

# THE EFFECTS OF DEMOGRAPHIC TRENDS ON ECONOMIC GROWTH IN THE EUROPEAN UNION

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## **Abstract**

The aim of this article is to assess the influence of demographic age shares on changes in economic growth in the EU from 1996 to 2013 using a fixed effects model. The authors hypothesise the demographic variable having a statistically significant effect on the macroeconomic variable. Conclusions and suggestions stemming from the analysis are expected to benefit policymakers and provide guidance to public institutions.

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**Keywords:** Demographic trends, ageing, economy

## **Introduction:**

With the onset of long-term transformations in the EU's demographic makeup, the issue of their implications for the economy has become acute. The status quo maintaining an ageing population coupled with low birth rates and no signs of imminent change manifested itself in a conundrum that neither the private nor the public sector currently appears to have the capacity to solve. Discussions covering these socio-economic changes spanned from developed countries like the USA to emerging economies such as India and China. For developing nations, the connection between demographics and the economy served as a basis for forward-thinking policy changes while others conducted research to understand the aforementioned processes as they manifested. Their efforts resulted in an extensive debate regarding the value of savings, return caps and the demographic variables' influence on the economy in general.

The EU context raises more questions due to previous studies being scarcer than those dedicated to the USA, specifically, on the relationship between GDP growth and demographic shifts.

The purpose of this research is to quantify the effects of processes such as the evolution of the age composition in the EU on economic growth and juxtapose estimation results with those obtained in comparable works.

This, in turn, forms a platform for insight to suggest areas necessitating remedial action.

This article consists of four parts: an overview of modern approaches to the relationship of demographic trends and the economy, the construction of the fixed effects model, and the assessment of the aforementioned trends' effects on economic output. The last section outlines the conclusions derived from the research.

### **Modern Approaches to the Relationship of Demographics and the Economy**

Stacking predictable short-run changes in demographic makeup raises the question of the current framework's longevity, considering retirement benefits, entitlements, returns on investment-based alternatives and economic development as a whole. Bloch (2011) argues all of the above will undergo an "asset meltdown" with cuts to reduce the amount of distributable welfare on every level from state-run schemes to investment funds. A Romanian study by Nadelea and State (2008, p. 1008-1012) contributes to the discussion by pointing out the costs of demographic transformations incurred by the consumer goods market.

Dizard (2013) seems to agree with the Bloch's sentiment, as far as pointing out the same sectors to be affected by demographic changes. Dizard further contributes to the discussion with the addition of non-healthcare elder goods and services, providers of which will manage to alter their businesses in a timely manner to reap benefits from changes in demand. He predicts that due to life expectancy remaining on the increase, demographic transformations 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. 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.

Jensen (2013) and Magnus (2008, 2010) offer a consensual valuation of the state of affairs, but their views on the downturn are muted. Magnus argues that regions experiencing the transition to low birth rates and low infant mortality rates 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. Nonetheless, both authors admit a doubling old age dependency ratio 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 (2013) concludes. Declé's (2000) 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 fewer workforces 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.

McKinsey Global Institute, 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, the UK, and among non-EU countries, they have used fifth-degree estimates of life cycle effects. 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).

The IMF dedicated an issue of *Finance and Development* to the matter. Bloom and Canning (2006) pointed 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, 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 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).

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. Conversely, his IMF paper notes a change in behaviour such as more women participating in the workforce or active immigration, as stated by Magnus, will resist the downward pressure on real income. Lacking such structural changes, public expenditures on pensions are to increase by as much as 16 p. p. of GDP by 2050 in countries like Spain, more than twice of the projection made by the European Commission (Catalán, 2007).

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 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.

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) used 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 different 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 cent per year was projected as sufficient to offset half of Japan’s aggregate GDP’s fall attributed to demographic changes. The model inspected 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.

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 was speculation about capital flows in 2007 stemming from loose monetary policy, the author suggested that demographic change is behind the current, “making a sudden reversal less likely” (Lueth, 2008, p. 15). Lueth makes it clear that ROI interests governments, which will be motivated to move from pay-as-you-go to investment-based schemes. He insists about processes such as globalisation and financial integration being beneficial in the long run, reassuring that the demographic transition may not cause a fall in returns as steep as others predict and he does not exclude the possibility of them increasing.

