### THE IMPACT OF POPULATION AGEING ON PRIVATE SAVINGS RATE: EMPIRICAL EVIDENCE FROM THE OECD MEMBER COUNTRIES

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#### ABSTRACT

In the recent decades there has been a huge fall in the private savings rate. There is a growing concern that increasing share of old age population has greatly contributed to the declining savings trend. The aim of the thesis is to examine the impact of population ageing on private savings rate. To analyze this relationship the extended Overlapping Generations Model is used by including social security system, and relative weights for private savings of both working age and old age population. Empirical estimation of the effect of population ageing is done by Fixed Effects and First Differences estimation methods using panel data set with 120 observations from twenty four OECD member countries. Both theoretical and empirical analyses conclude that population ageing has significant negative effect on private savings of the working age population, causing a reduction in average private savings rate.

Keywords: population ageing, private savings, OLG model

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#### INTRODUCTION

Saving is indispensable in every economy. Saving, which is translated into investment, is a key determinant of the economic growth. Moreover, it is related to the demand for real and financial assets, and also influences asset price formation. Therefore, the strongly declining trend of savings rate over the past two decades has provoked serious concerns among economists and policymakers. The downward sloping personal savings rate, consequently national savings rate, poses a number of economic and social problems, causing imbalances in the structure of the economic system. Thus the continuing declining trend of savings is a real phenomenon that needs further research. Possible explanations for the low savings rate have been an availability of consumer credits, a higher level of household wealth, improved social security and pension systems, booms in stock and housing markets, recent technological advances and increases in labor productivity, improvements in credit market and others. However, nowadays the change in demographic structure of the country, specifically the population ageing, is considered to be the main reason of decreasing savings rate. Since the age is a main determinant of preferences, a change in age distribution may alter the importance of various commodities in the structure of consumption, hence people's savings.

Today many countries are facing declining fertility and growing longevity, which are the main determinants of population ageing. Accelerating ageing of the population is usually observed in more developed countries, in particular the European countries and the Organization for Economic Co-operation and Development (OECD) member countries. Many theoretical and empirical analyses reveal statistically significant effects of demographic factors on the behavior of savings. Studies of the relationship between savings and population ageing are mostly based on standard life-cycle model of saving, which suggest that people save during their working years to finance consumption in retirement. However, prior empirical research on the life-cycle hypothesis is divided. For instance, Feldstein (1974), Kelley and Schmidt (1996), Borsch-Supan et al. (2006) and Horioka (2007) found that the larger is the share of elderly in population, the less is the savings rate. On the other hand, Jenkins (1988) and Oksanen (2009) derived contradictory results to the life-cycle model. Discrepancies in views can be partially explained by the shortcomings in choosing variables, data-mining, estimating models or introducing assumptions.

In this thesis, I aim to study the declining behavior of savings in economies where the population is ageing rapidly due to very low levels of fertility and gradually increasing life expectancy, both theoretically and empirically. To analyze the relationship between population ageing and private savings rate, I utilize Overlapping Generations Model (OLG) following Borsch-Supan et al. (2006) and Oksanen (2009). The OLG model is based on the life-cycle theory, but captures better life-cycle behavior than other infinite-horizon models, since there are two generations coexisting together at the same time period.

In theoretical part of this research I use the extended OLG model by adding the essential factor that greatly influences savings rate, which is the social security system, specifically pay-as-you-go public pension system. Moreover, I introduce separate weights for both working and old age population's private savings in order to more accurately evaluate the savings behavior of coexisting generations in the economy at a given period of time. Since the population ages, the increasing weight of dissaving by the old generation should oppress the savings of working age generation by causing decrease in average private savings rate of the economy. Thus, by analyzing the extended OLG model I aim to explain the decline in private savings rate by the increase in the share of elderly population. The distinctive feature of my analysis from previous studies is that it separately considers the relative strength of the influence of saving by working population and dissaving by elderly in the model.

For the empirical part of the thesis, I examine the overall effect of population ageing on the private savings rate by observing the OECD member countries. Econometric methods utilized to estimate the regressions are the Fixed Effects and the First Differences methods with country and time specific effects. The panel data set from sixteen years with five time periods is used to observe twenty four OECD countries. The results from the estimations show that there is a strong negative influence of the population ageing on the private savings rate. The outcome from the empirical analysis is consistent with the underlying theoretical model, which predicts that the growing elderly age cohorts and the shrinking younger age cohorts result in the reduction of personal savings rate.

The organization of the thesis is as follows. In the following section I discuss the theoretical framework of the research including definitions of the main parameters of interests, demographic trends for OECD countries, description of the OLG model, fundamental assumptions and arguments. The next two sections present data description and econometric model specification, respectively. Then the section describing the empirical framework by summarizing and interpreting estimation results follows. Finally, the last section provides policy recommendations and concluding remarks based upon the results.

### **THEORETICAL FRAMEWORK**

Saving is critically important in every economy, since it provides funds for financing investments in any spheres of the social and economic life, which is in its turn, is a key determinant of economic growth. In the past three decades there has been observed a strongly declining trend in private savings rate in OECD countries, as well as in many other countries in the world. Figure 1 illustrates the dismal performance of savings over the years in some of the representative OECD countries. It can be seen clearly that starting from the 80's household saving rates decreased sharply, especially for Italy and Japan. This kind of lowering saving trend can be observed almost in all OECD member countries and nowadays has become one of the major concerns. Numerous theoretical and empirical studies tried to explain the household saving behavior and indentify the causes of fluctuations. Researchers as Feldstein (1974), Evans (1983), Bakshi and Chen (1994) and Horioka (2007) proposed that explanations for the downward dropping tendency in savings could be due to the low economic growth, availability of consumer credit, high level of household wealth, larger public pension benefits, better social security programs, improvements in the credit markets, reforms in taxation and others. However, most of these factors found to have no effect on savings decline or if they had any, the impact was not large enough to explain the performance of savings rate. Moreover, researchers claimed that along with other elements, demographic factors should also be considered in analyzing the savings trend. Later, scholars found that the demographic factors, indeed, are the best explanation for observed tendency. Horioka (2007) mentioned the population ageing as the most important factor in the recent decline of savings rate.

