




# Does population ageing impact inflation?

Marija Radulović<sup>1</sup> | Milan Kostić<sup>1</sup> 

<sup>1</sup> University of Kragujevac, Faculty of Economics, Republic of Serbia

<sup>1</sup> University of Kragujevac, Faculty of Economics, Republic of Serbia

**Correspondence:**

Milan Kostić, Associate Professor at University of Kragujevac, Faculty of Economics, Republic of Serbia.

**Email:**

[mkostic@kg.ac.rs](mailto:mkostic@kg.ac.rs)

**Abstract**

Modern society is characterised by clear and distinct demographic processes, such as the constant decline in the number of children born and the ageing population in developed countries, resulting from complex biological, economic, social, political, and other factors. Demographic changes observed through population ageing have an impact on the economy and inflation. Therefore, the aim of this paper is to examine the impact of population ageing on inflation in Economic and Monetary Union (EMU) countries. The paper's authors used data from 1970 to 2016. The ARDL approach was used to test the long- and short-term relationship between population ageing and inflation. The results showed a positive relationship between population ageing and inflation in the long term and a negative relationship in the short term. The ageing population decreases inflation in the short term and increases inflation in the long term.

**KEYWORDS:**

population ageing, inflation, EMU countries, demographic changes, developed countries

## 1 INTRODUCTION

Modern society is characterised by clear and distinct demographic processes, such as the constant decline in the number of children born and the ageing population, resulting from complex biological, economic, social, political, and other factors. Demographic changes, observed through population ageing due to prolonged average life expectancy and declining fertility rates, are conditioned by economic, political, social, and other factors affecting the economy. The economic effects of population ageing in Europe are also reflected in the rapid increase in appropriations for social programs. In particular, pension insurance has become the cause of financial instability and the onset of the debt crisis (Šuković 2013). The population's age structure directly affects economic positioning and development opportunities because the population is the carrier of economic development, thanks to the productive role people play within the economy. Some changes are demographically reflected in extending the population's life expectancy, emphasising developed countries where the ageing population trend is visible, and the number of dependent populations is increasing (Pašalić 2017). Besides impacting the country's development, population ageing could affect other macroeconomic indicators, such as inflation. For countries, it is very important to maintain a low inflation rate as an indicator of macroeconomic stability. Therefore, the aim of this paper is to examine the impact of population ageing on inflation in Economic and Monetary Union (EMU) countries. These countries are developed countries and members of the European Union. The sample of countries is used because of the availability of data during the defined period, which is long enough to come to an objectively

scientific conclusion. Another reason is that these European countries have similar political, social, and cultural backgrounds as Serbia.

Based on the research results, the study aims to point out the relationship between demographic processes and inflation and give appropriate recommendations to all policymakers and interested stakeholders. According to the aim and hypothesis of the research, the paper is structured as follows: aside from the introduction and concluding remarks, there are three sections. Section 2 provides a theoretical background and literature review of the impact of population ageing on inflation. Section 3 provides an overview of the data and methodology used in the paper. Finally, the results of the empirical research are presented and discussed in section 4.

## 2 THEORETICAL BACKGROUND

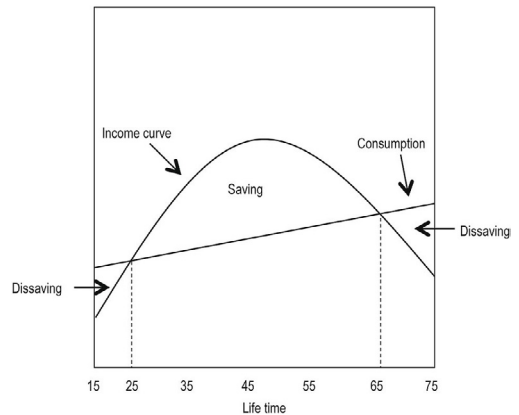
Demographic changes represent some of the most significant long-term challenges facing all countries both now and in the future. These changes will have severe consequences not just for the economy overall, but specifically on inflation, the study of which has received less attention, especially empirically. The most important indicators of the changing demographic structure of the population are life expectancy, fertility rate, and the percentage of the population aged 65. The data showed an increase in life expectancy, lower fertility rates, and an increase in the percentage of the population aged 65 and over compared to previous periods. As an indicator of population ageing, increases in the percentage of the population aged 65 and over can lead to higher or lower inflation. The impact of demographic change on

inflation depends on many factors studied from a theoretical and empirical perspective. Still, no consensus has been reached on the effects of demographic change on inflation.

