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MACROECONOMIC IMPLICATIONS OF POPULATION. EVIDENCE FROM EU COUNTRIES: DEVELOPING COUNTRIES VERSUS EX-COMMUNIST COUNTRIES

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Abstract
The relationship between population growth/decline and the evolution of macroeconomic indicators has emerged differently in different countries. It has become an issue debated by many countries, especially where there has been a decline in population. This article is based on data from 23 EU member states, for the period 1992-2021. For the analysis of the panel data, the study divides the 23 EU member states into two large groups: developed European countries and ex-communist countries. Linear regressions were constructed between population numbers as the independent variable and gross domestic product (GDP), total investment, inflation and unemployment rate as dependent variables. The result of the study states that population size does not have a strong influence on the total investment and unemployment rate indicators in either of the two categories of countries considered. Instead, the volume of the population is a representative component, with a significant impact on the size of GDP in the developed European countries of the European Union; there was also a significant impact on the size of inflation in the same group of countries. For ex-communist countries, things are a little bit different. This finding sustains that population is a fundamental element of macroeconomic indicators.

Keywords: *GDP; Population Growth; total investments; inflation; unemployment rate; data panel*.

JEL Classification: *E60, E20*

INTRODUCTION

The states of the world are going through a major demographic transition. Our generation is undergoing an unprecedented demographic shift, with Europe at its core. We are currently experiencing a slowdown in population growth and in many countries the age structure of the population is changing. These are two important processes that have appeared at European level. Thus, the term new demographic regime has entered the discussion on the demographic situation in many countries (see for example Macura et al., 2005; Kotowska & Jóźwiak, 2012).

For each nation the basic source in production is its population (being one of the production factors), and its transformation into human capital is a major challenge. In every nation, the population plays a crucial role in driving GDP growth. When a country has a relatively large pool of human capital, its GDP tends to rise, as the employed segment of the population directly contributes to economic output. To realize its full potential, a nation must ensure that a significant portion of its people are transformed into productive human resources who actively support GDP growth. Generally, countries strive to develop their populations into human capital, guided by tailored macroeconomic strategies for workforce development (Hosen, 2019).

The labour market problem is extremely complicated and has a significant impact on GDP through the demand-supply ratio. For example, population growth has multidimensional effects on various related issues, such as the age structure of a country's population, the size of a country's workforce, unemployment, etc. These factors

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affect and are, in turn, affected by overall economic growth. In our days, society is also facing a change in relational and reproductive patterns. This change is often called the second demographic transition. Among its most important features is the conflict between economic activity and maternity (Broniatowska, 2019).

In this paper we intend to analyze a demographic phenomenon in terms of the effects it (may) produces on the markets of EU member states in particular. We grouped these states into two categories: developed European states and ex-communist states. It is observed the existence of an aging process both at European level and in the particular cases of each state of the 27 states analyzed. This paper explores the issues from a long-term standpoint, analyzing the relationship between population growth or decline and the trends in four key macroeconomic indicators. The main hypothesis we use in this paper is that population growth / decrease has definite effects on macroeconomic indicators in the analyzed states.

This work has a double contribution to European literature. First, the long-term focus of the analysis allows for a more accurate assessment of the projected demographic challenges in the distant future. Second, by examining the links between demographic shifts and key economic indicators such as investment dynamics, GDP, unemployment, and inflation - we identify the long-term trends that policymakers should prioritize when addressing population-related issues, particularly in the context of labour supply.

The paper is organised as follows. Section I offers a revision of the previous literature research on the relationship between population growth and evolution of GDP, total investment, inflation and unemployment rate. Section II presents the data and methodology used in the study, followed by the results analysis and discussion in Section III. Section IV presents the conclusions of our study.

I. LITERATURE REVIEW

GDP is the total market value of all final goods and services produced in a country each year. GDP is a basic measure of a country's economic performance (Rahman, 2013), so it is widely used by economists to measure the health of an economy; changes in GDP are identified relatively quickly (Samuelson & Nordhaus, 1989). Changes in the age distribution of the population have important macroeconomic implications. Using annual data for the period 1960–2015, Goh, McNown and Wong (2020), tests if the share of population age has long-term influences on domestic savings, domestic investment, real GDP, inflation and the current account balance. A key observation of the authors' analysis states that the effects of demographic change on macroeconomic variables are statistically significant and quite strong. Another conclusion of the same study is that future trends in key macroeconomic variables are not monotonous; thus, long oscillations of demographic factors produce a mixture of periods of moderate growth and episodes of GDP stagnation.