Population ageing is defined as a shift in the distribution of a country's population toward older ages (Weil, 2006). Aspects of population ageing include an increase in population's mean and median age, decline in the youth, and rise in the elderly proportions of the population. Nowadays population ageing is occurring all over the world, and mostly in more developed and industrialized countries.



*Figure 1.* Household saving rate as a percentage of household disposable income (Data from OECD dataset: Economic Outlook No 88, Dec 2010)

Population ageing mainly arises from two demographic phenomena: increasing longevity and decreasing fertility. Increased longevity causes raise in the number of years when people are old relative to the years when they are young, thus changes age distribution of the total population. As for declining fertility, it is generally considered as a main explanation of growing ageing, because the reduction in the number of children changes the balance between youth and elderly, therefore causing society to age. Moreover, there are minor factors such as migration flows, which may as well contribute to the ageing of society. Figures 2 and 3 show declining fertility rates and increasing life expectancy over the years in four OECD countries, respectively. As can be seen from the Figure 2, the average number of children born per woman of childbearing age decreased from three children to almost one child per woman. On the other hand, Figure 3 shows that the longevity trends reflect positive

upward movement and increased life expectancy for almost ten years for each observed country.



Figure 2. Total Fertility Rate (Births per Woman) (Data from World Bank Data Catalog)





Population ageing causes multitude of social and economic effects. First of all, it influences the labor market, by changing its size and structure. Declining fertility will cause a decrease in the growth of the working age population, implying that investment to supply new workers with capital will also drop. Economic dislocation of age structure of the workforce will immediately affect financing of public pensions, health care and social insurance. Moreover, Bakshi and Chen (1994) found that the demographic changes affect capital market prices by bringing out fluctuations in asset demands, and Razin et al. (2002) concluded that ageing leads to lower taxes.

Population ageing is measured through dependency ratios. The dependency ratio is the ratio of those who are not in the labor force to the ones who are in the workforce. It can be decomposed into two ratios: young (aged 0-14) and old (aged 65 and over) dependency ratios. Thus, population ageing is characterized by the decrease in young dependency ratio and increase in old dependency ratio. Figures 4 and 5 show the old and young dependency ratios, respectively, for four representative OECD member countries observed before. As can be seen from Figure 4, the rapid upward movement in the old dependency ratio coincides with the rapid decline in the savings rate in Figure 1. Not many changes can be seen in young dependency ratio's behavior, however, downward trends can be observed for all countries. In addition, Fry and Mason (1982) found that the young dependency ratio does not have any significant effect on the savings rate. This statement is verified in my thesis. Since in this research I am mostly referring to working age population as a young population, to avoid confusion I refer to the young dependency ratio as a child dependency ratio.



*Figure 4.* Old (65+) Dependency Ratio (% of Working-age Population) (Data from World Bank Data Catalog)



*Figure 5.* Young/Child (0-14) Dependency Ratio (% of Working-age Population) (Data from World Bank Data Catalog)

At the same time as a number of young dependents is decreasing due to the fall in fertility, elderly dependency ratio is increasing as life expectancy is lengthening. Table 1 shows how dependency ratios have changed over the years in OECD member countries. The numbers in the table are the average for all OECD countries; it can be seen that there has been radical drop in child dependency ratio, whereas old dependency gradually increasing.

 Table 1. Change of Dependency Ratios in OECD Countries

 (Data from World Bank Data Catalog)

	1960	1970	1980	1990	2000	2009
Old (65+) dependency ratio	13.69	15.31	16.81	17.54	19.54	21.57
Child (0-14) dependency ratio	48.11	45.82	39.76	34.24	30.88	27.99

Increasing longevity is not as important a source of population ageing as low fertility. Although in the thesis I concentrate on the impacts of changes in dependency ratios due to lower fertility, the effect of increasing longevity should also be considered in the estimation process. Growth in life expectancy should be followed by retirement age increment, thus neutralizing effect of longevity increase. This assumption was introduced by Borsch-Supan et al. (2006). Since over the years there has been a gradual increase in official retirement age in numerous OECD member countries, the assumption above can be introduced in this particular study as well. Despite the fact that by introducing neutralizing effect assumption life expectancy increase can be eliminated, in the empirical estimation process I introduce control variable for longevity to show its effect on savings behavior if there is any, and also check the credibility of the assumption.

In the modern macroeconomics one of the major workhorse models that examine economic effects of demographic changes is the Overlapping Generations Model (OLG), which studies general consequences of life-cycle saving by individuals. At the base of OLG model is the Life-cycle Hypothesis, which was developed by Modigliani and Brumberg (1954) ,and states that individuals smooth consumption over their lifetime. This implies that due to uneven distribution of earnings during individual's life, one saves while his/her working years to finance his/her consumption in retirement. Many scholars, such as Feldstein (1974), Evans (1983), and Horioka (1996), have studied the link between ageing household's rational behavior and the rate of saving using Life-cycle Theory. In my thesis I would like to follow Borsch-Supan et al. (2006) and Kulish et al. (2006), and use OLG model to analyze the effect of demographic changes in the economy, since this model captures better life-cycle behavior than other infinite-horizon models.

The OLG model was initially introduced by Allais in 1947 and later developed by Samuelson (1958). Since then, the model has been widely used in many applications related to public finance theory and applied to solve various issues regarding population ageing and pension reforms. The distinctive features of this model from infinite-horizon models include that there may be multiple equilibria or even continuum of them and yet, the competitive equilibrium is not necessarily Pareto efficient (due to possibility of overaccumulation of capital). Moreover, there is a role for fiat money in the model, thus it can be applied in monetary economics applications. The OLG model is a proper model to study implications of life-cycle savings, since in the model savers are the ones who generate capital stock of the economy.