McMillan and Baesel (1990) studied the effects of demographic changes on inflation in the United States and found a positive relationship between variables. Katagiri et al. (2014) also studied how population ageing affected inflation and found a positive impact. They explained that population ageing, arising from a decline in the birth rate, shrinks the tax base and increases government expenditure, thus having a positive influence on inflation (Broniatowska 2017). These results align with the life-cycle hypothesis introduced by Modigliani and Brumberg (1954, as cited in Zwijnenburg and Goebel 2017) (Figure 1). The life-cycle hypothesis explains that individuals do not plan their consumption and savings based on their current income; they adapt consumption over their lifetime based on their lifetime earnings and their initial worth. Although their income fluctuates over a lifetime, consumption remains relatively stable, as a consequence of which their savings fluctuate over time (Zwijnenburg and Goebel 2017). If there is an increase in productivity during the years, incomes rise, and consumption by future generations will be higher than that of previous generations.

In line with the life-cycle hypothesis and aforementioned studies, one could conclude that population ageing could lead to higher prices and inflation.

On the other hand, Yoon et al. (2014) argue that population ageing has a negative impact on inflation after studying 30 OECD countries from 1960 to 2013. Gajewski (2015) also found negative effects of population ageing on inflation in 34 OECD countries from 1970 to 2013.



Source: Zwijnenburg, J., & Goebel, P. (2017)

Figure 1. The life-cycle hypothesis in theory

Faik (2012) and Anderson et al. (2014) also observed negative impacts of population ageing on inflation. Juselius and Takats (2015) studied 22 OECD countries from 1955 to 2010 and found that an increased share of older people, especially older pensioners (75+), had a negative impact on inflation. Shirakawa (2013) also concluded that population ageing negatively impacts inflation, as did Bullard et al. (2012). Broniatowska (2017) studied the impact of population ageing on inflation in 32 OECD countries from 1971 to 2015. Backing up these findings is a study from Mirowsky and Ross (1999), in which the authors argued that older individuals tend to adopt a more moderate lifestyle than younger individuals. Their results seem to be supported by a more recent study carried out by Olafsson and Pagel (2018) suggesting that all those factors could have a negative impact on inflation. The aforementioned results suggest that population ageing has a significant negative effect on inflation, contradicting the life-cycle hypothesis.

The fertility rate is also an important indicator of population ageing. Fedotenkov (2016) investigated the impact of the

fertility rate on inflation using the overlapping generations (OLG) model. The results showed that lower fertility rates lead to more modest interest rates on loans and lower money creation, causing a decrease in prices (Fedotenkov 2016).

Since the literature fertility rate, old dependency ratio, and youth dependency ratio are identified as the most critical indicators of demographic changes, these variables will be used in further research. Still, the most attention will be provided to the old dependency ratio, since previous findings show that population ageing is most closely related to lower inflation. According to the literature review and life-cycle hypothesis, the following hypothesis was tested: Population ageing positively impacts inflation in the short and long term. This means that increases in the average age of the population increase the inflation rate in the short and long term.

### 3 DATA AND METHODS

#### 3.1 DATA

##### *CPI – Consumer price index*

Inflation represents an increase in the general price level. It is quantified by the consumer price index (CPI), which indicates the annual percentage change in the cost of acquiring a basket of goods and services for the average consumer that may be fixed or updated at set intervals (Diallo 2016; World Bank 2020). Therefore, the CPI is used as a proxy for inflation and the dependent variable in the paper. The data were retrieved from the World Bank database.

##### *FR – Fertility rate*

The fertility rate refers to the number of children a woman would have if she lived

to the end of her reproductive years and bore children under age-specific fertility rates during the specified year (World Bank 2020). The fertility rate should be 2.1 for the simple replacement of generations.

##### *YDR – Youth dependency ratio*

The youth dependency ratio is a ratio of the size of the young, economically dependent population (0-14 years old) and the size of the working-age population (15-64 years old). It is calculated according to methods defined by Broniatowska (2017). The size of the young population is the total population between the ages 0 to 14 and is calculated using the de facto definition of population, which counts all residents regardless of legal status or citizenship (World Bank 2020). The size of the working-age population is the total population between the ages 15 to 64 based on the de facto definition of population, which counts all residents regardless of legal status or citizenship (World Bank 2020). The youth dependency ratio is calculated using the following formula:

$$YDR_{it} = \frac{N_{it}^{young}}{N_{it}^{working}} \quad (1)$$

$i=1, \dots, 14; t=1970, \dots, 2016$

##### *ODR – Old dependency ratio*

The old dependency ratio is a ratio of the size of the elderly population (65+ years old) and the size of the working-age population (15-64 years old). It is calculated according to methods defined by Broniatowska (2017). The size of the elderly population is the total population 65 years of age or older based on the de facto definition of population, which includes all residents re-

regardless of legal status or citizenship (World Bank 2020). The old dependency ratio is calculated using the following formula:

$$ODR_{it} = \frac{N_{it}^{old}}{N_{it}^{working}}$$

$i=1, \dots, 14; t=1970, \dots, 2016$  (2)