The literature abounds in articles that analyze the connection between the population of a country and the evolution of macroeconomic indicators. To explore the relationship between population growth and GDP growth, Hosen (2019) conducted a study across forty countries. The analysis revealed a significant long-term correlation between the two variables mentioned. Fox and Dyson (2015 explore the connection between birth rates and per capita income. Piketty (2014) observes that economic growth always involves a purely demographic component. The results of the study by Kasirlou and Rajaei (2017) showed that the population growth rate has an impact on GDP. Wesley and Peterson (2017) highlight contrasting effects of population growth on GDP growth in low-income versus high-income countries. In low-income nations, rapid population growth tends to have a negative impact in the short and medium term, primarily due to the high number of dependent children. However, over the long term, these countries may benefit from a demographic dividend as this youthful population matures into a productive workforce. Conversely, high-income countries experience low or even negative population growth, leading to age structures dominated by a large proportion of older individuals. Higher population growth in these countries could help alleviate the challenges of supporting an expanding retiree population. In low-income countries, GDP growth is anticipated to stay robust, fuelled by at least two main factors.

Several theoretical frameworks examine the fundamental relationship between population growth and GDP growth. The classical perspective focuses on the concept of a real subsistence wage - the minimum real wage necessary to sustain life. In contrast, the neoclassical view holds that population growth is independent of real GDP. Meanwhile, the new growth theory suggests that real GDP per capita increases as a result of individual choices driven by the pursuit of profit, and that such growth can continue indefinitely (Parkin, 2010). Papapetrou and Tsalaporta's paper (2020) examines the impact of population aging on macroeconomic performance, inflation and labour force participation, using a sample of 23 OECD developed countries from 1960 to 2014 and considering the institutional context. The results of the study show that a higher share of the elderly population leads to a lower growth of real GDP especially in countries with low population growth rates. Aging puts substantial downward pressure on inflation due to low aggregate demand.

There are several ways in which population growth could influence investment (Sweezy, 1940): (1) through

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its effect on the propensity to consume; (2) by its effect on competition from aggregate consumer demand; (3) by providing labour force and; (4) as an essential part of a particular large phenomenon which, in turn, vitally affects investment. Alsan, Bloom and Canning (2006) investigated whether population health affects foreign direct investment flows and concluded that health has a positive and significant effect on such flows for low- and middle-income countries. Jäger and Schmidt (2015) demonstrated for a group of 13 OECD countries between 1971 and 2007 that the share of older voters and public investment rates are co-integrated, indicating a long-term relationship between them, finding a negative and significant effect of population aging on public investment. Analyzing asymmetric panel data from 38 countries over the period 1977 - 2007, Asongu (2013) found a long-term positive causal relationship between population growth and public investment. However, when it comes to domestic investment, persistent fluctuations in human capital were shown to influence long-term changes in other types of investment.

The evidence of Farvaque and Mikhailov (2009) confirms that the demographic structure of a country is a key determinant of aversion to inflation. Recently, a new opinion that low inflation can be influenced, among other variables, by demographics has emerged in the literature. However, there is little empirical evidence for this hypothesis. Broniatowska (2019) analyzed whether inflation is related to the age structure of the population and, especially, whether an increased dependence ratio for age is correlated with a lower inflation rate. He estimated a panel data model for 32 OECD member economies for the period 1971-2015. The results of the estimates suggest that there is a relationship between demographics and low-frequency inflation. A higher dependency rate in old age is indeed correlated with lower inflation. Therefore, the continuous aging of the population can put downward pressure on inflation. Demography represents a large share of low-frequency inflation variation in 22 countries from 1870 to 2016 (Juselius & Takáts, 2021). The dependent population (young and old) is associated with higher inflation, and the working age population with lower inflation. Kalafatcılar and Özmen (2021) focused on the impact of demography on inflation in emerging market economies by analyzing the inflationary impact of different age cohorts. They, in their study, suggest that while the dependent population (retirees) is associated with inflationary pressures, the working age population (economists) is associated with deflationary pressures. In their work, Juselius and Takáts (2016) confirmed that the age structure of the population is a systematic factor of inflation. They found a stable and significant relationship between the age structure of a population and low-frequency inflation.

