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BACHELOR THESIS

Impact of Population Policies on Economic Development

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Declaration of Authorship

The author hereby declares that he compiled this thesis independently, using only the listed resources and literature.

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Abstract

Within the presented thesis, the issue on the impact of population policy types and economic development is investigated using econometric regression analysis on an unbalanced data panel of 188 countries during the period of 2000 to 2014. The key development of the existing econometric model is the adoption of population policy indicator variables according to the type of population policy (pronatal, antinatal, maintain and no intervention). The aim of this thesis is to show the significance and positive or negative correlation of population policy dummy variables with the use of representative datasets, which were selected according to empirical research. Additionally, the same model is also conducted for different groups of countries, (more developed, less developed and least developed) so as to examine the outcome according to the level of development. Consequently, short term negative effect of pronatalistic and maintaining population policy on GDP per capita is demonstrated. On contrary, regressions on different groups of countries validates no significant evidence on policy dummy variables.

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Topic Characteristics

The aim of this thesis is to explore the relationships between population policy and economic development.

Human population is exponentially increasing today. Some scientists estimated to surpass 10 billion world populations by the year 2050. Each country is trying to control their population using population control policies. There are mainly four ways, which country can have approaches on its population. A county, who wishes to increase its population size (pro-natalist), reduce the number of population (anti-natalist), keep the size of population (Maintain) or No intervention at all. I am here to find out whether the type of policy on population has statistical significance or not.

In addition, I will further investigate separately on more developed, less developed and least developed countries to check the robustness of my result applying the model for different samples.

Hypothesis

1. Anti-natalistic population policy is proportionally linked to its economic development.
2. Pro-natalistic population policy affects positively on economic growth.
3. No interventional population policy has negative impact on economic growth
4. More developed countries are, more significant effect of population policy on economic growth.
5. Effect of population policy varies according to a county's level of development and demographic transition.

Methodology

The data will be collected from number of sources such as United Nations and World Bank. The Panel data Fixed effects and Random effects models are used for countries all over the world, for the estimated time period of more than a decade. The model includes several dummy variables that indicates type of population policies. Moreover, sample countries are divided into three groups; more, less and least developed countries, and performed regression separately as well as full sample countries.

Expected Contribution

My aim is to extend and update the existing model. More importantly, I will introduce the adoption of population policy indicator dummy variables in the panel data regression, in order to find effect of the policy type on population.

Outline

1. Introduction: Short introduction on population issues and a change in population policy tendency in recent years.
2. Literature overview:
   A) Brief case study of population policy adoption.
   B) Brief overview of related empirical evidence
3. Methodology: Description of data sources, and data definition. I will describe the use of panel data, further explain why I use fixed effect/random effect model.
4. Result: Regression results are discussed.
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Core Bibliography

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List of Tables

Acronyms

ADF	Augmented Dickey Fuller
DEA	Data Envelopement Analysis
EAP	Economically Active Population
FE	Fixed Effects
GDP	Gross Domestic Product
GMM	Generalized Method of Moments
HAC	Heteroscedastic and Autocorrelation Consistent
ICPD	International Conference on Population and Development
IUD	Intra-Uterine Device
OLS	Ordinary Least Squares
RE	Random Effects
TFP	Total Factor Productivity
UN	United Nations
US	United States
VAR	Vector Auto-Regression
VECM	Vector Error Correlation Model

1 Introduction

Population expansion has becoming a major concern in this current world for more than a century already. Many of economists and demographist in the past have tried to investigate the relation between population and economic development/growth. The world is yet to discover the ultimately true relationships between population growth and economic development/growth, since each researchers use different set of data and different types of methodologies.

Nevertheless, in modern economy, each nations has the need of controlling its population size, thus population controlling policies are implemented for most of the countries. In fact, the tendency of population policy in this recent years show some differences compared with a few decades ago. Originally plenty of developing countries adopted anti-natalist population policy in order to decrease population expansion, but now developed countries face the problem of aging population and a number of developed countries started introducing pro-natalist population policy to increase future population size in this 21st century. This modern tendency arises the question of impact of population policy on economic development today.

The objective of this thesis is to explore the impact of population policy on economic development. For this purpose, panel data econometric regression method is used with population policy indicator variables, which indicates a country's type of population policy at the estimated period. Furthermore, our research also investigates into the change in effect of population policy indicator variables according to a country's level of development. The same panel data regression model is applied on four sets of countries; full sample, more developed, less developed and least developed countries.

The thesis is structured as follows: Chapter 2 gives some background knowledge of population and population policy, as well as presenting some case studies of population policy adoption. Chapter 3 presents literature review based on empirical evidence of related research articles, and their methodology and findings. Chapter 4 outlines the hypotheses statement. Chapter 5 demonstrates data and methodology of our panel data analysis. In Chapter 6, empirical results and findings are discussed. Finally Chapter 7 summarizes major findings and provides topics for further study.

2 Population and Population Policy

2.1 Population Issues

United Nations predicts that “by 2050, the world’s population is likely to reach an unprecedented size between 8.3 billion and 10.9 billion people.” (United Nations, 2013, p.47) This figure is based on an estimation that most of the population growth will happen in developing countries, especially in least developed countries. This rapid growth will accelerates a discussion on possible demographic phenomenon. Population growth is unstoppable, although resources are scarce.

In the year 1798, Thomas Malthus published a potent work “*An Essay on the Principle of Population”*. Within his essay, he predicts the future of state of society, and he presents a famous quotes, “Population, when unchecked, increases in a geometrical ratio, Subsistence, increases only in an arithmetical ratio.”, moreover “the power of population is so superior to the power in the earth to produce subsistence for man.”(Malthus, T., 1998) He have stressed out a negative impact of a rapid population growth, stating that if a high population growth rate remains, society will reach a point where there will be not enough food for every residents, which will eventually lead to poverty, misery and deprivation.

Ultimately there are two solutions to the consequence of population expansions, preventive checks and positive checks. Preventive check is moral restraints such as delayed marriage and abstinence, while positive check leads to premature deaths caused by famine, disease and war, which is not a morally acceptable outcome.

Several centuries after the publication of Malthus’s essay, a number of economists showed their assent to Malthusian thought, and some assert other views such as optimistic and revolutionist views.

In any case, there are a strong need for controlling human population somehow. Thus, population control policy has spontaneously established and spread worldwide.

2.2 Population Policy

Types of Population policy and tendency

According to the Permanent Population Committee, a definition of population policy as follows: “Population policy determines the principles, objectives and policies adopted by the State as regards population issues for the purpose of influencing population status, including variables in population growth and its main elements as well as general issues relating to health and education.” (Population Policy, 2012) Population policy is composed of a number of polices influencing all programs and activities directly and indirectly affecting population variables. Population variables are such as fertility, births, deaths, geographical, distribution, migration, population dynamics and so on. In truth, National population policy commonly targets to control fertility rates per woman.

In fact, there is a clear indicator for a nation to aim the level of fertility rate. It is known as fertility replacement level. Fertility rate is defined as a number of births per woman, and it is usually ideal when the figure is above 2, since boys generally born more than girls, moreover, not all of the girls survive until the reproductive age. In general, the fertility rate replacement levels are “estimated to be 2.1 births per woman in industrial countries and 2.4 per woman in developing countries.” (Batini, Callen, McKibbin, 2006). Replacement fertility rate could get as high as 3.5 births per woman in some countries, mostly from least developed regions. This is because of significantly high rate of mortality.

There are three major approaches to population polices.

1. The first is the regulatory approach, where governments impose regulations and restrictions that control the number of population
2. The second approach is to offer incentives: prizes or money to families that control the number of children they have
3. The third approach is to argue that according to demographic transition, fertility decline as people become more affluent. Therefore policies are implemented to raise people’s standards of living in the hope that will result in reduced population growth.

In reality, governments often use a number of combinations of these policy approaches.

There are 2 distinctive types of population policies, which are differentiated by its purpose; Pro-natalist population policy and Anti-natalist population policy. Pro-natalist population policy aims to raise a national population, on the contrary, Anti-natalist population policy aims to lower population size. There are also 2 more different views on policy on population growth; it will be discussed subsequently.