**GDPG – Gross domestic product growth rate (GDP growth rate)**

Gross domestic product (GDP) is the sum of gross value generated by all resident producers in the economy, plus any product taxes, minus any subsidies not included in the product value (World Bank 2020). The GDP growth rate represents the annual percentage growth rate of a country’s GDP. GDP values are expressed in constant 2010 US dollars. This variable is used as the control variable.

**EMU – EMU membership**

EMU is the dummy variable that is given a value of 1 if the country was a member of the European Monetary Union during the period  $t$ , and is given 0 otherwise. The detailed list of observed countries and the year when they became members of EMU is given in appendix Table 1. This variable is the second control variable.

Data and sources of data are presented in Table 1.

**3.2 METHODS**

Based on previous empirical studies, especially those done by Broniatowska (2017) and Fedotenkov (2016), a model was developed to estimate the impact of demographic changes on inflation in EMU countries. The following equations set the model:

$$CPI_{it} = f(FR_{it}, YDR_{it}, ODR_{it}, GDPG_{it})$$
 (3)

$$CPI_{it} = f(FR_{it}, YDR_{it}, ODR_{it}, GDPG_{it}, EMU_{it})$$
 (4)

where  $CPI_{it}$  is the consumer price index in EMU country  $i$  during the time period  $t$  (a proxy for inflation),  $FR_{it}$  is the fertility rate in EMU country  $i$  during the time period  $t$ ,  $YDR_{it}$  is the youth dependency ratio in EMU country  $i$  during the time period  $t$ ,  $ODR_{it}$  is the old dependency ratio in EMU country  $i$  during the time period  $t$ ,  $GDPG_{it}$  is the GDP growth rate in EMU country  $i$  during the time period  $t$ , and  $EMU_{it}$  is EMU membership (1 if the country is a member of European Monetary Union during the period  $t$ , 0 otherwise). Annual data from 1970 to 2016 for 14 EMU countries (Austria, Belgium, Cyprus, Germany, Spain, Finland, France, Greece, Ireland, Italy, Luxembourg, Malta, the Netherlands, and Portugal) were used. This data range represents the period of research. The cross-section dependence test and unit root tests were applied to determine whether there is a correlation and whether the data are integrated of the same order. In addition, the autore-

**Table 1.** Sources of data

Variable	Measure	Source
FR	Fertility rate	World Bank
YDR	Youth dependency ratio	World Bank
ODR	Old dependency ratio	World Bank
EMU	EMU membership	European Commission
GDPG	GDP growth rate (%)	World Bank

gressive distributed lag (ARDL) approach was used to examine the long-term and short-term relationship between population ageing and inflation. According to

Ghatak and Siddiki (2001), it produces statistically significant results on relatively small samples. Therefore, the following equations will be estimated:

Model 1:

$$DCPI_{it} = \gamma_2 ECT_{i,t-j} + \sum_{j=1}^k \beta_{j4} DCPI_{i,t-j} + \sum_{j=0}^k \delta_{j4} DFR_{i,t-j} + \sum_{j=0}^k \theta_{j4} DYDR_{i,t-j} + \sum_{j=0}^k \rho_{j4} DODR_{i,t-j} + \sum_{j=0}^k \nu_{j4} DGDPG_{i,t-j} + \alpha + trend + \varepsilon_{it} \quad (5)$$

where  $\beta_{j4}$ ,  $\delta_{j4}$ ,  $\theta_{j4}$ ,  $\rho_{j4}$ ,  $\nu_{j4}$  are coefficients,  $\varepsilon_{it}$  is the white noise term, and  $\gamma_2$  is the coefficient of the ECT (error-correction term) and explains the long-term relationship between the variables presented in equation (5).

$$ECT_{i,t-j} = CPI_{it} - \alpha - \sum_{j=1}^k \beta_{j3} CPI_{i,t-j} - \sum_{j=0}^k \delta_{j3} DFR_{i,t-j} - \sum_{j=0}^k \theta_{j3} DYDR_{i,t-j} - \sum_{j=0}^k \rho_{j3} DODR_{i,t-j} - \sum_{j=0}^k \nu_{j3} DGDPG_{i,t-j} \quad (6)$$

where  $\beta_{j3}$ ,  $\delta_{j3}$ ,  $\theta_{j3}$ ,  $\rho_{j3}$ ,  $\nu_{j3}$  are coefficients.

