DO HIGH BIRTH RATES HINDER ECONOMIC GROWTH?
A CROSS-COUNTRY STUDY

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By

Shun-Chun Cheng, B.A.

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Shun-Chun Cheng, B.A.

Thesis Advisor: Andrew Wise, Ph.D.

ABSTRACT

Using a multi-country panel data set of for the period 2004 to 2008, this study examines the impact of the birth rates on economic growth. Because the relationship between these two variables seems to be changeable over time, in a different context for each country, the correlation cannot be simply determined. Debate on whether the population growth hampers economy growth or, on the contrary, economic growth hinders population growth has lasted for hundreds of years. This paper focuses on the impact of population growth on economic growth by employing a cross-country panel data set. I find that the birth rates have a positive impact on economic growth, but the correlation becomes negative when birth rates reach a certain point. Moreover, the relationship again appears to be positive at another specific point. In some context, to some degree, therefore, the result supports the neo-Malthusian view. It also suggests that high birth rates do not necessarily hinder economic development. This means that governments all over the world should develop their population policies appropriately depending on their own demographic and economic contexts.
Table of Contents

I. Introduction ..................................................................................................................... 1
II. Background and literature review .................................................................................. 5
III. Theoretical model ......................................................................................................... 11
IV. Empirical model ........................................................................................................... 14
V. Data and descriptive statistics ....................................................................................... 19
VI. Findings and analysis .................................................................................................... 21
VII. Conclusion and policy recommendations ..................................................................... 32
VIII. Bibliography ............................................................................................................... 36
I. INTRODUCTION

Debate on the relationship between economic growth and population fertility has continued for hundreds of years. Some, such as Coale (1978), Barlow (1994), Brander and Dowrick (1994), and Kelley (1995), argue that there is a negative relationship between the two variables. Others, such as the neo-Boserupian school (Boserup, 1981), argue that population growth may have a level positive effect on economic growth. However, the majority of existing empirical studies have failed to demonstrate a negative causal effect of population growth or birth rate on economic growth. My hypothesis is that birth rates have an impact on economic growth in different directions. Although majority of studies have shown that high birth rates negatively affects economic growth, my hypothesis here is high birth rates are not necessarily associated with lower economic growth. It could be positively associated when birth rates get much higher, reaching a specific point.

Among the various debates, the Malthusian school is the most influential. It claims that given limited resources, population growth is ground to hamper economic growth. A number of empirical studies have shown the negative correlation between these two variables. A study conducted by James Brander and Steve Dowrick (1994) finds that a high birth rate appears to reduce economic growth through investment effects and possibly through “capital dilution.” Earlier studies by Coale and Hoover (1958) and others have also suggested that high fertility hampers per capita real income growth. Essentially, higher fertility rates mean that the resources of the economy have to be spread across more people. Those people do create value, but since productivity has decreasing marginally returns, they don’t create as much extra per capita as they
consume. Thus, higher birth rates lead to an increase in Gross Domestic Product (GDP) per capita, but a lower GDP per capita in the long run.

In light of current theory and studies, it seems that high birth rates are always associated with national poverty. However, it may be a mistake to claim simply that for developing economies with diverse resources and levels of structural transformation, high birth rates are always associated with low per capita income. For example, an interesting empirical study has subverted the traditional views, indicating that there may be two-way causation between the demographic variable and economic variable (Robin Barlow, 1994). This means that high GDP per capita or high economic growth has an impact on birth rate and vice versa.

Therefore, the objective of this paper is to test the relationship between birth rate and GDP per capita growth by drawing a cross-country panel dataset from the World Bank. That is, I seek to investigate the impact of GDP per capita growth of each country on its birth rate by controlling other potential variables. Does it always happen that countries with high economic growth or high GDP per capita have lower birth rates than those with low GDP per capita? Is it always true that poorer countries have higher birth rates? Does higher economic growth or higher GDP per capita mean a lower birth rate? If a high birth rate does not always hamper economic growth, maybe is it possible that high per capita real income can be associated with a high birth rate.

This paper examines the impact of birth rate on the economy in terms of GDP per capita growth by using World Bank cross-country data of 2004 to 2008. I expect this relationship between GDP per capita growth and birth rate to be negative, which implies that countries with higher GDP per capita growth have lower birth rates, and vice versa. However, to some degree, I
anticipate this relationship to be a quadratic function, meaning that countries with high GDP per capita growth are associated with a high birth rate when the GDP per capita growth approaches a certain point. In highly developed countries, I expect that the relationship between birth rate and GDP per capita growth will not necessarily be negative. Moreover, to further test the effect, I will also include a cubic equation in my empirical model.

In addition to birth rate, quadratic birth rate, and cubic birth rate, it includes some other demographic variables such as the mortality rate of a country, the labor participation rate, and the GDP as control variables in the empirical model. More importantly, any given country’s birth rate is likely to be associated with its social policies. Beginning in 1980, most governments have tended to develop population policies in order to deal with the rapid population growth or population stagnation. For example, zero population control programs and China’s one-child policy may profoundly influence the birth rate of those countries. Therefore, in order to see the relationship between birth rate and government population policy and to examine the impact of those population policies, I use two policy indicator variables separately to represent the influence of population policies in 1996 and 2009 in order to see the influence of such population programs. However, my model will ignore the relationship between birth rates and some demographic factors such as the age-structure of populations and the effect of abortion on birth rates due to the problems of data collection.