In fact, United Nations distinguishes population policies into 4 different types. Indeed, United Nations have a large contribution towards collecting data concerning, demographic variables. From 1990s, the United Nations begun to take demographic issues in earnest and began to play an active role in evaluating as well as forecasting global population issues. In year 1994, the United Nations organized the first International Conference on Population and Development (ICPD) in Cairo. Since then, UN continually analyzes population issues, gather data, and publishes relevant documents. Within United Nations' Department of Economic and Social Affairs, Population Division publishes "World Population Policies" every few years. It provides a data set on 48 variables in six thematic areas concerning population.

One of the observed variables is the policy on growth, which "indicates Government's stated policy to influence the rate of population growth in the country" (United Nations. 2013) and it has 4 different response categories; no intervention, maintain, raise and lower. Summary of government policies on rate of population growth for the period 1976 to 2013 is represented by Table 1.

By the use of Table 1, the tendency of world population for past 40 years can be observed. UN provides data that 73 states over 197 states (two Observer States and two non-UN member States are also included) have policies to lower population in 2013, in fact, out of 72 states are from less developed regions. This means that 49% of less developed states use anti-natalist policy. On the one hand, 39 states have pro-natalist policies and 24 states of those are more developed regional states. 49% of wealthy states implement pro-natalist policy. Government policies on the rate of population growth in recent years, have an inimitable tendency. In year 1996, there were only 25 states that wish to raise population. 11 of them are wealthy-states, and other 14 states are from less developed regions.

There were only 25 pro-natalist states in 1996, and 39 anti-natalist states in year 1976.

Table 1: Government policies on the rate of population growth, 1976-2013.

Year	By level of development									
	Number of countries					Percentage				
	Raise	Maintain	Lower	No intervention	Total	Raise	Maintain	Lower	No intervention	Total
World										
1976	28	0	39	83	150	19	0	26	55	100
1986	26	12	53	73	164	16	7	32	45	100
1996	25	16	71	81	193	13	8	37	42	100
2005	29	32	70	63	194	15	16	36	32	100
2013	39	41	73	44	197	20	21	37	22	100
More developed regions										
1976	8	0	0	26	34	24	0	0	76	100
1986	8	8	0	18	34	24	24	0	53	100
1996	11	6	1	30	48	23	13	2	63	100
2005	17	8	0	23	48	35	17	0	48	100
2013	24	7	1	17	49	49	14	2	35	100
Less developed regions										
1976	20	0	39	57	116	17	0	34	49	100
1986	18	4	53	55	130	14	3	41	42	100
1996	14	10	70	51	145	10	7	48	35	100
2005	12	24	70	40	146	8	16	48	27	100
2013	15	34	72	27	148	10	23	49	18	100
Least developed countries										
1976	5	0	6	31	42	12	0	14	74	100
1986	4	3	14	27	48	8	6	29	56	100
1996	1	1	27	20	49	2	2	55	41	100
2005	0	4	35	11	50	0	8	70	22	100
2013	0	3	41	5	49	0	6	84	10	100

Source: United Nations, 2013

This increase in number of pro-natalist state in more developed regions is because of the rise in concern of population aging in developed countries. Many of European countries such as Germany, Spain, Italy and Poland turned out to introduce pro-natalist policy in the 21st century. This recent tendency creates some valuable meanings to review recent population policy influence on economic development yet again.

Case study of population policy adoption

In this section, we would like to present one real life example for anti-natalist, pro-natalist and no intervention country.

The most well-known and extreme example of anti-natalist country is China. China has the world's largest population with a significant figure of 1.4 billion people. Chinese population control policy is so-called "One-Child Policy", which restricts only one child per couple. The One Child Policy was introduced in 1980, providing rewards as well as benefits for couples, who promised to have one child only. Benefits are things such as, supplementary health care subsidies and priorities in health care, in housing allocation, in educational provision, extra land and food were given for families with one child. Moreover, minimum legal age for marriage was raised for 22 for men and 20 for women, by doing this implementation, couples would have fewer time left to up bring child. The one child policy in reality, have some penalties punishments, too. Punishments may arise for unapproved delivery of a birth, a birth for couples with illegal marriage age, or having an approved 2nd child too early. Family planning staff who disrupt regulations by accepting bribes, making incorrect reports, or issuing fake birth certificates are also to be punished. Penalties generally include financial fines, losing government benefits, degradation or discharge from employment or from Communist Party membership. In the early 1990s, the guidelines were tightened further. The Decision on Strengthening the Family Planning Programmed to Strictly Control Population Growth of 1991contains provisions suggesting the use of IUDs and sterilization, and allowing forced pregnancy termination (abortions) in certain circumstances. However, the official policy is that coercive action should not be used as part of the country's population policies.

As a result of the One Child Policy, it is now predicted by the Chinese authorities that the country's total population will peak at 1.5 billion by 2033. The proportion of women at childbearing age decreased to 27%in 2000, and predicted decreases will lower the figure to 24.5%by 2020 and 19%by 2040. Meanwhile the percentage of aged people increased from 7.63% in 1982 to 9.84% in 2000, and it is expected to increase to 21.9% by 2030. Furthermore in 2050, the proportion of China's population that is aged will be 27.43%, and this will pose significant challenges for the provision of services for the elderly. (Codrington, 2009)

In fact, on 29th of October 2015, the abolition of One-Child Policy has announced by Chinese government, in order to cope with coming population aging concern.

In fact, however, there have been several consequences of this strict population control. In the peak year of 1983, family planning promoting members have carried out more than 20 million sterilizations, 17 million IUD insertions, and 12 million abortions. (Codrington, 2009) There is also concern that those children who are born and grow up without any siblings are becoming extremely selfish and spoilt. Single children in China tend to have every desire fulfilled by parents and other adults. For this reason, spoilt child are commonly known in China as 'little emperors'. In another generation, the concepts of 'aunt', 'uncle', 'cousin' 'sister' and 'brother' disappear in China. Chinese extreme Population policy completely changed social condition within a country.

One example of pro-natalist country: Singapore.

Singapore has a unique view on population such that people is the most precious resource, particularly those who are well-educated.
Thus in 1987, Singapore newly introduced a pro-natalistic population policy to target young citizens who put their personal interest above marriage and parenthood. The aim of the policy was to target fertility replacement level of 2.1 births per woman. Just before the introduction of the new policy in 1986, Singapore marked fertility rate record of 1.4. In contrast, in 1988, one year after the pro-natalist policy, fertility significantly rose up to 2.0, but yet it is below the replacement rate. Unless Singapore will continue to mark fertility rate above 2.1, it is said that Singapore's population will start to fall in 2030 with a peak population below 5.5 million. (Codrington, 2009) Moreover in 2030, since the post-war baby boomer will reach retirement age, the proportion of over 60-year-olds population will rise from 9% today to 25%. Singapore government needs to prevent this coming aging society by their population policy. Let me remark in passing, Singapore government especially demand a number of intellectually talented people. While their policy generally encourages two children each coupes, couples that are college graduates are encouraged to have four children. In addition, Singapore is trying to inspire the immigration of erudite and talented people from other countries, mostly from Asia, and deterring the emigration of well-educated graduates at the same time.

In contrast with China and Singapore, United States have no-interventional view on population. USA has no formal population policy apart from its laws governing immigration. US government believes that individual people have a right to choose their own family planning. This is contrary to the Chinese population vision, which is to make the overall goals as a priority over individual rights of people.

Thus, the US government has established laws providing family planning services. In this way, low income earned women have access to contraception and controlling birth. In most of province in US, a woman must have had a child or be pregnant, be single, and have an earnings that is below 50% of the poverty line to be qualified for refunds for family planning.

In 1970, the US government introduced a national family planning program. This program, today, provides financial support to around 75% of all family planning agencies. About four million Americans, as a result, use government funded family planning program to get abortions or sterilizations annually. (Codrington, 2009)

Maintain population policy is an application of both anti and pro-natalist population policies.

We must note that the effect of population policies alter across countries. Efficiency of population policy varies through educational level, religion and occupation of the people concerned. Muslim religion for instance,
Research in India shows that fertility declined more among non-Muslims than Muslims. (Codrington, 2009) This suggests that contraception is more likely to be adopted where it does not violate religious and social norms.