Arnott and Chaves (2012) present a development in the study of demographic variables as a determinant of economic shifts. The authors use a pool of 22 countries for the main regression and increase the number of degrees of freedom by force-fitting the equation into a two-to-four-degree polynomial. While a secondary regression with 176 countries is present in their study, the authors admit that data is fragmented, allowing for more accurate estimates only in developed countries. Their study involved a two-fold set with GDP per capita being analysed in one regression and returns on securities in the other. Both sets depicted: “a strong and intuitive link

between demographic transitions and both GDP growth and capital market returns“ (Arnott, 2012, p. 23).

Insight taken from the works laid out in this part is used as a basis to formulate the methodology to be used in hypothesis testing.

### The Methodological Framework of the Econometric Model

The model’s basic premise entails the use of secondary time series data as reported in a sample of countries over a specified period. The data is panelised, labelling the demographic variable as the regressor and the economic variable as the regressand in a panel least squares single-equation regression. To capture valuation and business cycle effects, the equation contains a proxy economic variable on the regressor side. This may be seen in equation (1).

$$r_t = a + \gamma X_{t-1} + b_1 s_{t,1} + b_2 s_{t,2} + \dots + b_N s_{t,N} + \epsilon_t, \quad (1)$$

where  $r_t$  – dependent variable at period  $t$

$a$  – intercept term

$X_{t-1}$  – proxy variable, used to gauge the business cycle

$b_N$  – coefficient for age group  $N$

$s_{t,N}$  – relative population share size of age group  $N$  at period  $t$ .

Note that the equation contains an intercept term, a lagged term for the valuation effect and denotes age shares for every cross-section in every period.

The main issue with equation (1) is that statistical data for most countries in a sufficiently large panel is available for a limited selection of years. As such, the number of data points is reduced, which complicates both analysis of the demographic variables’ slow evolution and its effect on the macroeconomic variable. In fact, estimating equation (1) directly is impossible for any country currently in the EU because including the intended number of five-year non-overlapping age groups ( $s_{t,i}$ ) does not leave enough degrees of freedom, as  $i$  spans from 1 to 18, coinciding with the number of periods  $t$ . Excluding a particular age group, for example, ages 0 to 4 or broadening the groups is an ad hoc solution that hides a part of the information contained in the original equation.

Hence, we may include a restriction for the number of coefficients:

$$b_i = D_0 + D_1 i + D_2 i^2 + \dots + D_k i^k, \quad (2)$$

This expression suggests replacing the coefficient  $b_i$  next to every demographic share with a single polynomial of the order  $k$ , supposed to reduce the number of coefficients to estimate from  $N$  to  $k$ . The order of the polynomial is determined by testing it against redundancies with parsimony in mind via the Wald coefficient restriction test. It is worth noting that the  $i$ ,

representing the number of the age group, spanning from 1 to N, is raised to the power from 0 to  $k$ .

Since demographic shares have the cumulative sum of unity and their sum of changes always equals to zero, a restriction is required on the transformed coefficients to avoid multicollinearity with the intercept term. The issue is captured by the initial term,  $D_0$  as described in equation (3).

$$D_0 = -\frac{1}{N}(D_1 \sum_{i=1}^N i + D_2 \sum_{i=1}^N i^2 + \dots + D_k \sum_{i=1}^N i^k), \quad (3)$$

Following the coefficient transformation and after the inclusion of  $D_0$  as shown in (3), the model's regression equation intended for panel LS estimation appears as follows:

$$r_t = a + \gamma X_{t-1} + D_1 \sum_{i=1}^N \left[ i s_t^{(i)} - \frac{i}{N} \right] + D_2 \sum_{i=1}^N \left[ i^2 s_t^{(i)} - \frac{i^2}{N} \right] + \dots + D_k \sum_{i=1}^N \left[ i^k s_t^{(i)} - \frac{i^k}{N} \right] + \epsilon_t, \quad (4)$$

Note that to conserve space, the presented equation does not contain fixed effects, which determine the country-specific intercept term, supposed to capture differences between countries in the panel. Equation (4) with fixed effects is used for out-of-sample robustness tests while equation (1) presents the end result containing implied regression coefficients of every demographic share to be compared with those obtained in previous studies, if available, using this methodology.