The next section gives background and reviews the literature regarding the various theories about the relationship between population fertility and economic growth that previous studies suggested. Section 3 presents my theoretical as well as an empirical model, data, and the descriptive statistics. Section 4 discusses the findings and the analysis of my model results,
including the limitations to the models and the outcomes. The final section discusses my conclusion and policy implications based on my findings.
II. BACKGROUND AND LITERATURE REVIEW

A great deal of intellectual effort has gone into assessing the relationship between population fertility and economic growth. For hundreds of years, debate regarding the correlation between these two variables has been vigorous and contentious. As the related literature reveals, it is hard simply to conclude the direction of causality between these two variables, as well as the relationship between them. Some argue that population growth does have an impact on the economy; while others argue that the economic environment is the key factor that decides the fertility rate.\(^a\) Besides, the correlation between population fertility and economic growth has been a debatable subject as well. The historical background has been comprehensively described by Allen C. Kelley (2000). Some of the following outline is based on Kelley’s study.

Simple correlations and cross-country regressions that explain the impact of demographic variables on per capita output growth are the primary pieces of evidence that have stimulated and sustained the recent debate. Nevertheless, the proposition brought up by Reverend Thomas Malthus in 1798 was the first theory to begin the debate on the relationship between population and the economy. Malthus claimed that population would grow at a geometric rate (e.g., 1, 2, 4…) due to a lack of conscious restraints on fertility, and that the food supply would grow at an arithmetic rate (e.g., 1, 2, 3…) due to diminishing returns to increasingly scarce land. The results would be food shortage, starvation, and deaths. Population pressures would constrain per capita income at the subsistence level. Some observers would call this constraint the “Malthusian trap.” Yet, the Malthusian positions regarding the linkage of population and the economy were thought

\(^a\) In this paper, however, I focus on the impact of population fertility on economic growth instead of the reverse relationship.
to be incomplete, so more robust and comprehensive theoretical as well as empirical models were needed.

Beginning in the 1950s, empirical studies concerning the population-economy linkage looked again at the “Malthusian Problem”. Studies were undertaken in order to understand the correlation between population and the economy and in an attempt to provide some solutions to potential social problems. Studies described in Allen C. Kelley’s paper of “Population and Economic Development” in 2000, found that the impact of demography on the economy was generally found to be negative, but that the negative impact was considered to be small for the decades of the 1960s and 1970s. For example, the study conducted by Coale and Hoover (1958) and an assessment paper performed by the National Academy of Science (1971), revealed that there was a highly negative assessment of the impact of rapid population growth. Additionally, their studies found no significant positive effects of demographic change on economic growth. However, these studies were only focused on short-term change and the immediate impact of demographic change on economic growth.

While some studies in the 1980s and the 1990s found a negative relationship between population growth and economic growth, some more positive effects of population growth and economic growth began to emerge (Kelley and Schmidt 1995). The paper by Julian L. Simon, et al. (1981) was the first study that challenged the pessimistic view of the demographic-economy linkage. The authors concluded that population growth was likely to exert a positive net impact on economic development in many Third World countries in the intermediate run. In addition,

\[\text{Allen C. Kelley (2000) found that the Malthusian problem reoccurred in the mid twenty century: “the simultaneous occurrence of declining mortality and exceptionally high and sustained fertility in scores of developing countries was resulting in high population growth rates. A concern emerged that these rates could not be sustained over long periods of time. While, as in the past, fertility would predictably decline, still it was unclear whether such a decline would be soon or rapid enough to avoid potentially deleterious effects on welfare, economic progress, and the environment.”}\]
Kelley and Schmidt (1995) found that the timing of demographic specifications has an important effect: birthrate reduction has an immediately positive impact on economic growth, while in fifteen or so years, the impact is reversed. Similarly, Birdsall stated that “rapid population growth can slow development, but only under specific circumstances and generally with limited or weak effects” (Birdsall, 1988).

The most important and influential research in this period is the reassessment conducted by a working group on Population Growth and Economic Development under the auspices of the National Research Council (1986). According to this paper, there are both important positive and negative impacts of population growth. “On balance, said the author, we reach the qualitative conclusion that slower population growth would be beneficial to economic development of most developing countries (p. 90).” However, they warn readers that whether the impact is strong or weak could not be determined given the evidence. Also, the impact of population on economic growth varies from country to country, and from time to time and situation to situation. The consensus in this period was that slower population growth indeed advances economic progress in most developing countries. However, the results were generally based on an examination of the short-term effects. Additional factors were needed in the empirical model to examine the longer-term effect. Overall, the varying relationship between economic growth and fertility found in this study supports my empirical findings.

Starting in the 1990s, more interesting findings and theories were developed. Empirical studies were enriched by the emergence of a theoretical framework provided by Robert J. Barro (1989) that incorporates demography into convergence models. After years spent examining the relationship between the population and the economy, an increasing number of analysts began to
agree that simple correlations used widely before were difficult to interpret and potentially, and a
question needed to be answered: what accounts for the changed correlation—the relationship
between population and economic growth from one of no-correlation to one of negative
correlation in the 1980s.

As a result, Robert J. Barro pioneered a research strategy by using the empirical
convergence models of economic growth. These empirical paradigms, pioneered by Barro,
distinguish between factors (economic, political, social, institutional, and geographic) that
determine each country’s long-run level of per capita output, and the shorter-to-intermediate-run
transition of countries to this longer-run state. These models lent themselves to the investigation
of the impact of demography since they exposed both short- and long-term effects. Efforts to
model demography using the new convergence models have varied notably. Barro, therefore,
concluded in his study that high fertility, population growth, and mortality each exert a negative
impact on per capita output growth, and reduction in the total fertility rate increases the potential
for economic growth in the long-run (Barro, 1997).

Moreover, two studies conducted separately by Kelley and Schmidt (1995), and Bloom and
Williamson (1998), both indicated that demographics influence economic growth in both a short-
and long-run way. In a later study, Kelley and Schmidt (2000) found a surprising result that
demography accounts for around 20 percent of changes in output per capita growth from 1960 to
1965 across a wide collection of countries. These findings are largely consistent with the claims
of the studies in the 1980s. Kelley’s survey in 1988 for the Journal of Economic Literature
concluded that “…economic growth … would have been more rapid in an environment of slower
population growth, although in a number of countries the impact was probably negligible and in some it may have been positive.”