3 Empirical Evidence

3.1 Empirical Evidence

Usually many of economists in the past have tried to clarify the relationship between population growth and economic growth through econometrical approach. Their conclusions are, interestingly enough, all different. Some say population growth significantly affects economic growth, and others say there is no relationship at all. Moreover, within those who have presented significance of population growth, some supports positive relationships, some advocate negative effects, different effect in short-term and long-term or effect varies in regards to the level of economic development and so on. There are also some economists who preach that not population growth affects economic growth, but economic growth affects population growth. The authors to be mentioned are: Pritchett (1994), Kelly and Schmidt (1996), Bloom and Williamson (1997), Thornton (2001), Tsen and Furoka (2005), Nakibullah (2010), Huang and Xie (2013), Yao, Kinugasa and Hamori (2013).

The observed differences in conclusion is mainly caused by the difference in their methodology as well as data. The type of econometric model, a selection of country, a period of observed years and selected independent variables are all important elements of the observations. Nakibullah (2010) and Yao, Kinugasa, Hamori (2013) investigated on a single country, Bangladesh for period 1962 to 1990 and China for period 1952 to 2007, respectively. On contrary, Kelly and Schmidt (1996) have collected data for 135 counties during the time period of 1960 to 1990 and Tsen and Froka (2005) have selected 9 Asian countires with dataset for unbalanced length of period for 36 to 50 years.

It is important to note that the majority of analysis in the past were mostly focused on developing countires only. This is because more developed countries tend not to have rapid population growth significance in the past, furthermore, most of developed countries had no-interventional view on population 20 years ago.

As well as methodology and data all varies in many aspects, types of models are all different, too. some used Panel data and Panel OLS (Kelly, Schmidt., 1996) (Bloom and Williamson ,1997) , simple time-series (Thornton., 2001), complex time-series such as vector auto-regression (VAR) (Nakibullah., 2010) and vector error correlation model (VECM) (Yao,Kinugasa, Hamori., 2013) Cointegration, Generalized method of moments (Huang, Xie., 2013) and so on. The type of model precisely affects conclusions. Simplistic stationary time series models may contain methodological mistakes, the other complex models such as cointegration and panel data could show somewhat moderated outcomes.

The Table 2 demonstrates several empirical works showing the diversity of conclusions depending on the methodology, unit of observation and period.

Table 2: Empirical Analysis Review on population and economic growth

Authors	Model	Data	Population growth affects economic growth	Additional comments
Kelley, Schmidt (1996)	Panel	135 countries, 1960-1990	Yes and No	Population growth effect on economic growth varies in regards to economic development level
Bloom, Williamson (1997)	Panel OLS	78 Asian and non-Asian countries, 1965-1990	Yes	Direction of relationship depends on the ratio of working-age population and population
Thornton (2001)	Time-series	Latin American countries, 1900-1994	No relationship	-
Tsen, Furoka (2005)	Cointegration	Japan, Philippines, Thailand, 1950-2000; China, 1952-2000; Korea, 1953-2000; Taiwan, 1951-1998; Hong Kong and Indonesia, 1960-2000; Singapore, 1960-1996	No relationship	Granger causation show in some cases, there is a causation, but because of unreliable methodology, we cannot take those results into account
Nakibullah (2010)	Time-series (VAR)	Bangladesh, 1962-1990	No	Economic growth affects population growth
Huang, Xie (2013)	GMM	90 countries, 1980-2007	Yes and No	In short-term population affects economic growth, in long-term there is no relationship; economic growth does not affect population growth no matter of timeframe
Yao, Kinugasa, Hamori (2013)	Time-series (VECM)	China 1952-2007	Negatively	Workforce structure positively impacts economic growth

Source: Škare and Blažević (2015)

Population Structure

(Bloom, Williamson, 1997) has taken into account of the growth rate of the economically active population, as well as growth rates of economically active population minus total population variable into the Panel OLS model. The growth rate in the economically active population is simply the growth rate of working-age population, which are aged 15 to 64. They also came up with a result that both variables are the key and statistically significant factor of economic growth. Yao, Kinugasa and Hamori (2013) have also included working-age population as an independent variable of their VECM regression. Both analysis concluded that the impact of working-age population is positively significant to economic development. In addition, Higgins and Williamson (1997) also arrived at a conclusion that changes in population structure affect capital stock, and eventually economic growth, through effects on savings, investment demand and the current account. Reviewing these empirical evidences, we observe that economic growth is affected largely by not only the population growth rate but also its population structure.

Influence on fertility:

Lant Pritchett (1994) terminates in his published article that changes in socioeconomic conditions are vital elements of fertility declines in less developed regions. Many of economists agree with this statement.

Education level

One of the vital socioeconomic conditions that have an effect on fertility rate is education level. Bloom and Williamson (1997) included logarithm of years of secondary schooling into their panel data analysis, also Huang and Xia included gross secondary school enrolment ration into their GMM models. Both paper shows significance of schooling variable on income per capita. Moreover, some economists focus on investigating especially into female literacy. Cross-country evidence shows much stronger effects of female than male education in reducing fertility (Schultz, 1993; Subbarao and Raney, 1993; Barro and Lee, 1993b)BY(Land Pritchett, 1994)Pritchett (1994) have also stated that household-level evidence shows the importance of female education for reducing fertility through lower fertility desires.(Pritchett, 1994) Summers (1992), for instance, provides an evidence that increasing female literacy rate in Pakistan was a cost-effective solution for lowering down fertility rate.

Savings rate

According to Regináč (2009), theoretically population growth does not instantly influence output, but it influences consumption, thus it could have an immediate effect on savings. Indeed Yao, Kinugasa and Hamori (2013) includes logarithm of savings rate into their model, since it has positively significant impact on GDP per capita. Moreover, Wang, Cai and Zhang (2004) shows empirical data that the savings rate is impacted positively by population size but impacted negatively by the structure of the dependent population.

Technological Progress

Yao, Kinugasa and Hamori (2013), for instance, count technological progress measure among their time-series analysis on Chinese economy. The reason for their technological measure adoption is to overcome the problem associated with the Solow residual, which is the part of growth that cannot be explained by simplistic form of the Solow growth model. They used Data Envelopment Analysis (DEA) approach developed by Coelli (1996), to compute average total factor productivity (TFP) growth of China. This methodology were applicable, since their analysis was focused on single country time-series model.

4 Hypotheses

4.1 Hypotheses

Based on the review of econometric models and research findings, although all the empirical evidence does not show the exact impact, we are able to build some hypothesis.

- **H_1: Population growth rate and economically active population rate are positively correlated with GDP per capita.**

  In fact, human capital generates GDP. If the number of active population has increased, a value of GDP is expected to increase proportionally.

- **H_2: Difference between growth rate of total population and growth rate of economically active population is positively correlated with GDP per capita.**

  As the empirical evidence was demonstrated by Bloom and Williamson (1997) is hypothesis should be supported.

- **H_3: There is a positive correlation between economically active population and GDP per capita**

  Similar to H_1andH_2, however not necessarily the growth rate of economically active population.

- **H_4: There is a negative correlation between population ages 65 and above and GDP per capita**

  Since the importance of population structures are presented in last chapter, increase in number of population above 65 and above shall lower the dependency ratio. As a consequence decreases GDP per capita.

- **H_5: Direction of the fertility rate effect on GDP per capita varies in regards to economic development level**

  As fertility rate increases, GDP per capita for developing country decreases, for developed country increases.

- **H_6: Increasing number of female student will lead to better population control, thus positively correlated to GDP per capita.**

  As the importance of female literacy on fertility rate was introduced in previous chapter, this will indirectly correlated with GDP per capita.

- **H_7: A country with population controlling policy leads to better effect on GDP per capita.**

  Ultimate goal of controlling population size is to keep high GDP as a nation, thus population policy indicator should affect positively.