The framework is put through a range of tests pertaining to the Gauss-Markov assumptions, its robustness and is subject to adaptation in case one of these assumptions is not met and the result may contribute to misleading conclusions.

As demonstrated in the first part of this paper, the variables and underlying data quality are crucial for BLUE estimation. Previously covered research limited to the USA theatre is mostly concerned with the former rather than the latter due to the relative legislative stability and availability of statistical data, allowing the researcher to focus on variable selection. The European context adds complexity factored by historical and methodological divisions, which affect the quality and availability of data and its variable forms.

Institutional changes are a noteworthy example, limiting the number of data points available for study in multiple countries to a period spanning from years after the collapse of the USSR until 2013. UN Penn World Tables provide estimates for the most general demographic and macroeconomic variables as well as official statistics with their quality classified accordingly. However, this data is limited to 5-year increments or 20 data points per 100 years in addition to complementary variables necessary for hypothesis testing being absent from their repository. Hence, the European statistical

authority, Eurostat and the ECB act as the chief sources of data, providing demographic and macroeconomic time series used in this paper.

One of the key issues concerning the execution of the model was formulating the scope of detail to describe an EU member state's demographic makeup. By referring to previous research and prior testing with draft models<sup>1</sup>, it was concluded that broad age groups withheld information present in the non-overlapping five-year cohorts reported by each member state. For countries such as France or Spain, these were published from 1948. For other countries, the series started from 1991 or 1993, a case not limited to CEE countries like Lithuania or Slovakia.

Unlike in previously cited research, the number of groups was 18, not 15, as Eurostat's age groups were concluded by 85 and over instead of 75 and over. Including all of the groups would have been impossible with the degrees of freedom available in an annual series from 1991 to 2013, excluding macroeconomic variables, were it not for the model's transformation of demographic shares into a polynomial.

The analysis includes the levels of demographic shares, as observed on January 1<sup>st</sup> of the year ( $t$ ) in question. 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 economic growth.

Annual percentage changes of real GDP (fixed prices, 2005 base) are used to represent the demographic makeup's effect on the economy as the regressand. Following the literature review, it may be concluded that this is not a unique area of study, covered by the McKinsey Global Institute (2004), IMF's Bloom and Canning (2006), Magnus (2010), Arnott and Chaves (2012) among others. There are functional alternatives to this variable as a measure of the state of the economy, but the model pertaining to the explanatory variables' influence aims to test hypotheses comparable to those present in previous research.

Empirical literature deliberated on in the first section suggested the inclusion of a variable to account for valuation effects and business cycles, a proxy variable for information that would otherwise be omitted, referring to public trading statistics as a feasible solution. The ECB provides an array of leading EU stock market indices, either taken directly from the market or synthesised via a long-lasting index such as Euro Stoxx 50. Whenever possible, this variable is supplemented with data from the member state stock market's main index used for settlements, adjusted for breaks. The measure is not taken for countries lacking such an index during the analysed period.

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<sup>1</sup>These draft models utilised broad age groups as defined by Eurostat (0-15, 16-64, 65 and over) or featured ad hoc grouping.



In case of multiple markets being present, as is the case in states such as Germany and France, data from the operator with the highest index capitalisation is selected. To reflect the measures taken in preparation of other variables, raw closing values of a year's first trading session are converted into annualised percentage growth rates. The timing and magnitude are to match those of the demographic shares.

Dividend yields are cited as an alternative and a supplement to stock market indexes. However, these would be more challenging to use as an efficient measurement instrument in markets with endemic higher volatility, compounded by the fact that dividends are generally distributed several months after the end of the year in question. It generates a time lag, the length of which differs from country to country, that the market index does not have. Furthermore, indices in Western Europe have been dividend-inclusive since as early as 1999. Adjusting pre-1999 values accordingly preserves the yield information while avoiding structural break.