In the OLG model agents live for two periods and thus there are two generations coexisting together: "young" who live in the first period and "old" who are living the second period of lifetime. Individuals work when they are young, receive the wage  $W_t$ , and consume part of it  $(C_{1t})$  in period one and save the rest of their wage to finance consumption  $(C_{2t})$  when they are old. Saving in period t generates capital stock in period t + 1, which is used to produce output together with the labor supply of the working generation in period t + 1. The number of individuals born at time t is  $N_t$ , and population grows at rate n is:

$$N_t = N_{t-1} (1+n_t)$$

whereas  $N_0$  is "initial old", i.e. old people in period one. From the equation above, the ratio of young population to the elderly, that is youth dependency ratio is equal to:

$$\frac{N_t}{N_{t-1}} = 1 + n(constant).$$

The old dependency ratio can also be calculated in an analogous way.

In this particular research the point of interest is  $1 + n_t$ , that is relative size of the two generations in period t. In the simple OLG model without social security savings per capita are not affected by  $n_t$ , since saving decisions implied by first order conditions from:

$$S_t = (1 + n_{t+1})k_{t+1},$$

the dynamic equation of which becomes:  $S_t = S(W_t, r_{t+1})$ . However, when there is an increase in the population ageing capital accumulation and capital-labor ratio increases, which results in higher wages and lower interest rates. This can be seen from Figure 6, which illustrates the effect of population ageing on capital accumulation without social security. Consequently, the OLG model needs to be extended by adding necessary variables in order to evaluate the actual effect of ageing on savings rate.



*Figure 6.* Effect of Population Ageing without Social Security (Source: Department of Economic Sciences, National and Capodistrian University of Athens: http://www.econ.uoa.gr/UA/files/512752736..pdf)

Indeed, there are many factors that directly and indirectly affect the private savings which need to be taken into consideration while empirically analyzing the model. I control for some of them by adding variables to the empirical regressions, whereas effect of immeasurable variables will be controlled by using country and time specific effects. However, some of the factors have a highly significant impact on savings behavior and must be added to the initial model, such as provision of pension benefits. One of the first scholars to introduce pensions into life-cycle savings theory was Feldstein (1974), who suggested that pensions affect personal savings in two ways:

- Personal savings decrease, because pensions substitute for household assets;
- Pensions will incentivize workers to the early retirement, thus pensions cause an increase in personal savings due to lengthening period of retirement over which accumulated assets will be spread.

Therefore, the effect of pensions on savings is ambiguous since it depends on the relative strength of the two forces above. However, simple life-cycle hypothesis suggest that assuming that there is no taxes and no uncertainty, people substitute future pensions for private savings, by keeping overall savings constant. Later, Feldstein (1976) using time-series analysis and estimating social security wealth finds that pensions depress household savings. The same conclusion was derived by Borsch-Supan et al. (2006) using OLG model with detailed long-term demographic projections.

Pension schemes are different across countries and the percentage of plans (e.g. mandatory, voluntary, defined benefit, defined contribution, hybrid etc.) varies within each country. Pension systems are usually distinguished as funded (contributions from employees are invested in a fund and returned with the interest in retirement) and unfunded (no assets are set aside and contributions from the employees directly transferred to current retirees).

When fully funded social security is introduced to the OLG model, capital stock of the economy will consist of private savings plus the reserves of the pension system. Since contributions to pension system are invested as capital, any increase in contributions is exactly offset by the same amount of decrease in private savings. Therefore, introducing funded social security system to OLG model do not reflect the impact of ageing on saving, because private saving and funded pension plans give the same return in the model. Thus agent does not care about who is saving, as long as total saving remains unchanged.

Since most OECD states finance pension arrangements by unfunded Pay-as-you-go (PAYG) pension system, now I estimate the effect of ageing using public pensions in the OLG model. When PAYG public pension system is introduced to the model private saving rate function depends on  $n_{t+1}$  and becomes:

$$S_t^p = S[W_t(k_t), \underbrace{r_{t+1}(k_{t+1})}_{f'(k_{t+1})}, D_t, n_{t+1}],$$

where  $D_t$  is a contribution paid by working generation. Here, it is assumed that contribution rates are constant over time. Differentiating the function above, FOC for the person at time *t* becomes (\*):

$$\frac{\partial S_t^p}{\partial n_{t+1}} = -\frac{\frac{1+r_{t+1}}{1+\rho}D_t U''(C_{2,t+1})}{U''(C_{1t}) + \frac{(1+r_{t+1})^2}{1+\rho}U''(C_{2,t+1})} < 0$$

This means that increased ageing caused by the drop in fertility reduces the expected pension the one might get when he/she is old, thus working age generation tries to save more to compensate for future drop in consumption. Moreover, wages and capital accumulation increases, whereas interest rates decrease. Since contribution rate is assumed to be constant, reduction in fertility reflects lower return on pension contribution causing older people dissave. To evaluate the actual effect of population ageing on private savings rate, one should consider separately private saving of both working and old population. As mentioned above, the OLG model shows that the reduction in fertility causes working age generation to save more, whereas elderly to dissave. Therefore, by "weighting" the relative strength of the impact of either working or old population's savings, the effect of ageing can be more accurately interpreted. In this manner, the recent declining trend in private savings rate should be explained by the fact that the aged population in the economy has much bigger influence on savings rate compared to the declining younger generation. To explain the argument more clearly, let us put it in formulation.