- **H_8: No interventionists have negative coefficient on GDP per capita**

  The nature that no interventionist being more fortunate in terms of GDP per capita is doubtful. Especially looking at positive correlation of population on economic growth

- **H_9: More developed countires have more significant effect of population policy on economic growth than less and least developed countries.**

  Most of population and economic growth analysis were focused in developing countries. In fact, however, population policy could be applied well

- **H_{10}: Less and least developed countries are better off applying Anti-natalist population policy in terms of the level of GDP per capita**

  Historical evidence of demographic of transition suggests fertility rate decline is a key element of economic development.

Although other possible hypothesis can be raised based on the review of econometric models and research findings, our main focus is on impact of population policy, thus our tested assumptions are limited to above named hypothesis..

5 Econometrical analysis

5.1 Estimation methods

This thesis analyzes relationships between economic growth and various other variables relates to population on panel data. As I have reviewed above, many studies of the topic were done in several econometrical methods such as time-series of a single country and panel data structure. Panel data estimation has become the standard methods in modern econometric tools. Panel data allow to incorporate both differences between individual countries and effects of changes of explanatory variables over time.

Baltagi (2005) admirably summaries key benefits of using panel data explained by Hsiao (2003) and Klevmarken (1989). The panel data estimation has following advantages:

i. Controlling for *individual heterogeneity*. Panel data suggests that entities (e.g. countries) are heterogeneous. Time-series and cross-section studies does not have heterogeneity characteristic, which may lead to obtain biased results.
ii. Panel data give *more informative data, more variability, less collinearity among the variables, more degrees of freedom and more efficiency*.
iii. Panel data are better able to study the *dynamics of adjustment*
iv. Panel data are better able to *identify and measure effects that are simply not detectable in pure* cross-section or pure time-series data
v. Panel data models allow us to *construct and text more complicated behavioral models* than purely cross-section or time-series data.

Panel data OLS may cause ignorance of individual and time difference, and also lead to coefficient inconsistency. In order to overcome this problem, it is important to apply either fixed effect model or random effect model.

5.2 Data Sample

The panel of annual data covers the period of 2000-2014, and the analysis units are 188 countries in the world. The data is chosen based on the discussion in previous chapters and its availability. Most of data are not available in public. That is why we choose year 2000 to 2014 as the estimation period, and why important factors such as net migration unfortunately cannot be included into our analysis.

It consists of 3 groups of countries: more developed countries, least developed countries and less developed countries. The more developed countries include all countries of Europe and Northern America, Australia, New Zealand and Japan, which sums up to 52 countries. The least developed countries comprise 47 countries, defined by United Nations. All the rest of 89 countries are labeled as the less (not least) developed countries. List of countries are shown in Appendix A.

Dependent variable

As many of economists have used GDP per capita as a measure of economic growth in the past, the dependent variable is *lnGDPp* – natural logarithms of GDP per capita at current prices (US dollars). Principal source of the data is United Nations Statistics Division (the logarithmic transformation was done by author). In this thesis we take its first difference of the logarithm value to get stationary values for analysis. (Further explained onwards)

Independent variables

Explanatory variables include several population indicators, all coming from the World Bank online database (the logarithmic transformation and first difference transformation of selected variables was done by author)

These are namely: *GPOP* – population growth rate, *GEAP*- Growth rate of economically active population (population ages 15-64), *lnEAP*- Natural logarithm of economically active population, *lnPOP65*- Natural logarithm of population ages 65 and above, *lnFert*- Natural logarithm of fertility rate (births per woman), *lnPriFe*- Natural logarithm of female primary school pupil and l*nSecFe*- Natural logarithm of female secondary school pupil.

GEAPGPOP - computed by the growth rate of economically active population minus the growth rate of total population. It is worth reminding that this explanatory variables are also used by the work of Bloom and Williamson (1997), and presented a positive significance in their model.

We have created 3 dummy variable to identify policy preferences in our analysis. Dummy variable *Maintain* takes value 1 if a country has maintain policy on its population and 0 otherwise. Pro-natalist country is captured by dummy variable *Pro*. A country with a population policy to raise its population, has 1 for this dummy variable, *Pro*. Another dummy variable is *Anti*. It indicates Anti-natalist country with a value 1.

Above all three dummy variables are relative to the other. Assuming that a country in a particular year has a value 1 in one of three dummy variables, this means that other two dummy variables both have a value 0. If all three policy indicator variables have 0, then this suggests that the country has no-interventional population policy scheme. This relativity allows us to examine the immediate impact of population policy on economic growth.

Policy dummy variables are set according to UN's publication World Population Policies 2013 and National Population Policies 2001. (United Nation, 2001, 2013)

As it can be observed from Table 4, the number of observations varies across variables. This will cause unbalanced data panel. Both education variables (*lnPriFe* and *lnSecFe*) have relatively smaller number of observations. We hope this will not cause any problem with our analysis.

Omitted variables:

Net Migration

Even though population is determined by a number of birth rate minus a number of death plus a number of net migration and some population policy either encourage or discourage migration, we have not included net migration figures into our model. This is because of data unavailability. Net migration data can be obtained from the World Bank, however some data are missing for certain countries, and more importantly, those data are five-year estimates, which means the data contain maximum only 3 data per country for our observed period of 2000 through 2014. This incomparably decreases a number of observations, and eventually will lead to the lack of sample size. Therefore in this paper we have excluded the elements of migration in population.

The list of variables are presented in Table 4. Moreover, Summary statistic of all variables except for indicator variables are presented in Table 3.

Table 3: Summary statistics for dependent and independent variables

Variable	**Obs.**	**Mean**	**Std. Dev.**	**Min.**	**Max.**
lnGDPp	2624	8.190394	1.640995	4.151191	12.10897
GPOP	2820	1.491238	1.520091	-4.399684	17.62477
GEAP	2685	1.936795	1.827902	-3.386712	23.8371
lnEAP	2685	15.27291	1.90941	10.77629	20.72753
lnPOP65	2685	12.91232	2.059689	7.938089	18.64603
GEAPGPOP	2685	.4074845	.6063641	-3.386712	7.196826
lnFert	2530	.9916143	.4992347	.0732505	2.045497
lnPriFe	2232	3.867928	.0459466	3.371645	3.995012
lnSecFe	1931	3.863691	.1111517	2.789803	4.062792

Source: Author’s computations

Table 4: Summary of dependent and independent variables

Variable	Description	Source
lnGDPp	Natural logarithm of GDP per capita (dependent variable)	United Nations
GPOP	Growth rate of total population (annual percentage)	World Bank database
GEAP	Growth rate of economically active population (ages 15 to 65)	Computed
lnEAP	Natural logarithm of economically active population (age 15-64)	World Bank database
lnPOP65	Natural logarithm of population ages 65 and above	World Bank database
GEAPGPOP	Growth rate of economically active population minus growth rate of population	Computed
lnFert	Natural logarithm of total fertility rate (births per woman)	World Bank database
lnPriFe	Natural logarithm of the number of female students enrolled in all primary education programs	World Bank database
lnSecFe	Natural logarithm of the number of female students enrolled in all secondary education programs.	World Bank database
Maintain	Indicator variable for a country with maintaining population policy (dummy variable)	Author
Pro	Indicator variable for a country with pro-natalist population policy (dummy variable	Author
Anti	Indicator variable for a country with anti-natalist population policy (dummy variable)	Author

Source: Author’s computations

5.3 Model

The core inspiration for the model is acquired from the paper by Bloom and Williamson (1997), called “Demographic Transformations and Economic Miracles in Emerging Asia”. Bloom and Williamson (1997) used panel OLS estimation for 78 Asian and non-Asian countries for the period from 1965 to 1990. In their work, as I have mentioned already, they demonstrates the importance of growth rate of economically active population.

On this basis, we formulated our econometric model, which places stress on population policy selection of countries. Since we will focus especially on impact of population policies, some of population structure variables and variables that are affected by the use of population policy is added into the model. Most importantly, our analysis includes some dummy variables to indicate countries’ policy type on population at that time. This allows us to present impact of population policy preference on economic growth.

$$\begin{aligned} lnGDPp_{it} = \beta_0 + \beta_1 GPOP_{it} + \beta_2 lnGEAP_{it} + \beta_3 lnEAP_{it} + \beta_4 lnPOP65_{it} \\ + \beta_5 GEAPGPOP_{it} + \beta_6 lnFert_{it} + \beta_7 lnPriFe_{it} + \beta_8 lnSecFe_{it} \\ + \beta_9 Maintain_{it} + \beta_{10} Pro_{it} + \beta_{11} Anti_{it} + \varepsilon_{it} \end{aligned}$$

In estimating our model, we conduct two panel data techniques: Fixed effect estimation (FE) and Random effects estimations (RE). We are going to make estimations on both, then chose the best model that fits our data in appropriate manner.