As a proxy solution outside the financial market, the economy's production function was considered. However, such a function's estimation for every country in the sample would add complexity and reduce the number of degrees of freedom upon its inclusion in the regression.

Stationarity is often a question when dealing with demographic variables due to their susceptibility to time trends. The variables selected for analysis, i.e. the demographic shares, are held within an interval [0;1] and are taken from a sample of more than 20 countries experiencing different stages of the demographic transition, thus increasing the power of the tests, or, in case of economic variables, are presented in the form of annual percentage changes.

It is worth noting at this point the model's primary goal is to examine dependencies rather than make predictions.

The EU's changing composition poses another challenge of analysing dependencies in an all-inclusive fashion. Eurostat does not publish the aforementioned data for years prior to 2001 for newest members such as Romania and Croatia. Therefore, EU25 is the basis for the analysis. With regard to data availability, the model described in this part involves data from 1996 to 2013.

### **Assessing the Effects of Demographic Trends in the European Union**

In this part, we apply the model to analyse the effect of demographic shares on the annual percentage change in real GDP. The main results of the analysis are presented in Table.

The basis for the model is panel data containing the transformed age shares, represented by D1, D2 (x10), D3 (x100), D4 (x1000) between the years of 1996 and 2013 and the country's main stock market index, lagged

by one period, represented by INDEX(1). The model includes fixed cross-section effects to address signs of serial correlation. The measure is tested with the Redundant Fixed Effects test. As a secondary measure to tackle serial correlation, the values of GDP and INDEX, lagged by one period, are taken into account.

After making the steps described above, demographic share variables D3 and D4 do not appear statistically significant. To measure the order of the implied polynomial, we run the Wald coefficient restrictions test for both D3 and D4. The probability of their redundancy is 0.13, which suggests their slope coefficients are statistically not dissimilar from naught at a 5 per cent significance level. Upon their removal from the regression, another iteration of the test run on D2 resulted in a probability of 0.018, which is enough to reject the null hypothesis at the same level of significance. This is in line with estimates obtained by Arnott and Chaves (2012) and the McKinsey Global Institute (2004). Disturbance variance is addressed by employing a White cross-section covariance matrix to obtain heteroscedasticity-consistent standard errors.

Table *Independent Variables and their Coefficients*

<i>Variable</i>	<i>Coefficient</i>	<i>Standard error</i>	<i>t-statistic</i>	<i>Probability</i>
C	-4.2036	1.4846	-2.8314	0.0049
D1	8.7571	3.6490	2.3998	0.0169
D2	-5.8888	2.0869	-2.8217	0.0050
INDEX(1)	-0.0119	0.0028	-4.1982	0.0000
GDP(1)	0.5117	0.0443	11.552	0.0000

Source: Calculated by the authors

The result is a model with a determination coefficient of 0.68 and a Durbin-Watson statistic of 2.009. All variables included in the regression appear statistically significant at a 5 per cent significance level. By running the Breusch-Godfrey serial correlation test, we tested for AR(q) processes of orders up to 5. The obtained Chi-squared statistic did not exceed the critical value at the aforementioned significance level.

Multicollinearity may be considered an issue characteristic to demographic data in the presence of micronumerosity. However, the practical implications of multicollinearity in the model in question are lessened by the nature of the data undergoing analysis as D1 and D2, the affected variables, are calculated from the same source. Furthermore, removing one of the variables would result in a specification error we avoid by leaving both in the regression to be studied jointly. With this data, it is possible to derive the implied regression coefficients of each five-year age cohort.

The implied regression coefficients of the original 18 age groups are reconstructed with the help of (3). They are regarded as such because the data pool was insufficiently large to generate the coefficients directly. The parabolic curve obtained (see Figure) should be read as follows: a 1 per cent increase in the share of the 30-34 age cohort in the population increases the annual growth rate of real GDP by 0.18 per cent. Likewise, an increase of 1 per cent in the share of the 80-84 age cohort in the population decreases the annual growth rate of real GDP by 0.36 per cent.

