LUND UNIVERSITY
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The Relationship between Fertility Rate and Economic Growth in Developing Countries

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Abstract: The relationship between fertility rate and economic growth is an important subject. This thesis sums up the current research status and use in regression and correlation data analysis, which consists of 120 developing countries in total from 1970 to 2014. On the one hand, total fertility rate has a negative effect on economic growth in the current period. When human capital is scarce, returns of investment on human capital will be lower than investment in offspring. As a result, in a society with limited quantity of human capital, people tend to choose higher fertility rate and invest little in each child. On the other hand, economic growth appears at the beginning of the high fertility rate; with the acceleration of economic growth, the fertility rate declines. Human capital investment had an increased effect of scale returns in declining fertility of economic development; if human capital is higher, investing in human capital will get higher returns; this encourages more investment in human capital and less on having offspring and along with faster economic growth.

Key words: Total fertility rate, economic growth, demographic dividend, human capital

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1. INTRODUCTION

1.1 Background

Since the end of the Second World War, some colonial states have successively become independent, and the population in developing countries has grown at an unprecedented speed. This has constituted most of the world's population growth. From 1950-1998, the world's population increased from 2.525 billion to 5.908 billion, of the 78% increased increase in population, 63.1% was Asian countries while 15.7% was from African countries (Wang, Zhai, Yang and Chen, 2007). The rapid and unsustainable population growth in developing countries has caught the attention of local governments and countries worldwide (Wang et al., 2007).

The population is one of the most important factors in economic growth and the speed of its growth determines its size. Weil (2013) questions the relationship between rapid population growth and poverty, stating that "rapid population growth causes a country to be poor, that something about being poor leads to rapid population growth, or that causality runs in both directions" (p.103). However, Rohwer (1999) points out that that a country's working-age population growth and its decisive effect on the country's economic growth speed is more than any other factors.

A demographic transition leads to a change in the supply and demand of labor, thus affecting the labor market. Labor is the primary element in producing output, and therefore, the population change will have an impact on economic growth. Recent work has resolved the population growth into its fertility and mortality components, and researchers have subsequently examined their independent effects on economic growth (Bloom & Williamson, 1997).

Throughout human history, economic forces have made the population continuously increase. But in the last two centuries, living standards of the world have begun to show significant improvement and this improvement has changed the relationship (Weil, 2013). The initial stage of economic growth will bring certain population growth, however, after the economic growth, fertility will decline. In the eighteenth century, Thomas Malthus and other economists stressed an important relationship between fertility growth and economic growth (Weil, 2013). Therefore, discussions surrounding fertility nowadays are usually in the context of development and growth (Hartmann, 2010). This thesis will analyze the relationship between fertility rate and economic growth.

A demographic transition would usually include changes in population size, population growth rate, and age distribution (Mason, Lee R., & Lee S., 2010). If countries act intelligently before and during a demographic transition, that is, as fertility rates fall, then changes in population is an unusual opportunity for faster economic growth and human development (Ross, 2004). Fertility reduction, an important economic and social phenomenon in the process of economic development, is the result of the economic and social development, and it plays an important role in a nation's population structure, economic and social production in turn. Understanding the relationship between fertility rate and economic growth has great significance in making corresponding economic and population policy and promoting long-term economic development.

Development is an abstract concept and difficult to define. When considering a developed society, it is natural to think if as a place where people have enough food, live in a healthy environment, and have enough clothes and commodities, even the luxuries, entertainment and leisure.

In addition to this, Ray (1998) had put forward a further concept, the state of a country's development excluding the social economic status, but also including a healthier environment, political stability, with no discrimination, or violence and where people can access health care and other institutions. It can see from the above, the development is very difficult to be precisely defined. Therefore, reviewing the status of the development of a country usually relies on measuring income, because it assumes that the per capita income can set with development level. Potential assumptions stated include economic development, such as health, life expectancy or literacy, those are according to the per capita income growth. As can be seen from the above, development is very difficult to be precisely defined (Ray, 1998; Hartmann, 2010). Moreover, reviewing the status of the development of a country, usually and mainly often depends on the income measures when evaluating a country's development status, because it assumes that a certain number of per capita income level of development can be set (Ray, 1998; Hartmann, 2010). The potential assumptions stated are including economic development, such as health, according to the per capita income growth.

Furthermore, a beneficial social concept that people may emphasize political rights and freedom, the development of knowledge and culture, family, a stable and low crime rate. However, high and well-being material, the same level of access is likely to be most other types of progress, despite existence itself, it is a prerequisite and worthy goal (Ray, 1998; Hartmann, 2010).

Generally speaking, the social structure, cultural background, and economic and environmental conditions are the main factors influencing the fertility changes. Before people consciously controlled fertility, the transformation of fertility pattern was mainly influenced by social and economic conditions, which is especially prominent in pre-industrial European countries (Liu & Yang, 1989). The researchers think the family planning policy is created to control population growth. At this time, in the countries, especially those characterized with a low-income, fertility unsurprisingly declined (Liu & Yang, 1989). Therefore, it is difficult to know if the family planning policy plays a main role or whether factors such as the social structure, cultural background, and economic and environmental conditions are the determinants of fertility decline. It is much more difficult for countries that are greatly influenced by population policies like China (Liu & Yang, 1989).

In this case, the influence of social and economic factors on fertility rate is often masked.

On the national level, it can be seen that most countries have population control policies, for example, China has the ‘one-child’ policy, which is a discreetly drawn economic incentives system. It rewards for one-child families and imposes punishments and disincentives for larger families (Weeks, 2008). Furthermore, most of the developing countries perceive their fertility rate as too high, whereas some developed countries are concerned about their fertility rate being low (Hartmann, 2010). Very low fertility rates have aggravated the trend of an aging population. When fertility decreases, the age distribution will change, leading to a demographic dividend (Ross, 2004). A demographic dividend is important for all countries, especially for developing Asian countries as fertility and mortality rates tend to experience large-scale declines at the same time. A demographic dividend emerges as a reason to study fertility dynamics.

1.2 Aim

This thesis aims to analyze the relationship between fertility rate and economic growth. As the primary body of the social economy and source of labor, humans are bound to promote or defer economic development (Liu, 2010). Population size, population quality, and population density have a very significant influence on the scale and speed of socio-economic development (Weil, 2013). The new wisdom essential to understanding long-term growth, recognizes that human beings, in addition to providing physical capital, make considerable economic investment and that fertility itself is shaped in important ways by economic considerations (Hartmann, 2010).

Numerous Asian economies have impacted population change significantly over the past 40 years (East Asia Forum, 2012). Therefore, it can be presumed that there is a strategic relationship between the rapid economic growth experienced by Asian economies and the reduced population growth rate. It is meaningful to know how the relationship between fertility and economic growth works in developing countries. This relationship between population growth and economic growth raises a question worth studying. The thesis mainly focus on two research questions, they are:

1. How the fertility impact on the economic growth in developing countries during 1970-2014?

2. How economic growth had impact on total fertility rate in developing countries during 1970-2014?

The thesis uses a theoretical perspective and an empirical approach to address the question. In the theoretical viewpoint, it will introduce demographic transition and demographic dividend, fertility transition, and economic growth. The empirical part of the thesis use various panel data estimation; they are pooled OLS and fixed effect estimation. Data is gathered from the World Development Indicators gathered from the World Bank. It is used in a regression to estimate the influence of fertility on economic growth and the influence of economic growth on fertility in developing countries. Various panel data estimation methods are applied, namely pooled OLS, and fixed effects estimation.

1.3 Scope and Limitation

Becker, Murphy and Tamura (1990) show that Human capital is the primary driver of economic growth, and the differences between the human capital donations exist. In their model, there are two steady equilibriums. One is the high human capital with low fertility, equivalent to that of developed countries, another is a relatively high fertility rate with low human capital, and this is equal to the developing world. In the thesis, it only explores the developing effect in actual data.

Regarding factors deciding the fertility rate change, basically there are two different kinds of view in western demographics. One is that the change of social and economic conditions and the fertility desires is the deciding factor (Blake, 1965; Liu & Yang, 1989). The other is that population policy plays an important role in the process of fertility decline (Liu & Yang, 1989). However, it is not convenient to accumulate the variable of population policy, therefore, this thesis do not consider the population policy in the developing countries.

This thesis mainly focuses on developing countries. The definition of developing countries follows the World Bank's definition, that: developing countries are defined according to their Gross National Income (GNI) per capita per year (World Bank, 2013). Countries with a GNI of US$11,905 and less are defined as developing (specified by the World Bank, 2013). Due to the lack of data, this thesis selects 120 developing countries from 1970 to 2014.

The two primary variables to examine what's the relationship between the fertility rate and economic growth are Total Fertility Rate (TFR) and the Growth Rate of per Capital. In this study, GDP per capita growth is used to measure economic growth, and TFR is used to measure the changes in fertility. In addition, GDP (Gross Domestic Product), life expectancy, school enrollment, gross capital formation also be used in the analysis.

The structures of the thesis are as follows. Chapter 2 concentrates on theoretical perspectives. It includes the demographic transition, demographic dividend, the fertility transition, fertility, and economic growth. Finally, it will introduce some determinants of population growth and make two hypotheses. Chapter 3 contains an economic analysis and conducts to test the formulated hypotheses. Chapter 4 is the empirical analysis and in Chapter 5 will draw a conclusion.

2. THEORY REVIEW

In recent years, demographic trends are of immense significance in developing countries (Bloom et al., 2001). Therefore, it is important to understand why the relationship between population change and economic growth becomes increasingly important. In the long run, population changes are one of the significant variables, which impact on macroeconomic performance (Loraine, 1991). On the one hand, increasing fertility will influence the growth of the labor force. The changes in population growth rate affect the relative age group, and then change the workers and non-workers ratio. If rapid population growth will increase the younger age dependency group, and if fertility declines, it will leave a larger group of elderly workers in the economy. Conversely, the population impacts on the market size and its composition. Increased efficiency and the scale of the business operation depend on the size of the market. The scales economy can affect the pace of industrialization of emerging pre-industrial state or offer up to improve productivity, therefore, to ensure more bigger and richer economies (Loraine, 1991).

Increasing the number of workers can affect the investment, which includes machinery, dams, equipment and other physical capital, and the human capital formation, which includes health, education, and skill levels (Loraine, 1991). Due to the rapid population growth, when workers enter the labor market, they will have less capital and reduce their productivity. However, the relationship between population growth and capital formation is not direct. Population growth influence on capital formation can be positive or negative; it depends on the different conditions, which prevail (Loraine, 1991). An example of this occurs when workers save their wages and profits are raises (Loraine, 1991; Ross, 2004; Gu, 2013). Furthermore, when the profits act as the primary source of funding for physical capital investment, high population growth will lead to more capital formation (Loraine, 1991). For instance, when workers keep their wages and raise profits, and, when the profits are the main source of funding for physical capital investment, however, high population growth will lead to more capital formation.

As theorized by Loraine (1991), increasing fertility or declining infant mortality, will change the population age distribution and affect the household savings. Human capital is another factor and may be affected by the labor force and the dependency ratio per worker (Loraine, 1991; Ross, 2004; Gu, 2013). This is because of increased demand for health and education in the proportion of newborns, so that a less dependent economy is more able to use taxation to finance these (Loraine, 1991). What's more, with lower wages and higher growth rates of the workforce, there will be less return on time and money invested in human resources, who may hinder privately financed investment (Loraine, 1991). At last, with insufficient positions for the youth, there will be an increasing unemployment rate as well as more depreciated skills, as they cannot be used (Loraine, 1991).

The economy is also influenced by domestic migrations. There is a connection between labor transfer within a sector and economic department, especially the transfer of labor outside agriculture (Loraine, 1991). The transfer of rural populations to cities is also due to industrialization and the labor pulled to new pursuits (Loraine, 1991). Rural sectors have higher population growth rates and youth migrate in the pursuit of the better available economic conditions. In spite of migration's contribution, when there is high population growth rate, the problem of under or unemployment develops (Loraine, 1991).

Different fertility rates among households can strengthen economic inequality with higher birthrates in lower-income families. Therefore, young people in high fertility families have fewer economic advantages like expenditures on education or health, which strengthens the economic inequality among such people (Loraine, 1991).

This chapter mainly reviews some relevant theory of demographic and economic growth, in order to get more in-depth understanding of the relationship between fertility and economic growth.

2.1 The Demographic Transition and the Dividend

This section talks about the demographic transition and the demographic dividend. Figure 1 shows the process of demographic transition. According to Weeks (2008), over the past five decades, demographic thinking is ruled by demographic transition, the theory of which was actually describing changes of population in developed countries, especially the transition from a mode of high birth and mortality rates to that of low birth and mortality rate with a sudden increase of growth rates, by which a larger population was produced at the transition’s end than its beginning (Weeks, 2008). Although there are some similarities among the transitions, which happened in different nations amidst various historical ages, differences of these transitions can also be found and can be used to explain the emergence of these transitions (Loraine, 1991).

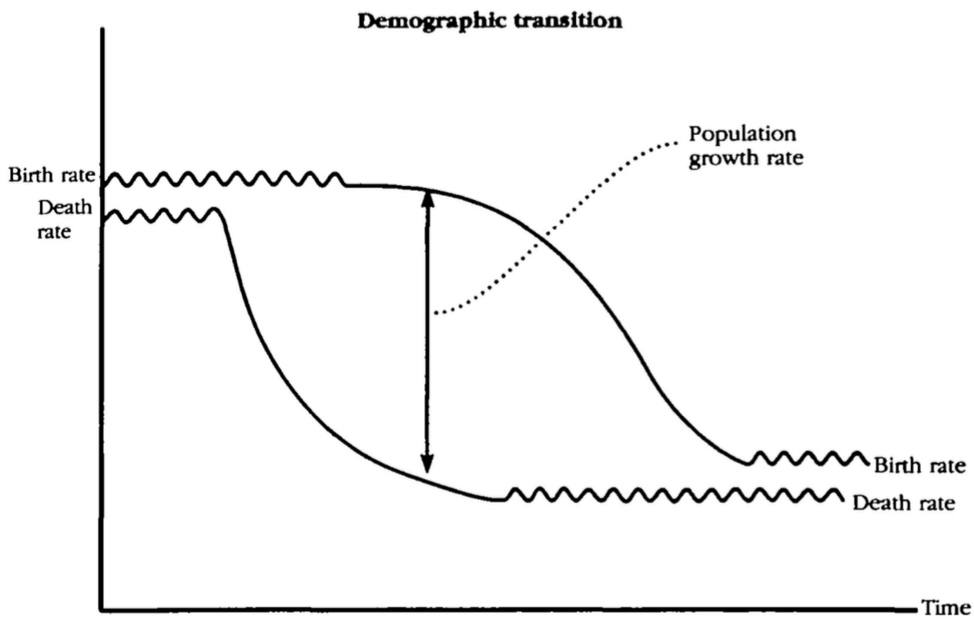


Figure1: The Demographic Transition

Source: Bloom and Williamson (1997)

2.1.1 Demographic transition

According to Mason, Lee R., Lee S. (2010), developing countries, like other countries around the world, are in the middle of a systematic series of demographic changes known as the demographic transition. In the majority of developing nations, "demographic" transition is on going, thus promoting the decrease of mortality, which first emerged near the closing of World War II (Bloom, Canning, and Sevilla, 2001). Medicine and public health has been greatly improved. Those fatal diseases, which used to kill millions of people have been controlled or completely eliminated because of the introduction of antibiotics like penicillin and of treatments for tuberculosis and diarrhea, and the use of DDT (Bloom et al., 2001). Meanwhile, sanitation and nutrition have been ameliorated. Healthier behaviors were widely accepted. These improvements resulted in the increase of life expectancies by about twenty years in some nations and also in the growth of population. This is because mortality did not decrease to the same degree in all ages. Infectious diseases used to be fatal diseases of the young; hence the containment of these diseases saved a great many youngsters (Bloom et al., 2001). These young people lowered the average size of the population. Declining fertility and mortality drive the demographic transition. Over and above declining fertility and mortality, the demographic transition contains the changes in population growth rate, population size and age distribution (Mason, Lee R., Lee S., 2010).

According to Bloom et al. (2001), nowadays, economists and social thinkers have debated three alternative positions that define the influences of population change on economic growth. The first of these is that population growth either restricts, promotes, or is independent of economic growth (David, David, & Jaypee, 2001). A pessimistic viewpoint considers that the world's food growth will be unable to satisfy the needs of population growth, thereby leading to starvation and death and therefore inhibiting economic growth. A more optimistic view is that population growth can contribute to economic development, and ascribes the reason for slow economic boom to the unreasonable system rather than non-rapid population growth (Jiang, 2008). Neutralism argues that after controlling factors such as level of education degree, trade openness and domestic systems, there is no evidence proving the correlation between population growth and economic boom. Each doctrine is supported with empirical evidence. However, when we look at proponents' explanations, we will find that these explanations focus on population size and growth. And the debate has under-emphasized a critical issue, which is that the age structure of the population can change dramatically as the population grows. Figure 2 shows population growth and the age structure. There may be dramatic changes in the age structure of the population, which means how the population is scattered in various age groups, when there is an increase of population (Bloom et al., 2001). As people at different ages have different economic behaviors, when a country's age structure changes, it may exert a profound influence on the economic performance. Figure 2 shows population growth and the age structure.