Model 2:

$$DCPI_{it} = \gamma_4 ECT_{i,t-j} + \sum_{j=1}^k \beta_{j8} DCPI_{i,t-j} + \sum_{j=0}^k \delta_{j8} DFR_{i,t-j} + \sum_{j=0}^k \theta_{j8} DYDR_{i,t-j} + \sum_{j=0}^k \rho_{j8} DODR_{i,t-j} + \sum_{j=0}^k \nu_{j8} DGDPG_{i,t-j} + \sum_{j=0}^k \lambda_{j6} EMU_{i,t-j} + \alpha + trend + \varepsilon_{it} \quad (7)$$

where  $\beta_{j8}$ ,  $\delta_{j8}$ ,  $\theta_{j8}$ ,  $\rho_{j8}$ ,  $\nu_{j8}$ ,  $\lambda_{j6}$  are coefficients,  $\varepsilon_{it}$  is the white noise term, and  $\gamma_4$  is the coefficient of the ECT (error-correction term) and explains the long-term relationship between the variables presented in equation (7).

$$ECT_{i,t-j} = CPI_{it} - \alpha - \sum_{j=1}^k \beta_{j7} CPI_{i,t-j} - \sum_{j=0}^k \delta_{j7} DFR_{i,t-j} - \sum_{j=0}^k \theta_{j7} DYDR_{i,t-j} - \sum_{j=0}^k \rho_{j7} DODR_{i,t-j} - \sum_{j=0}^k \nu_{j7} DGDPG_{i,t-j} - \sum_{j=0}^k \lambda_{j7} DEMU_{i,t-j} \quad (8)$$

where  $\beta_{j7}$ ,  $\delta_{j7}$ ,  $\theta_{j7}$ ,  $\rho_{j7}$ ,  $\nu_{j7}$ ,  $\lambda_{j7}$  are coefficients.

## 4 RESULTS

### 4.1 DESCRIPTIVE STATISTICS

Table 2 shows descriptive statistics for all variables used in the study. The average inflation in EMU countries from 1970 to

2016 was 5.15. Inflation decreased in all countries over the observed period. The minimum inflation was -4.48 (Ireland, 2009), and the maximum was 31.02 (Portugal, 1977). The Global Financial Crisis may have caused the minimum inflation in Ireland in 2009; deflation of a similar

**Table 2.** Descriptive statistics

Variable	Mean	Standard deviation	Minimum	Maximum	N
Inflation (CPI)	5.15	5.37	-4.48	31.02	658
Fertility rate	1.75	0.44	1.13	3.93	658
Youth dependency ratio	0.30	0.08	0.20	0.53	658
Old dependency ratio	0.21	0.04	0.14	0.35	658
GDP growth	2.96	0.86	-9.13	25.16	649

Source: Author's calculations in EViews 10

magnitude had not been experienced in Ireland since the 1930s, in the period immediately following the Great Depression. Relative to other European countries, including those on programs of international financial assistance, the deflation experienced in Ireland was greater in magnitude and longer in duration (Bermingham et al. 2012).

The average fertility rate in EMU countries from 1970 to 2016 was 1.75. In developed countries, a total fertility rate of around 2.10 live births per woman is the replacement level. In the absence of migration, that average number of live births per woman is required to keep population size constant. A total fertility rate of fewer than 1.3 live births per woman is referred to as "lowest-low fertility" (Kohler, Billari and Ortega 2002; Eurostat 2020). Only in Ireland in the observed period was the average fertility rate higher than 2.10 (2.42). There were no EMU countries with an average fertility rate below 1.30 in the observed period. Table 2 in the appendix shows the average fertility rate by EMU country from 1970 to 2016. The minimum fertility rate was 1.13 (Spain, 1998), and the maximum was 3.93 (Ireland, 1971).