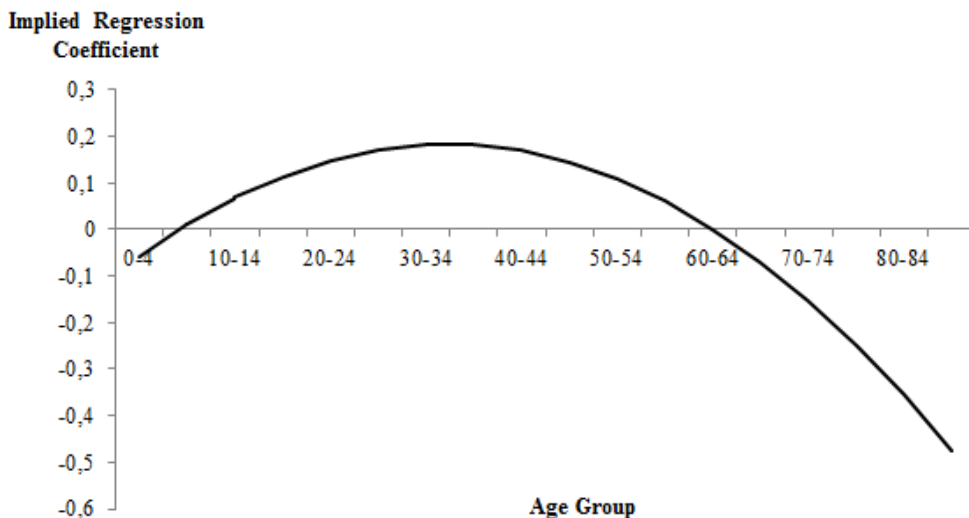


Figure. The Implied Regression Representation of Demographic Shares on Real GDP Growth.

Source: Calculated by the authors

What we see in Figure is in line with economic logic as both pre-adolescents and senior citizens in their retirement put pressure on growth while individuals of working age are the main contributors to real GDP growth, peaking at the age of 30-34, and dropping to zero at an age associated with retirement in parts of the EU. The insight obtained from Figure does not seem to contradict Life-cycle theory (LCT) assumptions.

The parabolic shape, the placement of the parabola's maximum, points of crossing the horizontal axis appear similar to the estimates obtained by the McKinsey Global Institute (2004) as well as Arnott and Chaves (2012). While these studies are comparable methodologically, they take a set of different countries, spanning in a different time period, which ultimately leads to similar conclusions.

However, this examination reaffirms conclusions of previous research, namely that the past is not a prologue to the future. This occurs in out-of-sample robustness tests, on a set of countries not present in the

regression, in which the model fares poorly, with determination coefficients below 10 per cent. The fact that countries such as Croatia, the newest member state, or Moldova, an aspiring EU member, do not have a liquid stock market and publish a narrower array of statistical data contributes to the challenge of using the model for forecasting. Hence, the model's theoretical contribution lies in providing a non-negative voice in the study of the relationship between demographic variables and the economy as a whole.

In practice, this paper gives policymakers a framework encompassing each five-year age group's net contribution to the economy. This encompasses the cohorts exhibiting a negative effect on real GDP growth, namely, those under the age of 10 and above the age of 64. Pinpointing the sources of dampened growth and quantifying their magnitude may have potential utility in the long term, be it a reform of parenthood and related social aid on the left side of the age spectrum or improvements of the pension system, which would tackle the right-hand side. Since an increase in the relative weight of groups on both ends of the age pyramid would have a negative effect on real GDP growth, given the circumstances do not change, EU member states should focus on the risks posed by an ageing society.

There are several non-exclusive ways of addressing the issue, based on Figure. Since it is unreasonable to assume a reduction in the relative weight of groups above the age of 64 in the current state of affairs without an increase in the weight of the previous groups, the straightforward solutions involves such an increase. Depending on the state of public finances, encouraging parenthood in an attempt to dilute the relative weight of those aged 65 and over and boost future growth may not be a functional alternative due to real GDP costs associated with the negative effect of the first two five-year age groups. It limits the possibility of using local resources to mitigate the negative effects. However, turning to non-EU countries, an outside source, as a means of stimulating real GDP growth via immigration may entail different costs despite being an attractive solution on the surface.