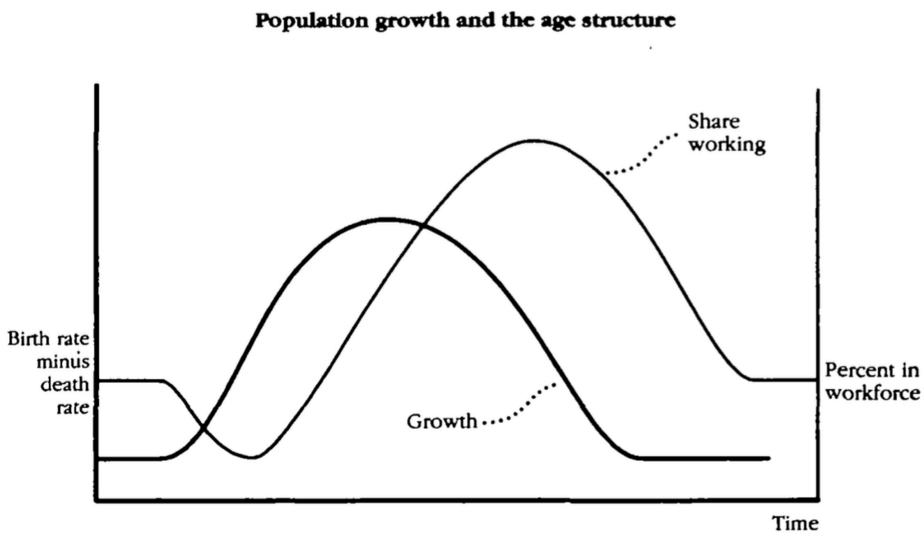


Figure 2: Population Growth and Age Structure
Source: Bloom and Williamson (1997)

Recent research has analyzed population growth into its fertility and mortality elements and examined their independent effects on economic growth. According to Bloom and Williamson (1997), they find that the fertility, specifically measure of past birth rates, is negatively and significantly impact on economic growth, whereas the effect of mortality is insignificant. In addition, these studies as precursors point that changes in fertility and mortality have different implications for the population age distribution and population growth affect economic growth insofar, it impacts on the ratio of working-age population to dependent population (Bloom & Williamson, 1997).

Demographic transition promotes the accumulation of human capital

Demographic transition has a significant influence on human capital investment, which can be divided, into two parts: education and health. It commenced in the decline in mortality rates, and this resulted in people's life expectancy to be extended; a longer life expectancy leads to fundamental changes in people's lives. At the same time, attitudes towards education, family, work and retirement age have changed (Bloom et al., 2001). According to Jiang (2008), considerable literature shows that in the process of economic growth, health and education human capital has the same weight in the role of human capital. As the demographic transitions, the health human capital investment increases, helping people improve their health conditions. Additionally, life expectancy also becomes higher than before. This is important for economic development, because some scholars found that as life expectancy increases by 1 year, the annual output growth rate will be increased by 4% (Bloom et al., 2001).

Demographic transition improves labor supply

First, as the demographic transitions, children who are born in high fertility years grow up in a labor age and become the labor, therefore increasing the labor supply. According to Bloom and Williamson (1997), demographic transition increases labor inputs per person, thereby improving economic development. Bloom and Williamson (1997) concluded this effect on three levels, namely the proportion of working-age population increases, the labor force participation rate of working age population increases and there is an increase in workers' working hours. Second, with the fertility rate decline and family size decrease, women can be free from family, and are more likely to enter the labor market. This also can increase labor supply.

Demographic transition increases national saving.

For the demographic transition influence on national savings, Ansely and Edgar (1958), put forward a famous hypothesis, called the 'Raising Hypothesis', which points out that: a decline in the infant mortality rate and high fertility leads to rapid population growth and ever-increasing children's dependency ratio, increasing consumer demand and decreasing amounts savings. Subsequently, children's dependency burden will evolve into sharp increases in an economically active population and also savings; ultimately, demographic transition is manifested by a huge burden of the growing elderly population, low savings and a decelerating economic boom. However, Phelps draws a conclusion contrary to this hypothesis through building a population-associated model. It argues that faster population growth will lead to higher savings rates, while ignoring the rich population dynamics implied in demographic changes (Jiang, 2008). Later research has gradually taken into account the impact that changes in population age structure has on the savings rate.

In summary, demographic transition not only includes changes in individual life cycle, but also reflects intergenerational replacement. With an increase in the proportion of working-age population, personal savings of this population will be conductive to increase the savings rate. At the same time, due to a decline in the dependency ratio, the heavy economic burdens including family upbringing and maintenance will have been relieved, thereby reducing household spending and improving the ratio of household savings. Therefore, developing countries that are going through demographic transition can shift from being heavily dependent on foreign capital to relatively self-sufficiency, so as to achieve healthy economic growth.

Since the Second World War, the developing countries have experienced a demographic transition at varying rates and times. The mortality and fertility of this transition went from high to low rates and produced a "boom" generation (Bloom et al., 2001). The "boom" generation is unprecedented because it gradually changes nations' age structure. The East Asian countries are in the vanguard of this transformation and created a miracle. Other regions, including Latin America, started their transition in the 1960s and 70s. Other areas, especially some countries in the Middle East and Africa, have still not fully commenced their transition, or they are just in the early stages of the transition (Bloom et al., 2001).

2.1.2 Demographic dividend

A demographic transition leads to three general types of economic consequences. First of all, the support ratio is changed to ensure that what the people of working age produce are enjoyed by varied numbers of the young and old generation. During the transition in which fertility is declining, increasing support ratios promote the growth rate of per capita income or consumption, with other factors remaining (Mason, Lee R., & Lee S., 2010). This consequence is named the 'first demographic dividend'.

Second, capital accumulation process is influenced. Since people live longer and give birth to fewer children, they can save more money for retirement. But the aging of population results in that the elder population holds more capital (Mason et al., 2010). Mix in aggregate capital-labor ratio is continuing to rise. The so-called "second demographic dividend" is thereby generated. As for the extent of this consequence, the proportion of the income of the old, which comes from public or familial transfers, but not private saving, influences it; the level of openness of the economy affects how much labor productivity increases home or abroad (Mason et al., 2010). In any circumstances, the capital-labor ratio rises, but the rate of saving from GDP might drop as population's age. At last, lower fertility and higher survival cause higher human capital investment for every child (Mason et al., 2010). Although the support ratio changes over the transition, the physical and human capital per capita accumulation keeps increasing, at lease when fertility starts dropping.

When a country's fertility rates rapidly fall, and the population's aging speeds up, the children's dependency ratio rapidly drops, and the labor force subsequently rises. Before the aging population proportion reaches a higher level, the population will form relatively abundant labor resources, and there will be fewer burdens on families. As a result, economic growth will occur at a faster pace. At this time, this favorable 'golden age' will promote economic development (Ross, 2004). It is what economists refer to as a 'demographic dividend'. Figure 3 shows the life cycle income and consumption.

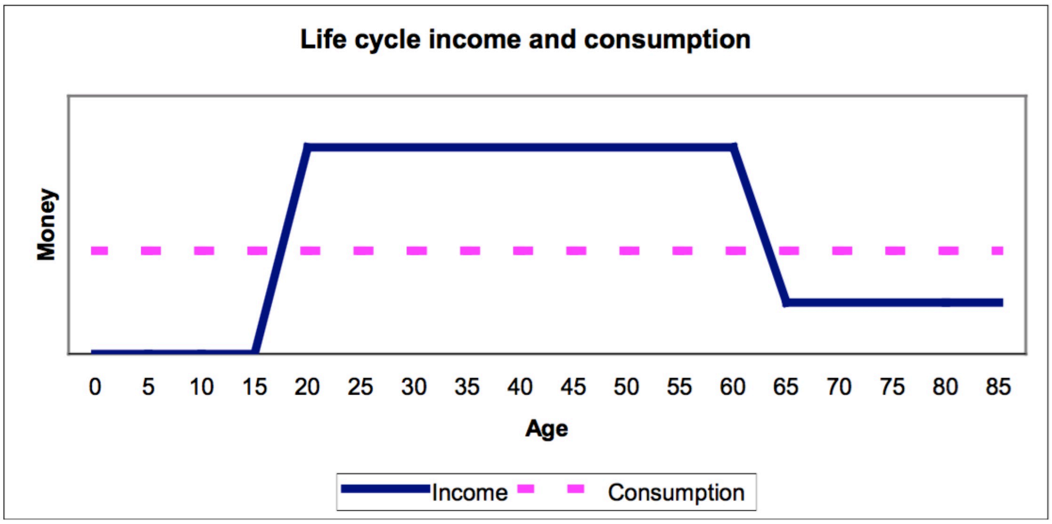


Figure3: Life Cycle Income and Consumption
Source: Bloom et al. (2001)

The population is a part of the economic and social development and is one of the determinants of economic growth. Bloom and Williamson (1997) first mentioned the concept of the demographic dividend. They showed how it provided a new perspective to examine the demographic transition impact on economic growth.

Basic concepts

As Gu (2013) explains, when a country's fertility rate rapidly falls, there are several consequences: aging population speeds up, the children's dependency ratio rapidly drops, and labor forces rise. However, according to Gu (2013), before the aging population proportion reaches a higher level, the population will form a relatively abundant labor resource. As a result, there will be fewer burdens on families, and it will make way for faster economic growth. At this time, this favorable ‘opportunity window’ will promote economic development (Ross, 2004). This is what economists call a ‘demographic dividend.' The demographic dividend period includes two periods: The First Demographic Dividend and The Second Demographic Dividend.

The First Demographic Dividend is when a country’s or a region’s working-age population increases. This contributes to the labor force, and the population burden is lessened (Gu, 2013). This condition drives economic growth.

The Second Demographic Dividend is when people’s health is improved, and consequently life expectancy is extended (Gu, 2013). However, in order to maintain the existing standard of living for retirement or to further improve the quality of life, people tend to save more money (He, 2013).

Several Mechanisms

1. Labor supply

The labor force in the early part of population growth increases rapidly, which brings a higher labor participation rate, and this directly promotes the development of the economy. At the beginning of the child population decline, the proportion of older people rises gradually, and labor supply increases quickly (Gu, 2013). When the child population declines and is stable, the proportion of elderly people increases and in turn progressively raises the social burden (Ross, 2004). Families need more working-age people, so this will be hindering economic development. In the first demographic dividend period, there will be a baby boom; babies born during this time will enter the labor market within twenty years (Ross, 2004; Gu, 2013). They will then add to the labor force and promote the development of the economy. After this boom, the birth rate may decrease; therefore families may need to raise fewer children because of this burden (Gu, 2013). This will create more opportunities for women to enter the labor market. For example, women will have more time to get educated, which will improve their chances of joining the labor market (Ross, 2004; Gu, 2013).

2. Human capital

Population age structure changes in the demographic dividend period. This change not only affects the labor supply but also affects labor productivity and human capital accumulation. Although the inevitable cause-and-effect relationships between the change of population age structure and human capital accumulation do not exist, when looking at the long-term, we can find it will affect economic development. On the other hand, demographic structural changes promoted human capital accumulation, but the economic effects may not be a significant embodiment during the demographic dividend period (Gu, 2013). However, there are other changes, for example: when social medical and health conditions gradually improve, living standards will also improve, thereby people will have a longer life expectancy; and having fewer children will enhance the health of women (Ross, 2004; Gu, 2013). When they enter the labor force to take part in the labor market, in turn, their social status will improve and will become more personally independent (Ross, 2004; Gu, 2013). When the fertility rate declines, parents' economic pressure will reduce at the same time, allowing them to afford the income to give their child better food and life (Ross, 2004; Gu, 2013).

3. Savings

In the early stage of the demographic dividend period, as the dependency ratio decreases, the savings rate correspondingly has no increase. However, the opposite holds true: the savings rate will increase along with dependency. Life Cycle Theory involves the study of the relationship between population age structure and capital accumulation (Gu, 2013). When income is higher than the consumption of the working age population, the remaining part is the net savings. Children have no source of income or savings, and, therefore, they are only a part of the consumer population. An aging population is a special group because they are not in the labor age they do not have labor income, so they have to rely on their savings for consumption. As a result, working–age adults will have to earn and save more money in order to maintain or improve their life quality (Gu, 2013). In a country or region, when the working age population increases, savings may also increase; creating favorable conditions for capital formation, and reaching the maximum growth in a period of time. As pointed by Ross:

The ability to save money is even greater when individuals born during periods of high fertility move into their 40s when their children are mainly on their own and require less support. With deposit scale, saving age extended and advances; all of this will increase the capital accumulation of the whole society, and promote economic growth. (2004, p.3)

When a country has completed the demographic transition, the 'demographic dividend' will occur. The demographic dividend first appeared in developed Western countries. Although these countries realized the demographic transition early, the transition lasted a long time, which meant that the population age structure changes associated with economic growth were not very noticeable; so few people noticed the effect of the demographic dividend (Gu, 2013). While developed countries' demographic transition process lasted for hundreds of years, many emerging industrialized countries, especially in East Asia, experienced a much shorter demographic transition process (Gu, 2013). They showed a very strong connection between population age structure change and economic growth, so progressively more people began to pay more attention to the relationship between demographic transition and economic growth.

On one hand, in developing countries, the integrity of demographic transition is regarded as the major factor to explain high population growth in these countries. This process in developed countries began in the middle 17th century at a comparatively slow speed. In developing countries, mortality started to improve later at a much faster speed, however. Mortality transition is caused by a significant improvement in living standard as well as public health, sanitation ways, food manufacturing and better ways to cure diseases. Although nowadays, in developed countries, these were discovered and improved at a slow speed, they are also in developing countries externally, causing the improvement of life expectancy at a much higher speed. Besides, revenues of today's developed countries have also transited.

On the other hand, the transition of fertility is more complicated while being influenced by a variety of factors, and there is not a smooth trend in the changing process of fertility. Particularly, the downtrend trend in fertility rate was interrupted by the Great Depression as well as the World War II. Just like what the mortality transition has experienced, fertility transition takes much less time in developing countries than in developed countries. When there is a sharp decrease in both mortality rate and fertility rate, there is an obviously faster trend in mortality decline, which created the gap between the two, and this gap was much greater than what developed countries had experienced. What's more, developing countries have incomplete fertility transition, indicating the generally high population growth rate in these countries.

2.2 Fertility Transition

The fertility transition means the decrease of fertility, from very high – under almost no intentional control, to very low, maybe due to the control of women, or more commonly of a couple (Weeks, 2008). The change often accompanies late childbearing (at least later than teenage) and early ending of childbearing. It is also beneficial to both mothers and children, for it gives both time and space to those desired children (Weeks, 2008).

Fertility transition will be affected by various factors, and it is a complicated process. Individuals have a greater ability to control birth if compared with the life expectancy (Hartmann, 2010). Fertility transition is not solely determined by only one social system, but by conditions in which socioeconomic variables keep changing. According to Loraine (1991), every human behavior is limited by time throughout his life. Therefore, time is an everlasting constraint denominator. Social, cultural and economic factors can all influence the use of time. These factors work through norms.

The different factors can be determined affect fertility choice. They are made up of the following parts.

Fertility choice and missing market

Historically, offspring played the role of a variety of institutions and markets that had not yet emerged, especially social security institutions (Ray, 1998). Without social security, a couple tended to give birth to more children in case some of them were to die. If the death does occur, a large number of births can compensate the loss of the couple (Ray, 1998).

Parents can get happiness from their children, as they without a doubt do in all societies, but this is not the only reason why they want to have a child (Ray, 1998). In addition to an aspect of 'consumption – good' of children is their role as a good 'investment'; this means a child can be looked at as a source of family support in old age, and more widely as a kind of insurance (Ray, 1998). These effects will disappear, if they can obtain old age security or insurance from a more businesslike source.

In old age, social security and insurances, which include such things as medical care, unemployment, natural disasters, life insurance, theft and disability were widely accessible in developed countries (Hartmann, 2010).

But it is not the same case in developing countries. This cannot only be attributed to an unstable economy and lack of government institutions.

Another reason is that people working in informal sectors or living in underdeveloped urban areas or rural areas do not have access to these institutions (Hartmann, 2010). Furthermore, a stable financial market is hard to maintain, for the typical market crisis such as moral hazard, and adverse selection, are difficult to overcome (Hartmann, 2010). But local expertise may be absent. Therefore, old age security is hard to obtain. For low-income workers, they can hardly save any money for their old age. That is why children have to serve as insurance for old age. When they grow up, they earn a living for both themselves and their parents. Children thus become the best substitute for insurance and compensate missing markets of their parents (Hartmann, 2010).

