

# Thesis Summary Nacho Pulido Master´s Thesis Seminar

## Research Question and Context

Classical macroeconomic approaches often resort to already built frameworks in order to model the explanatory behaviour and evolution of unemployment, inflation or any other measure of one could care for. These models are nourished by and evaluated with econometric techniques based on empirical data such that their fundamental objective is to unfold and predict subsequent economic performance. Solowian economics claim for the appearance of country convergence conditional on a set of characteristics whereas the introduction of an endogenous Ramsey model involving the use optimal control theory predicts the possibility of a steady state for a given set of variables. These variables and characteristics common to most models involve the interaction of population dynamics as an argument of any function describing the factors driving long-term economic prosperity, but such component is seldom endowed with an endogenous characteristic, and it is usually announced as a constant. Despite the inclusion of this parameter on modelling GDP per capita growth rate is often revealed as inversely proportional, the role of population growth rate holds an uncertain nature. Enhanced labour force or shifts in aggregate demand are both linked to the notion of population growth rate, thus impacting in a desirable way economic prosperity. On the other hand, the denominator rise (per unit of population) when computing the progress of GDP per capita or the potentially excessive demand pushing up price indexes (inflation) might justify the opposite. Yet the issue is far from black and white.

Empirical evidence suggests that MED countries are undergoing a process of stagnation in terms of population dynamics whereas pre-industrialized economies experience lingering peaks in the number of inhabitants. Economies like Japan, Italy or Spain are currently portraying negative population rates which diverge significantly from the average replacement rate required to sustain population from one generation to another one (2.1 children per woman), and World Health Organization projections point at the shrinkage of up to 10% in Europe in contrast with the African boost of over 50% by 2050. Our opening hypothesis requires us to explore the most relevant components shaping the evolution of population dynamics outside of the confounding effects arising from migration. A both cultural and economic perception calls for this analysis, locating the existing relationship between such variables with population rates and enabling the researcher to predict for future directions.

**Research question(s):** What is the impact on population growth of education level? Does this effect differ across continents/economies? What policies can public entities resort to in tackling such an issue?

**Research title:** Accounting for education enhancement effects on population growth dynamics: A wealth gap perspective.

## Relevance of the research question

The uneven nature of population growth rate emerges as the main argument calling for a dual analysis of the latter (e.g. splitting our task into a continental dimension analysis). This spans from the significant decline in demographic expansion present in many European economies to the existing abysmal gap with African countries such that, according to the the Wittgenstein Centre for Demography, Nigeria is approaching a fertility rate of 6 children per woman. Therefore, the different objectives to tackle population issues directly stem from the disparities observed between countries in terms of culture, development and economic conditions. Dealing with a problem of overpopulation requires public policy intervention which, as an earlier step, needs a deep understanding of the treatment variables (factors one can have an influence on) which can shape the output as efficiently as possible (population growth). Take, for instance, the one-child policy introduced in China in the early 80s which directly limits the number of children allowed per woman. Such a policy, set aside any moral or individual freedom apology, has proven to lead to an ageing society similar to the one currently experiencing in European economies.

According to Population Council researcher Mark Montgomery, boundless drops in fertility rates were immediately observed when developing countries revised their educational performance in the 70s, portraying a significant correlation between these two-events worth studying. Such correlations were accounted with complex analytical and computational techniques followed by a longitudinal approach (time series component) which allowed to observe this trend behavior in many countries and at different points in time. Our departure point will be to reveal the education level effect on population dynamics distinguishing between different classes of economies and continents. Of course, one could claim that such a causal effect could be stained by other confounding biases introduced by cultural spill overs (marriage rate, religious attention etc.) or structural properties (household size, economic openness etc.), and we must devote a section of the paper to depict the causal paths and potential confounders. Assuming our target variable holds a null independence nature, current population movements would behave as a function of past observations, hence suggesting the inclusion of an autoregressive time series model in addition to features related to the current state of it (household size, median age etc.).

The relevance of this study lies on the potential contribution to the broader topic of population dynamics and public policies which is one of the major threatening issues to many economies in terms of sustainable development and long-term prosperity (notice the issue is present at MED and LED level but in opposite directions).

