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Abstract. This paper aims to explore the relationship between a country's birth rate and GDP per capita. I use cross-sectional data for 108 countries from the CIA's World Factbook and The World Bank. From the research, it is clear that countries with lower infant mortality rates and higher levels of female education have lower birth rates, but the impact of GDP per capita remains ambiguous. It appears the relationship between GDP per capita and birth rates may be mediated through factors such as female empowerment, better healthcare, contraception availability, and family planning resources.

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I. Introduction

Over the last 50 years, the global average birth rate has nearly halved according to data from Gapminder (Gapminder). For much of human history, the average woman had at least five children and oftentimes this number was higher. Since then, this number has been approaching two children per woman over the last handful of decades. According to the existing research, there are three main reasons why this trend towards less children is occurring. They include the empowerment of women through increased access to education and the labor market, a decline in child mortality rates, and an increase in the cost of raising children in the modern world.

Due to the decline in birth rates, the global population growth rate has declined from a peak of 2.1% in the 1960s to nearly 1% today according to data from the Department of Economic and

Social Affairs of the United Nations (United Nations). The interesting part about this rapid change in reproduction is that nearly all countries across the world have gone from relatively high levels of reproduction to about two children per woman at some point in history. Additionally, these changes have become more and more rapid over time. For example, it took Iran only ten years for birth rates to decline from six children per woman to fewer than three children per woman during the years 1986 to 1996. In China, this change took eleven years, and this rapid decline in birth rate occurred from 1967 to 1978 which is before they instituted their one-child policy. However, it took both the United States and the United Kingdom over 80 years to make this reproductive transition throughout the 19th and early 20th centuries (Gapminder). In this study, I aimed to determine whether a countries GDP per capita can help explain the current level of a country's birth rate.

II. Literature Review

Before developing my own econometric model to evaluate the relationship of GDP per capita and a country's birth rate, I explored the existing research that has attempted to explain the change in birth rates over the past century. One of the most well-documented and researched reasons for the decline in birth rates has to do with the empowerment of women. The level of education, especially for women, is one of the most significant predictors of birth rates. In the 1960s, Gary Becker (1960), developed the theoretical argument for the relationship between greater education in women and a decline in children per women. His theory posits that as women increase their participation in the labor market their opportunity cost for having a child rises so they seek to have fewer children. Additionally, throughout the 20th century, women also increased their participation in the labor force. Due to industrialization, labor markets experienced major historical changes. Economies of the past were largely made up of extremely physically demanding agricultural jobs

which were almost exclusively held by men due to their comparative advantage in this occupation. However, as more jobs shifted away from manual agricultural labor and the manufacturing and service industries developed, the importance of education increased and the comparative advantage men held in the labor market began to erode. Thus, female labor force participation began to rise. The theory behind this change is known as "Unified Growth Theory" and was developed by Galor and Weil (1993) in the 1990s. Overall, the burden of child rearing is mostly undertaken by women; thus, it is not surprising that fertility is lower where women have higher levels of social status and many opportunities outside the household.

Another prominent explanation of birth rates is a country's infant mortality rate. For nearly all countries, rapid population growth usually takes place when the health of the population improves and mortality rates decline while birth rates remain high. The reasons that explain why birth rates eventually fall in response to these changes are mainly separated into two explanations. Some of the recent literature from Reher, Sandstrom, Sanz-Gimeno, and van Poppel (2017) suggest a family's need for child replacement disappears when countries are able to reduce their child mortality rates; thus, less families have another child to replace a deceased offspring. Alternatively, Say (1991) and Kalemli-Ozcan (2003) find evidence that families no longer have the need to "child hoard," meaning they have more births than desired to protect themselves against the possibility that a child will die prematurely. As mortality rates decline, this behavior disappears since premature deaths become rarer. Both theories provide solid evidence that mortality rates are an important driver of human reproductive activity. Over the past century, children have not only been surviving at a higher rate, but they have also become more expensive. Doepke (2004) finds that government policies related to child labor have played a role in the decline of fertility rates since greater restrictions for child labor have increased the opportunity costs of having children as

the family does not benefit from the child's contribution to the household. This suggests that child labor laws have influenced fertility rates over the years. Not only are less children producing income, they are also becoming more educated than children of the past. Finite resources in a household force decisions on whether to have an additional child. This leads parents to view the decision through a quantity or quality lens; thus, the increased cost of raising children has forced parents to have fewer children (Becker and Lewis, 1973). Today, children are more of an economic drain than an asset to a household.