The average youth dependency ratio in EMU countries from 1970 to 2016 was 0.30. The minimum youth dependency ratio was 0.20 (Germany, 2016) and the maximum was 0.53 (Ireland, 1976). Since the youth dependency ratio is a ratio

showing the size of the young, economically dependent (0-14 years old) population and the size of the working-age population (15-64 years old), a lower ratio means that the country has a smaller economically dependent population compared to the working-age population. The highest average youth dependency ratio in EMU countries from 1970 to 2016 was in Ireland (0.41). Table 3 in the appendix shows the youth dependency ratio by EMU countries from 1970 to 2016.

The average old dependency ratio in EMU countries from 1970 to 2016 was 0.21. Since the old dependency ratio is a ratio showing the size of the old population (65+ years old) compared to the size of the working-age population (15-64 years old), a lower ratio is considered better, as it suggests that the country has relatively few pensioners compared to the working-age population. The minimum old dependency ratio was 0.14 (Cyprus, 1980) and the maximum was 0.35 (Italy, 2016). It is estimated that in the mid-21st-century, the ratio between the old population and the working-age population will worsen in developed countries to about 44% in 2050. These changes are expected to be much more moderate in developing countries; the ratio of the old population to the working-age population will increase to about 21% in 2050 (Vogel et al. 2012; Šuković 2013).

The average GDP growth rate in EMU countries from 1970 to 2016 was 2.96. The minimum GDP growth rate was -9.13 (Greece, 2011) and the maximum was 25.16 (Ireland, 2015). Ireland is one of the world’s most globalised economies, so its total GDP and GDP per capita gains due to globalisation are high (Weiß et al. 2019; Radulović and Kostić 2020).

**4.2 CROSS-SECTION DEPENDENCE TEST**

A cross-section dependence Pesaran CD test was used to examine the null hypothesis that there is no cross-section dependence (correlation) in the time series (Pesaran 2004). It is critical to test for cross-sectional dependence in a panel analysis because ignorance of cross-section dependency leads to significant estimation bias. The results of the Pesaran CD test showed that changes in inflation, fertility rate, youth dependency ratio, old dependency ratio, and GDP growth rate that occurred in any of the observed EMU countries affected other countries as well (ie. there is a cross-section dependence in the time series) (Table 3).

**Table 3.** Cross-section dependence test

Variable	t-statistic
Inflation (CPI)	50.01***
Fertility rate (FR)	29.04***
Youth dependency ratio (YDR)	56.74***
Old dependency ratio (ODR)	42.07***
GDP growth (GDPG)	33.33***

\*\*\* indicate rejection of the null hypothesis at a 1% level of significance

Source: Author’s calculations in EViews 10

Because all time series have cross-section dependence, the second generation of the unit root test (CIPS cross-section Im, Pesaran, and Shin) was used to determine the order of integration of variables and obtain unbiased estimates (Pesaran 2007).

**4.3 UNIT ROOT TEST**

Table 4 displays the results of the Im, Pesaran, and Shin unit root tests (CIPS). The panel unit root test revealed that the series are not integrated of the same order. Some series, for example, are stationary at level I(0), whereas others are stationary at level I(1).

**Table 4.** Im, Pesaran, and Shin unit root test results (CIPS)

Variable	Im, Pesaran, and Shin	
	Individual intercept	Individual intercept and trend
CPI	-1.83	-6.70
D(CPI)	-15.63***	-13.93***
FR	-7.30***	-6.17***
YDR	-8.20***	-9.95***
ODR	5.64	-3.34***
D(ODR)	-1.44***	-1.80**
GDPG	-9.61	-9.88***

\*\*\* indicate rejection of the null hypothesis at a 1% level of significance

\*\* indicate rejection of the null hypothesis at a 5% level of significance

Source: Author’s calculations in Stata 15

FR, YDR, and GDPG are stationary at the level I(0), while CPI and ODR are stationary at the first difference I(1). The results of the panel unit root test are shown in Table 4. Since series have a different order of integration and there is no time series I(2), the panel ARDL test was used to test the relationship between inflation (CPI) and population ageing (FR, YDR, ODR).

Unit root tests could be influenced by the presence of a structural break in time series. Therefore, the Karavias and Tzavalis (2014) panel unit root test was used to test whether there are structural breaks in time series and whether the series has unit roots. The results showed that FR, YDR, and GDPG are stationary at the level I(0), while CPI and ODR are stationary at the first difference I(1). Since



there are structural breaks in time series and EMU membership can represent a breakpoint in the time series of inflation – because the European Central Bank has taken control of the monetary policies of EMU countries – EMU membership was used as an independent dummy variable.