Unemployment is largely used as a tool to measure the health of the economy. According to the OECD (2020), the unemployed are people who are fit for work, but who are unemployed and have taken specific measures to find a job. The unemployment rate is a key factor in the growth and development of a nation. Thus, unemployment can be explained as the number of people who are willing, able to work at the dominant wage rate, but who do not have a paid job (Gbosi, 2015). According to Smith (2015) population is the number of individuals living in a country at a time. There is a direct link between population growth and the unemployment rate. This is due to the fact that population growth without creating the right jobs will increase the unemployment rate. But paid employment provides enough income to lift households out of poverty, as households with unemployed are at higher risk of being poor and corrupt (Okowa, 1997). Unemployment means that an economy does not use its human resources efficiently (Gbosi, 2007). A rising level of unemployment could be caused by population growth in an economy. This is because as the birth rate increases, so does the population of a particular nation. Obayori and Udeorah (2020) analyzed the connection between population growth and unemployment and concluded that there is a direct relationship between population growth and unemployment. The work of Gallant et al. (2020) develops a search and matching model that incorporates temporary unemployment and applies the model to study the labor market dynamics of the US COVID-19 recession. On the other hand, an increase of real GDP and investment could make a positive contribution to reducing unemployment. Unfortunately, the current COVID-19 pandemic will increase the current unemployment rate due to isolation measures and staying home (Oshora et al., 2020).

If public and private sector efforts to develop human capital - such as investments in education, training, and research - remain constant, then population growth can serve as a key explanatory variable for GDP growth. In the absence of this factor, GDP is influenced by a range of other variables, including capital investment, technological advancement, resource allocation, external economic conditions, and socio-political factors, all of which can significantly impact the overall level of GDP. This study examines the relationship between population growth or decline, and four key macroeconomic indicators: GDP, Total Investment, Inflation and Unemployment Rate, in addition to analytically comparing nations from two categories of groups: developed economic countries and ex-communist countries.

Our study objectives are: (1) To find the long-term relationship between the increase / decrease of the population and the evolution of the GDP, of the total investments, of the inflation rate and of the unemployment rate between two groups of countries: capitalist and ex-communist; and (2) To see for which of the two groups of countries the correlations are stronger.

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II. DATA AND METHODOLOGY

II.1. DATA DESCRIPTION

This study includes a sample of 23 countries - all EU member states. We used, as dependent variables, GDP, Total Investments (TI), Inflation Rate (IR) and Unemployment Rate (UR). Regarding the independent variable, we used the population numbers (Pop) of these countries. So, the study used an explanatory analysis and an econometric analysis, based on data recorded in 1992-2021, to investigate the relationship between population numbers and four mentioned macroeconomic indicators. For each variable, the data recorded over 30 years were considered. The data of our study were taken from the site https://www.imf.org.

As a first step, we move on to a brief descriptive statistic of the population level (Pop), as shown in Table 1. All countries were analyzed in the period 1992-2021, except Estonia (1994-2021), Ireland (1995-2021), Lithuania (1999-2021), Malta (1995-2021) and Slovak Republic (1993-2021). As we can see in Table 1, Germany has the highest average annual value for the 31 years analyzed (81,460 million). At the opposite pole is Malta with an annual average of 0.421 million inhabitants.

Table 1. Annual average population of the analyzed countries (1992-2021).

Developed countries	Population (mil.)	Ex-communist countries	Population (mil.)
Austria	8.310	Bulgaria	7.655
Belgium	10.688	Croatia	4.352
Cyprus	0.762	Estonia*	1.356
Finland	5.291	Hungary	10.068
France	61.334	Latvia	2.224
Germany	81.460	Lithuania	3.118
Greece	10.817	Poland	38.218
Ireland**	4.353	Romania	21.169
Italy	58.612	Slovakia***	5.399
Luxembourg	0.491	Slovenia	2.025
Malta**	0.421		
Netherlands	16.326		
Portugal	10.327		
Spain	43.731		

* period 1994-2021; ** period 1995-2021; *** period 1993-2021.