As defined above,  $S_t^p$  – is private saving rate in the economy at time *t*. This equals to current private savings of working population at period *t*,  $S_t^y = S_t^p$ , because working age people are the ones who save in the economy. Therefore, personal savings of older generation should be defined as a saved capital accumulated one period prior to *t*, that is  $S_t^o = -S_{t-1}^p$ (negative sign means dissaving of elderly). Since in the OLG model there are only two generations living together at a given period of time, total saving in the economy at period *t* should be identical to the sum of the savings by both working and old age generations:

$$TS_t = S_t^{\mathcal{Y}} + S_t^o.$$

Now, let us introduce the previously mentioned "relative weighting" argument to the total savings equation. Assume, that weights of working age and old age generations in the population at period *t* are given, and equal to  $w_y$  and  $w_o$  respectively. Due to coexistence of only two generations in the model OLG at a given time, the following parity should be true:  $w_o = 1 - w_y$ . As a result, total savings equation in the economy at period *t* becomes the sum of weighted savings of coexisting generations at a current time, which is:

$$TS_t = w_y S_t^y + w_o S_t^o = w_y S_t^p + (1 - w_y)(-S_{t-1}^p) = w_y S_t^p - (1 - w_y) S_{t-1}^p.$$

Taking first order condition with respect to  $w_y$ , the following is derived:

$$\frac{\partial TS_t}{\partial w_y} = S_t^p + \frac{\partial S_t^p}{\partial w_y} + S_{t-1}^p.$$

The equation consists of private savings of both working and old population plus the partial derivative, which stands for the impact of changes in fertility on private savings rate. This element of partial derivative is identical to the final condition of private savings (\*) in OLG model, that was obtained before. Therefore, rewritten FOC will become:

$$\frac{\partial TS_t}{\partial w_v} = S_t^p + \frac{\partial S_t^p}{\partial n_{t+1}} + S_{t-1}^p.$$

According to the OLG model, the elements of the FOC have the following signs:  $S_t^p > 0$  and  $\frac{\partial S_t^p}{\partial n_{t+1}} < 0$ . Moreover,  $S_{t-1}^p$  is also positive and not affected by anything except the weight of old population. As a result, the sign of  $\frac{\partial TS_t}{\partial w_y}$  is ambiguous, because it depends on the relative weights of coexisting generations in the economy. For instance, when the size of working population decreases due to the reduction in fertility, then the dissaving by old population will increase. Thus there will be a raising negative effect on total savings as share of elderly grows; and vice versa.

Let us define the old dependency ratio, since in the empirical regression I use the old dependency ratio as a measurement of population ageing. By definition, the old age dependency ratio is equal to the ratio between the elderly population and working age population, that is:

$$Old \ Dep \ Ratio = \frac{1 - w_y}{w_y}.$$

According to the assumptions and derivations of OLG model, declining savings trend in the economy can be explained in a way that dissaving of elderly influences much more compared to savings of working population in the condition of population ageing. Therefore, empirical estimation of the effect of old dependency ratio on private savings rate should reveal the following:

$$\frac{\partial (Private \ Saving)_t}{\partial (Dep \ Old \ Ratio)_t} = \frac{\partial TS_t}{\partial (\frac{1 - w_y}{w_y})} < 0,$$

which is possible if and only if,  $\frac{\partial TS_t}{\partial w_y} > 0$ . Therefore, the extended model in this study will be applicable if the result of the regression illustrates the negative relationship between old age dependency ratio and private savings rate.

The obtained result from the extended OLG model is consistent with the Life-cycle hypothesis idea, which suggests people accumulate wealth while they are young and spend wealth when they are old. Indeed numerous research papers written over the years concluded that ageing negatively correlated with savings, such as Horioka (1996, 2007), Kelley and Schmidt (1996) etc. However, along with those scholars there were always authors arguing that elderly do not dissave and ageing actually increases savings rate, such as Jenkins (1988) or Oksanen (2009). One of their arguments against life-cycle hypothesis was that due to the low consumption after retirement elderly cannot spend as much as they would to make saving negative and furthermore, inter-vivo transfers actually add up to the savings. Discrepancy in views can also be explained due to technical shortcomings in data-mining and estimation. In my opinion, previous research in some sense failed to accurately describe impact of demographic changes on savings because of taking mostly aggregate variables, such as national savings and total dependency ratio. Large amount of papers extend models by adding total dependency ratio to test the effects of population ageing. However, total dependency ratio includes both children and elderly proportions, which does not reflect specifically aged population. In this particular research the OLG model is extended by adding old age dependency ratio to explicitly consider effect of aged population on savings rate. Although, the stream of previous research leads to questionable results, model that I estimate empirically suggests that the population ageing should be negatively correlated with private savings rate.

In order to examine how well the theoretical model corresponds to the reality of economic conditions, empirical analysis is necessary. As can be seen from the OLG model, saving function depends on employer's wage, interest rate, pension contribution rate and dependency ratio. Since contribution rate is assumed to be constant in the model, I include variable for pensions in the econometric regression model, in order to take into account the effect of public pension system. Despite the assumption that the effect of longevity is being neutralized with the increase of retirement age as mentioned before, I will estimate the model by adding life expectancy in order to show empirically the impact of longevity, if there is any.

### **DATA DESCRIPTION**

In order to test the relationship between population ageing and private savings rate various empirical studies used different methods and data. For empirical testing researchers mostly used cross-sectional data, as well as time series data or panel data sets.

In this research I use the panel data set, since studies which used cross-sectional data or time series data to test the effects of ageing suffered from some significant theoretical problems. For instance, Leff (1969) used cross-section data to estimate the effect of dependency ratios on savings rate and faced mulitcollinearity problems. Later Kelley and Schmidt (1996) found that Leff's logarithmic transformation designed to eliminate heteroskedasticity was also problematic. Even though cross-sectional analysis might not be valid to extend the results to an effect on the whole economy based on comparisons among the individuals, it still provides some credible empirical evidence. As for the time series analysis, this type of study derives the least efficient results in testing the economic impacts of population ageing. That is, results vary depending on the time period over which equation is estimated and they are sensitive to the precise formulation of the estimated regression. Feldstein (1974) used time series data to illustrate effect on savings, by calculating social security wealth, that later was found to be incorrect by Leimer and Lesnoy (1982). However, the evidence was not useful in explaining the savings behavior, which again shows the inconstancy of estimates using time series analysis.

Panel or longitudinal data is defined as multidimensional data, which consist of observations on multiple phenomena observed over many years for the same individual. Panel data requires replication for the same units over time, which brings several advantages over cross sectional or time series data. For instance, having multiple observations on the same units allows controlling certain unobserved characteristics of individuals, firms, and so on (Wooldridge, p.13). Therefore, in order to more accurately estimate the OLG model, panel data will be used in this study.