The final potential influence on birth rates is the variable on which my study is focused: GDP per capita. Intuitively, one would hypothesize that countries with higher income would be associated with lower fertility rates. Surprisingly, the existing empirical research in the realm in not particularly consistent. There might be a direct effect of high incomes on the declining demand of children, but it is difficult to say that the correlation between high incomes and low fertility alone are responsible for a country's decrease in fertility. Given this framework of empirical research, I decided to develop my own econometric model using this literature and evaluate the results I obtain from my own Ordinary Least Squares regression.

III. Data and Method

Data were collected for the 108 countries included in my model based on availability of data. The data point most responsible for reducing the number of countries included in my study was reliable data pertaining to the total average years of education per woman in a given country. Despite this challenge, there is representation for both developed and developing countries in my data set. The data on birth rates, GDP per capita, and mortality rates were taken from the CIA's World Factbook (CIA), and total average years of education per woman was gathered from the

World Bank (The World Bank). Table 1 describes each of the variables, their units, and their predicted effects on birth rates.

Table 1 – Variables, description, unit of variables and predicted signs

Variable Name	Description	Unit	Predicted Effect
BR	Birth rate per 1,000 people	# of births per 1,000 people	Dep. Variable
GDP	GDP per capita	$	-
MR	Mortality Rate	# of deaths per 1,000 live births	+
ED	Mean years of schooling, women (in reproductive age 15 to 49)	# of years	-

Once the data were collected, Ordinary Least Squares regressions were used. This assisted in finding a relationship between birth rates and the variables I determined should have an impact on birth rates based on the existing literature on this topic.

The first control variable was the mortality rate denoted by MR in the model. It is the number of deaths per 1,000 live births in a country. Including this variable in the statistical model controlled for the healthcare and perceived "value" of a child in a given country. Theories on the concepts of child replacement and child hoarding suggest that a lower mortality rate makes additional children less desirable. Additionally, the studies on the increasing costs of raising children also highlight the importance of mortality rate as a control variable in this econometric model. The predicted sign of the MR was positive.

The second control variable was the education level of women in a given country. It was measured by the mean years of schooling for women aged 15 to 49. This measure controlled for differences in the empowerment of women in different countries. Becker's theory on the influence of women's education on reproduction and the Unified Growth Theory suggest that more

empowered women have less children on average. Including this variable controlled for such effects in the econometric model. The predicted sign of ED was negative.

The independent variable of interest to me in this study was GDP. The unit of this measure was constant purchase power parity (PPP) dollars. Using purchasing power parity dollars controls for differences in price levels in different countries. The existing research indicates that as income levels increase in a country, the populace typically engages in different, more varied lifestyles which might convince prospective parents to have fewer or no children (George and Clark). Thus, the predicted sign of coefficiency of GDP was negative.

After the data were collected and filtered, descriptive statistics were studied to understand the structure of the data. The descriptive statistics are included below in Table 2. The dataset is not perfect because it omits some countries due to missing data. This was corrected by eliminating that country from the regression analysis which reduced the sample size of the dataset.

Table 2 – Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
OBS	108	54.5	31.32092	1	108
BR	108	18.46074	9.469886	6.89	47.28
GDP	108	21358.37	20902.27	1100	110300
MR	108	20.75056	20.15217	1.66	106.75
ED	108	8.611759	2.89854	1.95	13.24

The Ordinary Least Squares model employed in this analysis was as follows:

$$BR = f(GDP, MR, ED)$$

IV. Results and Interpretation

The regression results are presented in Table 3. The sample size of the test was 108. In this model, both mortality rate and mean years of schooling for women aged 15-49 were significant at 1%. GDP per capita was not significant at any of these levels.