Figure 1 shows that the evolution of the population of developed countries differs from one country to another. Thus, we have countries where the population has grown continuously (Belgium, Finland, France, Luxembourg, Malta), countries for which, after a first period of growth, followed a decrease (Greece, Italy, Portugal), as well as countries where the population increased, then decreased, and then increased again (Austria, Cyprus, Germany, Spain). However, for absolutely all these countries the population in 2021 is higher than in 1992, in some cases by more than 20% (Spain, Cyprus, Malta, Luxembourg).

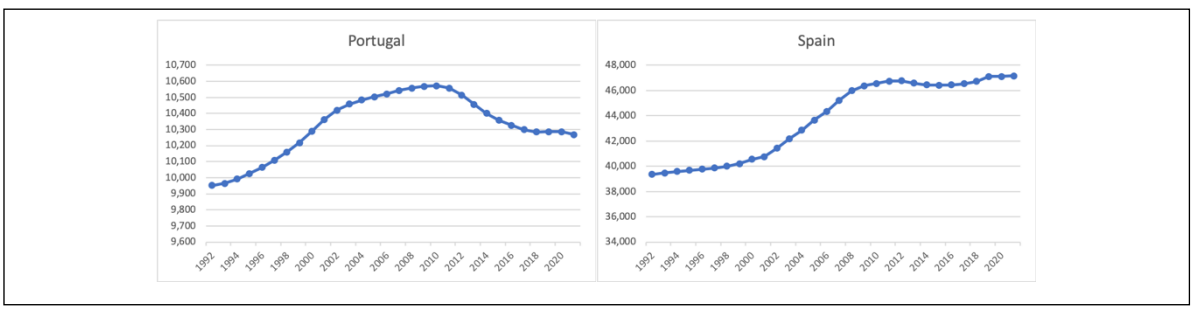

Figure 1. Population evolution in developed European countries during 1992-2021 (millions of inhabitants)

In the case of ex-communist states, things are different. With two exceptions, populations have a declining trend (Figure 2). The exceptions are Slovakia and Slovenia, but also here the difference between the end and the

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beginning of the period is below 5%. Spectacular decreases in population volume were registered in Romania, Bulgaria, Lithuania (over 20%). Even if, as a whole, their populations have decreased, we find countries with small fluctuations (Poland, Croatia).

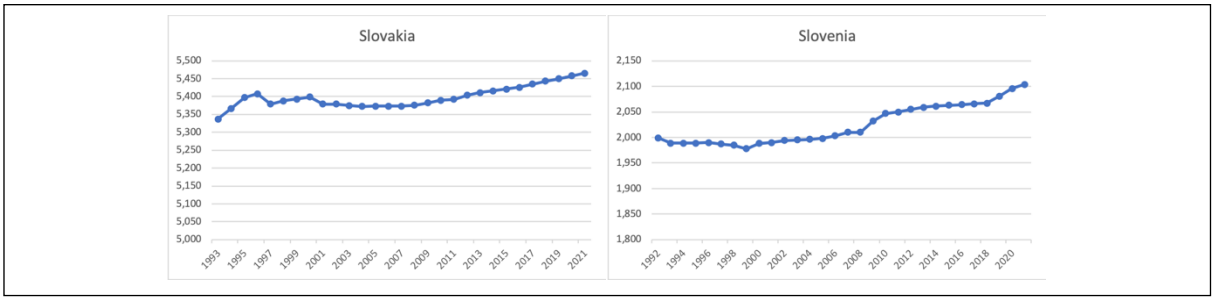

Figure 2. Population evolution in ex-communist European countries during 1992-2021 (millions of inhabitants)

According to Table 2, the mean value of the population for the period and all the considered countries is 17.476 million inhabitants, but this is different for the two groups. Thus, the average population is more than twice higher in developed European countries (22.642 million) than in ex-communist countries (9.946 million). Therefore, it is not difficult to see that the difference between these two developed and ex-communist countries in terms of population is significant, being a good argument to carry out a separate analysis of the population on these two subgroups in order to explain this variation.

Table 2. Some statistical values for the considered populations (millions of inhabitants)

Group	Mean	Std. Dev.	Min.	Max.
Developed countries	22.642	26.148	0.376	83.287
Ex-communist countries	9.946	11.272	1.315	38.667
All	17.476	22.264	0.376	83.287

Standard deviation is an indicator that tells us how far the values of a variable are from their average (Table 2). Both groups have high values of standard deviation, which confirms that the considered countries are not heterogeneous, i.e. there are very large differences between their populations. Of all the considered countries, the least populated is Malta in 1995 (0.376 million), and the largest population is found in Germany in 2021 (83.287 million). For ex-communist countries, Poland has the largest population in 1999, and the smallest is in Estonia in 2014.