Another possible solution refers to limitations in forecasting long-term changes in demographic variables: the past not being a prologue to the future. Changes over time in the way different demographic shares affect the economy may preclude the need for making a conscious policy effort in altering the demographic makeup of a population. The solution entails influencing behavioural patterns to pushing the null points further apart on the horizontal axis, which may be a point in favour of encouraging prolonged activity in the economy and reach the spending phase in LCT at a later age.

While the challenges policymakers face in the event of continuous demographic transformations are distinguishable largely thanks to the macroeconomic nature of real GDP growth-oriented legislation, such changes pose a different question to the private sector equipped with a

limited set of tools. This quality outlines the importance of effective dialogue between the parties involved, but it does not bar the potential usefulness of private initiatives.

As the EU ages, an increased pool of time series data may help in further contributing to this analysis. Alternatively, limiting the sample of countries to states where data has been available since at least 1950 may provide greater accuracy for the use in the relevant region, leaving newer member states unassessed. Collating countries with established statistical authorities upon considering their key structural differences is another alternative in order to reach a long-term conclusion with plausibly greater predictive power necessitating further research.

Finally, the paper provides an EU-centric voice in an American-dominated discussion. It is a study encompassing a number of member states, taking into account the longest period possible for joint analysis of all five-year age groups. While it highlights similarities between the demographic challenges faced by the EU and the USA in comparable studies, it also presents an outlook from a different socioeconomic perspective in an environment that encourages governments to review their commitments to national pension systems. The importance of dialogue during a period of uncertainty is further maintained by providing a platform for subsequent research. Either utilising alternative macroeconomic indicators or slicing results into smaller regional clusters, there are numerous possibilities to further our understanding of the effects of demographic trends on the economy and financial markets.

### **Conclusion:**

The on-going debate about the relationship between demographic and economic variables produced a body of academic work during the last 20 years. American research dedicated to the study of the Baby Boomer phenomenon in the USA has made a significant contribution to the discussion. Despite increasing interest in the topic, there is no consensus regarding the properties or existence of a transmission mechanism with different studies reaching opposite conclusions.

Research spearheaded by both policymakers and private initiatives highlights the shared nature of concerns related to changes in a population's demographic makeup. From social services to securities markets, steps were taken to analyse the underlying processes from the point of view of a number of industries, governments and international institutions.

Long-term estimates about the effects of demographic trends on the economy in academic literature are frequently based on a plethora of behavioural assumptions, making them susceptible to being altered in the presence of shocks. It limits the utility of currently available models.

In this paper, an attempt to analyse the effect of demographic transformations in the EU on the annual percentage change of real GDP has been made, thus adding a voice to the relevant academic debate. The proposed force-fitted polynomial model with fixed country cross-section effects has noted a statistically significant non-linear relationship between EU member states' demographic shares and annual growth of real GDP at a 5 per cent significance level. The fixed cross-section effects outlined inter-EU differences not caught by quantitative variables.

The model's findings did not reject LCT stipulations outright, with age groups pertaining to the period prior and after participation in the labour force putting pressure on the analysed economic variables. Conversely, the period associated with participation in the labour force exhibited a contrary effect.

Robustness of the calculated effect of each demographic share depended on the use of a sufficiently long period of time with formal variable restrictions in order to display the relationship between the slow evolution of a population's demographic composition and the underlying regressand. Robustness tests outlined the issue of predictability with the use of demographic shares: the models exhibited low precision, confirming their intended utility as an instrument for studying dependencies rather than forecasting. This property was also noted in comparable third party research.

While the lack of reliable long-term data makes progress in studying the effects of demographic trends in certain new member states of the EU slow, the conclusions reached by the authors as well as those in cited comparable research regarding the functional form of dependencies point to the possibility of period of underwhelming GDP growth. This, in turn, casts a doubt on the long-term sustainability of the social security system that is currently in place.

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