FE model is used whenever you are interested only in analyzing the impact of variables that are different over some time period. FE explore the link between predictor and outcome variables within a country. Each country, undoubtedly has its own unique characteristics which might or might not influence the dependent variable. FE remove the effect of time invariant characteristics so we can assess the pure net effect of the predictors on the outcome variables.

On the other hand, unlike the FE model, RE model has a characteristics that the variation across countries is assumed to be random and uncorrelated with the predictor or independent variables included in the model.

Greene (2008) presents the crucial distinction between FE and RE that whether the unobserved individual effect embodies elements that are correlated with the regressors in the model, not whether these effects are stochastic or not.

Technical issues

Before presenting these estimation results, it is important for us to discuss some technical issues.

The selection between fixed and random effects could be chosen using Hausman test (Wooldridge, 2003).

In fact, a dataset that meets all of the assumptions underlying multiple regression is limited. Failure to meet assumptions can lead to biased estimates of coefficients and especially biased estimates of the standard errors. (Wooldridge, 2012) Robust regression methods are designed to be not overly affected by violations of assumptions by the underlying data generating process. After better estimators are chosen by the use of Hausman test, robust regression are used to collect unbiased result.

We must also note that a dataset with a combination of stationary and non-stationary series can cause a serious mistake on our analysis. (Wooldridge, 2012) When there are combination of stationary and non-stationary data, we often want to transform non-stationary series into stationary series, or vice versa. One way to transform non-stationary data into stationary data is to take the first differences of the series. In order to find out non-stationary data variables in our dataset, some particular types of unit root test were proceeded. For balanced data, Harris-Tzavalis test, and for unbalanced data, Fisher-type tests were used through Stata software. For showing some proceeded examples. Stata outcome of Harris-Tzavalis unit root test for *GEAPGPOP* and *lnEAP* is provided in Appendix. In the case of *GEAPGPOP*, obtained p-value is below 0.01, therefore we successfully reject the null hypothesis, and this means that the series are stationary. On contrary, obtained p-value for *lnEAP* was 1.00, in this case we do not reject the null hypothesis and it contains unit roots (non-stationary data). As the overall outcome, *lnGDPp, lnFert*, *lnPriFE* and *lnSecFe* were considered as non-stationary series according to Fisher-type ADF test, and *lnAgeD, lnEAP, lnPOP65* and *GEAP* were considered as non-stationary series according to Harris-Tzavalis test. Therefore, first difference of above named variables are used in our analysis to stick with stationary panel data estimations.

*All panel data estimations and statistical tests were obtained using Stata software.

5.4 Hypotheses and expected estimation results

Table 5 list the hypotheses and relationships respect to expected signs of estimated variable’s coefficient.

Table 5: Hypotheses and corresponding expected estimation results

	Hypothesis	**Variable**	**sign**
1	Population growth rate and economically active population rate are positively correlated with GDP per capita	*GPOP* *GEAP*	+ +
2	Difference between growth rate of total population and growth rate of economically active population is positively correlated with GDP per capita.	*GEAPGPOP*	+
3	There is a positive correlation between economically active population and GDP per capita	*lnEAP*	+
4	There is a negative correlation between population ages 65 and above and GDP per capita	*lnPOP65*	-
5	Direction of the fertility rate effect on GDP per capita varies in regards to economic development level	*lnFert*	?
6	Increasing number of female student will lead to better population control, thus positively correlated to GDP per capita	*lnPriFe* *lnSecFe*	+ +
7	A country with population controlling policy leads to better effect on GDP per capita.	*Maintain* *Pro* *Anti*	+ + +
8	No interventionists have negative coefficient on GDP per capita	*_cons*	-
9	More developed countries have more significant effect of population policy on economic growth than less and least developed countries.	*Pro*	?
10	Less and least developed countries are better off applying Anti-natalist population policy in terms of the level of GDP per capita	*Anti*	+

Source: Author’s computations

6 Result and Interpretation

6.1 Full sample of countries

Firstly, we are going to present the regression result with fixed effects and random effect estimation. The outcome is shown in Table 6

Table 6: FE & RE estimation on Full sample of countries

D.lnGDPp	FE model	RE model
GPOP D1.	0.0564463*** (0.0125781)	0.0445012*** (0.0113463)
GEAP D1.	-0.0250863*** (0.0094478)	-0.0196621** (0.0086292)
lnEAP D1.	-1.831423** (0.5237234)	-0.6453817** (0.2841644)
lnPOP65 D1.	0.3337791 (0.2794281)	0.1817825 (0.2101209)
GEAPGPOP	0.053505*** (0.0114729)	0.0333932*** (0.007134)
lnFert D1.	0.8098202*** (0.1426858)	0.7776371*** (0.131158)
lnPriFe D1.	-0.3842295 (0.3492581)	-0.2471347 (0.321536)
lnSecFe D1.	0.1922422 (0.1393979)	0.2163703 (0.1334311)
1.Maintain	-0.0327307* (0.0176381)	-0.0040669 (0.0102059)
1.Pro	-0.0578549*** (0.0168487)	-0.0114638 (0.0103265)
1.Anti	-0.0233161 (0.014808)	-0.0027944 (0.008436)
Constant	0.1071902*** (0.0114584)	0.0769742*** (0.0074417)
R-squared overall	0.0235	0.0436

Number of observations=1536

Standard errors in parentheses
*******Indicates significance on 1% level (p<0.01)***
***** Indicates significance on 5% level (p<0.05)***
****Indicates significance on 10% level (p<0.1)***
D1. Indicates first difference transformation
1. Indicates dummy variable

Source: Author's computations

For selecting the best fitting model, we perform Hausman test, which is used to differentiate between FE model and RE model in panel data. Table 7 shows which estimator is preferred under the null hypothesis and alternative hypothesis. RE model in more efficient and preferred under the null hypothesis and FE estimator is consistent and preferred under the alternative hypothesis.

Table 7: Choice of Hausman test for FE and RE

	FE Estimator	*RE Estimator*
$\boldsymbol{H_0: Cov(u_i, x_{it}) = 0}$	Consistent & Inefficient	**Consistent & Efficient**
$\boldsymbol{H_A: Cov(u_i, x_{it}) \neq 0}$	**Consistent**	Inconsistent

Source: Author's computations

Stata output of the Hausman test for full sample of countries are shown in Appendix A. In our case, p-value equals to 0.0020, which is smaller than 0.01, thus the null hypothesis is rejected at a significance level of 0.01, thus FE model is chosen, since it is consistent.

Then we conducted heteroscedastic and autocorrelation consistent (HAC) robust standard errors on chosen FE model to check heteroscedacity issue, which must be satisfied.

Table 8: shows regression result of FE model for full sample of countries with robust-standard errors and p-value of fixed effect robust standard error regression.

On the column FE model, represents coefficient and standard error from normal FE estimation. The column *Robust Std. Err.* and *P>|t| (robust)* are extracted from FE regression with robust standard errors. With the robust regression, the point estimates of the coefficients are exactly the same as in original FE, but standard errors take into account issues concerning heterogeneity and lack of normality. The changes in the standard errors and p-values are observed.