#### 4.4 PANEL ARDL TEST RESULTS

The results of the panel ARDL test for the relationship between population ageing and inflation for two models represented by equations 5–8 are shown in Table 5 and Table 6. In addition, Table 5 shows the panel ARDL long-term results.

Model 1, besides the independent variables fertility rate, youth dependency ratio, and old dependency ratio, includes the control variable GDP growth rate. The panel ARDL test results showed that there is a positive long-term relationship between inflation and the fertility rate at the 1% significance level and between inflation and the old dependency ratio at the 10% significance level when

controlling for GDP growth rate. Also, the panel ARDL test results showed the negative long-term relationship between inflation and the youth dependency ratio at a 10% significance level. GDP growth rate has a positive and significant effect on inflation at a 1% significance level (Model 1). Model 2, besides the independent variables fertility rate, youth dependency ratio, and old dependency ratio, includes the control variables GDP growth rate and EMU membership. The panel ARDL results showed that there is a positive long-term relationship between inflation and the old dependency ratio at a 10% significance level when controlling for GDP growth rate and EMU membership. The EMU membership has a positive effect on inflation at a 5% significance level. When controlling for EMU membership, fertility rate and youth dependency ratio become non-significant (Model 2).

Since there is a positive relationship between inflation and the old dependency ratio in both models, it may be concluded that population ageing positively

**Table 5.** Panel ARDL long-term results

Independent variable	Dependent variable: CPI	
	Model 1	Model 2
FR	7.45*** (1.96), [3.81]	2.29 (2.08), [1.10]
YDR	-24.15* (14.46), [-1.67]	17.74 (14.37), [1.23]
ODR	26.82* (15.38), [1.74]	31.28* (17.37), [1.80]
GDPG	0.41*** (0.09), [4.77]	0.51*** (0.11), [4.58]
EMU		1.61** (0.82), [1.96]

Standard errors in () and t-statistics in []

\*\*\* statistically significant at a 1% level of significance

\*\* statistically significant at a 5% level of significance

\* statistically significant at a 10% level of significance

Source: Author’s calculations in EViews 10

impacts inflation. This means that population ageing increases inflation in the long run. The long-term results are opposed to the results obtained by Broniatowska (2017), who found that the old dependency ratio negatively affects inflation. The results are also opposed to the results obtained by Gajewski (2015), Faik (2012), Anderson et al. (2014), Juselius and Takats (2015), and Yoon et al. (2014), who found that population ageing has a negative impact on inflation. However, the results of this study are in line with the results obtained by Katagiri et al.

(2014), who found that population ageing has a positive effect on inflation. Furthermore, it may be concluded that EMU membership positively impacts inflation in the long run.

The error correction term (ECT) for both models is negative and statistically significant. This shows how much of the disequilibrium caused by a shock in the short term will be corrected in the long term. The error correction term (ECT) for Model 1 is -0.45 and statistically significant at a 1% level. This shows that in response to a shock, the speed of adjustment towards

**Table 6.** Panel ARDL short-term results

Independent variable	Dependent variable: CPI	
	Model 1	Model 2
ECT	-0.45*** (0.05), [-9.84]	-0.36*** (0.02), [-17.43]
D(FR)	0.17 (3.08), [0.06]	2.01 (2.47), [0.82]
D(FR(-1))	-0.99 (5.45), [-0.18]	-
D(YDR)	-72.69 (108.51), [-0.67]	-40.56 (40.13), [-1.01]
D(YDR(-1))	-3.65 (104.13), [-0.04]	-
D(ODR)	19.58 (117.39), [0.17]	-132.91** (57.85), [-2.29]
D(ODR(-1))	-85.28 (126.44), [-0.67]	-
D(GDPG)	-0.20*** (0.04), [-4.80]	-0.17*** (0.04), [-4.54]
D(GDPG(-1))	0.02 (0.04), [0.66]	-
EMU	-	-0.51 (0.36), [-1.40]
C	-1.34 (0.93), [-1.43]	-3.04*** (0.67), [-4.49]
Trend	-0.16*** (0.02), [-4.37]	-0.07*** (0.02), [-4.08]

Standard errors in () and t-statistics in []

\*\*\* statistically significant at a 1% level of significance

\*\* statistically significant at a 5% level of significance

\* statistically significant at a 10% level of significance

Source: Author's calculations in EViews 10

equilibrium is 45% annually. The error correction term (ECT) for Model 2 is -0.36 and statistically significant at a 1% level. This shows that in response to a shock, the speed of adjustment towards equilibrium is 36% annually. Therefore, convergence to the long-term equilibrium will be lower when controlling for GDP growth rate and EMU membership (Model 2) than when controlling only for GDP growth rate (Model 1) (Table 6).