To sum up, the majority of the empirical studies find through the 1980s that high birth rates or high population have a negative impact on economic growth. Although there is still a difficulty in identifying a casual effect of population growth or birth rate on economic growth, we can acknowledge as widely accepted that high population growth has a negative impact on economic progress to a certain extent.

In contrast to previous studies, in this paper, I re-examine the short-run impact, instead of the long-run impact, of birth rates on economic growth by employing a cross-country panel data set during the recent period of 2004 to 2008 from the countries for which data were available. I expect my results to support the “neo-Malthusian” view that high birth rates hamper one country’s economic growth, but only to a certain point, and that after this point the correlation between these two variables turn positive as Kelley and Schmidt (1995) claimed.

Besides, some studies suggest that policies related to population growth, such as government population limiting policies and zero population programs, are fundamentally important, and have led to renewed interest in the relationship between fertility and growth rates of per capita real income (Brander and Dowrick, 1993). Therefore, in this paper, in addition to re-examining the relationship between birth rates and economic growth by following the previous studies, I also include two “POLICY” dummy variables, reflecting government population policy in 1996 and 2009, for which 1 represents governments implement policies that discourage population growth, and 0 stands for any other government policies, in order to see the effect of population limiting policies on birth rates and economic growth.
I have two original contributions in this paper. *First*, I add a cubic term of the BIRTHRATE variable, \( \text{BIRTHRATE}^3 \), in order to further investigate the effect of birth rates on economic growth. As the previous studies showed, a high birth rate is considered to be associated with a lower economic growth. In my paper, however, I further hypothesize that the correlation between birth rates and economic growth is a non-linear relationship. That is to say, a higher birth rate does have a negative impact on economic growth, but the correlation becomes positive when birth rates reach a certain point. In other words, I hypothesize that the relationship between birth rates and economic growth is negatively associated with a higher birth rates, but as the birth rates get much higher, reaching a specific point, the relationship again is positive.

*Second*, as a higher birth rate has been concerned as a serious problem, countries with higher birth rates began to conduct population limiting policies, and vice versa. In order to see the effect of such population programs on birth rates, I, therefore, add two policy indicator variables to represent the influence of population policies in 1996 and 2009. Therefore, in my study, I first examine the relationship between birth rates and economic growth, and later I test whether the population limiting policies have an impact on controlling birth rates.
III. THEORETICAL MODEL

Three major approaches have dominated the empirical literature on economic-demographic modeling: simple correlations, production functions, and convergence-patterns studies, according to the paper, “Aggregate Population and Economic Growth Correlations”, written by Kelly (1995). Studies of the first kind have hypothesized, based on simple correlation analysis, that per capita output growth is influenced by various dimensions of demography. Simple correlations model usually are specified:

\[ Y = f(D) \]

Where:

Y stands for economic growth in terms of GDP per capita growth; and
D usually represents contemporaneous population growth, and sometimes population density, size, and/or age structure, and births and/or deaths.

Results of such models may be difficult to interpret because the models suppress the specific channels through which population affects the economy. However, such correlations give first-pass assessment on the effect of demography of economic growth.

The production function studies are based on estimating variants of a model. Production function models usually are specified:

\[ Y = g(D, K, L, H, R, \psi) \]

Where:

Y stands for economic growth in terms of GDP per capita growth;
D represents population growth, including birth rate and age structure;
K represents physical capital;
L represents labor force;
H represents human capital, such as education and health;
R represents resources, such as land and environment; and
\( \Psi \) represents other influences.

The production function models hypothesized that demographic processes are linked to the growth of factor inputs, such as labor force, education, and health, net investment, resources, and technology.

These models, however, face challenges to implementation. For example, estimations of depreciation, depletion, technology, and scale are difficult to compile and assess. In addition, potentially important demographic linkages through scale, diminishing returns, and technical change are sometimes combined into a “residual” (Brander, 1994).

Convergence-pattern or “technology-gap” models are based on the production function framework. However, these models explore the relationship between economic growth and the level of economic development. Convergence-pattern models usually are specified:

\[
Y/N_{gr} = g(Y/N, X; Z) \tag{3}
\]

Where

\( Y \) stands for economic growth in terms of GDP per capita growth;
\( Y/N \) represents the initial state of economic development, and encompasses many of those influences which are difficult to measure for the production-function rendering, such as capital-to-labor ratios, technology, and human capital;
\( X \) represents additional variables, when available, such as educational attainment and population density and size; and
\( Z \) represents factors that influence the economic environment as well as changes in the stocks: saving, investment returns and the like.

The relationship between \( Y/N_{gr} \) and \( Y/N \) is complicated. In the light of convergence literature, \( Y/N \) can be interpreted as a proxy for key omitted or difficult-to-measure factors of
production. Also, as there are diminishing returns to these factors, the sign on Y/N should be negative.

Analysis in this paper, therefore, is based on the approaches taken in the convergence-patterns literature. I propose the following theoretical model where the variables are as described above in conjunction with Equations (2) and (3):

$$Y_{gr} = f(Y/N, X, Z)$$ \hspace{1cm} (4)

Where:

Y stands for economic growth in terms of GDP per capita growth;
Y/N represents the initial state of economic development, such as capital-to-labor ratios, technology, and human capital;
X represents additional variables, such as mortality, life expectancy, and population density and size; and
Z represents factors that influence the economic environment as well as changes in the stocks: saving, investment returns and the like.
IV. EMPIRICAL MODEL