II.2. METHODOLOGY

The aim of the study is to test the working hypothesis and the appropriated research questions on both groups of countries:

Hypothesis 1. Does population growth influence the value of GDP? and Research question RQ1 How do the results of testing hypothesis 1 differ for the two groups of EU countries (developed European and ex-communist countries)?

Hypothesis 2. Total investment (IT) is influenced by population size (Pop)? and Research question RQ2. How do the results of testing hypothesis 2 differ for the two groups of EU countries?

Hypothesis 3. Inflation increase (Infl) is consistent with population growth? and Research question RQ3 How do the results of testing hypothesis 3 differ for the two groups of EU countries?

Hypothesis 4. The unemployment rate (UR) is influenced by population size? and Research question RQ4. How do the results of test hypothesis 4 differ for the two groups of EU countries?

To achieve this aim, a correlation and regression analysis was developed. Correlation was used to measure strength of the relationship between each of the two variables used in the study. It can be positive, negative or zero. The correlation coefficient may take on any value between +1 and -1. The correlation matrix will show us the correlation coefficients between sets of variables analysed. Each random variable (Xi) in the table is correlated with each of the other values in the table (Xj).

A regression analysis was used to estimate the relationships between these variables in order to highlight how the dependent variable changes when one of the independent variables varies and allows to mathematically determining which of those variables really has an impact.

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III. RESULTS AND DISCUSSIONS

Table 3 and 4 presents the correlations between the population of each country (Pop), considered in our paper as an independent variable, and dependent variables, i.e. Gross Domestic Product (GDP), Total Investment (TI), Inflation (Infl) and Unemployment Rate (UR) for all developed European countries and respectively for ex-communist countries.

Table 3. Correlation coefficients between Pop, GDP, TI, Infl and UR for developed European countries

Country	GDP	TI	Infl	UR
Austria	0.8959	-0.3392	0.9880	0.6649
Belgium	0.9134	0.6610	0.9915	-0.5730
Cyprus	0.9008	-0.5938	0.9784	0.7856
Finland	0.9032	0.5672	0.9954	-0.6995
France	0.9154	0.7910	0.9980	-0.3413
Germany	0.2872	-0.0491	0.4740	-0.4523
Greece	0.8504	0.0364	0.7233	0.2134
Ireland*	0.9533	0.3232	0.9601	0.0821
Italy	0.8363	-0.6532	0.9515	0.1851
Luxembourg	0.9565	-0.7969	0.9675	0.8700
Malta*	0.9430	-0.1983	0.8623	-0.7542
Netherlands	0.9069	-0.4627	0.9945	-0.1808
Portugal	0.7304	-0.3764	0.6759	0.4834
Spain	0.9567	-0.3209	0.9821	0.0003
* period 1995-2021.				

Table 4. Correlation coefficients between the dependent variables GDP, TI, Infl and UR and the independent variable Pop for ex-communist countries

Country	GDP	TI	Infl	UR
Bulgaria	-0.9481	-0.5140	-0.9351	0.6957
Croatia	-0.6620	-0.2686	-0.8267	0.2003
Estonia*	-0.8547	0.0946	-0.9385	0.2751
Hungary	-0.9269	0.0273	-0.9794	0.5658
Latvia	-0.8719	-0.2265	-0.9807	-0.0097
Lithuania	-0.9325	0.4271	-0.9866	0.5231
Poland	-0.8803	0.0812	-0.8646	0.4891
Romania	-0.9587	-0.0825	-0.9858	0.7221
Slovakia**	0.6594	-0.5397	0.6496	-0.6689
Slovenia	0.8492	-0.5645	0.8114	-0.0381
* period 1994-2021; ** period 1993-2021.				

Testing hypothesis 1. Does population growth influence the value of GDP?, and the question RQ1 How do the results of testing hypothesis 1 differ for the two groups of EU countries (developed European and ex-communist countries)? involves the analysis of Tables 3 and 4.