In general, the insurance purposes play a significant role in developing countries, and it should not be underestimated. Moreover, in the context of altering fertility patterns, the fertility rate can only by the way of providing different forms of old age security and insurance (Hartmann, 2010). This is an important method way of how economic development is used to influence fertility because normally higher stages of economic development and wealth are considered to be the improvement of market institutions.

Mortality and fertility

From a social viewpoint, a child may not look after its parents in their old age. This is an interesting social factor that may cut in either direction (Ray, 1998). In societies where the norm of looking after one's parents has practically vanished or is relatively non-existent to start with, the mental calculations that people are going to talk about may have no relevance at all for fertility decision (Ray, 1998).

By the first year after their birth, infants are faced with a 15% probability of death (Ray, 1998). Even though they survive this stage, they may die from all kinds of diseases. Illness is still a dreadful killer of children around the age of five in developing countries (Ray, 1998). Also, there is likely, the possibility that children may not be a sufficient source of income. In poor economic area, the fear will be bigger.

From a social point of view, a child may not take care of their parents when their parents reach old age (Ray, 1998). This is an interesting social element that can reduce the direction. Social norms, which take care of a person's parents almost, disappear or relatives don’t exist.

At the same time, even in societies in which people are required to support their elder parents, it is still possible that some might not carry out their responsibility. But the existence of irresponsible children does not lower fertility but raise it instead, for parents want compensation if this case does happen to them (Ray, 1998). At last, it is possible that parents might not realize the function of children when making fertility decisions; they have left behind the age characterized by high mortality (Ray, 1998).

The role of gender bias has been emphasized by Ray (1998) in this context. Gender bias can be immensely costly. Since if the parents demand a certain number of male children, it means that the total number of offspring will increase (Hartmann, 2010). And it can be seen how social norms and prejudice plays a significant role in determining the fertility, as these values affect the demand for the male offspring (Hartmann, 2010). In many societies, males are seen to be solely responsible for old-age support. Therefore, gender bias may affect fertility and could even maintain high fertility and reduce mortality (Hartmann, 2010).

The Costs of Children

This discussion has mainly focused on the advantage of children from the perspective of old-age security and replacement effects. On the other hand, the cost of bringing up a child influences parents' choice of fertility significantly.

According to Ray (1998), the costs will adopt two forms: direct costs and indirect costs. Direct costs are likely to be known as the direct costs of looking after the child, such as food, clothing, health and education. Indirect costs also called the opportunity cost of children, measure the amount of income inevitably in the process of raising a child. Time spent at home with their child can not be used to earn income, therefore the opportunity cost of children is roughly proportional to the wage rate multiplied by the time of parenting (Ray, 1998). With the low opportunity cost, fertility rates squint towards to be high.

According to Hartmann (2010), the children's preferences ought to be constant; parents having children can drive their intrinsic pleasure. At the beginning, a couple decides if they want to have children or not. If they decide that they will not have any children, they can devote all of their time to earn income (Hartmann, 2010). At present, when they begin to have children, their need to spend income on consumption of other commodities, compared with the budget of raising children will decrease. This is a result of two sources: The direct costs of children and forgone earnings, as their parents need to spend time to take care and cultivate children (Hartmann, 2010). Another source is the budget constraint, which is the relationship of shaping by the price of the two variables (children versus other goods) (Hartmann, 2010).

Gender bias is also an important element in the process. In many societies, which include a number of developed countries, it is assumed that women have to portion for the most time to take care of their children (Ray, 1998). This phenomenon means that in such a society, women's work is considered to be low wage (Ray, 1998). This phenomenon also results in the low opportunity cost of having children and the high birth rate (Ray, 1998). Similarly, high levels of unemployment can promote rises in fertility rates. This occurs when parents, faced with high rates of unemployment, lower children's opportunity costs, and as a consequence, the birth rates will increase (Ray, 1998).

Social Norms

It is natural for human beings to follow what others do. The herd mentality connects social relationship with society. Such a conformism psychology helps maintain a stable society and lower the enforcement of the law (Ray, 1998). In fact, culture is the expression of such a shared conformism. The benefits of such norms drag the transformation of the social environment. The conventions of a particular period are destined to be found unacceptable in another time periods (Ray, 1998). But it takes a long time for all the people to abandon these old conventions and adapt to new norms (Ray, 1998).

Old conventions will finally transform into new appropriate ones but in a quite a long period of time (Ray, 1998). Imagine in a poverty-ridden society in which infant mortality is high and children are forced to work. In such a society, it is not surprising that people welcome high fertility particularly sons (Ray, 1998). People in such a society have their own attitude towards issues like 'proper' marriage age, the role of women, the necessity of primary education, and the significance of contraception, ancestor worship, and even conventions like breast-feeding (Ray, 1998).

A variety of factors have been confirmed to be able to make an impact on fertility patterns in this way. For example, fertility choices are greatly influenced by religion, religious conventions, polygamy or the social significance of community to family or property rights (Hartmann, 2010). Under such circumstances, it is important to apply political instruments to make revolutions.

2.3 Economic Growth

In Malthus's model, economic growth is connected with a certain level of income per capita. When the income per capita exceeds the equilibrium level, the mortality rate decreases while the fertility rate increases, and vice versa. However, except for a few extremely poor countries, there was little evidence during the past 100 years supporting this model (Du, 2001). Despite this the numerous studies originating from this model have generally found that there are important links between per capita income, wage rates, men and women's education level and fertility rate, urbanization and other economic variables (mortality) (Du, 2001). We divide the understanding of fertility issues in the theories of economic growth preceded by neo-classical theory into two phases: in the first phase, which is described in the Solow model, although the population growth rate affects the level of steady economic growth, its rate is exogenous; in the second stage, in the growth model, economic development influences family birth plan, which means that the fertility rate is an endogenous factor within the economic system.

2.3.1 Exogenous Model

Neo-classical theory attaches great importance to the influence of physical investment on economic growth. It provides a new explanation on the impact of population growth (fertility rate) on economic growth. Neo-classical economists believe that fertility rate is an exogenous factor in the process of economic growth (Du, 2001). It is the relationship between the changes in physical capital investment and the equilibrium level that decides economic growth. According to the Solow model, investment rate varies in accordance to the level of per capita income (Solow, 1956). The intersection point of the savings rate curve and the effective rate of depreciation curve determines the steady-state economic level.

The Solow Model

The assumption which $S(t)$ (total savings) is the constant fraction s of $Y(t)$ (total income), then get

$$K(t+1) = (1-\delta)K(t) + sY(t) \qquad (2.3.1.1)$$

If the assumption is the population grows at a constant rate, and divide trough by population (P_t), therefore $P(t+1) = (1+n)P_t$, then (3.9) becomes

$$(1+n)k(t+1) = (1-\delta)k(t) + sy(t) \qquad (2.3.1.2)$$

This equation represents per capita magnitudes, namely $k = K/P$ and $y = Y/P$. In other words, the equation explains the per capita capital stock in the next period $t+1$, now adjusted by population growth. A growing population drags the per capita capital down; the higher n the lower is $k(t+1)$, and all other variables as constant.

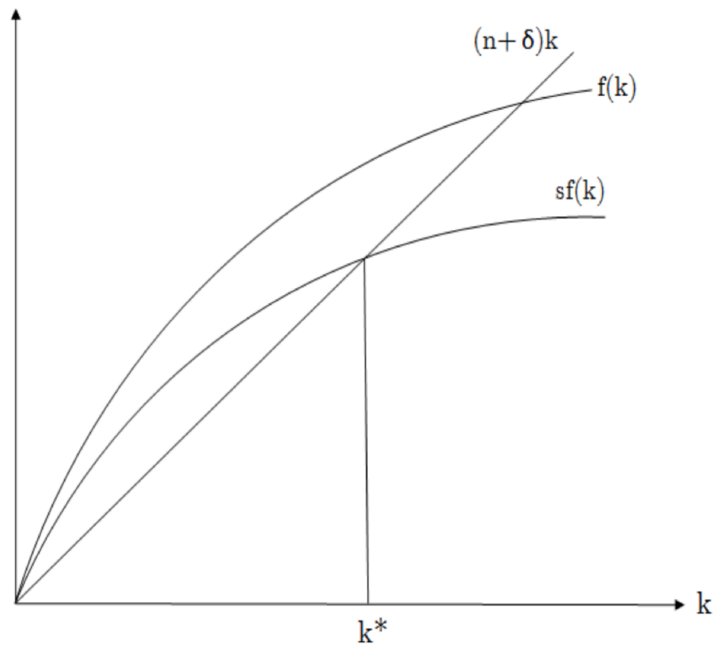


Figure 4: The Solow Model

Source: Hartmann (2010, p.15)

Dynamics of the Solow model is shown in Figure 4 graphically. According to different factors, the two graphs show the level of per capita capital. The effective depreciation of k is shown by the graph $(n + \delta)\, k$. The curve $sf\,(k)$ displays gross investment. From the figure, it can be seen that $0 \leq s \leq 1$, which means that this graph is proportional to the production function $f\,(k)$. The change in k is represented by the vertical distance between $sf\,(k)$ and $(n + \delta)\, k$. The steady state, k^* shows that the per capita capital remains the same. The transitional dynamics of the model cause the steady state. Starting from the point k below k^*, the savings $sf\,(k)$ overtakes the decline of capital. Therefore, per capita capital k increases at a positive rate. The closer point k reaches k^*, which is the slower growth rate of k. Similarly, for a starting value of $k > k^*$, depreciation exceeds the increase in capital and per capita capital decreases. The law of decreasing returns results in this mechanism, which ensures the flexibility of capital output ratio and the capital labor ratio. It is clearly evident that low values of k leads to the higher marginal product of capital, and vice versa. It is predicted by the model that any initial value of $k > 0$ make the economy converge in the long run to the steady state value k^*. The per capita quantities do not change in the steady state t. The growth rate of k is zero.

It can therefore be determined that, although the neo-classical model tells us that growth rate will be affected by the changes in steady-state conditions, it does not illustrate within the framework of its model what factors cause the increase (decrease) of population growth rate. Explaining such an important variable completely by exogenous forces is clearly not satisfactory. So, the economic growth model of endogenous fertility rate thereby comes into being. Becker and Barro (Becker & Barro, 1988; Barro & Becker, 1989; Becker, Murphy & Tamura, 1990) explain what fertility rate depends on in a series of documents. Barro (1991) even cites more than 100 countries' experience data to verify the effect of macroeconomic variables on fertility rate changes. However, to clarify the internal link between fertility rate and economic growth, the concept of human capital has to be introduced. In other words, economic growth cannot be simply attributed to the changes in physical investment (Du, 2001). The cause of human capital, its accumulation, as well as its effect on economic growth also should be studied.

2.3.2 Endogenous Model

Adam Smith believed that economic growth was connected with labor division but he didn't point out the direct link between them (Becker, Murphy and Tamura, 1990). Thomas Malthus put forward a formal model to describe a dynamic growth process how every nation came to a stable per capita income (Becker et al., 1990). His model shows that if incomes overtake the equilibrium level, death rates fall and fertility rises, and vice versa. Although the model influenced the economists in the nineteenth century, fertility rates dropped instead of rising during the past one and a half centuries all over the world (Becker et al., 1990).

The neoclassical growth model made up for the defect of the Malthusian model by fundamentally leaving out any connection between population and economy (Becker et al., 1990). This model is not only adjusted in the population growth rate but also on the investment rate in physical capital. If the per capita income overtakes the equilibrium level, the physical capital stock grows more slowly; while if the per capita is below equilibrium level, the stock grows more quickly (Becker et al., 1990).

Human capital is paid insufficient attention in both Malthus's and neoclassicists' approach. However, there is a great deal of evidence suggesting a tight connection between investment in human capital and growth (Becker et al., 1990). Human capital is presumed to affect development because economic development relies on advances in technological and scientific knowledge and skills, which is represented by human capital (Becker et al., 1990).

In this model, human capital is included as a main growth force. It is said that the production of human capital is human capital intensive. More human capital is required per unit of output than any other sectors of physical capital, child upbringing or consumption (Hartmann, 2010). The education sector offers an example, which makes it clear that human capital is used in the form of teachers and employed researchers more intensively than anywhere else. Unlike the decreasing returns on physical capital, it is assumed that human capital can show a positive connection between the present human capital and extra human capital (Hartmann, 2010). Argumentation is not difficult to understand here again, for evidence accumulated in learning processes indicate that if core knowledge of fundamentals exists, complicated issues are more easily understood.

The significant characteristic, which causes human capital, is that the return rates on human capital do not decrease with the increasing human capital stock at the same time. To avoid low aggregate human capital, the return rates are low and increase with the rise of human capital stock (Hartmann, 2010). As more knowledge become more difficult to digest, returns to extra human capital starts decreasing.

Becker et al. (1990) believes that human capital displays a characteristic of increasing return vis-a-vis its stock volume. Thanks to this characteristic, in countries, which are rich in human capital, returns from investment in human capital investment will be higher than investment in offspring (Becker et al., 1990). But when human capital is scarce, returns of investment on human capital will be lower than investment in offspring (Becker et al., 1990). As a result, in a society with limited quantity of human capital, people tend to choose higher fertility rate and invest little in each child (Becker et al., 1990). Therefore, different stable states are respectively formed in societies with abundant or scarce stock of human capital.

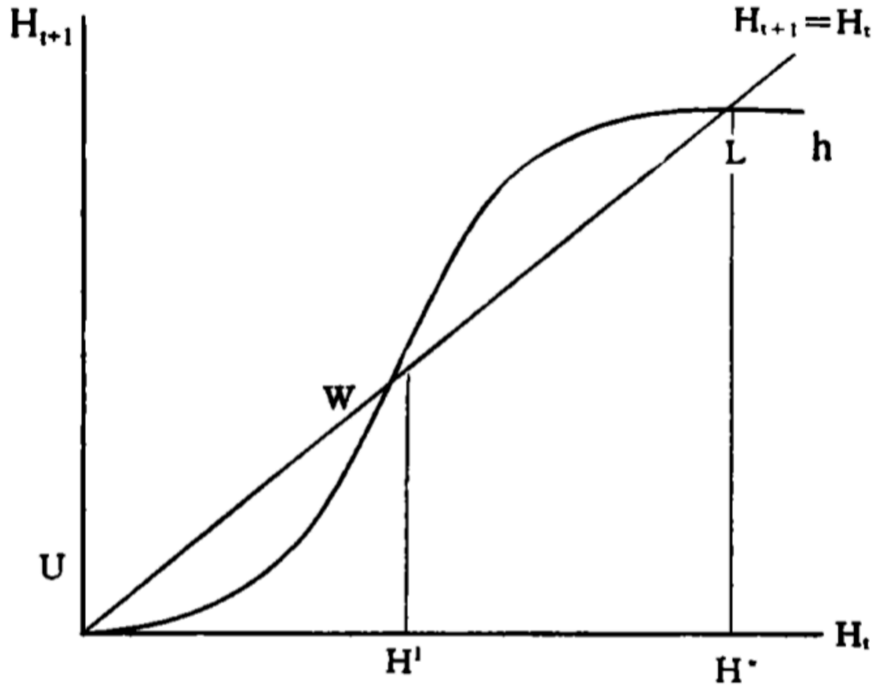


Figure 5: Steady States with Human Capital
Source: Becker et al. (1990, p.17)

Figure 5 illustrates the relationship between human capital at horizontal axis of time t and vertical axis of time $t+1$. In Figure 2, we can find that U and L are two points in steady growth. When the stock volume of human capital level H is lower than H^1, the economy is always closer to point U because income from human capital investment is less than the future consumption. However, when H is lower than H^1, human capital accumulation has reached a certain level and investment in human capital keeps growing because of its increasing revenue. Demand for children declines because children become more "expensive". Therefore, economic growth will reach a steady state under these conditions.

$$[a(n^*)]^{-1} = R_h(H^*) \qquad (2.3.2.1)$$

The right side of the equation is the return of investment in human capital. n^* is the fertility rate at steady state and □ (n) is the parents' degree of altruism of each child. Becker and Barrow (1988) build a model through the relationship between human capital and fertility rate to show that in the real world there are multiple stable economic growth steady states. This theoretical model also explains to some extent why rich nations with high growth rate and poor countries with a low growth rate actually exist, without showing the growing trend aspirated in the neoclassical theory (Du, 2001).

According to Backer et al. (1990), the growth analysis attributes the increase of human capital stock to endogenous fertility and a rising return rate on human capital. Societies develop because of the birth of many children, great investment in these children and physical capital accumulation through a long period of time. In a society with abundant human capital, return rates of investment in human capital are higher than that in children, while in a society where human capital is scarce, the return rates of investment in children is relatively lower (Becker et al., 1990). Therefore, in the latter society, families often raise many children and invest little in each of them; but in the former society, people do the opposite (Becker et al., 1990).