The mortality rate had a positive relationship with a country's birth rate. This is consistent with the theories on child replacement, child hoarding, Doepke's studies on child labor, and Becker and Lewis's study on increased cost of raising children. The p-value of MR was very close to zero indicating a very high statistical significance. Compared to the existing research in the area, these results are consistent.

The mean level of education for women had a negative relationship with a country's birth rate. This is consistent with the theories from Becker and the Unified Growth Theory. A one-year increase in the average women's education in a country led to a drop in a country's birth rate of 1.2 children per 1,000 people. The p-value of ED was very close to zero as well which indicates a very high statistical significance. Again, these results are consistent with the existing research on this topic.

Finally, there was no significant relationship between GDP per capita and a country's birth rate which initially came as a surprise. Intuitively, I believe the relationship between these variables should be significant because most wealthy countries tend to have lower birth rates. However, after digging into the research in this area, similar studies have reached the same conclusion. Researchers have suggested that the relationship between the two variables may not be direct. Instead, they hypothesize that GDP per capita's relationship with a country's birth rate is mediated by factors such as female empowerment, better healthcare, higher opportunity costs associated with raising children, contraception availability, and family planning resources.

The adjusted R-squared for this test was about .76, meaning that the model explains about 76% of the causes of a country's birth rate. The F-statistic and the p-value of the F-statistic were 92.62 and 0.0000, respectively. These results signify that the independent variables included in

this model had significant effects on the dependent variable. By looking at these numbers, the robustness of the test can be verified.

Table 3 – Regression Output (with Robust standard errors to control for heteroskedasticity)

```
2 . reg BR GDP MR ED, vce(robust)

Linear regression                               Number of obs     =        108
                                                F(3, 104)         =      92.62
                                                Prob > F          =     0.0000
                                                R-squared         =     0.7671
                                                Root MSE          =     4.6357

------------------------------------------------------------------------------
             |               Robust
          BR |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         GDP |  -.0000119   .0000235    -0.51   0.615    -.0000584    .0000347
          MR |   .2447538   .0601997     4.07   0.000     .1253755     .364132
          ED |  -1.204682   .3509087    -3.43   0.001    -1.900547   -.5088167
       _cons |   24.00959   4.063417     5.91   0.000     15.95169     32.0675
------------------------------------------------------------------------------
```

After running the regression, I checked the above results for evidence of multicollinearity since the independent variables may have high correlation with one another. High correlation between independent variables is undesirable because this results in unreliable regression output. To test whether the model's results had a multicollinearity problem, a variance inflation factor (VIF) test was conducted. If the variable scores from the VIF test were more than 10, then the model would suffer from a multicollinearity problem. Conversely, if the scores were less than 10 then there would be no multicollinearity issues. From the results of the VIF test in Table 4, I was able to verify that the model results did not have multicollinearity as all the scores were less than 10.

Table 4 – Variance Inflation Factor (VIF) Test

```
3 . vif

    Variable |      VIF       1/VIF
-------------+----------------------
          ED |     4.67    0.214003
          MR |     3.68    0.271789
         GDP |     2.15    0.465131
-------------+----------------------
    Mean VIF |     3.50
```

V. Conclusion

This study used an OLS regression to investigate the factors influencing a country's birth rate. It finds that mortality rates have a positive relationship with birth rates, female education levels have a negative relationship with birth rates, and GDP per capita has an ambiguous or insignificant relationship with a country's birth rate. For the most part, these findings are consistent with the existing research on this topic.

This study does have some limitations. First, countries were excluded due to lack of data. This reduced the size of the dataset which could have influenced model's results. Second, the model used in this study was created by myself by merging research on the various determinants of birth rates and choosing the ones that I believed were the most theoretically sound. Since I am not an expert in population dynamics or anthropology, my judgment in this area is not completely reliable.

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