According to the data in Table 3, for developed European countries we have very strong correlations between Pop and GDP variables, in twelve of the fourteen considered countries the correlation coefficient being over 0.85. The only exceptions are Portugal, with a slightly lower correlation coefficient, but still important (0.7304) and Germany, where it is very small (0.2872), which leads to a very weak correlation between the two characteristics. However, in all cases the values are positive, which allows us to say that population growth leads to a higher value of GDP.

For ex-communist countries, things are a little bit different. In eight out of ten cases, the correlation coefficients are negative, which associates the decrease of the population of these countries in the last 30 years with an increase in GDP. Exceptions are Slovakia and Slovenia, the only countries in this category whose populations have increased during this period (Fig. 2). However, the absolute values of all these coefficients are high or very high, which leads to a strong link between the two variables considered (Pop and GDP).

Developing the regression analysis, we can see the data from Table 5 which shows the linear regressions between the gross domestic product (GDP) expressed in billions of dollars and the populations (Pop) of Western European countries for which the link between these two variables is significant, the correlation coefficient being

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greater than 0.8.

Table 5. Linear regression between GDP and Pop in developed European countries

Country	GDP	Coef.	T-stat.	P-val.	R-squared
Austria	cons.	-1860.88	-9.06	0.0000	0.8027
	Pop	263.55	10.67	0.0000	
Belgium	cons.	-1961.47	-9.86	0.0000	0.8343
	Pop	220.56	11.87	0.0000	
Cyprus	cons.	-107.58	-6.84	0.0000	0.7262
	Pop	11.7599	8.01	0.0000	
Finland	cons.	-1813.19	-10.00	0.0000	0.8158
	Pop	381.28	11.13	0.0000	
France	cons.	-10001.17	-9.87	0.0000	0.8379
	Pop	198.46	12.03	0.0000	
Greece	cons.	-2764.16	-7.96	0.0000	0.7131
	Pop	274.41	8.55	0.0000	
Ireland	cons.	-790.34	-12.18	0.0000	0.9087
	Pop	233.73	15.77	0.0000	
Italy	cons.	-11495.86	-7.01	0.0000	0.7195
	Pop	225.64	8.07	0.0000	
Luxemburg	cons.	-90.52	-11.60	0.0000	0.9149
	Pop	272.70	17.34	0.0000	
Malta	cons.	-31.73	-11.12	0.0000	0.8892
	Pop	95.49	14.16	0.0000	
Netherlands	cons.	-4165.32	-9.78	0.0000	0.8825
	Pop	296.90	11.38	0.0000	
Spain	cons.	-4032.29	-13.72	0.0000	0.9153
	Pop	116.56	17.39	0.0000	

From Table 5 we can find a statistically significant linear relationship between GDP and Pop at a significance level of 1% (p value <0.0001), for all considered developed countries. The sign of the Pop coefficient is the expected one, being positive. The Pop coefficient tells us how much the Gross Domestic Product increases (billions of dollars), if the population of that country will be larger by one million inhabitants. The highest coefficient is found in Finland (381.28), for which an increase of 1000 inhabitants will lead to an increase of 381 million dollars in GDP. At the opposite pole is Cyprus, where every thousand inhabitants contribute 11 million dollars to the country's GDP.

For all linear models, the variable Pop explains the volume of gross domestic product in proportions of over 70% (R-squared > 0.71), in three cases, Ireland, Luxembourg and Spain, even over 90%. In conclusion, according to our calculations, the volume of the population is a representative component, with a significant impact on the size of GDP in the developed European countries of the European Union, therefore, the H1 hypothesis is valid in this case. Our results agree with the results of other authors: Hosen (2019), Fox and Dyson (2015), Piketty (2014), Kasirlou and Rajaei (2017).

In the case of ex-communist countries, as we mentioned before, we have only two cases in which the correlation coefficient between the two variables is positive. The parameters of the linear regression model for these two countries are given in Table 6.

Table 6. Linear regression between GDP and Pop

Country	GD	Coef.	T-stat.	P-val.	R-squared
Slovakia	cons. Pop	-4261.64 801.15	-4.49 4.55	0.0001 0.0000	0.5348
Slovenia	cons. Pop	-604.10 316.87	-8.01 8.50	0.0000 0.0000	0.7311

In the case of Slovenia, the variable Pop explains the volume of gross domestic product in proportion of over 70% (R-squared = 0.7311), while for Slovakia, only in proportion of 53.48%, the rest being explained by

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other factors not considered in this model.