Two stable stages are arrived as the incentive to invest in human capital increases because of the increase in human capital. In the first one, there are large families and little human capital whereas in the other one, families are small but there exists huge human and physical capital (Becker et al., 1990). If a country has enough fortune and policies encouraging investment, it will swing from the "Malthusian" equilibrium to the "development" equilibrium (Becker et al., 1990).

In different historical stages of human development, the interactive relationship between population and other economic variables has been dissimilar. Before the Industrial Revolution, the growth of per capita income in agricultural societies was always restricted by the subsequent population growth. Therefore, it was very difficult for human society to break through the Malthusian trap (Du, 2005). During the Industrial Revolution, technological change brought by continuous system innovation made long-term continuous growth of per capita income possible (Du, 2005). As a result, the mutual relationship between population and other economic variables was also beginning to change. Population decided the relative abundance of economic resources and factors of production, and affected the structure of the economic. Furthermore, the increase of per capita output no longer stimulated population increases as before (Du, 2005). On the contrary, the fertility decline became the general trend of the developed countries.

The experience of developed countries and some developing countries with successful economic boom has shown that the population growth rate will grow first, and decline later with an inverted u-shaped trajectory as the economy develops; this situation is referred to as the demographic transition by economists (Sun, 2013). Because of the different economic development stages, the transition time is different, however, the inverted u-shaped trajectory remains the same.

In the early stages of economic development, people's living level was low, and fertility rate and the death rate were very high, and the population growth rate was low. With economic development people's living level gradually improves, the death rate slowly declines, but the fertility rate does not decline as well, which leads higher population growth rate. Galor and Weil (2000) named the stage when the life level and rate of population gradually increased as the ‘later stage of Malthus’. With further economic development, the fertility rate has a declining trend and mortality continues to drop, and this leads the low population growth rate (Sun, 2013). It can be seen that the relative change of fertility rate and mortality rate results in the inverted u-shaped trajectory of the population growth rate we have observed.

For the gradually reduced death rate in the process of economic development, we can explain convincingly that, for example, a reduction of wars and disasters, the rising level of per capita income, improved medical and health conditions, and the improvement of the knowledge level all contribute to making mortality rates lower (Sun, 2013).

No phenomenon is isolated in the process of economic development, if observed closely, we will find that there are two important phenomena with fertility decrease one is when people gradually increase investment in education thereby improving human capital level (Sun, 2013). The other is important change in the economic structure, and the traditional output ratio of departments and production technology gradually reduces (Sun, 2013). The labor force over time goes into the modern production department. The traditional and modern departments produce the same kind of products in the economy. Unskilled labor production is used in the traditional departments while skilled labor and capital are utilized in modern departments (Sun, 2013). Because of the higher wage of skilled labor and the cost of producing offspring, the fertility rate in skilled labor lower is than unskilled labor. As the per capita material capital gradually improves in the economy，the proportion of skilled labor is higher and higher, which leads to the gradual reduction of fertility (Sun, 2013).

For the phenomenon of fertility decline in economic development, the existing literature explains it from different angles. Through a dynamic model, Barro and Becker (1989) explored the effects the factors of equilibrium had on fertility rate. They assumed that parents were concerned about their offspring's utility level, and came to their conclusion by maximizing the intergenerational aggregation of utility function that the faster technology develops, the lower the fertility. Through the alternative relationship of quantity and quality, Becker et al (1990) explained that human capital investment had increased the effect of scale returns in declining fertility of economic development; if the human capital is higher, investing human capital will receive higher returns, which makes people invest more in the human capital and less in having offspring and whereby there will be faster economic growth. If human capital is low, then the investment is low, and people will have more offspring and make investment in the human capital low. Galor and Weil (2000) think that the quantity and quality will later affect parents. Along with the development of the economy, the population quality will have an increasing effect on the economy. The investment in education and accumulation of human capital will lead to higher utility, which leads to quality taking the place of quantity and the fertility will become low (Sun, 2013).

Galor and Weil (1996) also explain the fertility decline from the perspective that the wage gap between men and women gradually narrows. There are two kinds of labor in the economy: male and female. Females provide only mental labor, whereas male provides physical and mental works. Capital and mental labor in the economy are complementary. Having offspring requires parents' time. With the increase of per capita capital in the economy, women's wages will gradually improve, the corresponding reproducing cost will also increase, and this leads to a decline in fertility. Some literatures explain the fertility decline from the angle of 'Bringing up their children for old age' (Sun, 2013). It think besides the utility brought by having offspring for parents, children are also an important guarantee (Sun, 2013). In the case of an unsound social security system, the fertility will be higher considering the income provided by offspring will be the main source of older parents' consumption. As the social security system gradually becomes sound, the elderly will depend less on offspring, which will lead to a decline in fertility.

Gender preference depends on the wage difference between men and women. In the process of economic development, capital accumulation and increasing technology levels make the wage difference between men and women decreased, and the gender preference will be decreased, along with the fertility in the economy (Sun, 2013).

Xu and Lin (2009) explore changing trends in the population growth rate under the condition that consumers use necessities and unnecessary goods at the same time. Children need to consume necessities and parents' time, and the utility function is non-homothetic. They constructed technological progress's function of the necessities and unnecessary goods, which made technological progress rate in the department of necessities faster before the Industrial Revolution. After the Industrial Revolution, the technological progress in the department of unnecessary goods becomes quicker. Technological progress before the Industrial Revolution led to that the relative price of necessities raising children decline, and it also could increase people's income at the same time (Sun, 2013). The relative price effect and income effect would encourage parents to have more children, and population growth will naturally increase. After the Industrial Revolution, although the technical progress can increase income, the relative price of necessities in raising children rises (Sun, 2013). The relative price effect may offset income effect, and it makes the population growth rate decline.

2.4 Determinants of Population Growth

This section provides some fundamental concepts and defines terms to measure different determinants of population growth. Based on the basic demographic equation described by Hinde (2009), we use the population P_t of a country, at time *t* then the size of this population one year later is given by:

$$P_{t+1} = P_t + B_t - D_t + I_t - E_t \qquad (2.4.1)$$

Where B_t and D_t are respectively the numbers of births and deaths occurring in the population between times t and $t+1$. I_t is the number of immigrants; E_t is the number of emigrants during the same period. $B_t - D_t$ is respectively natural increase. Put simply, population growth is calculated as the difference between the birth rate (fertility) and death rate (mortality).

The total fertility rate (TFR) is the most direct measure of the level of fertility and is most widely used since it refers to births per woman. It can show the potential of population change in a region. As clearly pointed out by Weeks (2008):

> The TFR uses the synthetic cohort approach and approximates knowing how many children women have had when they are all through with childbearing by using the age-specific fertility rates (ASFR) at a particular date to projects what could happen in the future if all women went through their lives bearing children at the same rate that women of different ages were at that date (p.238).

The TFR represents the average number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children according to a given fertility rate at each age (Hinde, 2009). The formula for calculation is

$$ASFR = \frac{birth\ in\ year\ t\ to\ women\ aged\ x\ last\ birthday\ at\ the\ time\ of\ birth}{mid-year\ population\ of\ women\ aged\ x\ last\ birthday} \quad (2.4.2)$$

$$\mathrm{TFR} = \sum_{\mathrm{i}=15}^{49} \mathrm{ASFR_i}. \quad (2.4.3)$$

Here, we assume the ASFR represents ages between 15 and 49 as of the last birthday and we obtain the total number of children a woman would have in her lifetime (Hinde, 2009). TFR is popular as an indicator, because it measures a country's total fertility and then combines the age-specific birth rate with the age distribution of a country (Hartmann, 2010). However, TFR cannot be used to make predictions regarding future population trends (Hartmann, 2010).

Instead, the net reproduction rate (NRR) is often used to predict future population trends (Hartmann, 2010). The net reproduction rate (NRR) is the average number of daughters that would be born to a woman if she lived to the end of her childbearing years adjusted for the mortality rate of a given year (Weeks, 2008). NRR is always slightly lower than Gross Reproduction Rate, since some women will die before entering or finishing their childbearing years. Otherwise, the NRR will be less than half of the TFR. It can be written as

$$NRR = \sum_{X=15}^{49} f_x^d L_x \qquad (2.4.4)$$

Here, f_x^d measures the average number of daughters that one woman has while she lives through the entire year of age between exact ages x and $x + 1$. The L_x refers to the number of woman-years lived between exact age x and $x + 1$ by a birth cohort of size 1 (Hinde, 2009).

Both the TFR and the NRR measure population growth but are used for slightly different purposes. The TFR, for example, provides an indication of population growth (Hinde, 2009). In contrast to the TFR, according to Hinde (2009), the NRR is better suited to predict population growth and is simply the gross reproduction rate adjusted for mortality. Because of this, it is important to understand that economic growth is affected more than fertility and to get the whole picture of population growth, therefore more variables need to be considered (Hartmann, 2010).

2.5 The Hypotheses

Theory and literature provides a solid foundation to analyze the relationship between total fertility rate and economic growth. According to this, this thesis has following hypotheses:

1. According to literature, when human capital is scarce, returns of investment on human capital will be lower than investment in offspring. Therefore, in the initial period, high fertility might reduce the economic growth.

2. According to the traditional economic theory, economic growth in the initial stage of a country is often accompanied by a high fertility rate; then with the economy further developing, the fertility rate will go down. Therefore, this thesis assumes that developing countries will have high fertility in the beginning, and then with economic growth fertility will reduce.

3. METHODOLOGY

3.1 Data

In order to analyze the relationship between fertility and economic growth, this thesis uses data of 120 developing countries in total from 1970 to 2014. All variables and data are collected form the World Bank (2015). Based on previous research, the research is based on the following variables.

- **The growth rate of per capita GDP**: it is the dependent variable of the model. Yearly percent growth ratio of GDP divided by midyear population is in light of constant local currency (World Bank, 2015). Aggregations are in light of steady 2005 U.S. dollars. Per capita GDP means that midyear population divides gross domestic product. GDP at buyer's costs is the aggregate of the grand total included by every resident producer economically plus each product tax minus each subsidy excluded from the product value (World Bank, 2015). The calculation is conducted in the absence of deducting depreciation of manufactured resources or for exhaustion and downturn of natural wealth (World Bank, 2015). Values per capita are picked with the purpose of explaining a nation's scale. As the emphasis is placed on the life quality, under-approximation of GDP variables, it will never be conducive to comparing GDP variations of a nation with numerous residents to a nation having less populace (Hartmann, 2010). For instance, the first GDP can be tremendous in an absolute term; yet from the perspective of in per capita, fewer enhancements are uncovered compared to the other nation (Hartmann, 2010). Yearly percent development ratio of GDP divided by midyear population is in light of constant local currency.

- **GDP (current, us$)**: GDP level data, for each country measured as the per capita GDP. Gross Domestic Product (GDP) measures the economic growth of each country and is a key concept in national income accounting. GDP is the total market value of final goods and services produced within a given period by factors of production located within a country (Case, Fair & Oster, 2009). GDP divided by midyear population refers to GDP per capita. GDP is the aggregate of the grand total included by every resident producer economically plus each product tax minus each subsidy excluded from the product value. The calculation is conducted in the absence of deducting depreciation of manufactured resources or for exhaustion and downturn of natural wealth (World Bank, 2015). Solow's model forecasts that a richer nation having higher GDP degrees would develop more slowly compared to a relatively impoverished nation because of declining returns to renewable variables. As thus, it is expected that there is a negative indication of the variable (Hartmann, 2010).

- **Total Fertility Rate (birth per women)**: this represents a women, born the number of children, it until end of her childbearing years. In addition, she bears children in conformity with current age-specific fertility rates (World Bank, 2015). The definition was given in Section 2.2.

- **Life expectancy at birth, total (year)**: it demonstrates the quantity of years a baby will survive on the off chance that popular mortality patterns at birth were to be consistent during its lifetime (World Bank, 2015). According to Hartmann (2010), health represents the level of human capital in the economy. Therefore, the life expectancy at birth is chosen as the variable in the regression.

- **School enrollment, secondary schooling for males**: Secondary school enrollments of males are another variable to represent the level of human capital in the economy. This is chosen as observed male enrollment rate have a more significant effect on economic growth than that for females (Robert & Xavier, 2004). Gross enrollment proportion is the proportion of aggregate enrollment, paying little heed to age, to the number of the age target that is formally corresponding to the degree of education received (World Bank, 2015). Secondary training finishes the offering of fundamental training starting primarily, and goes for building a basis for lifetime acquisition and people advancement, via providing more instruction oriented at subjects or skills utilizing more particular instructors (World Bank, 2015). The decision of using the male enrollment proportion is grounded on the perception that male education exerts a critical impact on financial development, whilst female secondary education and elementary school enrollment ratios fail to uncover a huge impact (World Bank, 2015). The choice of taking the male enrollment rate is based on the observation that male schooling has a significant effect on economic growth, whereas female secondary schooling, as well as primary school enrollment rates, does not reveal a significant impact (Robert & Xavier, 2004).

- **Gross capital formation**: Formation of growth capital (previously known as the gross domestic investment) comprises of costs on augmentations to the fixed economic resources plus net variations at the inventory level (World Bank, 2015). Inventories refer to stocks of merchandises that companies hold to satisfy impermanent or sudden vacillations during manufacturing or sales, and 'work in progress' (World Bank, 2015). Data are in present U.S. dollars. To handle the impact of the savings ratio, a factor on the formation of Growth capital is considered in the list of factors. In technical terms, the factor gauges the formation of growth capital (adding the economy's fixed resources and net variations at the inventory level) in GDP percentage (World Bank, 2015).

Total Fertility Rate and the Growth Rate of per Capital GDP are two primary variables to examine what’s the relationship between the fertility rate and economic growth. However, the research explores the ultimate factors that the level of economic development decides fertility level, but the direct influence has less effect. They indirectly affect the change of the fertility rate through the intervening variable (Sun and Jin, 1994). Therefore, I choose more intervening variables, for instance, GDP, life expectancy, school enrollment, and gross capital formation. As I mentioned in section 2.1, demographic transition has a significant influence on human capital investment, which can be divided, into two parts: education and health. Here, life expectancy represents health level of human capital, and school enrollment represents education level of human capital.

According to the World Bank (2015), the current fiscal year 2016, the level of income economies are defined as GNI per capita and calculated by using World Bank methods. The World Bank defined that low-income level economies were GNI per capita as $1045 or less in the year 2014. Middle-income economies are GNI per capita more than $1045 as well as less than $12736. High-income economies GNI per capita are $12736, or more. The separation of lower-middle-income and upper-middle-income economies GNI per capita is $4125.

Table 1: Country Classification

	Number of	**Countries**	**Criterion**
	Total	Sample	
Low income	31	27	GNI per capita $\leq$\$1045
Lower middle income	51	45	\$1045 $<$ GNI per capita $\leq$ \$ 4125
Upper middle income	53	46	\$4125 $<$ GNI per capita $\leq$ \$ 12735
High income	80	2	GNI per capita $\geq$\$12735

Adapted from World Bank, 2015

3.2 Method

This section aims to outline and talk about the overview of estimation methods and illustrate econometric regression models. In the analysis section, the relationship between fertility and economic growth is studied by using different panel data estimation methods. In this section, method and notation are based on Asteriou and Hall (2011).

A panel data set is formulated from a sample that contains N cross-sectional units (for example countries) that are observed at different T time periods. The linear panel data model can be given by:

$$Y_{it} = a_i + \beta X_{it} + u_{it} \tag{3.2.1}$$

Where α_i can now differ for each country in the sample. At this point there may be a question of whether the β coefficient should also vary across different countries, but this would require a separate analysis for each one of the N cross-sectional units and the pooling assumption is the basis of panel data estimation.

For pooled OLS (Ordinary Least Squares) estimation of the model, the following assumptions need to hold.

1. The covariance of the explanatory variables and the error term is zero: $E(\mu_t) = 0$ for all t. Consequently the deterministic part of a model, $\alpha + \beta X_i$ can be interpreted as a statistical average relation.
2. There are no exact linear relationships among the sample values of any two or more of the explanatory variables.
3. Homoscedasticity. This requires that all disturbance terms have the same variance. So that $Var(u_t) = \sigma^2 = constant\ for\ all\ t.$
4. All explanatory variables are non-random.
5. All explanatory variables have values that are fixed in repeated samples, and as $n \to \infty$ the variance of their sample value $1/_n \sum (X_{jt} - \bar{X}_j)^2 \to Q_j$ $(j = 2, 3, \dots\dots, k)$, where the Q_j are fixed constants.