Table 8: FE & FE with robust regression on full sample of countries

D.lnGDPp	FE model	Robust Std. Err.	P>|t| (robust)
GPOP D1.	0.0564463***(0.0125781)	0.0102129	0.000***
GEAP D1.	-0.0250863***(0.0094478)	0.0064763	0.000***
lnEAP D1.	-1.831423**(0.5237234)	0.2610984	0.000***
lnPOP65 D1.	0.3337791(0.2794281)	0.2041603	0.213
GEAPGPOP	0.053505***(0.0114729)	0.0073293	0.000***
lnFert D1.	0.8098202***(0.1426858)	0.1162193	0,000***
lnPriFe D1.	-0.3842295 (0.3492581)	0.2405318	0.169
lnSecFe D1.	0.1922422(0.1393979)	0.0996762	0.054*
1.Maintain	-0.0327307*(0.0176381)	0.0092076	0.067*
1.Pro	-0.0578549***(0.0168487)	0.011502	0.002***
1.Anti	-0.0233161(0.014808)	0.0077934	0.160
Constant	0.1071902***(0.0114584)	0.0062068	0.000***
Number of observations=1536			
R-squared within=0.0482, between=0.0048, overall=0.0436			

Standard errors in parentheses

******Indicates significance on 1% level (p<0.01)***

***** Indicates significance on 5% level (p<0.05)***

****Indicates significance on 10% level (p<0.1)***

D1. Indicates first difference transformation

1. Indicates dummy variable

Source: Author’s computations

Normal FE model and FE robust model both shows positive significance of 1% level on explanatory variables *GPOP*, *GEAPGPOP* and *lnFert* and negative significance of 1% level on *GEAP* and *Pro*, 10% level on *Maintain*. This means that growth rate of total population, difference between growth rate of total population and economically active population and fertility rate are positively correlated to GDP per capita. Moreover, the growth rate of economically active population, Pro-natalistic indicator and Maintain indicator variables are negatively correlated to GDP per capita to some extent.

The distinctions between significance of explanatory variables on normal FE and robust FE model are observed from the variable *lnEAP* and *lnSecFe*. With original estimator, *lnEAP* were significant at 5% level and *lnSecFe* does not show any reliable significance at all, however with robust regression, *lnEAP* become more significant at 1% level and *lnSecFe* become significant the 0.1 level. FE estimator with robust regression contains slightly more significant variables and slightly smaller standard errors for all variables than FE estimator without robust regression.

Based on the result from robust version of the regression, even though coefficient is mostly small values since we take first difference of logarithmic form of variables, significance and direction of coefficient for *GPOP* and *GEAPGPOP* and *lnSecFe* are observed as we expected. Positive significance of *lnFert* is a new finding. In fact, however, what is more surprising is, the direction of coefficient for G*EAP*, *lnEAP*, *Maintain* and *Pro* are negative. We initially expected all of them to be positively correlated. Especially the growth rate of economically active population should theoretically influence GDP per capita in a positive way. Other unexpected outcome is, the coefficient of constant being positive. The coefficient of constant, in fact, implies the effect of non-interventional countries. This means non-interventionists are better off in terms of GDP per capita than all the other population policy adopting countries. Nevertheless, with this result we could somewhat show some significance of policy indicator variables such as *Maintain* and *Pro*. Unfortunately, the dummy variable *Anti*, is represented as insignificant in our analysis.

This results can check our hypotheses 1 through 8. The result supports some of our expected estimation result and hypotheses. Hypothesis 3 is completely denied because of insignificance of lnPOP65. Fully supported assumption is hypothesis 2.and other 6 assumptions are partially approved to some extent.

Negative coefficients of *Pro* and *Maintain* dummy variables is possibly because of our short term observation model. Our model does not acquire long-run impact of explanatory variables. It is understandable that pro-natalist population policy leads to decrease in saving rate of households, thus short term negative impact of population variables are acquired.

Insignificance of the dummy variable, *Anti*, may have arose from the fact that many of less developed and under developed fragile countries adopt anti-natalistic policy, thus the impact of imposed anti-natalist population policy is helpless.

6.2 More, less and least developed countries.

The last question that remains to be examined in our study is whether the findings from previous section are still robust when applying them to a different data set, for different country samples. We have used the same procedures as above to three different groups of countries depending of the level of development: more developed, less developed and least developed countries. List of more, less, least developed countries are shown in Appendix.

Firstly we conducted both FE and RE estimations for three groups of countries.
The results are presented in Table 9, 10 and 11.

Then Hausman test was carried out for each group of samples. Acquired p-value from Hausman test from more developed, less developed and least developed countries are 0.3890, 0.1952 and 0.5720 respectively (for more detail see Appendix A). Obtained p-values from all three Hausman test is bigger than 0.05, thus the null hypothesis are not rejected for all three cases, thus RE is selected, since it is more efficient than the FE model. (See Table 7 once again)

After that, RE estimations with robust standard error are applied again. (See Table 12, 13 and 14 for the result)

Table 9: FE & RE estimation results for more developed country

D.lnGDPp	**FE model**	**RE model**
GPOP	0.0793287***	0.0757273***
D1.	(0.228398)	(0.0205038)
GEAP	-0.050285***	-0.0444499***
D1.	(0.0180464)	(0.0162771)
lnEAP	-0.7842037	-1.442037**
D1.	(1.640365)	(0.7116985)
lnPOP65	0.6457594	0.4272832
D1.	(0.6307176)	(0.4508823)
GEAPGPOP	0.0976523***	0.094673***
	(0.0246284)	(0.0145514)
lnFert	0.8444962***	0.8925603***
D1.	(0.1787489)	(0.167203)
lnPriFe	-1.709744	-1.769006
D1.	(1.502192)	(1.444346)
lnSecFe	0.2507871	0.1877704
D1.	(0.5409326)	(0.5163261)
1.Maintain	-0.0204117	-0.0137416
	(0.03268)	(0.0147398)
1.Pro	-0.0391562*	0.0046939
	(0.020041)	(0.0116295)
1.Anti	-0.02771	0.0098866
	(0.0434748)	(0.0340454)
Constant	0.07819***	0.0659039***
	(0.0160644)	(0.0110129)
R-squared overall	0.1090	0.1523

Number of observations=531

Standard errors in parentheses
******Indicates significance on 1% level (p<0.01)***
***** Indicates significance on 5% level (p<0.05)***
****Indicates significance on 10% level (p<0.1)***
D1. Indicates first difference transformation
1. Indicates dummy variable

Source: Author's computations

Table10: FE & RE estimation results for less developed country

D.lnGDPp	**FE model**	**RE model**
GPOP	0.0426942**	0.0344552**
D1.	(0.0174088)	(0.0157195)
GEAP	-0.0159326	-0.0115567
D1.	(0.0130732)	(0.0119502)
lnEAP	-1.470492**	-0.674889*
D1.	(0.6234249)	(0.392666)
lnPOP65	0.3316076	0.3988363
D1.	(0.3501271)	(0.2836203)
GEAPGPOP	0.0364167**	0.0211539**
	(0.0156792)	(0.0107864)
lnFert	0.6548389**	0.6972232***
D1.	(0.2684677)	(0.2410186)
lnPriFe	0.3673421	0.120333
D1.	(0.7542039)	(0.7120272)
lnSecFe	0.1461192	0.1321286
D1.	(0.2110758)	(0.2057943)
1.Maintain	-0.050088**	-0.0034852
	(0.0233993)	(0.0142765)
1.Pro	-0.0714419**	-0.0395182
	(0.0364461)	(0.0251981)
1.Anti	-0.0448723**	-0.0127275
	(0.0199911)	(0.0122827)
Constant	0.1146625***	0.0807318***
	(0.0177156)	(0.0122935)
R-squared overall	0.0127	0.0286
Number of observations=704		

Standard errors in parentheses

******Indicates significance on 1% level (p<0.01)***

***** Indicates significance on 5% level (p<0.05)***

****Indicates significance on 10% level (p<0.1)***

D1. Indicates first difference transformation

1. Indicates dummy variable

Source: Author’s computations

Table 11: FE & RE estimation results for least developed country

D.lnGDPp	FE model	RE model
GPOP	0.0972906**	0.0714766*
D1.	(0.042857)	(0.0390418)
GEAP	-0.0257861	-0.0317521
D1.	(0.0275733)	(0.0244221)
lnEAP	-0.6722957	-0.0037574
D1.	(2.980656)	(0.8240542)
lnPOP65	-0.9166886	-0.5095367
D1.	(1.003029)	(0.4753125)
GEAPGPOP	0.0036393	0.0022958
	(0.0404547)	(0.015187)
lnFert	1.103241	-0.1938958
D1.	(1.388261)	(0.6808648)
lnPriFe	-0.6565731	-0.5635583
D1.	(0.4564927)	(0.4057647)
lnSecFe	0.3133129	0.3166886
D1.	(0.2135315)	(0.1907958)
1.Maintain	-0.0406852	-0.0438232
	(0.0865099)	(0.0484691)
1.Pro	0	-0.0756843
	(omitted)	(0.0526423)
1.Anti	0.0072191	0.0104782
	(0.028124)	(0.0155707)
Constant	0.149049***	0.0870588***
	(0.0730074)	(0.0277499)
R-squared overall	0.0152	0.0379