Hypothesis 2. Total investment (IT) is influenced by population size (Pop).

Research question RQ2. How do the results of testing hypothesis 2 differ for the two groups of EU countries (developed European and ex-communist countries)?

According to Tables 3 and 4, the correlation coefficients between the two variables are quite small, which leads to less intense connections between the two variables. The only countries for which these values are over 0.65 are Belgium and France. The parameters of the linear regression model for these two countries are given in Table 7.

Table 7. Linear regression between TI and Pop

Country	GD	Coef.	T-stat.	P-val.	R-squared
Belgium	cons. Pop	4.50 1.76	1.11 4.66	0.2756 0.0000	0.4348
France	cons. Pop	-3.20 0.41	-0.86 6.84	0.1354 0.0000	0.6257

Interpreting these values, we can say that every million inhabitants of France, contributes to an increase of 0.41 percent of GDP in investment, while in the case of Belgium, to an increase of 1.76. The not very high values of R-squared come to confirm that the connection between the two variables is not very intense.

Therefore, taking into account the above, we can conclude that the size of the population does not have a strong influence on Total Investment in either of the two categories of countries considered.

Hypothesis 3. Inflation increase (Infl) is consistent with population growth.

Research question RQ3 How do the results of testing hypothesis 3 differ for the two groups of EU countries (developed European and ex-communist countries)?

According to the data in Table 3, for developed European countries we have very strong correlations between the variables Pop and Infl, in eleven of the fourteen considered countries the correlation coefficient being over 0.85. The only exceptions are Greece, with a slightly lower correlation coefficient, but still important (0.7233), Portugal (0.6759) and Germany, where it is even lower (0.4740), which leads to a very weak correlation between the two characteristics. However, in all cases the values are positive, which allows us to say that an increase in population leads to a higher value of Infl.

Table 8 presents the linear regressions between the inflation index and the populations (Pop) of Western European countries for which the connection between these two variables is a significant one, the correlation coefficient being higher than 0.8.

Table 8. Linear regression between Infl and Pop in developed European countries

Country	GD	Coef.	T-stat.	P-val.	R-squared
Austria	cons. Pop	-288.30 47.36	-24.77 33.84	0.0000 0.0000	0.9761
Belgium	cons. Pop	-209.12 27.74	-28.34 40.22	0.0000 0.0000	0.9830
Cyprus	cons. Pop	-29.00 151.11	-6.26 25.04	0.0000 0.0000	0.9572
Finland	cons. Pop	-322.42 77.36	-43.17 54.83	0.0000 0.0000	0.9908
France	cons. Pop	-171.38 4.25	-54.87 83.48	0.0000 0.0000	0.9960
Ireland	cons. Pop	-4.20 22.04	-0.75 17.17	0.0000 0.0000	0.9219
Italy	cons. Pop	-420.57 8.65	-13.58 16.37	0.0000 0.0000	0.9054
Luxemburg	cons. Pop	-14.31 202.05	-2.89 20.25	0.0000 0.0000	0.9361
Malta	cons.	-37.31	-2.56	0.0000	0.7465

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Country	GD	Coef.	T-stat.	P-val.	R-squared
	Pop	292.97	8.51	0.0000	
Netherlands	cons.	-248.29	-37.26	0.0000	0.9891
	Pop	20.56	50.41	0.0000	
Spain	cons.	-142.41	-17.16	0.0000	0.9645
	Pop	5.22	27.56	0.0000	

From table 8 we can find a statistically significant linear relationship between Infl and Pop at a significance level of 1% (p value <0.0001). For all developed European countries, the sign of the Pop coefficient is positive. The Pop coefficient tells us how much inflation increases if the population of that country will increase with one million inhabitants. The highest coefficient is found in the small countries of Luxembourg and Malta, for which an increase with one thousand inhabitants will lead to an increase of 0.202 and 0.292 points of the inflation index, respectively. At the opposite pole is France, where every thousand inhabitants contribute 0.004 points to the inflation index.

For all the linear models found, the variable Pop explains the volume of inflation in proportions of over 90% (R-squared > 0.90), in two cases, Finland and France, even over 99%. In conclusion, according to our research, the volume of the population represents a representative component, with a significant impact on the size of inflation in the developed European countries, members of the European Union. Therefore, hypothesis H3 is valid in this case. The findings of our study are consistent with those of previous research See Broniatowska (2019), Juselius and Takáts (2021), Kalafatcılar and Özmen (2021).

