Population growth rate

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Population growth is a fundamental aspect of societal development, reflecting changes in the number of individuals within a given region over time. It is influenced by factors such as birth rates, death rates, migration, and healthcare advancements. Understanding population growth is crucial for policymakers, planners, and communities as it impacts various aspects of society, including workforce dynamics, resource allocation, and social infrastructure. In addition, it is one of the most important tools for measuring a country's current situation and the level of development.

However, there are plenty of other key factors that might explain the population growth rate, such as life expectancy and fertility rates. This study aims to consider these overlooked determinants in order to help society understand their vital roles. On the contrary, this paper needs to use already known, more traditional, factors such as net migration which will be helpful to draw the overall picture. Moreover, it would be wise to differentiate countries by region, hence, observing Europe separately from the other continents.

It is reasonable to believe that all the factors mentioned above will give results significant enough to explain how effective each variable is on the given subject of observation. Other research papers have already discussed the importance of such variables, such as "Population dynamics with immigration and low fertility" (Espenshade, 1986) He argues that one of the most important factors to discuss along with migration is, of course, fertility rates, especially in Third World countries. In his paper, there is enough evidence to say that immigration and fertility rates are, in fact, heavily connected with this exact topic.

Another paper that focuses more on migration and discusses its effect on population trends (growth rate) from 1850 to 2016 is "The Impact of Migration on Long-term European Population Trends". (Morphy, 2016) as it is already mentioned the main objective of this research was to prove that migration's influence on population trends should not be negligible.

In addition, the least discussed factor of population growth around the world is life expectancy. However, among the rarest research papers about this topic, there is "Life Expectancy and Population Growth in the Third World" (Gwatkin, 1982) in which the author discusses the indirect effect one can have on another.

This paper aims to reinforce these popular authors' ideas by manipulating data to make a linear regression.

Methodology

This econometric model uses a multiple linear regression model to explain the causal relationships between given variables and their impact on population growth rate. The explanatory variables being Fertility rate, life expectancy, net migration, and an additional dummy variable that determines whether a country is in Europe or not. The data used to make this model is taken from the World Bank Database with a base year being 2019 to avoid post Covid-19 uncertainty in the later years. With the help of Excel, the given data was cleaned, all the unnecessary observations and variables were removed, and the dummy variable was created. Then, stata was used to run the multiple linear regression model with OLS estimation method. There are a total of 217 observations basically covering all the countries in the world. The final model has the following form:

$$Pop.growth.rate = \beta_0 + \beta_1 netmigrationinthousands + \beta_2 lifeexpectancy + \beta_3 fertilityrate + \delta\ ineurope + u$$

Net migration is the number of immigrants minus the number of emigrants over a period of time, in this case, 2019. For the purpose of getting a relatively better slope coefficient, the variable had to be transformed in a way that would make sense. Net migration was scaled in thousands thus having better results. As expected, the mean of all net migration was close to zero, however, not precisely because of all the other miscellaneous factors.

Variable	Obs	Mean	Std. dev.	Min	Max
netmigrati~s	217	-.1470327	164.5523	-1177.218	1158.444

The second determinant of the explained variable is life expectancy. The data shows that the average life expectancy across all countries is approximately 73 years. It should be noted that not all countries had enough data to be collected and that's why 8 observations (countries) had to be omitted from the econometric model. At a 95% confidence level, it can be interpreted that a population of a randomly selected country life expectancy is approximately between 72 and 74 years.

Variable	Obs	Mean	Std. dev.	Min	Max
lifeexpect~y	209	72.93105	7.52422	52.91	85.18

According to this model, fertility rate, which is the number of children born alive to women of that age during the year as a proportion of the average annual population of women of the same age, also has a considerable influence on the population growth rate. Overall fertility rate of 2.3 is considered as normal for the past few years and it isn't unexpected that in 2019 the average fertility rate across all countries was 2.575. furthermore, there are outliers such as Chad and Niger (Africa) with rates of 6.41 and 6.96 respectively.