Number of observations=301

Standard errors in parentheses

******Indicates significance on 1% level (p<0.01)***

***** Indicates significance on 5% level (p<0.05)***

****Indicates significance on 10% level (p<0.1)***

D1. Indicates first difference transformation

1. Indicates dummy variable

Source: Author’s computations

Table 12: RE & RE with robust regression on more developed country

D.lnGDPp	**More developed countries RE model**	**More developed countries RE model with robust regression**
GPOP D1.	0.0757273*** (0.0205038)	0.0757273*** (0.0202797)
GEAP D1.	-0.0444499*** (0.0162771)	-0.0444499*** (0.0136638)
lnEAP D1.	-1.442037** (0.7116985)	-1.442037** (0.6020229)
lnPOP65 D1.	0.4272832 (0.4508823)	0.4272832 (0.4993882)
GEAPGPOP	0.094673*** (0.0145514)	0.094673*** (0.0142742)
lnFert D1.	0.8925603*** (0.167203)	0.8925603*** (0.1522065)
lnPriFe D1.	-1.769006 (1.444346)	-1.769006 (1.290233)
lnSecFe D1.	0.1877704 (0.5163261)	0.1877704 (0.4477298)
1.Maintain	-0.0137416 (0.0147398)	-0.0137416 (0.0121342)
1.Pro	0.0046939 (0.0116295)	0.0046939 (0.010467)
1.Anti	0.0098866 (0.0340454)	0.0098866 (0.0099609)
Constant	0.0659039*** (0.0110129)	0.0659039*** (0.0102669)
R-squared overall	0.1523	
Number of obs.	531	

Standard errors in parentheses
******Indicates significance on 1% level (p<0.01)***
***** Indicates significance on 5% level (p<0.05)***
****Indicates significance on 10% level (p<0.1)***
D1. Indicates first difference transformation
1. Indicates dummy variable

Source: Author’s computations

Table 13: RE & RE with robust regression on less developed country

D.lnGDPp	**Less developed countries RE model**	**Less developed countries RE model with robust regression**
GPOP	0.0344552**	0.0344552***
D1.	(0.0157195)	(0.0119351)
GEAP	-0.0115567	-0.0115567
D1.	(0.0119502)	(0.0077405)
lnEAP	-0.674889*	-0.674889**
D1.	(0.392666)	(0.3052033)
lnPOP65	0.3988363	0.3988363*
D1.	(0.2836203)	(0.2397633)
GEAPGPOP	0.0211539**	0.0211539**
	(0.0107864)	(0.009517)
lnFert	0.6972232***	0.6972232***
D1.	(0.2410186)	(0.2155434)
lnPriFe	0.120333	0.120333
D1.	(0.7120272)	(0.5017335)
lnSecFe	0.1321286	0.1321286
D1.	(0.2057943)	(0.1485355)
1.Maintain	-0.0034852	-0.0034852
	(0.0142765)	(0.0125241)
1.Pro	-0.0395182	-0.0395182
	(0.0251981)	(0.0391272)
1.Anti	-0.0127275	-0.0127275
	(0.0122827)	(0.0116484)
Constant	0.0807318***	0.0807318***
	(0.0122935)	(0.0105966)
R-squared overall	0.0286	
Number of obs.	704	

Standard errors in parentheses

******Indicates significance on 1% level (p<0.01)***

***** Indicates significance on 5% level (p<0.05)***

****Indicates significance on 10% level (p<0.1)***

D1. Indicates first difference transformation

1. Indicates dummy variable

Source: Author's computations

Table 14: RE & RE with robust regression on least developed country

D.lnGDPp	**Least developed countries RE model**	**Least developed countries RE model with robust regression**
GPOP	0.0714766*	0.0714766
D1.	(0.0390418)	(0.0484249)
GEAP	-0.0317521	-0.0317521
D1.	(0.0244221)	(0.0194955)
lnEAP	-0.0037574	-0.0037574
D1.	(0.8240542)	(0.7241882)
lnPOP65	-0.5095367	-0.5095367
D1.	(0.4753125)	(0.3710597)
GEAPGPOP	0.0022958	0.0022958
	(0.015187)	(0.0167472)
lnFert	-0.1938958	-0.1938958
D1.	(0.6808648)	(0.6898697)
lnPriFe	-0.5635583	-0.5635583
D1.	(0.4057647)	(0.3489881)
lnSecFe	0.3166886	0.3166886*
D1.	(0.1907958)	(0.1702222)
1.Maintain	-0.0438232	-0.0438232*
	(0.0484691)	(0.0231024)
1.Pro	-0.0756843	-0.0756843***
	(0.0526423)	(0.0135532)
1.Anti	0.0104782	0.0104782
	(0.0155707)	(0.0136509)
Constant	0.0870588***	0.0870588***
	(0.0277499)	(0.0254438)
R-squared overall	0.0379	
Number of obs.	301	

Standard errors in parentheses

*******Indicates significance on 1% level (p<0.01)***

***** Indicates significance on 5% level (p<0.05)***

****Indicates significance on 10% level (p<0.1)***

D1. Indicates first difference transformation

1. Indicates dummy variable

Source: Author’s computations

Interpretations on result of more developed countries.

Original RE estimation and RE estimation with robust regression both shows almost the same result with same level of significance on all explanatory variables. Positively significant variables at 0.01 level are: *GPOP*, *GEAPGPOP* and *lnFert.* Negatively significant variable at 0.01 level is *GEAP* and at 0.05 level is *lnEAP*. These results are mostly the same as full sample of countries, however there was no significance on any of population policy dummies and variables that are concerned with education (*lnPriFe* and *lnSecFe*).

Interpretations on result of less developed countries.

Simple RE model shows 0.01 level positive significance on *lnFert* only and 0.05 level positive significance on *GPOP* and *GEAPGPOP*. *lnEAP* is the only negatively significant variable at 0.1 level. On contrary, RE estimation with robust regression shows *GPOP* and *lnFert* as 1% level positively significant variable, plus *GEAPGPOP* and *lnPOP* as 5% and 10% positive significant variables respectively. The only negatively correlated variable is *lnEAP* with significance level of 0.05. It is important to note that the RE estimation with robust regression is the only model in our analysis showing *lnPOP65* as significant variable at some extent, but our expected direction of the coefficient was negative.

Interpretations on result of least developed countries.

The result on least developed countries is poor. Standard RE estimate shows only *GPOP* as a significant variable, in addition, at 10% level. RE estimate with robust regression shows *lnSecFe* and Maintain as a variable with 10% significance. It also shows *Pro* dummy variable as strongly significant, however none of least developed country adopts pro-natalistic population policy in our estimation period, and thus it has no reliability on this result. This is reason why the dummy variable Pro is omitted in FE model (See Table 11). This result may have come from a lack in number of observations. Only 301 observations are recognize, even though there are maximum 705 observations (47 countries times 15 years). More than half of observations are missing because of data unavailability.

Overall interpretations

The acquired result does not support any of hypothesis 9 and 10.

Policy types provided by UN only indicates the preference. We are not able to observe the level of effort, which each country put in order to reach the expected population policy. As I have mentioned before, the effect of population policy completely varies by virtue of socio-economic condition of a country.

7 Conclusion

This paper tries to examine the impact of population policy on economic development, using a panel data approach. After reviewing the existing studies on population and economic growth, our econometric model with an interference of population policy indicator variables was built, based on past theoretical and empirical evidences. Furthermore, we have applied the same model for different samples of countries: more, less and least developed, in order to check the solidity of obtained result.