Based on the theoretical model, I propose the following equations:

\[
\text{GDP\_GROWTH} = \beta_0 + \beta_1\text{BIRTHRATE} + \beta_2\text{BIRTHRATE}^2 + \beta_3\text{BIRTHRATE}^3 + \beta_4\text{MORTALITY} + \beta_5\text{LAB\_PARTICIPATION} + \beta_6\text{LIFE\_EXPECTANCY} + \beta_7\text{SAVING} + \beta_8\text{FDI} + \beta_9\text{GDP} + \beta_{10}\text{POLICY\_LOWER} + \psi. \quad (5)
\]

\[
\text{GDP\_GROWTH} = \beta_0 + \beta_1\text{BIRTHRATE} + \beta_2\text{BIRTHRATE}^2 + \beta_3\text{BIRTHRATE}^3 + \beta_4\text{MORTALITY} + \beta_5\text{LAB\_PARTICIPATION} + \beta_6\text{LIFE\_EXPECTANCY} + \beta_7\text{SAVING} + \beta_8\text{FDI} + \beta_9\text{GDP} + \beta_{10}\text{POLICY\_GLOWER} + \psi. \quad (6)
\]

\[
\text{BIRTHRATE} = \beta_0 + \beta_1\text{POLICY\_LOWER} + \beta_2\text{GDP} + \beta_3\text{MORTALITY} + \beta_4\text{LIFE\_EXPECTANCY} + \beta_5\text{LAB\_PARTICIPATION} + \beta_6\text{AG\_PER} + \beta_7\text{GDP\_GROWTH} + \beta_8\text{FDI} + \psi. \quad (7)
\]

\[
\text{BIRTHRATE} = \beta_0 + \beta_1\text{POLICY\_GLOWER} + \beta_2\text{GDP} + \beta_3\text{MORTALITY} + \beta_4\text{LIFE\_EXPECTANCY} + \beta_5\text{LAB\_PARTICIPATION} + \beta_6\text{AG\_PER} + \beta_7\text{GDP\_GROWTH} + \beta_8\text{FDI} + \psi. \quad (8)
\]

Where (with expected signs in parentheses):

- \text{GDP\_GROWTH} is the ratio of GDP per capital growth, measured annually in current US dollars;
- \text{BIRTHRATE} is the ratio of crude birth rate percent per 1,000 people (+);
- \text{BIRTHRATE}^2 is the quadratic form of BIRTHRATE (-);
- \text{BIRTHRATE}^3 is the cubic form of BIRTHRATE (+);
- \text{MORTALITY} is the ratio of mortality rate of infants percent per 1,000 live births (+);
- \text{LAB\_PARTICIPATION} is the labor participation rate percent of total population ages 15 above (+);
- \text{LIFE\_EXPECTANCY} is the life expectancy at birth measured by years (-);
- \text{SAVING} is gross savings (percent of GDP) (+);
- \text{FDI} is foreign direct investment measured by current US dollars (-);
- \text{GDP} is GDP per capita, measured by current US dollars (-);
- \text{AGRICULTURE} is the value added percent of GDP
- \text{POLICY\_LOWER} is a dummy variable reflecting government population policy in 1996, which 1 represents governments implement policies that discourage population growth, and 0 stands for any other government policies. (+ or -);
- \text{POLICY\_GLOWER} is a dummy variable reflecting government population policy in 2009, which 1 represents governments implement policies that discourage population growth, and 0 stands for any other government policies. (+ or -); and
- \psi is error term that represents other impacts which are not included in this model.
I first regress GDP_GROWTH on a number of exogenous variables to examine the relationship between GDP growth and birth rate. These equations tell us the correlations between GDP growth and birth rate, when holding other variables constant. The difference between Equations (5) and (6) is the policy variable. Equation (5) has a population policy variable that refer to the population limiting policies that each country’s government employed in 1996, and Equation (6) uses 2009 population limiting policies. Secondly, in order to see how the population limiting policies have affected birth rate, I employ two more equations— Equation (7) and (8), which regress birthrate on government population limiting policies in 1996 and 2009 separately, and a number of exogenous variables such as mortality rate, life expectancy, labor participation rate, and some other economic factors. These two equations show the correlation between birth rates and population limiting policies.

In general, the coefficients are expected to have signs as follows. The coefficient for BIRTHRATE should be positive, the coefficient for BIRTHRATE$^2$ should be negative, and the coefficient of BIRTHRATE$^3$ should be again positive, indicating that rapid population growth would hamper GDP growth as the literatures suggest. However, I add the cubic term of birth rate to my equation, and I anticipate the coefficient will change from negative to positive, indicating that a high birth rate is not expected to hinder economic growth at higher levels. Such a result would support my hypothesis that if the magnitude of the coefficient is statistically significant, then the relationship between birth rate and economic growth can be both positive and negative.

The “catch-up effects” also referred to as the theory of convergence, is a theory speculating that, since poorer economies tend to grow more rapidly than wealthier economies, all economies in time will converge in terms of per capita income. In other words, the poorer economies will
literally "catch-up" to the more robust economies. As a result, the Catch-up effect suggest that
the sign for the coefficient of GDP should be negative, suggesting a country with a higher GDP
 tends to have lower GDP growth. The sign for the MORTALITY coefficient could be positive. I
would expect that countries with a high mortality rate are poorer than those with lower mortality.
As a result, the coefficient should be positive as the catch-up effect suggests. The sign for the
coefficient of SAVING should be positive, indicating that a higher saving rate has a positive
effect on GDP growth.

The coefficients for the LIFE_EXPECTANCY should be positive, indicating that countries
with higher life expectancy have higher GDP growth. The sign for the coefficient of
LAB_PARTICIPATION could be positive, which suggests that the higher the rate of labor force
participation, the higher GDP growth would be. Higher labor participation means lower
unemployment; therefore when the labor participation rate goes up, generally so does GDP
growth. POLICY_LOWER and POLICY_GLOWER variables could have a positive or negative
sign. The negative signs suggest that the population limiting policies have a negative effect on
GDP growth. The coefficients also could be positive because the population limiting policy could
have a positive impact on its GDP growth.