For OLS estimators to be linear, assumptions are needed. Since the values of the explanatory variables are fixed constants, it can easily be shown that the OLS estimators are linear functions of the Y-values. The estimator itself is given by:

$$\hat{\beta} = (X'X)^{-1}X'Y \qquad (3.2.2)$$

Where, since X is a matrix of fixed constants, $W = (X'X)^{-1}X'$ is also a $n \times k$ matrix of fixed constants. Since W is a matrix of fixed constants, $\hat{\beta}$ is a linear function of Y, so by definition it is a linear estimator.

The Fixed Effects Method

In the fixed effects method the constant is treated as group (section)-specific. This means that the model allows for different constants for each group (section). So the model is similar to that in Equation (1). The fixed effects estimator is also known as the least squares dummy variable (LSDV) estimator because, to allow for different constants for each group, it includes a dummy variable for each group. The model can be expressed as:

$$Y_{it} = a_i + \beta_1 X_{1it} + \beta_2 X_{2it} + \cdots + \beta_k X_{kit} + u_{it} \qquad (3.2.3)$$

To measure how valid the fixed effects method is, we should first carry out tests to find out if fixed effects (namely different constants for each group) are surely allowed to be added into the model. For this purpose, we can use standard F test to verify fixed effects against the simple common constant OLS method. If all the constants are the same (namely homogeneity), the hypothesis is invalid, and that therefore the common constant method is applicable:

$$H_0 = a_1 = a_2 = \cdots = a_N \qquad (3.2.4)$$

The F-statistic is:

$$F = \frac{(R_{FE}^2 - R_{CC}^2)/(N-1)}{(1-R_{FE}^2)/(NT-N-k)} \sim F(N-1, NT-N-k) \qquad (3.2.5)$$

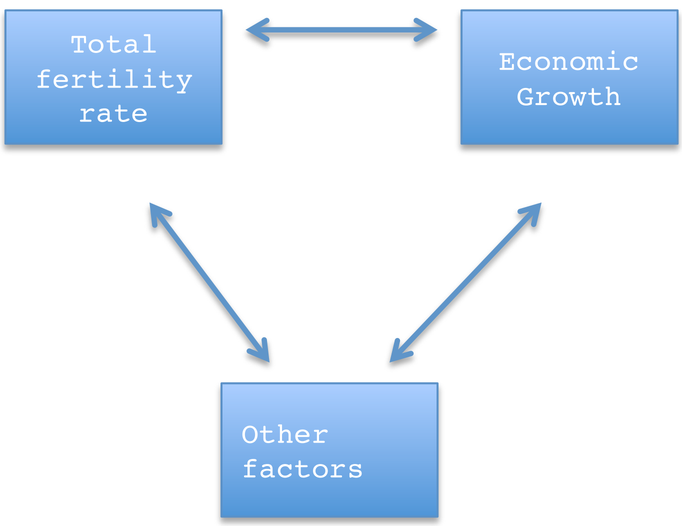
Where R^2_{FE} is the coefficient of determination of the fixed effects model and R^2_{CC} is the coefficient of determination of the common constant model. If F-statistical is bigger than F-critical we reject the null.

The fixed effects model has the following properties:

1. Fundamentally, it takes control of all effects, which are specifically set for a certain individual and remain all the same. Therefore, if we had a panel of countries, the fixed effects would take all of the following things into consideration, natural endowments, geographical effectors and other fundamental factors differ among countries but remain all the time.
2. Lots of dummy constants may be involved in some cases since some panels are likely to have thousands of individual numbers – like large survey panels. Then the fixed effect model would exhaust N degrees of freedom.

3.3 Model

In order to explore the possible factors, which affect the relationship between total fertility rate and economic growth, pooled OLS and fixed effect is used.



Above graph shows the relationship between total fertility rate and economic growth. According to this graph, this thesis include two part, they are:

Total fertility rate → economic growth

Economic growth → total fertility rate

The regression can be written as:

$$Y = \alpha + \beta X + u \tag{3.2.6}$$

Where Y is the independent variable, X is the dependent variables, α is the constant and β is the coefficient, which indicates the explanation ability of individual variables. In addition, three models in each part.

Frist part: How the fertility impact on the economic growth in developing countries?

In the first party, Y indicates GDP growth rate, X includes Ln (TFR), Ln (GDP), Ln (GCF), LE and EDU. All variables will explain in the data section. In particular, with a focus on how fertility impact on economic growth in developing countries, this part has 5 models. Considering the Pool OLS Regression, I set up two variables in the basic model, they are the Ln (TFR) and GDP Growth Rate, and model can be written as:

$$GDP\ Growth\ Rate = \alpha + \beta \text{Ln}\ (TFR) + u \tag{3.2.7}$$

In order to have better explanations, this part establishes four different extension models on the basis of the basic model. The extension models gradually consider other variables (LE、EDU、GCF、GDP).

The first extension model adds variables LE and EDU on basic of the basic model. The second extension model adds variables Ln (GCF) and Ln (GDP) on the basis of first extension model. The structure of third extension model is that add the interaction items between Ln (TFR) and time on the basis of second extension model, and judge if Ln (TFR) impact on GDP growth rate will alter along with time. Then establish panel regression model, explore the interaction items between variables and time, between Ln (TFR) and

Statue, as well as their influences on GDP Growth Rate; in the meanwhile, add variables form after TFR logged 18 years to investigate if demographic dividend effect exists. Because “baby boom” will becomes major labor at least 18 years later.

Second part: How economic growth had an impact on total fertility in developing countries?

In the second party, Y indicates total fertility rate, X includes GDP growth rate, Ln (GDP), Ln (GCF), LE and EDU. Before all, with a focus on how economic growth impact on total fertility rate in developing countries, this part also includes 5 models (one basic model and four extension models). Considering the Pool OLS Regression, same as first part, they are two variables in the basic model, they are the GDP Growth Rate and Ln (TFR), and model can be written as:

$$Ln\ (TFR) = \alpha + \beta * GDP\ Growth\ rate + u \qquad (3.2.8)$$

In order to have better explanations, this part establishes four different extension models on the basis of the basic model. The four extension models gradually consider other variables (LE 、 EDU 、 GCF 、 $GDP\ Growth^2$).

4. ECONOMETRIC ANALYSIS

4.1 Descriptive Analysis

The aim within the below analysis is used in regression and correlation analysis of data, which are data for three years on average of variables and involved 15 stages. The specific reasons to use this analysis is the original data in different years are missing too much data, if the average interval is too large, it means using the average year may not be very complete, therefore, the average for five years or over five years as time estimate representative is not a satisfactory measure.

In addition, when doing the scatterplot variable matrix, firstly mapping the scatterplot matrix of the whole samples (1970-2014), the second respectively mapped the interval scatterplot matrix for nine years. The interval for 3 years on average was chosen, instead of the term of 3 years as a scatterplot matrix. This is because if intervals for 3 years, plotting the scatter diagram will become about 15 diagrams, which will take up significant space. On the top of the relationship between the variables, if variables are stable for relatively long intervals, therefore, the relationship between variables in a longer period won't have much change over a longer period. Consequentially, the best chose is nine years for the interval.

4.1.1 Variable Scatterplot Matrix

For preliminary exploration of the relationship between explanatory variable and explained variable, complete samples were made on the scatterplot matrix, as well as a variable in different period (9 years interval), as shown in figure 6 to figure 11.

From figure 6, it is evident hat the explained variable GDP GROWTH and explanatory variable LnTFR, LnGdp, LnGCF, LE, EDU *et al.* Demonstrate a exist certain linear relationship, but no obvious trend of characteristic; In addition, explanatory variable showed a strong linear relationship, and part of explanatory variable was evident in the synchronization between a rising and falling trend. For example, the variables of LnTFR and LnGCF, LE, EDU have an obvious negative correlation relationship.

Similarly, in figure 6 and figure 11 the variables by time interval of the scatterplot matrix can be segmented, and the further explained variable GDP GROWTH and explained variable LnTFR, LnGdp, LnGCF, LE, EDU are relatively stable within linear relations, and the performance feature of variables show no obvious change over multiple times.

Figure 6: The Matrix Plot for all Variables (1970-2014)

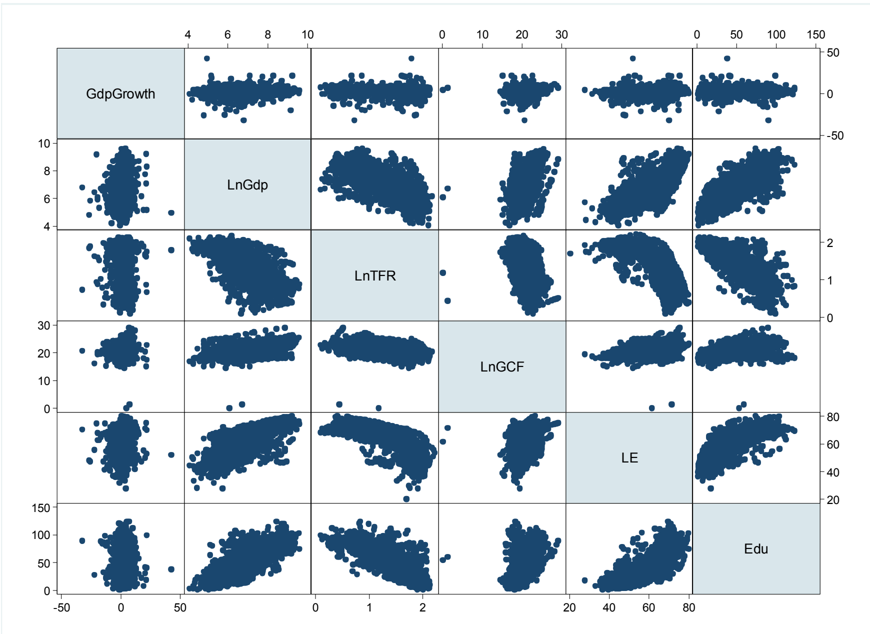


Figure 7: The Matrix Plot for all Variables (1970-1978)

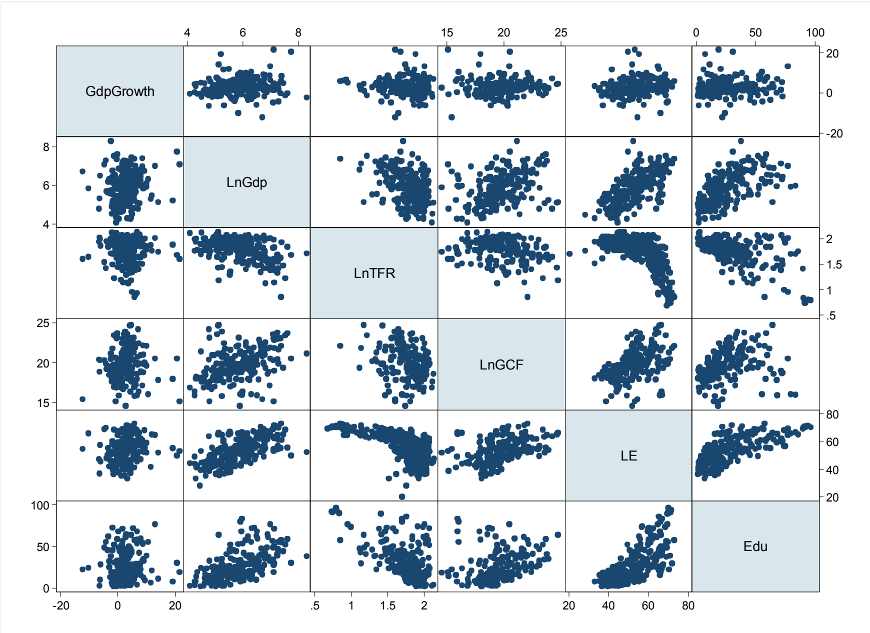


Figure 8: The Matrix Plot for All Variables (1979-1987)

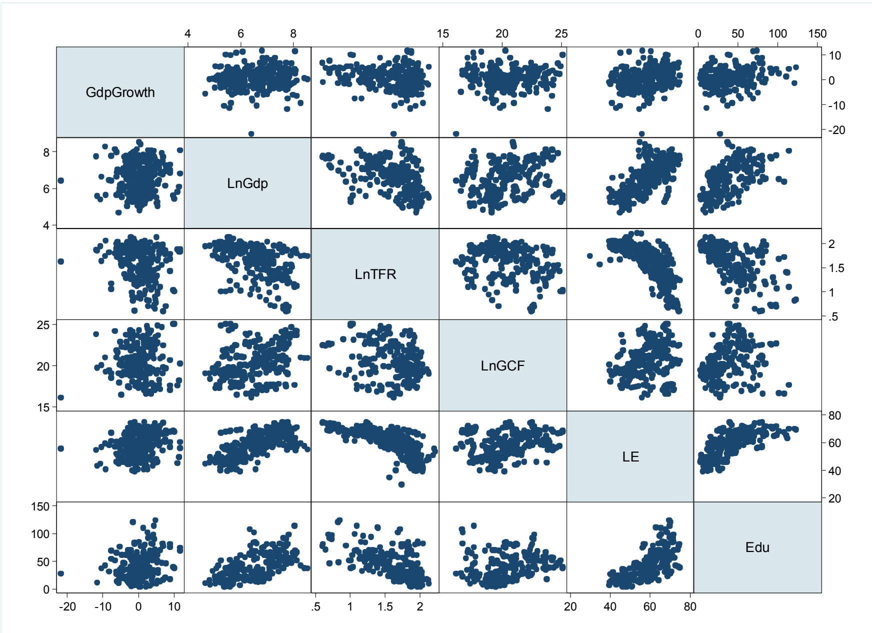


Figure 9: The Matrix Plot for all Variables (1988-1996)

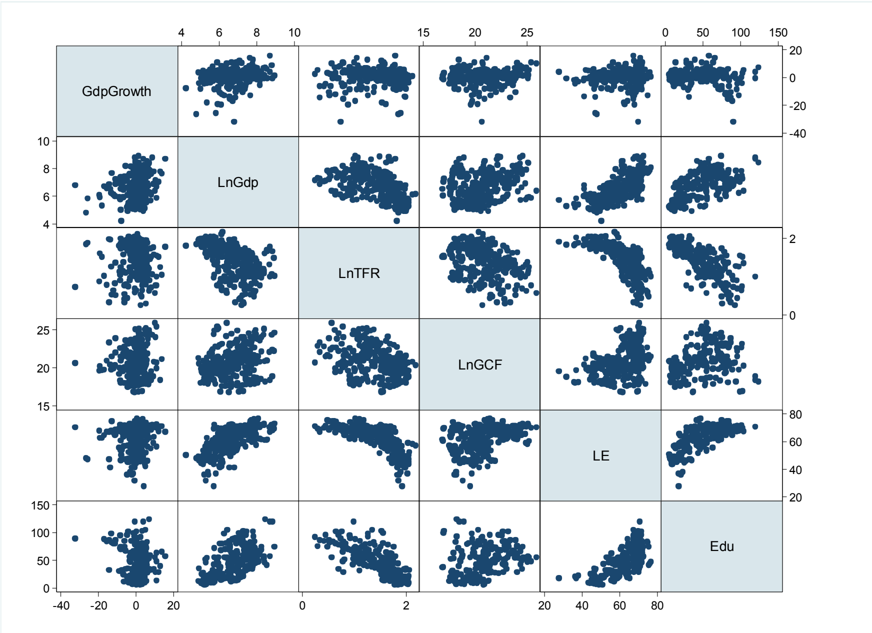


Figure 10: The Matrix Plot for all Variables (1997-2005)