The result of this paper obtained using the available dataset show that there is significant and positive effect of growth rate of population, the difference between population growth rate and economically active population growth rate, and fertility rate on GDP per capita. Moreover, the indicator variables for pro-natalistic and maintaining population policy have evidently showed significance on GDP per capita to some extent. Although both indicators unexpectedly demonstrate negative correlations, there is a possibility that in a long-run, the coefficient is positive.

The core contribution of our work were to modernize and extend the existing model, and more importantly, the adoption of population policy indicator variables. The selection of more data available variables, the application of more complex econometric techniques and the expansion of estimation period may be able to gain better impact of population policy indicator variables. Furthermore, long-run effect of population policy indicator could be investigated using different approach. Indeed, this could be a subject of further study.

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Appendix A: Lists and Figures

List of 47 least developed countries according to United Nations:

Afghanistan, Angola, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Cambodia, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, the Gambia, Guinea, Guinea-Bissau, Haiti, Kiribati, Lao People's Democratic Republic, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Myanmar, Nepal, Niger, Rwanda, Samoa, Sao Tome and Principe, Senegal, Sierra Leone, Solomon Islands, Somalia, Sudan, Togo, Tuvalu, Uganda, the United Republic of Tanzania, Vanuatu, Yemen and Zambia.

List of 52 more developed countries:

Albania, Andorra, Armenia, Australia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Canada, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Kyrgyzstan, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Monaco, Netherlands, New Zealand, Norway, Poland, Portugal, Republic of Moldova Romania, Russian Federation, San Marino, Slovakia, Slovenia, Spain, Sweden, Switzerland, The Former Yugoslav Rep. of Macedonia, Turkey, Ukraine, United Kingdom, United States of America,

List of 89 less developed countries:

Algeria, Antigua and Barbuda, Argentina, Bahamas, Bahrain, Barbados, Belize, Bolivia, Botswana, Brazil, Brunei Darussalam, Cabo Verde, Cameroon, Chile, China, Colombia, Congo, Costa Rica, Cote d'Ivoire, Cuba, Democratic Republic of Korea, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Fiji, Gabon, Ghana, Grenada, Guatemala, Guyana, Honduras, India, Indonesia, Iran, Iraq, Israel, Jamaica, Jordan, Kenya, Kyrgyzstan, Kuwait, Lebanon, Libya, Malaysia, Maldives, Marshall Islands, Mauritius, Mexico, Micronesia, Mongolia, Morocco, Namibia, Nicaragua, Nigeria, Oman, Pakistan, Palau, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Qatar, Republic of Korea, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Saudi Arabia, Seychelles, Singapore, South Africa, Sri Lanka, Suriname, Swaziland, Syrian Arab Republic, Tajikistan, Thailand, Tonga, Trinidad and Tobago, Tunisia, Turkmenistan, United Arab Emirates, United Republic of Tanzania, Uruguay, Uzbekistan, Venezuela, Viet Nam, Zimbabwe

Figure 1: Harris-Tzavalis unit root test for *GEAPGPOP*

```
. xtunitroot ht  GEAPGPOP

Harris-Tzavalis unit-root test for GEAPGPOP
-------------------------------------------
Ho: Panels contain unit roots               Number of panels  =    179
Ha: Panels are stationary                   Number of periods =     15

AR parameter: Common                        Asymptotics: N -> Infinity
Panel means:  Included                                   T Fixed
Time trend:   Not included
-----------------------------------------------------------------------
                    Statistic        z          p-value
-----------------------------------------------------------------------
 rho                  0.7721      -2.8043       0.0025
-----------------------------------------------------------------------
```

Figure 2: Harris-Tzavalis unit root test for *lnEAP*

```
. xtunitroot ht   lnEAP

Harris-Tzavalis unit-root test for lnEAP
----------------------------------------
Ho: Panels contain unit roots               Number of panels  =    179
Ha: Panels are stationary                   Number of periods =     15

AR parameter: Common                        Asymptotics: N -> Infinity
Panel means:  Included                                   T Fixed
Time trend:   Not included
-----------------------------------------------------------------------
                    Statistic        z          p-value
-----------------------------------------------------------------------
 rho                  0.9824      11.8100       1.0000
-----------------------------------------------------------------------
```

Figure 3: Hausman test for full sample of countries

	Coefficients (b) FEF	(B) REF	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
D.GPOP	.0564463	.0445012	.0119451	.0054287
D.GEAP	-.0250863	-.0196621	-.0054242	.0038468
D.lnEAP	-1.831423	-.6453817	-1.186041	.4399282
D.lnPOP65	.3337791	.1817825	.1519966	.1841989
GEAPGPOP	.053505	.0333932	.0201118	.0089852
D.lnFert	.8098202	.7776371	.0321831	.0561854
D.lnPriFE	-.3842295	-.2471347	-.1370948	.1363665
D.lnSecFE	.1922422	.2163703	-.024128	.0403473
1.Maintain	-.0327307	-.0040669	-.0286638	.0143854
1.Pro	-.0578549	-.0114638	-.0463911	.0133132
1.Anti	-.0233161	.0027944	-.0261105	.0121701

```
                  b = consistent under Ho and Ha; obtained from xtreg
   B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test:  Ho:  difference in coefficients not systematic

              chi2(11) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                       =       29.30
            Prob>chi2 =      0.0020
```

Figure 4: Hausman test for more developed countries.

	Coefficients (b) FEM	(B) REM	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
D.GPOP	.0793287	.0757273	.0036014	.0100624
D.GEAP	-.050285	-.0444499	-.005835	.007793
D.lnEAP	-.7842037	-1.442037	.6578331	1.477932
D.lnPOP65	.6457594	.4272832	.2184763	.4410327
GEAPGPOP	.0976523	.094673	.0029793	.01987
D.lnFert	.8444962	.8925603	-.0480641	.0632006
D.lnPriFE	-1.709744	-1.769006	.059262	.4128501
D.lnSecFE	.2507571	.1877704	.0629867	.1612929
1.Maintain	-.0204117	-.0137416	-.0066701	.0291671
1.Pro	-.0391562	.0046939	-.0438501	.0163217
1.Anti	.02771	.0098866	.0178233	.0270364

```
                  b = consistent under Ho and Ha; obtained from xtreg
   B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test:  Ho:  difference in coefficients not systematic

              chi2(11) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                       =       11.67
            Prob>chi2 =      0.3890
```

Figure 5: Hausman test for less developed countries

	(b) FES	(B) RES	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
D.GPOP	.0426942	.0344552	.008239	.0074809
D.GEAP	-.0159326	-.0115567	-.0043759	.0053012
D.lnEAP	-1.470492	-.674889	-.7956035	.4842231
D.lnPOP65	.3316076	.3988363	-.0672287	.205301
GEAPGPOP	.0364167	.0211539	.0152628	.0113795
D.lnFert	.6548389	.6972232	-.0423843	.1182578
D.lnPriFE	.3673421	.120333	.2470091	.248678
D.lnSecFE	.1461192	.1321286	.0139906	.0469223
1.Maintain	-.050088	-.0034852	-.0466027	.0185394
1.Pro	-.0714419	-.0395182	-.0319237	.026332
1.Anti	-.0448723	-.0127275	-.0321448	.0157727

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(11) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 14.73
Prob>chi2 = 0.1952

Figure 6: Hausman test for least developed countries.

	(b) FEL	(B) REL	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
D.GPOP	.0972906	.0714766	.025814	.0176766
D.GEAP	-.0257861	-.0317521	.0059659	.0128003
D.lnEAP	-.6722957	-.0037574	-.6685383	2.86448
D.lnPOP65	-.9166886	-.5095367	-.4071519	.8832578
GEAPGPOP	.0036393	.0022958	.0013435	.0374959
D.lnFert	1.103241	-.1938958	1.297137	1.209831
D.lnPriFE	-.6565731	-.5635583	-.0930148	.2091426
D.lnSecFE	.3133129	.3166886	-.0033756	.0958785
1.Maintain	-.0406852	-.0438232	.003138	.0716569
1.Anti	.0072191	.0104782	-.0032591	.0234204

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(10) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 8.58
Prob>chi2 = 0.5720