In general, the coefficients of Equations (7) and (8) are expected to have signs as follows.
The sign for the coefficient of POLICY_LOWER and POLICY_GLOWER should be negative,
indicating that governments with population limiting policies should have lower birth rates if
these population limiting policies are effective.

The sign for the coefficient of GDP should be negative, indicating that a higher GDP per
capita has a negative effect on birth rates. It has been widely observed that the birth rates of
countries tend to fall as they become wealthier. The people of poor countries lack the means to rise over their station in life or improve their national standing. As a result, not only do poor countries have high birth rates, they also have high death rates, especially high rates of infant mortality. In order to ensure that there are children alive, people in poor countries tend to marry young and to have more children.

I would expect that countries with a high mortality rate are poorer than those with lower mortality. Therefore, the sign for the MORTALITY coefficient could be positive, indicating that a country with a higher mortality has a higher birth rate as well.

The coefficients for LIFEEXPECTANCY should be negative, indicating that countries with higher life expectancy have lower birth rates. I expect that countries with higher life expectancy are more developed and have higher live standards so that the birth rates would be lower as we expect in a developed country.

The sign for the coefficient of LABPARTICIPATION could be negative, indicating that a country with a higher labor participation rate has a lower birth rate. Countries with higher labor participation rates are considered richer and more developed, therefore, the correlation of LABPARTICIPATION should be negative. The coefficient of AGRICULTURE could be positive, which suggests that the higher agriculture percents of GDP, the higher birth rates would be. Countries with more agriculture are generally viewed less developed and poor countries have higher birth rates, compared to those with high development. As a result, the correlation between birth rates and agriculture should be positive. GDP growth and FDI variables could have negative signs. The negative signs suggest that countries with a higher GDP growth and FDI would have lower birth rates because a higher GDP/FDI suggests a higher developed level of
country.
V. DATA AND DESCRIPTIVE STATISTICS

For the empirical model, I employ a cross-country panel dataset from the World Bank, the World Development Indicator catalog. I created the two policy indicators, one for 1996 and the other for 2009, using population policy data from the Department of Economic and Social Affairs Population Division. The purpose of this paper is to examine the impact of birth rate on economy in terms of GDP growth by cross-country comparisons. The data set consists of available demographic and economic variables for all countries in the world for the period from 2004 to 2008. The major standard used in selecting nations is whether data were available for all variables. However, the readers should be aware of a problem with the data that may affect the reliability of the empirical results. Although I only employ data for the five years from 2004 to 2008, a cross-national dataset such as I use is flawed by the presence of substantial heterogeneity in unobserved variables across countries and over time. I control for this problem when estimating the empirical model by reporting heterogeneity robust standard errors. The summary statistics from the data are listed in Table 1.
Table 1
SUMMARY STATISTICS OF VARIABLE

<table>
<thead>
<tr>
<th>Variables</th>
<th>N</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP growth (annual %)</td>
<td>950</td>
<td>5.678821</td>
<td>4.148812</td>
<td>2.7e-06</td>
<td>46.5</td>
</tr>
<tr>
<td>Birth rate, crude (per 1,000 people)</td>
<td>995</td>
<td>22.35088</td>
<td>11.01536</td>
<td>7.2</td>
<td>53.624</td>
</tr>
<tr>
<td>Savings (gross saving %)</td>
<td>836</td>
<td>22.80513</td>
<td>13.23394</td>
<td>-19.01313</td>
<td>142.2254</td>
</tr>
<tr>
<td>GDP per capita (current US$)</td>
<td>956</td>
<td>12232.82</td>
<td>19138.83</td>
<td>92.77942</td>
<td>141114.3</td>
</tr>
<tr>
<td>Mortality (per 1,000 live births)</td>
<td>760</td>
<td>34.21329</td>
<td>32.81286</td>
<td>1.2</td>
<td>139.8</td>
</tr>
<tr>
<td>Life expectancy (at birth, total (years))</td>
<td>975</td>
<td>68.33591</td>
<td>10.36544</td>
<td>41.09798</td>
<td>82.63415</td>
</tr>
<tr>
<td>Labor participation, total (% of total population ages 15+)</td>
<td>920</td>
<td>64.21337</td>
<td>9.856621</td>
<td>36.4</td>
<td>89.5</td>
</tr>
<tr>
<td>Agriculture, value added (% of GDP)</td>
<td>797</td>
<td>14.19433</td>
<td>13.40437</td>
<td>0</td>
<td>68.17391</td>
</tr>
<tr>
<td>Population limiting Policies in 1996*</td>
<td>665</td>
<td>0.3125</td>
<td>V/A</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Population limiting policies in 2009*</td>
<td>1215</td>
<td>0.8413462</td>
<td>V/A</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>FDI, net inflows (BoP**, current US$)</td>
<td>922</td>
<td>8.51e+09</td>
<td>2.69e+10</td>
<td>31593.78</td>
<td>3.28e+11</td>
</tr>
</tbody>
</table>

*For dummy variables, Mean is replaced by the number of observations equal to 1.
** Balance of Payments
Data source: World Bank (World Development Indicator), and Department of Economic and Social Affairs Population Division (World Population Policies 2009)
VI. FINDINGS AND ANALYSIS

This section systematically tests whether birth rate has a positive or negative effect on economic growth by controlling for some other variables that affect growth, such as gross savings rate, mortality rate, life expectancy, labor force participation, and government population limiting policies. I first provide the basic results and then estimate two more equations, testing the correlation between birth rate and government population limiting policies, in order to see the effect of population policies on birth rates.
A. Basic results

The results from Equation (5), detailed in section IV, are summarized by the following statistics:

<table>
<thead>
<tr>
<th>Table 2: Model Summary (Equation (5))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of observations</td>
</tr>
<tr>
<td>R-Squared</td>
</tr>
<tr>
<td>Adjusted R Squared</td>
</tr>
<tr>
<td>SSR</td>
</tr>
<tr>
<td>F-Statistic</td>
</tr>
</tbody>
</table>

***Significant at the 99% level of confidence.

In the models, the coefficients for the variables in Equation (5) are as follows:

<table>
<thead>
<tr>
<th>Table 3: Model Coefficients (Equation (5))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>(Constant)</td>
</tr>
<tr>
<td>BIRTHRATE ***</td>
</tr>
<tr>
<td>BIRTHRATE² ***</td>
</tr>
<tr>
<td>BIRTHRATE³ ***</td>
</tr>
<tr>
<td>SAVING ***</td>
</tr>
<tr>
<td>GDP ***</td>
</tr>
<tr>
<td>MORTALITY **</td>
</tr>
<tr>
<td>LIFE_EXPECTANCY</td>
</tr>
<tr>
<td>LAB_PARTICIPATION **</td>
</tr>
<tr>
<td>FDI</td>
</tr>
<tr>
<td>POLICY_LOWER (1996) *</td>
</tr>
</tbody>
</table>

*Significant at the 90% level of confidence.

**Significant at the 95% level of confidence.

***Significant at the 99% level of confidence.

In general, Equation (5) measures the effect of birth rate on economic growth. The regression results are consistent with my hypothesis that birth rate has both positive and negative effects on economic growth, depending on how high the birth rate is. The R-squared for this equation is 0.2229, which suggests that 22.29% of the variation in the relationship is accounted for by this regression. The R-squared suggests that the equation does a good job of capturing the
true relationship between birth rate and economic growth. Furthermore, the F-statistic is also high statistically significant, indicating that birth rates are associated with economic growth. I believe that a valid interpretation of the results in table 3 is as follows:

*First*, the coefficients of birthrate, birthrate2, and birthrate3 are all statistically significant at the 99% level, which supports my hypothesis that birth rate has an impact on economic growth in different directions.

The positive sign for the coefficient of birthrate indicates that countries with higher birth rates have higher GDP growth. However, as the birth rate goes up and approaches 10.37, the effect on GDP growth switch as to negative, meaning that a higher birth rate hampers economic growth at a certain point, as the coefficient of birthrate2 shows. More precisely, there is a diminishing marginal GDP growth effect when there is an increasing birth rate.

In order to further test the effect of birth rate on economic growth, I include a cubic form of birth rate, expecting the reverse relationship from the quadratic form. The statistically significant and positive coefficient of birthrate3 supports my hypothesis. The positive sign of birthrate3 indicates that at a very high birth rate (specifically 37.36), the relationship between birth rate and economic growth turns positive. The magnitude of those coefficients indicates that a very high birth rate does not hamper economic growth. Contrarily, a very high birth rate encourages economic growth. Figure 1c maps the relationship between birth rate, birth rate quadratic and birth rate cubic and GDP growth.

---

"This figure is drawn by the author and is not based on my data. It represents the general relationship between the two variables."
Second, as expected, the positive sign for the coefficient of gross saving of GDP means that a higher saving rate has a positive effect on GDP growth, when holding other variables constant. This variable has a high t-statistic, indicating a high level of statistical importance. The reason for the magnitude of this coefficient is obvious. The gross saving rate can be directly transferred to a variety of investments, as gross savings rate has a positive relationship with GDP growth. When the gross saving rate of a country is higher, it has more capital to invest, and thus, the GDP growth will be enhanced.

Third, the fact that the coefficient of GDP is negative and statistically significant shows that a higher GDP per capita is associated with a lower economic growth, as Figure 2 shows. The significance of this coefficient supports the idea of the “catch-up effect,” a theory that expresses
the possibility of poorer economies growing at a quicker pace than richer economies. Moreover, the variable GDP in my paper stands for the development level of each country. As a result, when GDP is controlled for, the empirical results would show how a range of exogenous variables affect economic growth for each country at the same development level.

Figure 2. GDP per capita V.S GDP growth

The positive sign of MORTALITY with statistical significance means that a higher mortality increases GDP growth as expected. Countries with high mortality rates are generally at a lower level of development than those with lower mortality. As a result, the coefficient of mortality is positive as the catch-up effect suggests. This serves as another control for the level of development.

The coefficient of LAB_PARTICIPATION shows a positive relationship with GDP growth, holding other variables constant. The high t-statistic indicates that when the rate of labor force participation is...
participation goes up, so does the GDP growth. Since labor force participation represents the labor force participation rate of the total population ages 15 and above, and the labor force participation rate is highly associated with the unemployment rate, a high labor force participation rate is equivalent to a low unemployment rate. As a result, the coefficient of labor participation rate is positively associated with GDP growth.

In this model, the signs of life expectancy and FDI are not statistically significant at any statistical significance levels. In addition, the coefficient of POLICY_LOWER has a negative sign, indicating that countries with population limiting policies have lower GDP growth. However, while this coefficient is statistically significant, there may be an endogeneity issue and I do not address it in my paper. Since the purpose of this paper is to examine the relationship between birth rates and economic growth, I do not focus on the equations testing the correlation between birth rate and population limiting policies. Therefore, in this paper, I ignore the potential endogeneity issue which may result in the shortcoming of not controlling for exogenous variables.\(^d\)

\(^d\) The problem of endogeneity can arise as a result of measurement error, autoregression with autocorrelated errors, simultaneity, omitted variables, and sample selection errors. Broadly, a loop of causality between the independent and dependent variables of a model leads to endogeneity. In other words, endogeneity occurs when the independent variable is correlated with the error term in a regression model. This may imply that the regression coefficient in an Ordinary Least Squares (OLS) regression is biased.
The results from the Equation (6) detailed in section IV are summarized by the following statistics:

<table>
<thead>
<tr>
<th>Table 4: Model Summary (Equation (6))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of observations</td>
</tr>
<tr>
<td>R-Squared</td>
</tr>
<tr>
<td>Adjusted R Squared</td>
</tr>
<tr>
<td>SSR</td>
</tr>
<tr>
<td>F-Statistic ***</td>
</tr>
</tbody>
</table>

***Significant at the 99% level of confidence.

In the models, the coefficients for the variables are as follows:

<table>
<thead>
<tr>
<th>Table 5: Model Coefficients (Equation (6))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>(Constant) *</td>
</tr>
<tr>
<td>BIRTHRATE ***</td>
</tr>
<tr>
<td>BIRTHRATE2 ***</td>
</tr>
<tr>
<td>BIRTHRATE3 ***</td>
</tr>
<tr>
<td>SAVING ***</td>
</tr>
<tr>
<td>GDP ***</td>
</tr>
<tr>
<td>MORTALITY ***</td>
</tr>
<tr>
<td>LIFE_EXPECTANCY</td>
</tr>
<tr>
<td>LAB_PARTICIPATION **</td>
</tr>
<tr>
<td>FDI</td>
</tr>
<tr>
<td>POLICY_GLOWER (2009) ***</td>
</tr>
</tbody>
</table>

*Significant at the 90% level of confidence.
**Significant at the 95% level of confidence.
***Significant at the 99% level of confidence.

The only difference between Equation (5) and (6) is the timing of the government population limiting policy. The policy variable, POLICY_LOWER, in equation (5) reflects government population limiting policies in effect in 1996. In contrast, the policy variable, POLICY_GLOWER, in Equation (6) represents the population limiting policies in effect in 2009.
These two variables in Equations (5) and (6) show the effect of the population limiting policies on GDP growth.

As table 5 shows, the statistically significance of all the coefficients in Equation (6) remain the same as those from equation (5). The F-statistic remains high statistically significant, indicating that birth rates are associated with economic growth. However, although it seems that the population control policies hurt GDP growth, the effect of government population limiting policies in equation (6) seems to be lower, compared to those in equation (5).

However, as with Equation (5), while this coefficient is statistically significant, there may be an endogeneity issue and I do not address it in my paper. Since the purpose of this paper is to examine the relationship between birth rates and economic growth, I do not focus on the equations testing the correlation between birth rate and population limiting policies. Therefore, in this paper, I ignore the potential endogeneity issue which may result in the shortcoming of not controlling for exogenous variables.
B. Birthrate versus Government Population Limiting Policy

In this section, I run two additional models in order to see how government population limiting policies affect birth rates. Like the estimations above, the only difference between the two models below is the date of the population limiting policies, and the addition of agriculture as a percent of GDP.

The results from the Equation (7) detailed above are summarized by the following statistics:

<table>
<thead>
<tr>
<th>Table 6: Model Summary (Equation (7))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of observations</td>
</tr>
<tr>
<td>R- Squared</td>
</tr>
<tr>
<td>Adjusted R Squared</td>
</tr>
<tr>
<td>SSR</td>
</tr>
<tr>
<td>F-Statistic ***</td>
</tr>
</tbody>
</table>

***Significant at the 99% level of confidence.

In the models, the coefficients for the variables were as follows:

<table>
<thead>
<tr>
<th>Table 7: Model Coefficients (Equation (7))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>(Constant) ***</td>
</tr>
<tr>
<td>POLICY_LOWER (1996) ***</td>
</tr>
<tr>
<td>GDP</td>
</tr>
<tr>
<td>MORTALITY ***</td>
</tr>
<tr>
<td>LIFE_EXPECTANCY ***</td>
</tr>
<tr>
<td>AGRICULTURE ***</td>
</tr>
<tr>
<td>LAB_PARTICIPATION ***</td>
</tr>
<tr>
<td>GDP_GROWTH ***</td>
</tr>
<tr>
<td>FDI</td>
</tr>
</tbody>
</table>

*Significant at the 90% level of confidence.
**Significant at the 95% level of confidence.
***Significant at the 99% level of confidence.
The results from the Equation (8) detailed above are summarized by the following statistics:

<table>
<thead>
<tr>
<th>Table 8: Model Summary (Equation (8))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of observations</td>
</tr>
<tr>
<td>R-Squared</td>
</tr>
<tr>
<td>Adjusted R Squared</td>
</tr>
<tr>
<td>SSR</td>
</tr>
<tr>
<td>F-Statistic ***</td>
</tr>
</tbody>
</table>

***Significant at the 99% level of confidence.

In the models, the coefficients for the variables were as follows:

<table>
<thead>
<tr>
<th>Table 9: Model Coefficients (Equation (8))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>(Constant) ***</td>
</tr>
<tr>
<td>POLICY_GLOWER (2009) ***</td>
</tr>
<tr>
<td>GDP **</td>
</tr>
<tr>
<td>MORTALITY ***</td>
</tr>
<tr>
<td>LIFE_EXPECTANCY ***</td>
</tr>
<tr>
<td>AGRICULTURE **</td>
</tr>
<tr>
<td>LAB_PARTICIPATION ***</td>
</tr>
<tr>
<td>GDP_GROWTH *</td>
</tr>
<tr>
<td>FDI **</td>
</tr>
</tbody>
</table>

*Significant at the 90% level of confidence.
**Significant at the 95% level of confidence.
***Significant at the 99% level of confidence.

As the results of these two regressions show, “limiting policy” is statistically significantly and positively associated with birth rate, holding other variables constant. The R-squares for those two equations are 0.83 and 0.85 respectively, which suggests that roughly 84% of the variation in the relationship is accounted for by these regressions. The R-squares suggest that the equations do a good job of capturing the true relationship between birth rates and population limiting policies. The F-statistic is also high statistically significant, indicating that birth rates are associated with population limiting policies. Furthermore, we can see that POLICY_GLOWER both of greater magnitude and more statistically significant than POLICY_LOWER, suggesting
that population limiting policies implemented in 2009 have a stronger association with birth rates than policies implemented in 1996. Of course, the previous mentioned issue with endogeneity may affect these results, particularly with POLICY_GLOWER.