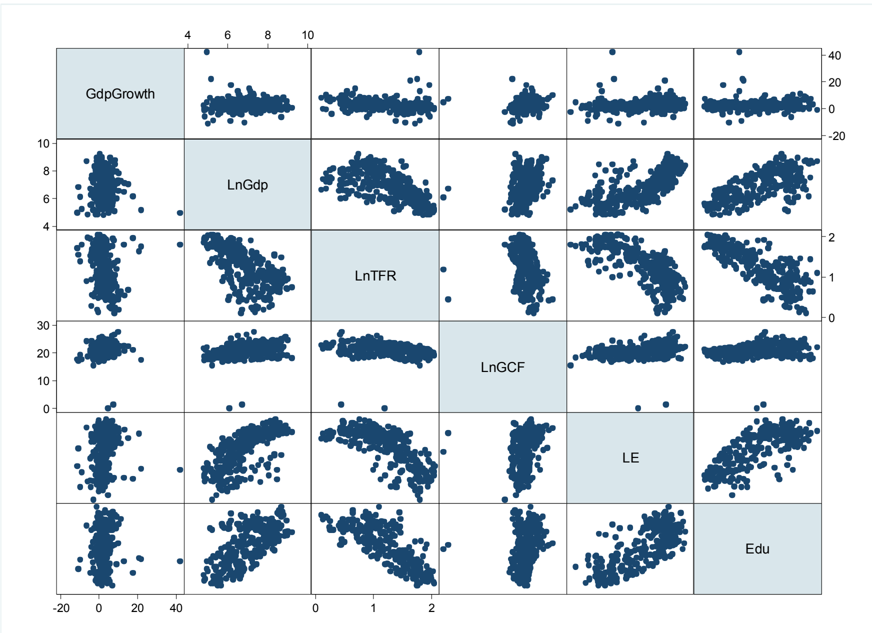
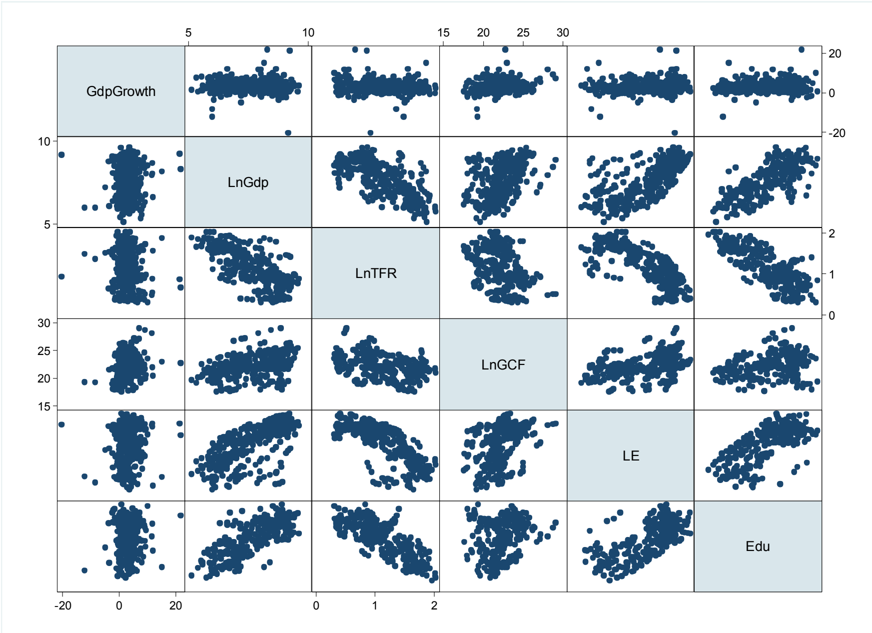


Figure 11: The Matrix Plot for all Variables (2006-2014)



4.1.2 Summary of Descriptive Statistics

In order to obtain more detailed statistical characteristics of each explanatory variable and explained variable, I conducted a descriptive statistical analysis, and calculated the related statistical characteristic descriptive indexes of the response variables within the whole sample (1970-2014) and the different time periods (an interval of 3 years), including statistics sample size, mean, standard deviation, minimum, maximum, skewness, and kurtosis, as shown in Table 2 and its continued Table.

As per the mean statistics, it can find that the mean of GDPGROWTH variables, either in the whole sample or in 15 periods, fluctuates between plus or minus 5%. The mean GDPGROWTH for 120 countries from 1970 to 2014 maintained at about 1.8446%. The mean LnGdp variable grew slowly in 45 years and overall maintained at around 6.8161. The mean LnTFR variables dropped in 45 years, from 1.7452% in 1970-1972 to 1.1180% in 2012-2014, and the overall values maintained at about 1.4323%. The mean of LnGCF, LE, EDU and other variables increased to different degree at different time periods, in which LE rose most obviously, and the overall level maintained at 20.8601, 69.5531 and 49.8396% or so.

As per statistics that reflect the dispersion degree (standard deviation, maximum, minimum, coefficient of variation[1]), LnGCF deviation degree in different countries at different times is the largest, followed by LnGDP, LE, LnTFR, EDU, and so on, and finally GDPGROWTH.

In accordance with skewness and kurtosis coefficients, whether it is the whole sample or samples within different periods, each variable has some deviation from the normal distribution. A normal distribution has a skewness of 0 and a kurtosis of 3. If a distribution's kurtosis is 3, it is leptokurtic as normal distributions; if it exceeds 3, it is more leptokurtic; if it is less than 3, it is less leptokurtic; if a distribution's skewness is 0, it is as skew as normal distributions; if it is greater than 0, it is right-skewed; if it is less than 0, it is left-skewed.

4.2 Correlation Analysis

After drawing the above scatterplot matrices, although it can preliminarily determine the correlation between variables (positive or negative), for more accurate relevant conditions, it still need to conduct relevant analysis to acquire the concrete correlation coefficient between each variable and correlativity to carry out significance testing of a given significant level.

Using the pwcorr command in STATA, I obtained a correlation coefficient matrix after conducting a correlation analysis, as shown in Table 3. Table 3 presents that each variable is significantly correlated ($p<0.05$), in which GdpGrowth has a significantly negative correlation with LnTFR ($p <0.01$), but significantly positive correlations with LnGDP, LnGCF ($p<0.01$), LE ($p<0.01$), EDU ($p<0.05$) and so on. In addition to a significant negative correlation between LnTFR and explanatory variables ($p<0.01$), significant

[1]Coefficient of variation = mean/standard deviation

positive correlations ($p<0.01$) exist between each of the other explanatory variables.

Table 3: Correlation Matrix

	GdpGrowth	LnGdp	LnTFR	LnGCF	LE
GdpGrowth	1				
LnGdp	0.1159***	1			
LnTFR	-0.1569***	-0.6868***	1		
LnGCF	0.1468***	0.4273***	-0.4025***	1	
LE	0.1707***	0.7377***	-0.7775***	0.398***	1
Edu	0.0723**	0.7361***	-0.7864***	0.3609***	0.7667***

Notes: *** p<0.01, ** p<0.05, * p<0.1

4.3 Regression Analysis 1 (fertility to economic growth)

4.3.1 Pooled Regression (POLS)

To further study the relationship between economic growth and the total fertility rate, I have established multi-group models to study the specific numerical relationship between economic growth and the total fertility rate under the premise of controlling other variables. Considering the original data stretched across large year intervals (45 years, a total of 15 intervals), I added the virtual time variable (i.e. periods effect) in each group model. The specific regression results are shown in Table 4.

From the parameter estimates of five groups of models in Table 4, in order to determine whether the impact of LnTFR on economic growth will change with time, I added interaction terms LnTFR and time T. The results show that the interaction terms were not significant, and therefore I excluded the conjecture that the impact of LnTFR on economic growth would change with time.

Meanwhile, it can also see from Model 2 to Model 4, the impact of education variable (EDU) on economic growth has shown negative characteristics ($p<0.01$), possibly because of the practical situation. From Model 3 to Model 4, the impact of Natural Log of Gross Capital Formation Inflation (LnGCF) on economic growth has shown a significantly positive relationship ($p<0.01$). The numbers are respectively 0.192 and 0.194; and the impact of LnGDP on economic growth fails to pass the t test at the significance level of 5%.

Table 4: Pooled Regression Results (All Sample)

Model / VARIABLES	(1) gdpgrowth	(2) gdpgrowth	(3) gdpgrowth	(4) gdpgrowth
LnTFR	-2.883***	-2.548***	-2.869***	-0.361
	(0.645)	(0.855)	(0.810)	(2.112)
T_LnTFR				-0.240
				(0.176)
le		0.0452	0.0328	0.0377
		(0.0285)	(0.0258)	(0.0265)
edu		-0.0335***	-0.0294***	-0.0278***
		(0.00958)	(0.0103)	(0.0102)
LnGdp			-0.246	-0.319
			(0.243)	(0.229)
LnGCF			0.192**	0.194**
			(0.0849)	(0.0862)
1991-1993	-2.322***	-2.783***	-2.582***	-2.118***
	(0.833)	(0.875)	(0.881)	(0.810)
1994-1996	0.112	-0.00687	-0.224	0.606
	(0.647)	(0.678)	(0.672)	(0.858)
1997-1999	0.792	0.474	-0.0751	1.082
	(0.712)	(0.749)	(0.520)	(1.039)
2000-2002	0.652	0.317	0.426	1.877
	(0.609)	(0.610)	(0.589)	(1.295)

2003-2005	2.354***	1.924***	1.980***	3.729**
	(0.607)	(0.581)	(0.560)	(1.447)
2006-2008	2.984***	2.928***	2.976***	5.020***
	(0.595)	(0.582)	a	(1.658)
2009-2011	0.979	0.745	0.787	3.117*
	(0.602)	(0.569)	(0.553)	(1.859)
2012-2014	1.694***	1.185*	1.317**	3.912*
	(0.599)	(0.605)	(0.604)	(2.033)
Constant	0.781	1.059	-0.536	-2.331
	(0.894)	(2.372)	(3.136)	(3.861)
Observations	1,016	793	755	755
R-squared	0.120	0.129	0.169	0.173
Notes: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1				

4.3.2 Panel Regression (RE&FE)

4.3.2.1 The Basic Model

Despite pooled regression being able to reveal the relationship between economic growth and the total fertility rate, taking the collected data I collected as the panel data, in order to more effectively use data, it should also establish a corresponding random- or fixed- effects model should also be established to better fit the data and come to more reliable and stable statistical conclusions.

First, it proposes interaction terms of time T and LnTFR in a mixed regression, and have re-established a set of mixed regression model. Second, considering the random- and fixed- effects that may exist, I have built a fixed effects model and a random effects model; then on the basis of three model groups, I carried out Breusch-Pagan LM testing and Hausman testing that determine the model's specific forms.

The model form test results showed that: comparing the random effects regression model with the mixed regression model, the corresponding p value of the chi-square in the LM test is significantly less than 0.05, so I should choose the random effects regression model; comparing the fixed effects model and random effects model, the corresponding p value of the chi-square in the Hausman test is also significantly less than 0.05, so I should choose the fixed effects model.

Specifically, the regression results are shown in Table 5. Although as per experiments, the fixed effects model is proven to be the optimal model form, judging from the coefficient of three model groups, the three model groups come to basically consistent parameter estimates. Compared to the mixed regression model and the random effects model, the parameter estimate of the fixed effects model is too large. Although the LnTFR coefficient in the fixed effects model fails to pass the significance test at the significance level of 5%, total fertility rate has a negative effect on economic growth in the current period. In the mixed regression model and random effects model, the corresponding p values have less than 0.01 of significance level, respectively -2.869 (POOLED), -1.964 (FE), and -2.798 (RE).

Similarly, whether it is a mixed regression model, fixed effects model or random effects model, the regression results indicate that EDU has a negative influence on economic growth; the impact of LnGDP on economic growth has passed the significance test with 1.645 at the significant level of 5% in the fixed effects model. On the contrary, it fails to pass the significance test at the 5% significance level in the mixed regression and random effects regression, but the coefficient is negative. In addition, the impact of LnGCF on economic growth has passed the significance test at the 5% significance level in the mixed regression and random effects models, showing a positive impact, while it does not pass the significance test at a given significance level in the fixed effects model.

Table 5: Regression Results of Basic Model (All Sample)

Model / VARIABLES	POOLED	FE	RE
	gdpgrowth	gdpgrowth	gdpgrowth
LnTFR	-2.869***	-1.964	-2.798***
	(0.810)	(1.751)	(1.012)
le	0.0328	0.0462	0.0377
	(0.0258)	(0.0727)	(0.0304)
edu	-0.0294***	-0.104***	-0.0354***
	(0.0103)	(0.0248)	(0.0127)
LnGdp	-0.246	1.645**	-0.128
	(0.243)	(0.688)	(0.288)
LnGCF	0.192**	0.0778	0.182***
	(0.0849)	(0.0584)	(0.0618)
1991-1993	-2.582***	-2.315***	-2.508***
	(0.881)	(0.866)	(0.839)
1994-1996	-0.224	0.135	-0.167
	(0.672)	(0.718)	(0.646)
1997-1999	-0.0751	0.318	-0.0623
	(0.520)	(0.623)	(0.493)
2000-2002	0.426	1.191*	0.429
	(0.589)	(0.713)	(0.572)
2003-2005	1.980***	2.840***	2.017***
	(0.560)	(0.945)	(0.558)
2006-2008	2.976***	3.320***	2.948***
	(0.558)	(1.101)	(0.571)
2009-2011	0.787	1.078	0.728
	(0.553)	(1.332)	(0.561)
2012-2014	1.317**	1.624	1.255**

	(0.604)	(1.558)	(0.628)
Constant	-0.536	-12.57*	-1.109
	(3.136)	(7.146)	(3.225)
Observations	755	755	755
R-squared	0.169	0.195	0.168
Number of id	-	119	119
Breusch-Pagan LM Test			$\chi^2(1) = 6.92$
Hausman Test		$\chi^2(14) = 28.01$	

Notes: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

4.3.2.2 Considering the Interaction Effect between Rich and Poor countries

To further optimize the model, according to the GNI per capita published by the World Bank, I divided the country samples into two types: rich and poor, and then examine whether wealth or poverty will influence LnTFR's impact on economic growth. Similarly, I have constructed three model groups, which are the mixed regression model, fixed effects model and random effects model. The testing of the model form is consistent as abovementioned, and the results have also shown that the fixed effects model is an excellent model.

From the regression results in Table 6, it can see the impact of LnTFR on economic growth basically complies with earlier models in this paper. The mean is between -2.986 and -2.641. Wherein, the corresponding p values of

LnTFR coefficients in the mixed regression model and random effects model are less than 0.01.

The interaction term coefficient of national status and LnTFR model is positive in three model groups. In other words, the impact of LnTFR on economic growth in rich countries is greater than that in poor countries, and the difference between the two is 0.934 (POOLED, p<0.05), 1.140 (FE), and 0.837 (RE, p<0.10).

In addition, LnGDP, LnGCF, LE, EDU, among many others, basically exert the same influences on economic growth in the earlier models.

Table 6: Regression Results With Interaction Variable (All Sample)

Model / VARIABLES	POOLED	FE	RE
	gdpgrowth	gdpgrowth	gdpgrowth
LnTFR	-2.986***	-2.641	-2.914***
	(0.815)	(2.280)	(0.998)
S_LnTFR	0.934**	1.140	0.837*
	(0.422)	(2.705)	(0.485)
le	0.0307	0.0411	0.0345
	(0.0258)	(0.0767)	(0.0294)
edu	-0.0334***	-0.103***	-0.0378***
	(0.0104)	(0.0247)	(0.0127)
LnGdp	-0.609**	1.662**	-0.454
	(0.285)	(0.682)	(0.360)
LnGCF	0.196**	0.0772	0.185***
	(0.0838)	(0.0589)	(0.0607)
1991-1993	-2.556***	-2.342***	-2.487***
	(0.877)	(0.877)	(0.839)
1994-1996	-0.167	0.0920	-0.115
	(0.674)	(0.730)	(0.649)
1997-1999	0.0724	0.275	0.0642

	(0.518)	(0.615)	(0.496)
2000-2002	0.600	1.126	0.576
	(0.586)	(0.687)	(0.573)
2003-2005	2.273***	2.753***	2.261***
	(0.565)	(0.903)	(0.582)
2006-2008	3.394***	3.207***	3.317***
	(0.591)	(1.051)	(0.601)
2009-2011	1.293**	0.933	1.172*
	(0.594)	(1.262)	(0.617)
2012-2014	1.879***	1.450	1.745**
	(0.672)	(1.468)	(0.723)
Constant	2.411	-11.50	1.539
	(3.395)	(8.124)	(3.774)
Observations	755	755	755
R-squared	0.175	0.195	0.174
Number of id	-	119	119
Breusch-Pagan LM Test			$\chi^2(1) = 4.89$
Hausman Test		$\chi^2(15) = 40.57$	

Notes: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

4.3.2.3 Split the Sample into Two Cases

While adding the interaction terms of national status and LnTFR in the model, it can explore whether the impact of LnTFR on economic growth would change with the national status. However, in further explorations, I divided the data samples into two parts (poor/rich), and corresponding regression analysis was conducted on each of these two samples. The models established included mixed regression model, fixed effects model and random effects model, the results are shown in Table 7 and Table 8.

According to the Breusch-Pagan LM test and the Hausman test findings, whether in poor country samples or in wealthy country samples, the fixed effects model is the optimal model. In accordance with the specific parameter estimates of the model, it can find that: LnTFR of poor countries exerts significantly stronger negative effects on the current economic growth (POOLED, -3.045, p<0.01), (FE, -3.684), (RE, -3.156, p<0.05) than in rich countries (POOLED, -2.089, p<0.10), (FE, -1.349), (RE, -2.089, p<0.10).