The macro panel data set consists of 120 observations collected from twenty four OECD member countries over five most recent time periods (1993 – 2009). The length of each time period is four years. The data was mainly collected using official databases of World Bank and OECD. The list of observed countries is given in Table 2. Countries were chosen according to the availability of data and common factors across countries, such as pension system (mostly PAYG system).

Austria	Finland	Japan	Slovak Republic
Australia	France	Korea	Spain
Belgium	Germany	Netherlands	Sweden
Canada	Hungary	Norway	Switzerland
Czech Republic	Ireland	Poland	United Kingdom
Denmark	Italy	Portugal	United States

Table 2. List of the OECD Member Countries Observed in the Empirical Estimation

The dependent variable in the estimation model is private savings rate. For this factor I use data for household saving rate as a percentage of disposable household income. Household saving constitutes the major part of national savings and considered to be the prime cause of fluctuations in the economy. Data for this variable is obtained from OECD Economic Outlook: Statistics and Projections Database (EO No. 88, December 2010).

Household saving is defined as a difference between household disposable income and household consumption expenditure. Disposable income mainly consists of the sum of employment income, self-employment earnings, property and other income (receipts of interest, dividends and social benefits) minus payments of taxes, social security contributions and interests. Household consumption expenditures include essentially cash spending on consumer goods and services. Some countries, such as the United States and Canada, do not consider pension benefits as a part of the household income. However, saving remains unaffected, since it is adjusted by adding back contributions to the pension in order to reconcile income with the correct savings concept.

The main independent variable is the population ageing. In order to estimate ageing I use the data for old age dependency ratio, which was collected from the World Bank Data Catalog. Old age dependency ratio is estimated as a ratio of people over 64 to the working age population aged 15-64. Data is constructed as the proportion of older dependents per hundred working age population. As mentioned before, many previous studies used total dependency ratio, which consist of both old and young dependency ratios, to estimate the economic impact of ageing. However, to explicitly consider the population ageing, old age dependency ratio needs to be examined.

In addition to the main variables, I also control over several factors that might have an influence on the private savings rate. As the OLG model predicts, saving is very much interrelated with income. Thus, one of the control variables will be gross domestic product (GDP) per capita based on purchasing power parity (PPP) obtained from the World Bank International Comparison Program Database. I use the logarithmic transformation of GDP per capita in order to have the variable normally distributed and assume constant elasticity over all values of the data set. Besides income, in the OLG model saving was also defined by interest rate and pension contribution rate. By adding year-on-year consumer price index obtained from OECD Economic Outlook Dataset (EO No 88, December 2010), I control for the interest rate in the regression model. Consumer price index is a good proxy for the interest rate, since it reflects changes in the cost of acquiring a relatively stable basket of goods and services to the average consumer.

Since contribution to pension was assumed to be constant in the model, however introducing PAYG system emphasized effect of ageing on saving, I will use public pension

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expenditures as a control variable in the empirical estimation. Data for public social expenditure on benefits for old-age as a percentage of GDP was gathered using OECD Social Expenditure Statistics Database.

The OLG model shows that declining fertility causes working age population to save more, however average saving is still declining. Indeed, Fry and Mason (1982) showed that child dependency ratio has little or no impact on national savings rate. To re-estimate this effect, I will extend the regression by controlling for child dependency ratio, which is ratio of population aged 0-14 to the working age population. Another source of population ageing longevity was assumed to be neutralized by the increase in the retirement age. In order to prove credibility of the assumption, I will add life expectancy at birth to see the effect of longevity on savings rate. Data for both variables was collected from the World Bank Data Catalog.

Kelley and Schmidt (1996) claim that savings are posited to increase at higher levels of income. Thus, following previous studies the authors add growth rate of GDP to their model in order to capture the impact of life-cycle consumption smoothing. In addition to the growth rate, I control for the elderly labor force participation rate, which is the percentage of aged 65 and over in an active workforce, and unemployment rate that also might further explain the savings behavior in the economy. Data for these control variables was obtained from OECD Datasets.

Mean, standard deviation, maximum and minimum values of each variable are presented in Tables 3 and 4 overleaf. Table 3 illustrates descriptive statistics of variables in initial form, whereas Table 4 shows descriptive statistics for the first differences of the main and control variables. I include first differences of the variables to account for the effect of changes in the variables.

(Initial variables)Variable	Mean	Standard Deviation	Maximum value	Minimum value
Savings	8.029	5.005	23.100	- 4.229
Old Age Dependency Ratio	21.911	4.264	33.919	7.747
Log GDP per Capita	4.375	0.182	4.746	3.763
Pension Expenditure	6.306	2.432	11.819	0.862
Interest Rate	3.156	4.803	36.866	- 4.480
Child Dependency Ratio	26.711	3.959	40.458	19.823
Life Expectancy	77.798	2.675	82.700	69.200
GDP Growth Rate	1.209	3.325	11.495	- 8.083
<b>Unemployment Rate</b>	7.812	3.826	19.305	2.199
Elderly Labor Force Participation Rate	7.955	7.007	30.092	1.049
Number of Observations	120	120	120	120

## Table 3. Descriptive statistics (Initial variables)

# Table 4. Descriptive statistics(First Differences of the variables)

Variable	Mean	Standard Deviation	Maximum value	Minimum value
$\Delta$ Savings	- 0.881	3.417	7.345	- 10.900
$\Delta$ Old Age Dependency Ratio	0.787	1.013	3.871	-1.274
$\Delta$ Log GDP per Capita	0.080	0.030	0.181	0.016
$\Delta$ Pension Expenditure	0.095	0.634	1.950	- 2.751
$\Delta$ Interest Rate	- 1.423	3.281	4.130	- 21.784
$\Delta$ Child Dependency Ratio	- 1.241	1.378	1.472	- 5.190
$\Delta$ Life Expectancy	0.974	0.363	2.300	0.200
$\Delta$ GDP Growth Rate	- 1.027	4.345	9.436	- 13.597
$\Delta$ Unemployment Rate	- 0.327	2.896	8.853	- 9.579
$\Delta$ Elderly Labor Force Participation Rate	0.210	1.442	3.616	- 4.522
Number of Observations	96	96	96	96