The positive signs here indicate that countries with population limiting policies have a high birth rate, suggesting that population limiting policy may not be a wise thing or that population limiting policies take a long time to be effective. In this perspective, birth control policies do not seem to work well because countries with population limiting policies still have higher birth rates. However, this may also imply that those countries with population control policies already had high birth rates. So, even if those countries employ population limiting policies, they may not able to control immediately high birth rates. Importantly, in Equations (7) and (8), I ignore the year of population policy change; I ask only whether population limiting policies were in effect or not in 1996 and 2009. I also ignore the endogeneity issue. However, as the high F-value, as well as the R-squares show, in my paper I find contrary to expectations that population limiting policies do not have a negative impact on birth rates. Moreover, the empirical results of Equations (5) and (6) show that population limiting policies have a negative effect on GDP growth, indicating that GDP growth will be hindered by a population limiting policy. In sum, the four equations seem to show that developing and executing a population limiting policy may not have the intended effect because the results shows that those policies fail to control high birth rates and hurt GDP growth.
VII. CONCLUSION AND POLICY RECOMMENDATIONS

The catalyst of this paper is an empirical finding, showing a non-linear relationship between birth rates and economic growth in a short-run period between 2004 and 2008. Because the relationship between these two variables seems to be changeable over time, in different context for each country, the nature of the correlation cannot be simply described.

In the 1960s and 1970s, studies as the literature typically concluded that the rate of population growth did not appear to have a notable impact on per capita output growth. However, beginning from the 1980s, studies showed that a strong and robustly negative impact emerged. Despite the wide acceptance of the fact that high population growth had a negative impact on economic growth, some scholars, such as Boserup (1981), argued that population growth may have had a level positive effect on economic growth in 1990s.

Using the previous studies and the theories of economic growth as a guide, in this paper, I attempted to discern whether birth rates hamper economic growth by using a cross-country panel dataset for the years 2004 to 2008. In order to re-examine the impact of birth rates on economic growth, I employ four empirical models, including variables related to the economy, demography, and population policy.

There is divergence of opinion regarding the desirability of population growth. Some people think that rapid population growth is a serious problem; while others think that population growth should not be a matter of grave concern. However, cross-country evidence on the relationship between population growth and economic growth is not consistent and uniform. In my paper, I find that the birth rate does hamper economic growth at a certain point. When the birth rate reaches a very high level, however, the relationship between these two variables is no
longer negative, but instead positive. This finding is robust even after I control for a number of demographic and economic variables.

My empirical findings in this paper not only supports the Neo-Malthusian view that population growth has a negative impact on economic grow, but also proves the view that population growth should not be terrifying, and could actually encourage GDP growth at certain levels.

In addition, in this paper, I employ two policy variables that refer to each country’s population limiting policy to see the impact of such policies on GDP growth as well as on birth rates.

Based on the empirical results, first, I find that population limiting policies have a positive correlation with birth rates, indicating that population limiting policies do not really control the birth rates, contrary to what countries who are tempted to control their birth rates may assume.

Second, I find that population limiting policies have negative relationship with GDP growth, which means that the employment of population limiting policies are associated with a lower GDP growth. The results show that population limiting policies not only fail to have the expected effect on controlling birth rates, but they may also hamper economic growth, which should be a warning to those governments who now have population limiting policies.

Based on the empirical results, I, therefore, propose the following policy implications:

First, I conclude that since the correlations between GDP growth and birth rate can be both negative and positive in different contexts in the short term; and given the findings that high birth rates do not necessarily hamper a country’s economy; and that population limiting policies may be generally ineffective and may actually hurt economic growth, governments should be more
careful when they are setting up a population limiting policy. This is especially true in the face of the increasing difficulties of generating support for population programs during a period of declining birth rates.

Second, it is possible to argue that the population limiting policies do work, but perhaps at very low speed. In other words, they take a very long time to be effective. If this argument is true, governments should still be careful about implementing population limiting policies. Governments should develop some surrounding policies such as evaluating programs, tracing systems and policies that ensure the population limiting policies can be effectively implemented.

In the paper “Zero Population and the Economies of Developed Nations,” the author has suggested that developed countries should not try to counteract declining growth rate trends (Thomas, 1978). Moreover, as Coale (1968) has argued, “no country can grow at a positive rate forever, and in the long run the average rate of population growth must be zero, thus, net reproduction rates permanently in excess of 1.0 do not represent a solution to any problem.” If these arguments are true, it may also suggest that population limiting policies are not fundamentally necessary. From the empirical result in my paper, the population limiting policies have no effectiveness and they hurt economic growth. Presumably, these programs are costly, as countries expend resources with a negative rate of return.

However, because I ignore the potential endogeneity issue, which may result in the shortcoming of not controlling for endogenous variables, it is hard to tell the population limiting policy implications based on the empirical results in this paper.

Third, back to the essential question: based on the results from the empirical models, the statistically significance of the coefficients suggests a non-linear relationship, in that birth rates
and economic growth are not necessarily negatively associated. However, it would be arbitrary to recommend that all countries in the world stop considering population issues. Since countries are in different demographic and economic contexts, policies related to population and the economy should be developed within context of each country.

Finally, I only use two years of population limiting policies, 1996 and 2009, due to data collection problems. Additionally, in my estimations, I cover only 5 years. This study, therefore, may suffer from the criticism that the observation period is too short and the data covering population policies are inadequate. As a result, more data and variables should be included and traced in these models for future research.
VIII. BIBLIOGRAPHY


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