Table 7: Regression Results for the Poor Country

Model / VARIABLES	POOLED gdpgrowth	FE gdpgrowth	RE gdpgrowth
LnTFR	-3.045*** (1.175)	-3.684 (2.509)	-3.156** (1.341)
le	0.0178 (0.0375)	0.0213 (0.0945)	0.0187 (0.0447)
edu	-0.000390 (0.0126)	-0.0536 (0.0413)	-0.00277 (0.0165)
LnGdp	-0.790** (0.325)	1.307* (0.775)	-0.639 (0.414)
LnGCF	0.222* (0.130)	0.0304 (0.0584)	0.174 (0.107)
1991-1993	-2.982** (1.202)	-2.969** (1.307)	-2.926** (1.260)
1994-1996	-0.340 (0.849)	-0.290 (0.939)	-0.341 (0.835)
1997-1999	-0.0168 (0.575)	-0.169 (0.677)	-0.0801 (0.558)
2000-2002	0.622 (0.722)	0.688 (0.739)	0.530 (0.659)
2003-2005	1.630** (0.701)	1.719* (0.941)	1.591** (0.646)
2006-2008	2.670*** (0.584)	2.147* (1.106)	2.564*** (0.555)

2009-2011	1.339**	0.473	1.134*
	(0.648)	(1.342)	(0.633)
2012-2014	2.073***	1.312	1.905**
	(0.784)	(1.672)	(0.827)
Constant	-0.819	-11.60	-0.482
	(4.584)	(9.166)	(4.675)
Observations	434	434	434
R-squared	0.177	0.164	0.176
Number of id		70	70
Breusch-Pagan LM Test			$\chi^2(1) = 2.30$
Hausman Test		$\chi^2(14) = 39.53$	
Notes: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1			

Table 8: Regression results for the rich country

Model / VARIABLES	POOLED	FE	RE
	gdpgrowth	gdpgrowth	gdpgrowth
LnTFR	-2.089*	-1.349	-2.089*
	(1.108)	(3.154)	(1.247)
le	0.0120	-0.0180	0.0120
	(0.0326)	(0.106)	(0.0337)
edu	-0.0791***	-0.161***	-0.0791***
	(0.0168)	(0.0308)	(0.0179)
LnGdp	-0.218	1.928	-0.218

	(0.527)	(1.213)	(0.610)
LnGCF	0.111	0.134	0.111
	(0.0970)	(0.104)	(0.0702)
1991-1993	-1.639	-1.395	-1.639
	(1.248)	(1.319)	(1.130)
1994-1996	0.295	0.526	0.295
	(1.041)	(1.529)	(1.082)
1997-1999	0.235	0.713	0.235
	(0.881)	(1.687)	(0.926)
2000-2002	0.710	1.496	0.710
	(0.912)	(1.893)	(0.972)
2003-2005	3.194***	3.903	3.194***
	(0.904)	(2.473)	(1.058)
2006-2008	4.477***	4.344	4.477***
	(1.118)	(2.925)	(1.268)
2009-2011	1.173	1.164	1.173
	(1.055)	(3.454)	(1.256)
2012-2014	1.535	1.220	1.535
	(1.092)	(3.766)	(1.284)
Constant	7.635	-3.595	7.635
	(5.051)	(11.62)	(5.445)
Observations	321	321	321
R-squared	0.243	0.284	0.243
Number of id	-	49	49
Breusch-Pagan LM Test			$\chi^2(1) = 0.01$
Hausman Test		$\chi^2(14) = 28.86$	
Notes: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1			

4.4 Regression Analysis 2 (economic growth to fertility)

4.4.1 Pooled Regression Result

In testing the hypothesis that economic growth is accompanied by a decline in fertility rates, I took the following measures to reach a real and effective conclusion. I selected certain control variables (the control variables were involved in the models one by one), and I constructed several models to study and analyze them separately. In reflecting economic growth, I took two rates for its measurement, GDP Growth and the Square of GDP Growth (written as GDP $Growth^2$ in the following passage). Traditional economic theory holds that the initial stage of a country's economic growth is often accompanied by a high fertility rate; then as the economy further develops, the fertility rate will go down, which can be clearly demonstrated with the rate of GDP $Growth^2$. In addition, I chose OLS parameter estimation, and the robust standard error for the models.

The regression analysis, shown in Table 9, reflects that in Model 1 and Model 2, the coefficients are significant. The GDP Growth rates are significantly not equal to zero when the significant level lies on 1% and 5% respectively, which shows that the economy grows while the fertility rate decreases. Additionally, although the GDP Growth rate cannot be significantly tested in model 3, 4, or 5, they all show negative coefficients. Specifically, in Model 5, the GDP $Growth^2$ is under the significant test with a regression coefficient -0.000516（$p<0.01$）, proving our hypothesis that economic growth appears at the beginning of the high fertility rate; with the acceleration of economic growth, the fertility rate declines.

Besides, in the 5 models, the variables LE, EDU, and LnGCF have been tested for their significant level. Take Model 5 as an example, the three regression coefficients are -0.0202 ($p<0.01$), -0.00674 ($P<0.01$), and -0.00938 ($p<0.10$). These show that when other conditions remain unchanged, the longer life expectancy is, the lower fertility rates are; the higher male enrolment rates are, the lower fertility rates are; the greater the gross capital formation is, the lower fertility rates are.

Table 9. Pooled Regression Results For LnTFR （All sample）

Model / Variables	(1) LnTFR	(2) LnTFR	(3) LnTFR	(4) LnTFR	(5) LnTFR
GDP Growth	-0.0107***	-0.00609**	0.000590	-0.000986	-0.00242
	(0.00293)	(0.00242)	(0.00177)	(0.00201)	(0.00217)
GDP Growth ^{2}	-0.000203	-3.94e-06	-0.000210	-0.000110	-0.000516***
	(0.000305)	(0.000186)	(0.000128)	(0.000136)	(0.000145)
LE			-0.0328***	-0.0200***	-0.0202***
			(0.000804)	(0.00107)	(0.00116)
Edu		-0.0123***		-0.00699***	-0.00674***
		(0.000373)		(0.000469)	(0.000496)
LnGCF					-0.00938*
					(0.00478)
1973-1975	-0.0372	0.0127	0.0180	0.0356	0.0454
	(0.0349)	(0.0350)	(0.0368)	(0.0358)	(0.0400)
1976-1978	-0.0905**	0.0238	0.0337	0.0615*	0.0648
	(0.0384)	(0.0385)	(0.0363)	(0.0373)	(0.0412)
1979-1981	-0.170***	0.0333	0.0274	0.0886**	0.0856**
	(0.0430)	(0.0414)	(0.0368)	(0.0380)	(0.0417)
1982-1984	-0.223***	0.0166	0.0259	0.0852**	0.0795*
	(0.0434)	(0.0423)	(0.0365)	(0.0383)	(0.0407)
1985-1987	-0.255***	0.0134	0.00880	0.0834**	0.0681*
	(0.0433)	(0.0406)	(0.0358)	(0.0371)	(0.0397)
1988-1990	-0.305***	-0.0532	-0.0191	0.0288	0.0236
	(0.0438)	(0.0408)	(0.0359)	(0.0369)	(0.0392)
1991-1993	-0.419***	-0.129***	-0.0743**	-0.0279	-0.0253

	(0.0451)	(0.0409)	(0.0378)	(0.0387)	(0.0409)
1994-1996	-0.466***	-0.183***	-0.140***	-0.0874**	-0.0916**
	(0.0483)	(0.0412)	(0.0389)	(0.0396)	(0.0423)
1997-1999	-0.541***	-0.186***	-0.202***	-0.114***	-0.129***
	(0.0512)	(0.0393)	(0.0404)	(0.0379)	(0.0408)
2000-2002	-0.593***	-0.187***	-0.228***	-0.125***	-0.128***
	(0.0495)	(0.0395)	(0.0407)	(0.0376)	(0.0400)
2003-2005	-0.606***	-0.175***	-0.234***	-0.113***	-0.103**
	(0.0482)	(0.0401)	(0.0408)	(0.0388)	(0.0410)
2006-2008	-0.629***	-0.159***	-0.230***	-0.102***	-0.0759*
	(0.0470)	(0.0408)	(0.0401)	(0.0387)	(0.0413)
2009-2011	-0.686***	-0.151***	-0.229***	-0.0854**	-0.0697
	(0.0479)	(0.0423)	(0.0403)	(0.0394)	(0.0431)
2012-2014	-0.706***	-0.155***	-0.229***	-0.0919**	-0.0764*
	(0.0467)	(0.0427)	(0.0400)	(0.0396)	(0.0438)
Constant	1.851***	2.117***	3.525***	3.007***	3.211***
	(0.0268)	(0.0257)	(0.0499)	(0.0551)	(0.0991)
Observations	1,537	1,206	1,534	1,204	1,125
R-squared	0.260	0.668	0.671	0.740	0.748

4.4.2 Panel Regression Result (Include Pooled REG)

In the mixed regression model results, it is seen that Model 5 performed comparatively better. The coefficients of each variable in the model can be adopted under different significant level tests. The R^2, which is 0.748, shows a well-performed goodness of fit. As a result, I decided to adopt Model 5 for the base model construction. I used mixture regression, fixed-effect regression and random-effect regression for the estimation of the model parameters. Additionally, I also used Breusch-Pagan LM test and Hausman test to determine the best model.

With the help of STATA, which is software for specific model parameter estimation. It contracted Table 10. First of all, it can be seen from this table that the test values of Breusch-Pagan LM and Hausman are 2276.70 and 95.28 respectively. With a given 5% significant level, I crosschecked the test value in the table and found neither the chi-square values were in the accepted domain. As a result I denied the original hypothesis under the Breusch-Pagan LM test and the Hausman test, and the result concluded that the fixed-effect model is best model.

With a further look at regression coefficients in the models, although the coefficients of GDP Growth in three models have not passed the detection, they are all negative: -0.00242 (POOLED), -0.000361 (FE), and -0.000675 (RE). What is more, the GDP Growth^2 in the mixed regression model is significant. Its regression coefficient is -0.000516 ($p<0.01$), which shows that in the process of economic growth, it is accompanied by amount and then decreases in the fertility rate, but in the fixed-effect model and the random-effect model, it is not significantly equal to zero.

Furthermore, the variables LE and EDU in the three models have passed the detections at different significant levels. Among the three tests the regression coefficients of LE are -0.0202 (POOLED, $p<0.01$), -0.00654 (FE, $p<0.10$), and -0.0108 (RE, $p<0.01$). The three sets of estimated coefficients all show the negative impact that is brought from LE to LnTFR. The regression coefficients of EDU are -0.00674 (POOLED, $p<0.01$), -0.00438 (FE, $p<0.01$), and -0.00563 (RE, $p<0.01$). The three are numerically consistent, suggesting that as male enrolment increases, the overall fertility rate declines. The variable LnGCF's coefficient is only significant in the mixed regression model, which is -0.00938 ($p<0.10$), showing that with other conditions unchanged, by every 1% the Gross capital formation increases, the LnTFR decreases by 0.00938%. In neither the fixed-effect model nor the random-effect model, the LnTFR's coefficients are significant, seeing a 0.00577 (FE) and 0.00373 (RE), respectively.

Table 10. Panel Regression Results For LnTFR （All sample）

Model / Variables	POOLED	FE	RE
	LnTFR	LnTFR	LnTFR
GDP Growth	-0.00242	-0.000361	-0.000675
	(0.00217)	(0.000995)	(0.00107)
GDP Growth ^{2}	-0.000516***	1.73e-05	-2.18e-06
	(0.000145)	(6.65e-05)	(6.88e-05)
LE	-0.0202***	-0.00654*	-0.0108***
	(0.00116)	(0.00335)	(0.00303)
Edu	-0.00674***	-0.00438***	-0.00563***
	(0.000496)	(0.000913)	(0.000869)
LnGCF	-0.00938*	0.00577	0.00373
	(0.00478)	(0.00379)	(0.00331)
1973-1975	0.0454	0.00596	0.0186*
	(0.0400)	(0.0112)	(0.0103)
1976-1978	0.0648	0.0118	0.0353*
	(0.0412)	(0.0200)	(0.0184)
1979-1981	0.0856**	-0.0231	0.0145
	(0.0417)	(0.0272)	(0.0247)
1982-1984	0.0795*	-0.0410	0.00424
	(0.0407)	(0.0332)	(0.0305)
1985-1987	0.0681*	-0.0807**	-0.0272
	(0.0397)	(0.0354)	(0.0317)
1988-1990	0.0236	-0.121***	-0.0624*
	(0.0392)	(0.0367)	(0.0334)
1991-1993	-0.0253	-0.179***	-0.117***
	(0.0409)	(0.0387)	(0.0357)
1994-1996	-0.0916**	-0.249***	-0.183***
	(0.0423)	(0.0413)	(0.0386)
1997-1999	-0.129***	-0.305***	-0.234***

	(0.0408)	(0.0432)	(0.0406)
2000-2002	-0.128***	-0.337***	-0.258***
	(0.0400)	(0.0461)	(0.0433)
2003-2005	-0.103**	-0.362***	-0.270***
	(0.0410)	(0.0490)	(0.0464)
2006-2008	-0.0759*	-0.372***	-0.269***
	(0.0413)	(0.0526)	(0.0489)
2009-2011	-0.0697	-0.363***	-0.250***
	(0.0431)	(0.0576)	(0.0524)
2012-2014	-0.0764*	-0.372***	-0.257***
	(0.0438)	(0.0610)	(0.0553)
Constant	3.211***	2.094***	2.406***
	(0.0991)	(0.196)	(0.165)
Observations	1,125	1,125	1,125
R-squared	0.748	0.765	0.710
Number of id	-	120	120
Breusch-Pagan LM Test			$\chi^2(1)$ = 2276.70
Hausman Test		$\chi^2(19)$ = 95.28	

4.4.3 Considering the Interaction Effect Between Statue and GDP Growth

Similar to our consideration of how the overall fertility rate influences the economic growth in the model, I also examined into the different national states (poor or rich) and the interaction with economic growth, so as to explore whether the effects of economic growth on the overall fertility would change with the various national status. The models were still built in the forms of mixed regression, fixed-effect regression, and random-effect regression. The specific results are shown in Table 11 as follows:

From the results in Table 11, it has drawn 2 conclusions. (1) In the tests on the model form, the chi-square statistic values of Breusch-Pagan LM test and Hausman test are 2242.22 and 98.40 respectively. The corresponding P values are significantly less than 0.01, thus I chose fixed-effect regression model rather than random-effect regression model (2). In the parameter estimation of the model, the GDP Growth coefficients and the national status interaction coefficient are -0.0136 (POOLED, $p<0.01$), -0.00206 (FE), and -0.00415 (RE, $p<0.05$), reflecting that the different status of a country's economic growth influences the total fertility rate in a different way, for example, in a rich country, economic growth has a negative influence on its fertility rate. Moreover, the coefficient of GDP Growth^2 in the mixed regression is -0.000377 ($P<0.05$), which further reflects that the impact of economic growth on the overall fertility rate is a downward opening parabola form, i.e., in the early stage of economic growth, the overall fertility rate increases; however, in the later stage, the faster the economy grows, the lower the fertility rate becomes. In addition, with respect to the result from the model in Table 10, the variables LE and EDU passed different tests on various significant levels. The regression coefficients of LE are -0.0194 (POOLED, $p<0.01$), -0.00659 (FE, $p<0.10$), and -0.0110 (RE, $p<0.01$), while EDU's are -0.00673 (POOLED, $p<0.01$), -0.00442 (FE, $p<0.01$), and -0.00572 (RE, $p<0.01$). These coefficients all show that as the life expectancy and male enrolment increase, the overall fertility rate goes down. In the same way, the coefficients of variable LnGCF are significant merely in the mixed regression model, while not significant in the fixed-effect or random-effect regression model. They are -0.00876 (POOLED, $p<0.10$), 0.00588 (FE), and 0.00389 (RE). These figures suggest that with the other conditions unchanged, by every 1% the gross capital formation grows, LnTFR decreases by -0.00876%.