### **ECONOMETRIC MODEL SPECIFICATION**

Since the data set used in this research is the panel data, I use econometric methods for panel data to empirically estimate the OLG model. Using panel data gives great advantages to researchers, since in this type of the data set endogeneity in the cross-sectional units can be controlled. Basic framework of the regression model with panel data set is the following:

$$y_{it} = \alpha_0 + \beta X_{it} + \delta_i + \varepsilon_{it},$$

where in  $y_{it}$ , *i* denotes individual, firm, country etc., and *t* stands for the time period.  $X_{it}$  is a vector of regressors, excluding constant term. Parameter  $\delta_i$  is referred as an individual effect or heterogeneity and contains set of unobserved individual and group specific variables that affect  $y_{it}$ , all of which are constant over time *t* (Greene, p. 285).  $\varepsilon_{it}$  is an idiosyncratic or time-varying error, which represents unobserved factors that change over time and have an effect on  $y_{it}$  (Wooldridge, p. 420). The main point of interest—coefficient  $\beta$ , which captures impact of independent variables on  $y_{it}$ , can be estimated in different ways.

Leff (1969), Fry and Mason (1982) used Pooled Ordinary Least Squares method to estimate the relationship between dependency ratio and savings rate. Pooled OLS is estimated by pooling cross sections at different points of time, whilst assuming unobserved effect  $\delta_i$  to be uncorrelated with  $X_{it}$ . Using this method to estimate the OLG model with panel data set will lead to inconsistent results, because true error component of savings function cannot be uncorrelated with the income per capita. Therefore pooled OLS method is not efficient in this particular research.

If  $\delta_i$  is correlated with the explanatory variable, this can be eliminated by differencing adjacent periods, since  $\delta_i$  is constant over time. This method is called First Differences Method and it is estimated as a simple cross-sectional equation, but each variable is differenced over time (Wooldridge, p. 421):

$$\Delta y_{it} = \beta \Delta X'_{it} + \Delta \varepsilon_{it}$$

When there is more than two years of time periods, then the first differencing is very useful for policy analysis. Thus, I estimate the model using First Differences estimation method. While using more than two years of time periods it must be assumed that  $\Delta \varepsilon_{it}$  is uncorrelated over time in order to get consistent coefficients. Moreover, when number of periods is relatively small compared to the number of cross-sectional units, to account for secular changes that are not being modeled, dummy variables for each period should be included (Wooldridge, p.430). I control time-varying effects by including period specific effects whilst estimating the model, therefore I do not include dummies in the model formulation. Furthermore, I estimate regression using White period standard error correction method in order to get robust standard error estimates consistent under serial correlation.

Another widely used method in testing models with panel data set is Fixed Effects estimation method. General equation of the model is the following:

$$y_{it} = \beta X'_{it} + \delta_i + \varepsilon_{it},$$

where  $\delta_i$  is a group-specific constant term that "embodies all the observable effects and specifies an estimable conditional mean" (Greene, p. 285). Therefore, this approach is one of the alternative ways to eliminate fixed effects,  $\delta_i$ , besides First Differences method. The estimated Fixed Effects coefficients are consistent under strict exogeneity assumption, that is idiosyncratic error  $\varepsilon_{it}$  should be uncorrelated with each independent regressor in the model across all time periods (Wooldridge, p. 442). Fixed Effects method is the second method that I use to empirically test the OLG model derived earlier. I use country fixed effects to control for influences that vary across countries, such as cultural attitudes towards work and saving. These influences are sufficiently constant over time within countries. Moreover, I use period fixed effects to control for global, time specific effects, such as global financial recession. Additionally, I will use White period standard errors and covariance for robust standard error estimators which are consistent under serial correlation.

Besides methods considered above there is also Random Effects method which is often used to estimate the panel data set models. In this estimation method an intercept is explicitly included so that it can be assumed that unobserved effect,  $\delta_i$  has a zero mean (Wooldridge, p. 449). Moreover, unobserved effect is assumed to be uncorrelated with each explanatory variable. As mentioned above, this assumption is less likely to hold in the baseline OLG model, thus Random Effects will not give credible results in this case and will not be used in the empirical estimation.

Consequently, in this particular study I concentrate on two methods to estimate the main model: Fixed Effects and First Differences. The main Fixed Effects regression model to be estimated is the following:

$$Savings_{it} = \alpha_0 + \alpha_1 DepRatio_old_{it} + \beta X'_{it} + \delta_i + \theta_t + \varepsilon_{it},$$

where the i – subscript is for country and t – subscript is for the time period. Dependent variable is household savings rate as a percentage of household disposal income and the main independent variable is old age (65+) dependency ratio. The regression to be estimated using First Differences method is the following:

$$\Delta Savings_{it} = \alpha_1 \Delta DepRatio\_old_{it} + \beta \Delta X'_{it} + \Delta \varepsilon_{it}.$$

The coefficient  $\alpha_1$  is the main point of interest in both model specifications and according to the baseline theoretical model prediction its sign should be negative.

 $X'_{it}$  is a vector of explanatory variables and includes the following regressors that might have an influence on the private savings rate:

- log(inc\_per\_cap) GDP per capita with logarithmic transformation, in order to have variable normally distributed and assume constant elasticity over all values;
- *pension\_exp* public social expenditure on benefits for old-age as a percentage of GDP;

- *int\_rate* year-on-year consumer price index change as a proxy for the interest rate;
- *DepRatio\_child* child (0-14) dependency ratio;
- *Life\_exp* total life expectancy at birth;
- *GDP growth* GDP growth rate;
- *LFparticip\_old* elderly (65+) labor force participation rate;
- *unemp* unemployment rate.

### **EMPIRICAL RESULTS**

In this section of the thesis results from empirical analysis of the extended OLG model are presented. Results obtained from estimating regressions using Fixed Effects and First Differences estimation methods are reported on the next pages in the Tables 5 and 6, respectively. All of the results derived using White period robust coefficient variance estimator, which gives standard errors that are robust to arbitrary serial correlation and time-varying variances in the disturbances. Moreover, I used country and period specific effects, in order to control for cross-section and time varying factors, such as differences in culture and global recession, respectively.

