 2017.
3. Kasnauskienė, G.; Michnevič, K. Does life expectancy and ageing influence GDP growth in Central and Eastern European countries? International conference "Моніторинг, моделювання та менеджмент емерджентної економіки" (en. Monitoring, modelling and management of the emergent economy). Odessa, Ukraine, May 24-26, 2017.
4. Michnevič, K. Demographic shifts and their consequences for the investment funds in the European Union. National conference "Lietuvos ekonomikos augimo ir stabilumo strateginės kryptys" (en. "Strategic economic development and stability trends in Lithuania"). Vilnius, Lithuania, October 22, 2015.
5. Michnevič, K. The Effects of Ageing on Household Consumption in Central and Eastern Europe. XV international conference "Economy and Business." Elenite, Bulgaria, September 1-4, 2015,
6. Kasnauskiene G., Michnevic K. The effects of demographic trends on economic growth in the European Union. International conference: 3rd International Scientific Forum. Amman, Jordan, April 22-25, 2015.

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