EURO STEP-UP: POPULATION MOVEMENT IMPACT ON EUROPEAN GDP

Comparative Analysis of GDP Growth in European Commission Countries, having account emigration, immigration and student enrollment in education

INTRODUCTION

The **EURO STEP-UP** is a company that belongs to the European Commission, and its goal is to do a global analysis of the economic performance of the Commission's European countries. The purpose of this research is to understand the main reasons, and the main factors, which variables will affect positively or negatively the economy of all European countries precisely (Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden) from respective year 2021. This research will focus on Gross Domestic Product growth in the member states of the European Commission while taking demographic shifts like immigration, emigration, and student enrollment into account. With the use of this study, policymakers may better comprehend the connection between population transitions and economic growth and develop focused plans to balance tolerating a variety of demographic transformations with maximizing economic results. Given our goal, we defined our research questions as:

Is directly observed the economic factors of emigration, immigration, and student enrollment in education **have statistical evidence (with heteroskedasticity and without heteroskedasticity) on the Gross Domestic Product of European Commission Countries?**

Countries belonging to the eurozone are important, in explaining **the gross domestic product of European countries**? Taking into account the independent variables, emigration, immigration, and student enrollment in education?

DATA

Our data frame was formed by the combination of several data sets from the Eurostat, Wikipedia, Eurydice, Migrant Learners, OECD, Luxembourg Minister of Education, PORDATA, and UNDP.

Our data frame has **26 observations for each variable and has a total of 28 variables**. Each observation represents a European country and each variable captures a different economic, demographic, and educational aspects of these countries.

After careful analysis, we have concluded that it is more efficient and relevant to focus our attention on just these 5 variables **the Total Immigration (imigrtot)**, **Total Emigration (emigrtot)**, and **Student Enrollment in Education (stdenroleduc)**, **Expectancy of birth over 80 years (expbirthd), and country of Europe haves Euro Coin (eurozone) in European Commission Countries** because they are statistically evident in our linear model and will help us to verify the final results of our research questions.

Name	Type	Description
Countries_2021	Character	Countries of EU In 2021
imigrtot	Integer	Total Number of Immigrants
emigrtot	Integer	Total Number of Emigrants
stdenroleduc	Integer	Student enrollment on education
expbirthd	Integer	*Expectancy Births Over 80 Years = 1 & Expectancy Births Lower 80 Years = 0*
eurozone	Integer	*Country of Europe haves Euro Coin = 1 & Country of Europe does not haves Euro Coin = 0*

Table 1: Research Question independent variables of our main regression

METHODOLOGY

1. REGRESSION

The results of the tests were obtained trough codes in the R Studio.

The linear regression was used to understand the impact that the immigration, emigration, and the student enrollment in education affects the gross domestic product in European Countries.

By observing the independent variables, we can conclude:

We have statistical significance in the variables immigration, emigration, and the student enrollment in education that conduct our research, because their p-value is lower than 0.05.

Meaning that we should reject the H0 at the 5% significance level.

Also, we can observe that the Intercept is not significant for the significance level of 5% because their p-value is higher than 0.05.

Meaning if all independent variables have the value zero we should not reject the H0 at the 5% significance level.

```
## Call:
## lm(formula = log(gdpcountry) ~ log(imigrtot) + log(emigrtot) +
##     log(stdenroleduc), data = data)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.73313 -0.28493  0.04094  0.22631  0.94457
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)       -1.4943     0.8562  -1.745  0.09490 .
## log(imigrtot)      1.0560     0.2873   3.676  0.00133 **
## log(emigrtot)     -0.6847     0.2448  -2.797  0.01052 *
## log(stdenroleduc)  0.6564     0.1174   5.592 1.27e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.4232 on 22 degrees of freedom
## Multiple R-squared:  0.9263, Adjusted R-squared:  0.9162
## F-statistic: 92.16 on 3 and 22 DF,  p-value: 1.302e-12
```

Test 1: European Commission Gross Domestic Product Main Regression

ANALYSIS & RESULTS

2.REGRESSION REFLECTIONS: EXPLORING INSIGHTS BEYOND HETEROSKEDASTICITY

We conducted two analyses to understand the real impact of independent variables on the gross domestic product (GDP) of European countries. First, we performed **individual T-tests** to assess how each independent variable explains the GDP without considering heteroskedasticity. Then, we conducted a **second analysis using F-tests** to evaluate the joint impact of independent variables on the GDP without considering heteroskedasticity.