First of all, basic regression, which consists of the main independent variable, i. e. the old age dependency ratio, was estimated to see the individual effect of population ageing on private savings rate. As can be seen from the tables, both Fixed Effects and First Differences methods give the expected result—the coefficient of old age dependency ratio is negative and statistically significant. Estimation by Fixed Effects method derives that 1 percent increase in the share of elderly in population will result in 0.95 percent decrease in private savings rate. The number becomes 0.84 after with both country and time specific effects, whereas coefficient of determination,  $R^2$ , improves. On the other hand, outcome from First Differences estimation shows smaller magnitude of partial effect of the old dependency ratio on savings rate, -0.51, but the coefficient is significant and with the expected sign. This proves that increase in the share of elderly will oppress the savings rate of working population by higher dissaving behavior. Therefore, combined effect of both the old and young generation on savings is negative.

### Table 5. Estimation Results—Fixed Effects Estimation Method

(White period standard errors and covariance)

Dependent Variable: Private Savings Rate					
Independent variables	Cross- Section Fixed Effects	Cross- Section and Period Fixed Effects	Cross- Section Fixed Effects	Cross- Section and Period Fixed Effects	Cross- Section and Period Fixed Effects
Old (65+) dependency ratio	-0.946*** (0.261)	- 0.842*** (0.294)	-0.671** (0.341)	- 0.997*** (0.349)	- 0. 962** (0.434)
Log (GDP per capita)			- 7.104 (13.580)	- 19.703 (13.619)	- 21.151 (17.262)
Child (0-14) dependency ratio			0.207 (0.347)	0.073 (0.308)	0.031 (0.376)
Public Pensions Expenditure			- 0.643 (0.841)	- 0.189 (0.815)	- 0.207 (0.891)
Interest rate	—		- 0.113 (0.139)	- 0.105 (0.148)	- 0.126 (0.178)
Life Expectancy			0.261 (1.043)	- 0.562 (1.193)	- 0.663 (1.179)
Elderly (65+) Labor Force Participation Rate					0.103 (0.311)
Unemployment					- 0.011 (0.217)
GDP growth					- 0.106 (0.205)
С	28.766*** (5.724)	26.474*** (6.443)	32.410 (30.252)	159.332 (126.639)	173.512 (144.566)
R <sup>2</sup>	0.73	0.79	0.75	0.81	0.81
Durbin-Watson Statistics	1.77	1.74	1.79	1.83	1.77
Number of Observations	120	120	120	120	120

\*\*\*-coefficient significant at any conventional significance level

\*\*- coefficient significant at 5% significance level

\*-coefficient significant at 10% significance level

(Standard errors are given in parenthesis)

### Table 6. Estimation Results—First Differences Estimation Method

(White period standard errors and covariance)

Dependent Variable: Private Savings Rate				
Explanatory variables	Period Fixed (dummy variables)	Period Fixed (dummy variables)	Period Fixed (dummy variables)	
Old (65+) dependency ratio	- 0.542** (0.242)	- 0.512** (0.263)	- 0. 481* (0.267)	
Log (GDP per capita)		- 9.129 (12.445)	- 15.443 (14.058)	
Child (0-14) dependency ratio		0.129 (0.264)	- 0.024 (0.340)	
Public Pensions Expenditure		- 0.376 (0.625)	- 0.549 (0.696)	
Interest rate		- 0.209** (0.106)	- 0.258** (0.121)	
Life Expectancy		- 1.395* (0.826)	- 1.349 (856)	
Elderly Labor Force Participation Rate			0.397* (0.235)	
Unemployment			- 0.068 (0.185)	
GDP growth		_	- 0.265* (0.158)	
С	- 0.454 (0.304)	1.508 (0.983)	1.320 (1.378)	
$\mathbf{R}^2$	0.22	0.27	0.32	
Durbin-Watson Statistics	2.81	2.88	2.73	
Number of Observations	96	96	96	

\*\*\*-coefficient significant at any conventional significance level

\*\*- coefficient significant at 5% significance level

\*-coefficient significant at 10% significance level

(Standard errors are given in parenthesis)

When some of the control variables were added into regressions, magnitude of the old age dependency ratio's partial effect on private savings rate decreased, but the sign remained unchanged for both of the estimation methods. The third column of Table 5 shows that whilst estimating regression with some of the explanatory variables, main coefficient of interest lost its significance and magnitude. This is due to the time-varying factors, since after controlling for them coefficient becomes strongly significant and consistent. After adding other controls and time and country fixed effects, the coefficient of old age dependency ratio became -0.96, that is statistically significant in any conventional significance level. This number is very close to the one that was obtained from the basic regression; this once again shows that the results are robust. As for First Differences method, adding control variables into regression reduced the magnitude of the share of elderly, but significance level and sign did not change.

From the both estimation methods it can be seen that coefficient of the old age dependency ratio is remarkably significant when estimated using time and country specific effects. Results are consisted with the baseline OLG model and robust. The most interesting and attention dragging feature from the results is that the two models derive very different estimators for the effect of population ageing on private savings rate. Specifically, coefficients obtained from First Differences estimation method are almost half of those obtained using Fixed Effects estimation method. One of the explanations might be that this difference is due to the serial correlation in the errors. Thus to check this hypothesis Durbin-Watson Statistics values obtained from estimating regressions are also reported in the tables.

Durbin-Watson (DW) Statistics is used to detect presence of the serial correlation in the residuals from the regression analysis. When the DW Statistics is close to two, it means that there is no autocorrelation in the errors. Obtained DW Statistics by estimating model using Fixed Effects method is close to two, thus there is no serial correlation. On the other hand, DW Statistics for First Differences method is quite high, showing the presence of negative serial correlation in the residuals. Therefore, it can be concluded that results obtained from the Fixed Effects estimation method are more efficient and consistent than those derived from the First Differences method, due to the serial correlation in the residuals.