If short-term coefficients are observed, it may be concluded that there is a negative and statistically significant relationship between inflation and the old dependency ratio at a 5% significance level (except for Model 1, where the old dependency ratio is not statistically significant). The results for the short-term relationship oppose the results obtained for the long-term relationship. The results are in line with the results obtained by Broniatowska (2017), Gajewski (2015), Faik (2012), Anderson et al. (2014), Juselius and Takats (2015), and Yoon et al. (2014), who found that population ageing has a negative impact on inflation. Furthermore, the GDP growth rate has a statistically significant and negative impact on inflation (Model 1 and Model 2). The results are opposed to the long-term relationship results. There are no statistically significant relationships between other variables (fertility rate and youth dependency ratio) and inflation in the short term, and EMU membership and inflation.

If error-correction terms for individual countries are observed, it may be concluded that for both models, ECT is negative and statistically significant. This shows how much of the disequilibrium caused by a shock in the short term will be corrected in the long term. For Model 1, convergence to the long-term equilibrium will be slowest in Portugal (23%)

**Table 7.** Short-term coefficients for individual countries

Country	Model (1)	Model (2)
	ECT	ECT
Austria	-0.49***	-0.43***
Belgium	-0.52***	-0.42***
Cyprus	-0.59***	-0.32***
Germany	-0.39***	-0.31***
Spain	-0.27***	-0.22***
Finland	-0.73***	-0.51***
France	-0.31***	-0.37***
Greece	-0.39***	-0.31***
Ireland	-0.52***	-0.39***
Italy	-0.40***	-0.41***
Luxembourg	-0.35***	-0.28***
Malta	-0.83***	-0.46***
Netherlands	-0.32***	-0.34***
Portugal	-0.23***	-0.34***

\*\*\* statistically significant at a 1% level of significance

\*\* statistically significant at a 5% level of significance

\* statistically significant at a 10% level of significance

Source: Author’s calculations in EViews 10

and fastest in Malta (83%). For Model 2, convergence to the long-term equilibrium will be slowest in Spain (22%) and fastest in Finland (51%).

## 5 CONCLUSION

The relationship between population ageing and inflation in EMU countries was examined using the ARDL approach. The results showed that there is a negative relationship between the old dependency ratio and inflation in the short term. The results also showed that there is a positive relationship between the old dependency ratio and inflation in the long term. Therefore, the hypothesis that population ageing positively impacts

inflation in the short and long term is partially confirmed. What does this mean?

In the short term, the ageing population reduces spending because older people, mainly pensioners, have lower incomes than the working-age population, higher savings, and some expectations about unpredictable spending in the future. They try to save more for an unexpected longer life and the entirety of their retirement. This is a precautionary saving. In the short term, older individuals tend to adopt a more moderate lifestyle than younger individuals. This is why there is a short-term negative relationship between the ageing population and inflation.

In the long run, as one can see, the spending of the older generation is more stable, with a tendency to rise compared to previous generations (Life-cycle hypothesis, Figure 1). Because of that, the ageing population has a positive impact on inflation in the long term.

The research results show that economic policymakers should pay attention to the effects of population ageing on inflation and adopt appropriate measures and policies to mitigate the impact of population ageing on inflation and the

country's economic development. These measures and policies should be designed to increase the volume of working-age and young populations through employment incentives, family planning policies, etc. A lower old dependency ratio could reduce the inflation rate in the long term. On the other hand, the working-age population (if they work) is a generator not only of demand and consumption; this population is a generator of supply, also. A higher supply of goods and services could stabilise inflation in the short and long term.

The problem of the ageing population is bigger in developed countries than in developing and least-developed countries. Because of that, policies that improve the volume of younger people are more important in these countries than in others.

Future research into the problem area should focus on developing and least developed countries. Furthermore, future research should include a broader sample of countries over a more extended period of time. The author also recommends including more variables in the study to capture the effects of real interest rates, money supply, etc.