For ex-communist countries, things are a little bit different. In eight out of ten cases, the correlation coefficients are negative, which associates the decrease of the population of these countries in the last 30 years with an increase of the inflation. There are two exceptions, as in the case of the correlation between GDP and Pop, Slovakia and Slovenia, the only countries in this category whose populations have increased during this period (fig.2). However, the absolute values of all these coefficients are high or very high, which leads to a strong link between the two variables considered (Pop and Infl). The parameters of the linear regression model for Slovakia and Slovenia are given in Table 9.

Table 9. Linear regression between Infl and Pop

Country	GD	Coef.	T-stat.	P-val.	R-squared
Slovakia	cons.	-2584.94	-4.31	0.0001	0.5220
	Pop	493.81	4.44	0.0001	
Slovenia	cons.	-944.91	-6.77	0.0000	0.7283
	Pop	506.07	7.34	0.0000	

In the case of Slovenia, the variable Pop explains the volume of inflation in proportion of over 70% (R-squared = 0.7283), while for Slovakia, only in proportion of 52.20%, the rest being explained by other factors not considered in this model.

Hypothesis 4. The unemployment rate (UR) is influenced by population size.

Research question RQ4. How do the results of test hypothesis 4 differ for the two groups of EU countries (developed European countries and ex-communist countries)?

According to Tables 3 and 4, the correlation coefficients between the two variables are generally quite small, which leads to less intense connections between the two variables. The only countries for which these values are over 0.70 are Cyprus (0.7856), Luxembourg (0.8700) and Romania (0.7221). The parameters of the linear regression model for these three countries are given in Table 10.

Table 10. Linear regression between UR (percent of total labor force) and Pop (mil.)

Country	GD	Coef.	T-stat.	P-val.	R-squared
Cyprus	cons.	4.04	-5.08	0.0000	0.6171
	Pop	5.31	6.71	0.0000	
Luxembourg	cons.	-5.03	-4.93	0.0000	0.7569
	Pop	19.21	9.33	0.0000	
Romania	cons.	-11.52	-3.43	0.0001	0.5214
	Pop	0.87	5.52	0.0001	

According to these values, we can say that an increase of ten thousand inhabitants of Luxembourg, is

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followed by an increase of 0.19 percent of unemployment rate, and in the case of Romania, an increase of 0.008. The not too high values of R-squared come to confirm that the connection between the two variables is not very intense.

Therefore, considering the above, we can conclude that the size of the population does not have a strong influence on the Unemployment Rate in either of the two categories of countries considered.

IV.CONCLUSIONS

It is therefore essential for any nation to understand the relationship between its GDP growth rate and both short- and long-term population growth, as the stability of these variables can shape the fundamental macroeconomic dynamics (Hosen, 2019). From the series of panel data of the two groups of countries, this study primarily investigated the short- and long-term relationships between the population growth rate and GDP, total investment, inflation rate and unemployment rate. After evaluating these data, regarding the four macroeconomic indicators, the research results are below.

In our paper, the characteristics of the population differed significantly among various groups of countries. In general, it can be inferred that capitalist countries are likely more successful in converting a larger share of their population into human capital compared to ex-communist countries. Hence, there is a possibility for people in capitalist countries to contribute more to GDP growth. The study revealed that in most of the countries analyzed - twelve out of fourteen from the capitalist group - there is a significant long-term relationship between GDP growth and population growth. This statement agrees with Hosen (2019). For ex-communist countries, in eight out of ten cases, the decline in the population of these countries over the last 30 years is associated with an increase in GDP, with two exceptions.

The size of the population does not have a very strong influence on two of the four macroeconomic indicators studied: Total Investment (TI) and Unemployment Rate (UR) in neither of the two categories of countries considered. However, the fundamental factors influencing investment activity differ from country to country in different stages of development (Blonigen and Wang 2004).

The volume of the population is a representative component, with a significant impact on the size of inflation in the developed European countries, members of the European Union. For ex-communist countries (in eight out of ten countries), the correlation coefficients are negative, which associates the decrease of the population of these countries in the last 30 years with an increase in inflation.

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