## Hypothesis and Analytical/Computational approach

Our proposal will hold that education enhancement is strongly linked with the notion of family planning, sex education and female labour participation which eventually gives rise to birth control and gender parity.

The first section of the paper will operate under the hypothesis that such an impact on population growth rate will differ across countries portraying different characteristics (civil rights, economic conditions, geography etc.) and this will require a cautious specification of the root model in order to compute marginal effects. Under this scenario our work calls for the previous feature engineering technique in which interaction terms will reveal as key (for instance, civil rights multiplied by education). Once the non-linear particularization is reached, we will test for the hypothesis of identical marginal effects by replacing in the original equation our restriction and resorting to an F-statistic on the sum of squared residuals. We will compare this analysis with an IV test for isolating the sole effect of education on population growth rate by evaluating the validity of public expenditure on education as an instrument. Recall our subject of interest is to capture the non-confounding effect of education on population growth and to test the hypothesis that this effect holds a significant cross-country variation.

The second segment of the project will deal with the construction of a predictive (dichotomous) model based on a logistic regression in order to forecast instances in which a country experiences negative population growth rates in contrast with the opposite case. At this stage of our analysis, one will notice the fact that approximately 90% of the database holds a positive population growth rate, hence the challenge faced is to be able to maximize assessment metrics on precision and sensitivity. The results stemming from this section of the paper focus on MECs in contrast to our previous part on developing economies, and we will compute the marginal effect over a set of variables on contributing to the probability of driving into the region of negative growth rates. Notice we should expect some concave relationships between our variables and the marginal effects due to the model election.

The final section of the thesis introduces a time series approach with population evolution as a target variable in order to test the hypothesis of the autoregressive component explained earlier. The logic is that, if such a variable is proven to behave as a function in which one of the stronger arguments is a lag of the same variable, then accuracy of predictions using this model would improve the ones from the predictive analysis based on our binary variable.

## Data Exploration

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| --- | --- | --- | --- |
| Attribute | Class | Description | Source |
| Country Name | Character/String | The name of the country starting with upper case | World Bank |
| Year | Numeric/Date Discrete | Year of the observation | World Bank |
| Gdp growth rate | Numeric/Float Continuous | Yearly growth rate as a percentage | World Bank |
| Pop growth rate | Numeric/Float Continuous | Yearly growth rate as a percentage | World Bank |
| School years | Numeric/Float Continuous | Average number of years of schooling | Our World in Data |
| Education Expenditure | Numeric/Float Continuous | Expenditure on education as a percentage of GDP | Our World in Data |
| Continent | Categorical/factor | String indicating the country continent | Penn World Table |
| Life Expectancy | Numeric/Float Continuous | Number of years expected to live at current year | Our World in Data |
| Migration rate | Numeric/Float Continuous | Positive/Negative rate indicating the balance | World Bank |
| Health Expenditure | Numeric/Float Continuous | Healthcare expenditure as a GDP percentage | World Bank |
| Median Age | Numeric/Float Continuous | Median population age at current year | World Bank |
| Marriage rate | Numeric/Float Continuous | Number of marriages per 1000 people | Our World in Data |
| Civil rights | Categorical/factor | 1-7 scale (1 scoring the best) | Our World in Data |
| Religion degree | Numeric/Float Continuous | Percentage of population who thinks religion is important | The International Religious Demographic Project |
| Latitude | Numeric/Float Continuous | Location variable | github.com/albertyw/avenews |
| Longitude | Numeric/Float Continuous | Location variable | github.com/albertyw/avenews |

References :

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* <https://www.researchgate.net/publication/235434071_The_Optimal_Population_Growth_Rate_in_Diamond_1965_Model---The_Role_of_Demographic_Dividend/citations>
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* https://www.weforum.org/agenda/2015/07/how-education-can-moderate-population-growth/#:~:text=%E2%80%9CEducation%20leads%20to%20lower%20birth,economic%20growth%20easier%20to%20achieve.%E2%80%9D