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## APPENDIX

**Table 1.** EMU membership

EMU country	Membership year
Austria	1999
Belgium	1999
Cyprus	2008
Germany	1999
Spain	1999
Finland	1999
France	1999
Greece	2001
Ireland	1999
Italy	1999
Luxembourg	1999
Malta	2008
Netherlands	1999
Portugal	1999

Source: European Commission (2020)

**Table 3.** The average Youth dependency ratio by EMU country, 1970-2016

Country	Mean Fertility Rate
Austria	0.28
Belgium	0.29
Cyprus	0.36
Finland	0.29
France	0.32
Germany	0.25
Greece	0.29
Ireland	0.41
Italy	0.27
Luxembourg	0.27
Malta	0.32
Netherlands	0.30
Portugal	0.31
Spain	0.30

Source: Author's calculation in EViews 10

**Table 2.** The average Fertility rate by EMU country, 1970-2016

Country	Mean Fertility Rate
Austria	1.55
Belgium	1.71
Cyprus	2.02
Finland	1.73
France	1.94
Germany	1.42
Greece	1.64
Ireland	2.42
Italy	1.52
Luxembourg	1.59
Malta	1.77
Netherlands	1.67
Portugal	1.79
Spain	1.69

Source: Author's calculation in EViews 10

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# Da li starenje stanovništva utiče na inflaciju?

## Sažetak

Savremeno društvo karakterišu različiti demografski procesi, poput stalnog smanjenja broja rođene dece i starenja stanovništva u razvijenim zemljama, što je posledica složenih bioloških, socioloških, ekonomskih i drugih faktora. Demografske promene u svetu predstavljaju jedan od najznačajnijih dugoročnih izazova sa kojima će se suočiti sve zemlje na globalnom nivou, a koje će imati ozbiljne posledice na ekonomiju i inflaciju, čijem proučavanju je posvećeno malo pažnje, i u teorijskom i u empirijskom smislu. Najvažniji pokazatelji promene demografske strukture stanovništva su očekivani životni vek i učešće stanovništva starijeg od 65 godina, pre svega zato što je došlo do povećanja očekivanog životnog veka i povećanja stope učešća stanovništva starog 65 i više godina u ukupnoj populaciji u odnosu na prethodne periode. Shodno značaju koji starenje ima za sociološka i politička kretanja, ali i za ekonomska kretanja, cilj rada je ispitivnje uticaja starenja stanovništva na inflaciju, na primeru zemalja Evropske monetarne unije (EMU). U radu su korišćeni podaci od 1970. do 2016. godine. Model zasnovan na autoregresivnom rasporedu docnji, odnosno ARDL (AutoRegressive Distributed Lag) model je korišćen za ispitivanje kratkoročne i dugoročne veze između starenja stanovništva i inflacije. Rezultati istraživanja su pokazali negativnu vezu između starenja stanovništva i inflacije u kratkom roku i pozitivnu vezu u dugom roku. Kratkoročno gledano, starenje stanovništva smanjuje potrošnju jer stariji ljudi, uglavnom u penziji, imaju niža primanja od radno sposobnog stanovništva. Oni prilagođavaju svoju potrošnju trenutnom statusu, a takođe ostvaruju i izvesnu štednju radi predostrožnosti zbog neočekivnih događaja u budućnosti (*precautionary saving*). To je razlog zašto postoji kratkoročni negativni odnos između starenja stanovništva i inflacije, odnosno starenje stanovništva smanjuje inflaciju u kratkom roku. Dugoročno gledano, potrošnja stanovništva je stabilna (hipoteza životnog ciklusa, koja se odnosi na potrošnju/*life-cycle hypothesis*) sa tendencijom povećanja zbog međugeneracijskog porasta produktivnosti, što upućuje na blagi rast potrošnje koji utiče na porast cena i inflaciju. Na osnovu ovoga može se zaključiti da starenje, koje se manifestuje, pre svega kroz povećanje učešća populacije iznad 65. godine u ukupnoj populaciji, dugoročno povećava cene i samim tim dovodi do inflacije. Rezultati istraživanja pokazuju da kreatori ekonomske politike treba da obrate pažnju na efekte starenja stanovništva na inflaciju i usvoje odgovarajuće mere i politike koje će ublažiti uticaj starenja stanovništva na inflaciju i ekonomski razvoj. Ove mere i politike moraju da povećaju obim radno sposobnog i mladog stanovništva i podstaknu zapošljavanje. Manje učešće starog stanovništva u populaciji može da utiče na smanjenje inflacije u dugom roku. Takođe, porast radno-sposobnog stanovništva, koje je uz to i stvarno zaposleno, generator je povećanja ponude, što može dugoročno da smanji inflaciju u jednoj ekonomiji.

## Ključne reči:

starenje stanovništva, inflacija, EMU zemlje, demografske promene, razvijene zemlje