2.1 F- TEST

F-TEST: The unrestricted model includes all independent variables, while the restricted model only includes the *stdenroleduc,* the variable that explains better our linear model. We want to understand if has a critical impact by removing emigrtot & imigrtot. The unrestricted model is considered significant if the observed F-statistic (Fobs) exceeds a critical value of 4.259677. The F-statistic for the findings was 7.842403. The **unconstrained model is statistically significant at the 5% significance level**, indicating that immigration and emigration collectively account for the gross domestic product in European Commission Countries.

2.2 T- TEST

T-TEST: The Tobs values for immigration, emigration and student enrollment on education are 3.6756, -2.796977 and 5.591141, respectively. Comparing them with the critical value of 1.717144 **for a significance level of 5%**, we see that they are all higher, indicating that **all the variables are significant in explaining** the Gross Domestic Products in European Commission Countries.

3. INSIGHTS AMIDST HETEROSKEDASTICITY: UNVEILING REGRESSION DYNAMICS

Now, we conducted a **Breusch-Pagan** analysis to examine how each individual independent variable explains the gross domestic product (GDP) in European Commission countries while accounting for the presence of heteroskedasticity. Subsequently, we performed a **Robust Estimation** analysis to correct for heteroskedasticity, revealing which variables effectively explain the GDP in European countries post-correction.

```
## Call:
## lm(formula = resid(reg10)^2 ~ log(imigrtot) + log(emigrtot) +
##     log(stdenroleduc), data = data)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -0.3258 -0.1201 -0.0374  0.1185  0.5125
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)       0.81184    0.39502   2.055   0.0519 .
## log(imigrtot)     0.27906    0.13254   2.105   0.0469 *
## log(emigrtot)    -0.19577    0.11295  -1.733   0.0971 .
## log(stdenroleduc) -0.11720    0.05415  -2.164   0.0416 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1952 on 22 degrees of freedom
## Multiple R-squared:  0.254,  Adjusted R-squared:  0.1523
## F-statistic: 2.497 on 3 and 22 DF,  p-value: 0.0863
```

Test 2: Breusch Pagan of our Regression Model

Observing the **Breusch Pagan Test**, we can conclude that we have presence of heteroskedasticity in the variable immigration, and in the variable student enrollment in education. **We are rejecting the H0 at significance level of 5%.**

```
##
## t test of coefficients:
##
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)      -1.49429    1.11198 -1.3438  0.19271
## log(imigrtot)     1.05605    0.42071  2.5101  0.01992 *
## log(emigrtot)    -0.68469    0.35276 -1.9410  0.06518 .
## log(stdenroleduc) 0.65640    0.20822  3.1525  0.00462 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Test 3: Robust Estimation of our Regression Model

Observing the **Robust Estimation**, we can conclude that we have presence of good estimators, after correcting the standard errors only in the variables **immigration & student enrollment in education**. **We are rejecting the H0 at significance level of 5%.**

3.1 HETEROSCEDASTICITY ACROSS WHITE FULL AND SPECIAL TEST

The **White Full Test and the White Special Test** are employed when its needs to **assess the presence of heteroscedasticity** in a regression model. In this case, when analyzing **all variables together** in the White Full Test and the White Special Test, without examining them individually, we consistently **find no evidence of heteroscedasticity**. This conclusion is based on the failure to reject the null hypothesis in both tests, where the p-values exceed the 5% (respectively with 17% and 49%) significance level. Therefore, we can confidently state that there is **no presence of heteroscedasticity analyzed together our variables** in our data based on these comprehensive analyses.

4. SIGNIFICANCE OF EUROZONE MEMBERSHIP IN EUROPEAN GDP DYNAMICS

Lastly, according to **our last research question**, we will understand how the **euro coin influences the Gross Domestic Product** in European Commission Countries by applying the **Chow Test.**

4.1 CHOW TEST

According to the **Chow Test**, countries within the European Union have considerably longer life expectancies beyond 80 years of age when there is a Euro coin (eurozone). This has a favorable effect on GDP growth, especially when it comes to emigration, immigration, and school enrollment. **We should reject H0 at the 5% significance level for all variables**, indicating that the Euro coin is important for promoting growth in the economy in all of these countries.