Nevertheless, coefficients obtained from First Differences are consistent and robust within specification, despite the discrepancy between two estimation methods. Then what could explain the large difference in the results obtained from estimating two explicit models using the same observation units? Another explanation for this question can be the following. Since in the data set one time period includes four years, short term changes may be different from the long term changes when estimating the models. For instance, sudden increase in old cohort or decrease in young cohort in the short term can change the saving behavior of households. Let's consider an example by breaking the old cohort itself into two different age groups: the youngest elderly who just entered the cohort within short term and the oldest elderly in the cohort. Then, if there is an increase in old age dependency ratio due to the increase of the share of youngest elderly in old cohort, then overall dissaving pattern of the cohort might change. That is, dissaving of youngest elderly cohort is usually less than that of the oldest, thus the average dissaving pattern of the cohort can be smaller. Therefore, the effect of old-age dependency ratio on savings will become less negative. The same analysis can be done by looking at savings pattern among working age population. This example can explain the discrepancy in the result, since long term effects are usually captured in Fixed Effects estimation method as oppose to the First Differences. However, the sign of coefficients obtained from the both methods is the same and meets the expectations by the baseline theoretical model.

Turning to the explanatory variables in the model, I start estimating the regressions by adding control variables that tend to have influence on private savings rate in the OLG model *per se*, such as interest rate, pension expenditures, income, child dependency ratio and

longevity. As oppose to the main variable, control variables are insignificant when model is estimated using Fixed Effects method, and some of them become significant when estimated by First Differences. However, all of the explanatory variables have the expected signs, in agreement with the life-cycle hypothesis which lies on the base of the OLG model. Precisely, according to the life-cycle theory households reduce savings when their wealth level, i.e. income, increases. Both models derived negative parameters for income per capita, despite insignificance. As discussed in the theoretical part of the thesis, social security is a substitute for the savings by providing "insurance" during the retirement and thus, it is negatively correlated with the savings rate. Both methods give negative results for the pension expenditure coefficients; but since contribution rate for PAYG in the OLG model was taken as a constant, it is not surprising that coefficients are not highly significant. Furthermore, the coefficient for the interest rate becomes significant at five percent significance level when estimated using First Differences, negatively affecting savings, which is also consistent with the fundamental theoretical OLG model. It means that the interest rates have strong effect in the short run, but in the long run the effect vanishes, since Fixed Effects method do not derive significant results for this variable. Another variable, life expectancy, was expected to have no effect, due to the assumption that effect of longevity was neutralized by the increase in retirement age. However, First Differences method derives significant estimator at ten percent significance level for it, yet the significance of the coefficient disappears once the other controls have been added. Therefore introduced assumption of neutralizing effect in the model is credible. Consistent with the findings of Fry and Mason (1982), I found that child dependency ratio have no effect on savings rate.

According to Horioka (2007), many papers failed to accurately test the relationship between population ageing and savings rate by not taking into account employment of elderly in the economy. Thus I further estimate both regressions by including elderly (65+) labor force participation rate and unemployment rate. Indeed, First Differences show that elderly labor force participation rate increases private saving, that is working old people save and contribute to generating capital stock in the economy. However, this effect is significant only in the short term. I also controlled for the GDP growth rate following Kelley and Schmidt (1996) and obtained intuitive estimation outcomes.

Overall, results are consistent with the predictions of the baseline extended OLG model and harmonized with the results of the most prior empirical research. From the both methods I obtained robust, clear and credible results. All the variables have intuitive signs and expected influence on private savings rate. Therefore, I believe that baseline OLG model is highly applicable to the real economic world, particularly to OECD member countries.

### **CONCLUSION AND POLICY RECOMMENDATIONS**

In this thesis I have analyzed how population ageing affects private savings rate using panel data set for twenty four OECD member countries. For this I used the extended version of OLG model with pay-as-you-go pension system by adding separate weights for working age and old age cohorts. Final model specification predicted that the decline in fertility rate induces working age population to save more, whereas the elderly dissave. However, as a share of old age population increases, the population ageing has a negative correlation with private savings rate, due to larger dissaving in the economy by elderly that oppressed savings of working generation. Empirical estimation using the Fixed Effects and First Differences methods derived expected and consistent coefficients for old age dependency ratio, confirming negative effect of ageing on private savings.

According to the predictions about future age distribution in the OECD countries, the old age dependency ratio is going to increase even further in the upcoming decades. This, certainly, will change the structure of the labor force, which is likely to put downward pressure on savings rate. Savings is essential, since it increases resources for future consumption, helps to protect against accidents and unexpected losses. For a nation as a whole savings is also very important, because it is one of the major sources of investment and a key factor of economic growth. Low savings rate negatively influences the capital market development, productivity rates and many other spheres of economic and social life. Further decline in savings rate leads to the continuous dependence on savings of foreign individuals and firms. Therefore, policymakers should prepare accordingly and make reforms to reduce negative consequences of the increasing population ageing and prevent savings from further decline.

Based upon the results obtained from the study, demographic and economic policy reforms can be suggested. Since one of the sources of population ageing is a decline in

fertility, policy reforms should consider rising fertility rates. It can be done by rewarding young families for having children; and helping them to balance their family life and jobs by reforming labor-market rules that will allow more flexible transition of employers between part-time and full time working schedules. Another demographic policy suggestion can be encouraging legal migration by implementing highly skilled worker programs to member countries. The higher immigration rates can also substitute for higher fertility rates.

As for the economic policy reforms, many OECD countries have projected to move from the pay-as-you-go public pension system towards the funded pension system in order to cut costs of increasing old-age benefits. Indeed, Borsch-Supan et al. (2006) found that this transition increases savings rate in the economy, as well as labor supply and the rate of return to capital. Moreover, since longevity is anticipated to grow further, elderly should be encouraged to work longer by increasing the retirement age. In that case workforce will grow, as well as productivity, since older workers can also train the young generation because they tend to be more experienced. This will result in the increase of capital accumulation in the economy.

Overall, both theoretical and empirical analyses of the thesis confirm that the population ageing has a strong negative impact on the private savings rate. From the findings it can be concluded that OLG model is highly applicable in case of ageing OECD countries.

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