Variable	Obs	Mean	Std. Dev.	Min	Max
fertilityr~n	210	2.575	1.28816	.92	6.96

And the last variable that is going to be involved in this project is "InEurope". It is a dummy variable, and it was created in Excel by distinguishing the region of each country. If a country was in Europe, it was defined as 1, and if it was located on the other continents, it was respectively defined as 0. In total, there were 217 observations, out of which 41 are in Europe and the rest of them are distributed on the other continents (176 observations).

in Europe	Freq.	Percent	Cum.
0	176	81.11	81.11
1	41	18.89	100.00
Total	217	100.00	

Results

The results of running multiple regression on this data are appropriate enough to draw conclusions. According to the Stata output, it is remarkably simple to analyze the situation. The estimated coefficients show how the given variables are connected to the population growth rate.

It should be noted that the only negative slope coefficient is -0,48465 and it belongs to the variable called "Ineurope". Showing that European countries have a population growth rate smaller compared to other regions by 0.48465%. This result is reasonable since Europe has less growth in recent years compared to other regions such as Asia, since it is known that China and India have been facing dramatic population growth, which heavily impacts relativity between continents.

However, other coefficients of the independent variables, fertility rate, life expectancy, and net migration, are positive, which means that they have a positive direct effect on the dependent

variable. When a country's life expectancy increases by 1 year, population growth rate goes up by 0,03592 (slope estimate) percent, ceteris paribus. Furthermore, fertility rate has the largest impact on the predicted variable, one-unit increase causes the population growth rate to change by 0,77597 percent. This variable can be considered economically large, while that can not be said about the coefficient of net migration when it is calculated in thousands, it is the smallest one, 0,001418 (however, there are other cases, for example when it is measured in millions, when this variable becomes economically large). This can be interpreted in the following way, when net migration increases by one thousand people (meaning either the number of immigrants rise or the number of emigrants decrease), the dependent variable increases by 0,001418%. Hence, this coefficient definitely is not economically large.

The Stata output shows that all of the predictor variables are statistically significant, as their P values are sufficiently small. They are all important variables at a 99% significance level, except for life expectancy (98%). This model also passes the F test. From the result of the F statistic, it is true to say that these variables are jointly significant. The next and one of the best indicators of how good the multiple linear regression is R^2, which shows how the population growth rate is explained by fertility rate, life expectancy, net migration, and being in Europe. The numeric value of it, in this case, is 0.502, which means that this econometric model explains a great part of the dependent variable, as R^2 between 0.3 and 0.6 is already thought as a good result because there are so many distinct factors that cannot be considered in one model.

. reg populationgrowth lifeexpectancy fertilityrate migrationinthousands ineurope

Source	SS	df	MS		
Model	160.129424	4	40.0323561	Number of obs	= 209
Residual	158.846404	204	.778658842	F(4, 204)	= 51.41
				Prob > F	= 0.0000
				R-squared	= 0.5020
				Adj R-squared	= 0.4922
Total	318.975828	208	1.53353764	Root MSE	= .88242

populationgrowth	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lifeexpectancy	.0359264	.0151142	2.38	0.018	.0061265	.0657264
fertilityrate	.7759756	.0866077	8.96	0.000	.6052147	.9467365
migrationinthousands	.0014185	.0003728	3.81	0.000	.0006835	.0021534
ineurope	-.4846503	.174535	-2.78	0.006	-.8287741	-.1405265
_cons	-3.369619	1.286578	-2.62	0.009	-5.906314	-.8329242

Conclusion

To conclude, the research that has been put into this paper shows significant evidence that these overlooked factors, such as life expectancy, net migration, and fertility rates should be included in more discussions about population growth.

It can be said that every factor that is mentioned here has intuitive meanings behind it. For instance, the positive impact of life expectancy on population growth may be influenced by various factors such as improved healthcare, better living conditions, and socio-economic development, which collectively contribute to the overall well-being of a population.

Furthermore, the findings of the research are consistent with the fact that migration has a substantial impact on population dynamics. Migration patterns may be influenced by several factors, including political stability, economic opportunity, and social circumstances within a nation. These factors can ultimately impact population growth.

Finally, the most straightforward effect can be seen with fertility rates. If a country struggles with population dynamics, the government should finance all the expenses associated with pregnancy and labor, as a result, they will have higher fertility rates and population growth, respectively.

Overall, this research calls for a broader consideration of these factors in policy and planning discussions, providing valuable insights for sustainable development and future challenges.

References

Espenshade, T. J. (1986). *population dynamics.*

Gwatkin, D. R. (1982). *Life expectancy and population growth.*

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