```
##
## Call:
## lm(formula = log(gdpcountry) ~ eurozone * log(imigrtot) + eurozone *
##     log(emigrtot) + eurozone * log(stdenroleduc), data = data,
##     subset = (expbirthd == 1))
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.26000 -0.10784 -0.00702  0.00000  0.63311
##
## Coefficients:
##                           Estimate Std. Error t value Pr(>|t|)
## (Intercept)                113.008     38.798   2.913   0.0172 *
## eurozone                  -116.024     38.804  -2.990   0.0152 *
## log(imigrtot)              48.059     15.458   3.109   0.0125 *
## log(emigrtot)             -10.604      3.417  -3.104   0.0126 *
## log(stdenroleduc)         -36.499     12.157  -3.002   0.0149 *
## eurozone:log(imigrtot)    -47.017     15.468  -3.041   0.0140 *
## eurozone:log(emigrtot)     10.053      3.425   2.935   0.0166 *
## eurozone:log(stdenroleduc) 37.176     12.158   3.058   0.0136 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.2665 on 9 degrees of freedom
## Multiple R-squared:  0.9845, Adjusted R-squared:  0.9724
## F-statistic: 81.41 on 7 and 9 DF,  p-value: 2.044e-07
```

Test 4: Chow Test of our Regression Model

CONCLUSION & RECOMMENDATIONS

After analyzing various **tests including the F-Test, T-Test, Breusch Pagan Test, Robust Estimation, White Full Test, and Special Test**, we have drawn several conclusions regarding our research questions.

Firstly, our **analysis indicates that emigration alone is not a reliable independent variable** for explaining GDP in European Commission countries. This conclusion **is supported by the Robust Estimation results the best heteroscedasticity technique for** demonstrating that emigration lacks a good estimator, as evidenced by the **failure to reject the null hypothesis at a significance level of 5%**. Furthermore, the **presence of heteroskedasticity** in the data related to emigration, as suggested **by the Breusch Pagan Test**, raises questions about the reliability of using emigration as a predictor of GDP. Therefore, these findings cast doubt on the efficacy of emigration as a standalone explanatory variable for GDP in European Commission countries. Conversely, i**mmigration and student enrollment in education demonstrate efficiency in their estimators**, as indicated by the **rejection of the null hypothesis at a significance level of 5%** and the **presence of heteroskedasticity detected by the Breusch Pagan Test.**

Regarding our second research question, which examines the **influence of life expectancy over 80 years, the presence of the eurozone**, and variables such as emigration, immigration, and student enrollment in education on GDP in European countries, we observed we had positive results. The **eurozone emerges as a significant factor across all variables, with p-values consistently below 5%.**

In summary, while **emigration alone may not be a strong predictor of GDP in European Commission countries, immigration and student enrollment in education demonstrate significant explanatory power**. Furthermore, the presence of the **eurozone consistently influences GDP** across various factors.

Our recommendations include the **implementation of policy interventions aimed at maximizing the positive economic impacts of emigration**. Additionally, regarding the second research question, we suggest that **European countries adopt the Euro Coin to contribute to a higher life expectancy of individuals** (over 80 years), thereby positively impacting gross domestic product, as supported by our independent variables.

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