Table 11. Regression Results With Interaction variable (All Sample)

Model / Variables	POOLED	FE	RE
	LnTFR	LnTFR	LnTFR
GDP Growth	0.00298	0.000421	0.000894

	(0.00248)	(0.00132)	(0.00135)
GDP Growth ^{2}	-0.000377**	4.26e-05	4.66e-05
	(0.000151)	(7.46e-05)	(7.46e-05)
Statue × GDP Growth	-0.0136***	-0.00206	-0.00415*
	(0.00401)	(0.00213)	(0.00219)
LE	-0.0194***	-0.00659*	-0.0110***
	(0.00114)	(0.00335)	(0.00300)
Edu	-0.00673***	-0.00442***	-0.00572***
	(0.000493)	(0.000924)	(0.000878)
LnGCF	-0.00876*	0.00588	0.00389
	(0.00463)	(0.00384)	(0.00337)
1973-1975	0.0379	0.00525	0.0173*
	(0.0400)	(0.0112)	(0.0104)
1976-1978	0.0580	0.0115	0.0347*
	(0.0420)	(0.0198)	(0.0180)
1979-1981	0.0798*	-0.0228	0.0156
	(0.0413)	(0.0272)	(0.0244)
1982-1984	0.0719*	-0.0406	0.00544
	(0.0404)	(0.0331)	(0.0302)
1985-1987	0.0597	-0.0803**	-0.0259
	(0.0395)	(0.0352)	(0.0312)
1988-1990	0.0117	-0.121***	-0.0615*
	(0.0387)	(0.0366)	(0.0330)
1991-1993	-0.0403	-0.180***	-0.117***
	(0.0412)	(0.0385)	(0.0354)
1994-1996	-0.103**	-0.249***	-0.181***
	(0.0422)	(0.0412)	(0.0382)
1997-1999	-0.142***	-0.304***	-0.233***
	(0.0405)	(0.0431)	(0.0401)
2000-2002	-0.145***	-0.337***	-0.256***
	(0.0397)	(0.0460)	(0.0428)
2003-2005	-0.117***	-0.361***	-0.267***

	(0.0407)	(0.0490)	(0.0457)
2006-2008	-0.0915**	-0.371***	-0.266***
	(0.0413)	(0.0527)	(0.0485)
2009-2011	-0.0921**	-0.362***	-0.248***
	(0.0433)	(0.0576)	(0.0518)
2012-2014	-0.101**	-0.372***	-0.254***
	(0.0441)	(0.0610)	(0.0546)
Constant	3.161***	2.096***	2.414***
	(0.0974)	(0.197)	(0.164)
Observations	1,125	1,125	1,125
R-squared	0.751	0.765	0.716
Number of id	-	120	120
Breusch-Pagan LM Test			$\chi^2(1)$ = 2242.22
Hausman Test		$\chi^2(20)$ = 98.40	

4.4.4 Considering the rich country

I took a step further to study the influence that the economic growth in the countries with a different national status (rich or poor), would have on overall fertility rates. According to the World Bank's GNI per capita, I divided the sample into two parts and applied both to a mixed-effect model, fixed-effect model, and random-effect model. The regression result can be seen in Tables 12 and 13.

Combining the results in Table 12 and 13, I have 3 conclusions. (1) On the choice of the models, the results of Breusch-Pagan LM test and Hausman test on the countries regardless of their national status all suggest the best model is fixed-effect model. (2) As for the influence on the LnTFR from GDP Growth, GDP $Growth^2$, LE and EDU, no matter whether it is a rich or poor nation, the effects are largely in the same direction, yet they vary on their magnitude. This can be seen in the following example, when rich countries receive greater influence than poor countries, with the influence arising form economic growth on the fertility rate. The coefficients of GDP Growth are -0.00560 VS -0.000382 (Rich Country VS Poor Country, POOLED), -0.00158 VS -0.000165 (Rich Country VS Poor Country, FE), -0.00178 VS -0.000206 (Rich Country VS Poor Country, RE). The coefficients of GDP $Growth^2$ are -0.000694 ($p<0.01$) VS -0.000454 ($P<0.01$) (Rich Country VS Poor Country, POOLED), -0.000104 VS 2.41e-05 (Rich Country VS Poor Country, FE), -0.000114 VS 5.44e-06 (Rich Country VS Poor Country, RE), showing that the negative impact that economic growth brings to the fertility rate is greater in rich countries than in poor countries. (3) The variable LnGCF has a significant influence on LnTFR in rich countries, while in poor countries, the influence is not significant. In the samples of rich countries, the three sets of models show variations in the influence direction. The coefficient of mixed regression model's coefficient is -0.0162 ($p<0.05$), while in the fixed-effect and random-effect models, they are 0.0104 ($p<0.05$), and 0.009 ($p<0.05$). The mixed-effect model shows that the LnGCF has a negative impact on LnTFR, while the fixed-effect and random-effect show the influence is positive.

Table 12. Regression Results for the Rich Country

Model	POOLED	FE	RE
Variables	LnTFR	LnTFR	LnTFR
GDP Growth	-0.00560	-0.00158	-0.00178
	(0.00393)	(0.00140)	(0.00144)
GDP Growth ^{2}	-0.000694**	-0.000104	-0.000114
	(0.000310)	(0.000152)	(0.000146)
LE	-0.0254***	-0.0117*	-0.0140**
	(0.00193)	(0.00587)	(0.00550)
Edu	-0.00502***	-0.00260**	-0.00303***
	(0.000922)	(0.00111)	(0.00112)
LnGCF	-0.0162**	0.0104**	0.00900**
	(0.00796)	(0.00431)	(0.00354)
1973-1975	0.0106	-0.0422**	-0.0344*

	(0.0473)	(0.0195)	(0.0191)
1976-1978	-0.00372	-0.0880**	-0.0729**
	(0.0640)	(0.0384)	(0.0361)
1979-1981	-0.0383	-0.162***	-0.140***
	(0.0639)	(0.0510)	(0.0480)
1982-1984	-0.0388	-0.194***	-0.167***
	(0.0639)	(0.0559)	(0.0528)
1985-1987	-0.0550	-0.241***	-0.211***
	(0.0626)	(0.0643)	(0.0605)
1988-1990	-0.111*	-0.291***	-0.258***
	(0.0632)	(0.0716)	(0.0677)
1991-1993	-0.166**	-0.367***	-0.331***
	(0.0650)	(0.0714)	(0.0671)
1994-1996	-0.246***	-0.450***	-0.412***
	(0.0711)	(0.0736)	(0.0696)
1997-1999	-0.330***	-0.532***	-0.493***
	(0.0704)	(0.0760)	(0.0714)
2000-2002	-0.318***	-0.572***	-0.527***
	(0.0654)	(0.0779)	(0.0736)
2003-2005	-0.313***	-0.603***	-0.554***
	(0.0699)	(0.0824)	(0.0782)
2006-2008	-0.265***	-0.613***	-0.559***
	(0.0749)	(0.0883)	(0.0839)
2009-2011	-0.303***	-0.615***	-0.560***
	(0.0770)	(0.0923)	(0.0863)
2012-2014	-0.307***	-0.614***	-0.559***
	(0.0794)	(0.0967)	(0.0904)
Constant	3.738***	2.256***	2.447***
	(0.196)	(0.343)	(0.314)
Observations	465	465	465
R-squared	0.662	0.861	0.611
Number of id	-	49	49

Breusch-Pagan LM Test			$\chi^2(1)$ = 1227.21
Hausman Test		$\chi^2(19)$ = 38.26	

Table 13. Regression results for the poor country

Model / Variables	POOLED	FE	RE
	LnTFR	LnTFR	LnTFR
GDP Growth	-0.000382 (0.00272)	-0.000165 (0.00121)	-0.000206 (0.00126)
GDP Growth ^{2}	-0.000454*** (0.000163)	2.41e-05 (7.25e-05)	5.44e-06 (7.66e-05)
LE	-0.0150*** (0.00149)	-0.00416 (0.00417)	-0.00710* (0.00394)
Edu	-0.00728*** (0.000652)	-0.00351** (0.00140)	-0.00527*** (0.00134)
LnGCF	-0.00240 (0.00461)	0.00113 (0.00271)	8.67e-05 (0.00307)
1973-1975	0.0390 (0.0451)	0.0114 (0.0153)	0.0219 (0.0142)
1976-1978	0.0546 (0.0442)	0.0208 (0.0218)	0.0396* (0.0204)
1979-1981	0.103** (0.0457)	0.00720 (0.0292)	0.0389 (0.0273)
1982-1984	0.0849** (0.0431)	-0.00878 (0.0390)	0.0294 (0.0355)
1985-1987	0.0779* (0.0430)	-0.0498 (0.0411)	-0.00227 (0.0370)
1988-1990	0.0391 (0.0416)	-0.0801** (0.0399)	-0.0301 (0.0372)
1991-1993	-0.0195 (0.0439)	-0.133*** (0.0425)	-0.0826** (0.0406)

1994-1996	-0.0684	-0.192***	-0.138***
	(0.0476)	(0.0476)	(0.0456)
1997-1999	-0.0865*	-0.237***	-0.180***
	(0.0456)	(0.0504)	(0.0487)
2000-2002	-0.0993**	-0.273***	-0.208***
	(0.0471)	(0.0537)	(0.0517)
2003-2005	-0.0621	-0.297***	-0.219***
	(0.0494)	(0.0580)	(0.0567)
2006-2008	-0.0595	-0.315***	-0.226***
	(0.0507)	(0.0631)	(0.0622)
2009-2011	-0.0411	-0.315***	-0.213***
	(0.0524)	(0.0678)	(0.0661)
2012-2014	-0.0484	-0.336***	-0.228***
	(0.0535)	(0.0735)	(0.0715)
Constant	2.788***	2.099***	2.300***
	(0.107)	(0.219)	(0.200)
Observations	660	660	660
R-squared	0.701	0.718	0.657
Number of id	-	71	71
Breusch-Pagan LM Test			$\chi^2(1)$ = 1049.14
Hausman Test		$\chi^2(19) = 63.28$	

5. CONCLUSION

This thesis aims to examine what's the relationship between fertility rate and economic growth. Empirical analysis based on data from World Bank 2015. Throughout the course of human history, the development of the economy is closely related to the growth and decline of the population. Economic historians study the economic development of countries primarily through demographic variations, technological evolution, and the income changes of the citizens (Habakkuk and Postan, 1965). The relationship between demographic variables and other economic variables has been dynamic through different historical stages. (Ji, 2014)

Becker (1960) was one of the first economists to branch into economic analysis of fertility. He analyzed parenting with the theory of consumer behavior in an economic way. The analysis shows that children are specific goods, while the reproductive behavior is the customers' response to the demand of their children. However Schultz (1973) provides a better theoretical framework to provide a further understanding of the determinants of fertility. The theory believes that as the parental salary raises, the family income will increase, and so will the opportunity costs of raising children (Ji, 2014). Thereby people's fertility desires and their demand for the numbers of children will be reduced.

To approach fertility in a social perspective, it is thought that different cultural backgrounds will promote or refrain it. In the traditional agricultural society, the low parental social status, lack of education, and a relatively closed living environment resulted in higher fertility; on the contrary, with the improvement of women's status and the level of their education, plus their more frequent participation in social and economic activities, and a more effective implementation on contraception or birth control, the fertility tended to be reduced.

Fertility has attracted a lot of attention to be deciding factor of economic development in theoretical and empirical studies. Fertility changes affect economic growth, and the economic growth in return, affects fertility. Most previous researches and literature show that economic growth has a negative effect on fertility (Galor and Weil, 1996; Doepke,2004). In the population study, total fertility rate is a meaningful indicator. It can be used to compare women's fertility in different periods of time. It can also reflect the population trend, which is a significant indicator for a country to make demographic decisions. Therefore, it is commonly used among scholars in research.

The majority of scholars believe that the mortality and fertility primarily cast their impact to economic development through investing in human capital. Ehrlich and Lui (1991) brought life expectancy into a endogenous growth model for the first time. The study shows that exogenous the decline of mortality results in lower fertility, higher children's human capital investment from parents, and the stimulation to economic growth. Kalemli-Ozcan (2002) discussed the relationship between fertility and human capital investment and its impact on economic growth. He pointed out that when mortality is not established, there is a preventive demand in the family for their future generations. Along with the decline in mortality, this demand will be reduced, so as to encourage the family to increase educational investment for next generations. Thus the relationship between the demographic change and the per capita income is a hump shaped configuration. (Mao, 2013)

Constructing a theoretical framework, this paper studied the relationship between fertility and economic growth. With a data simulation, we have proved the influence of fertility and the development of the economy. The intensive study began from the 1970s and despite many of the elementary propositions put forward in this study are accepted and approved. The empirical analysis is basically satisfactory.

The conclusions are as follows:

The influence of fertility to economic growth:

1. The results reflect that at the current period, high fertility rate will result in lower economic growth. It means total fertility rate has a negative effect on economic growth in the current period.

2. The impact of Gross Capital Formation on economic growth showing that their exists a positive impact. When we divided data samples into rich and poor, the results show that total fertility rate of poor countries exerts significantly stronger negative effects on the current economic growth than in rich countries.

The economic growth impact on fertility rate:

1. Traditional economic theory shows that a country's initial stage of the economic growth is often accompanied by a high fertility rate; then with the economy further developing, the fertility rate will go down. The empirical analysis proves this hypothesis that economic growth appears at the beginning of the high fertility rate; with the acceleration of economic growth, the fertility rate declines.

2. When other conditions remain unchanged, the longer life expectancy, the higher male enrollment rates, or the greater the gross capital formation, there will be lower fertility rates.

3. The different status of a country's economic growth will impact on the total fertility rate in a different way; for instance, economic growth has a negative influence on its fertility rate in a rich country.

4. All variables show that no matter whether it is a rich or poor country, the effects are largely in the same direction, but they vary in their magnitude. This can be seen in the example: when rich countries receive greater influence than poor countries, with the influence arising capital forms of economic growth on the fertility rate. It shows that the negative impact that economic growth brings to the fertility rate is greater in rich countries than in poor countries.

5. The Gross Capital Formation has a significant influence on the total fertility rate in rich countries. However, the influence is not significant in poor countries.

The thesis findings mainly cover and sum up the current research status. Many findings are reported and used from developed countries as the explanations; however, they cannot be applied to developing countries. To study the relationship between fertility and economic growth is helpful for developing countries to make enough appropriate recommendations and predictions.

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APPENDIX

Table 2: Description Statistics (All Sample)

Varible	Periods	N	Mean	STD	Min	Max	Skewness	Kurtosis
GdpGrowth	1970-2014	1549	1.8446	4.6126	-32.2732	42.0883	-0.3979	13.0912
	1970-1972	75	3.2608	3.9789	-6.5291	19.1661	1.0463	5.4178
	1973-1975	75	2.5326	4.5605	-10.1849	21.5375	1.3878	9.0075
	1976-1978	80	2.5188	4.2807	-12.1572	14.0870	-0.2202	4.2132
	1979-1981	91	0.7826	5.0632	-21.8199	11.7243	-1.0902	6.6613
	1982-1984	95	0.0449	3.9029	-11.4697	10.0970	-0.0117	3.2867
	1985-1987	100	0.7233	3.4232	-9.2423	11.3232	0.1288	4.1006
	1988-1990	104	0.9785	5.0325	-25.5455	15.3940	-1.2084	9.8240
	1991-1993	111	-1.2583	7.1316	-32.2732	13.9107	-1.5128	6.7203
	1994-1996	113	1.2146	4.4765	-17.9768	12.0565	-1.3623	7.1291
	1997-1999	114	2.0315	5.1256	-8.8986	42.0883	4.5334	35.3517
	2000-2002	118	1.9734	3.7587	-10.7683	21.9075	1.0301	9.6030
	2003-2005	118	3.6611	3.7315	-11.4210	17.4569	0.0535	7.3040
	2006-2008	119	4.2471	3.5801	-8.4301	21.7134	0.9294	8.0864
	2009-2011	118	2.1149	3.3827	-20.3387	9.2923	-2.2601	18.0347
	2012-2014	118	2.7344	3.1943	-12.0751	21.3038	1.0770	15.1727
LnGdp	1970-2014	1569	6.8161	1.1123	4.0836	9.5910	0.1758	2.2902
	1970-1972	78	5.4754	0.6737	4.0836	6.7579	-0.0791	2.1971
	1973-1975	79	5.9146	0.7749	4.4525	7.7434	0.0237	2.1708
	1976-1978	82	6.2332	0.7936	4.7001	8.3062	0.0749	2.2823
	1979-1981	93	6.5289	0.8534	4.6491	8.5404	-0.0127	2.2337
	1982-1984	94	6.5347	0.8603	4.8171	8.4114	0.0464	2.0070
	1985-1987	99	6.5668	0.8415	5.0223	8.2787	0.0614	2.0451
	1988-1990	113	6.7063	0.8757	5.0873	8.8225	0.1035	2.2707

1991-1993	112	6.7010	0.9308	4.7835	8.8848	0.1324	2.3099
1994-1996	113	6.7379	1.0335	4.2137	8.9275	-0.0211	2.1397
1997-1999	114	6.8107	1.0357	4.8392	8.9975	0.0359	2.0336
2000-2002	118	6.8060	1.0473	4.7825	8.9694	0.0820	2.0156
2003-2005	119	7.0752	1.0500	4.8247	9.2031	-0.0790	1.9774
2006-2008	119	7.4838	1.0644	5.1319	9.3974	-0.2014	1.9250
2009-2011	118	7.6953	1.0291	5.3957	9.3549	-0.2590	1.8738
2012-2014	118	7.8615	1.0320	5.5307	9.5910	-0.3110	1.9882

Table 2: Description Statistics (Continued)

Varible	Periods	N	Mean	STD	Min	Max	Skewness	Kurtosis
LnTFR	1970-2014	1782	1.4323	0.4651	0.1017	2.2203	-0.6128	2.3332
	1970-1972	119	1.7452	0.3070	0.7403	2.1107	-1.7387	5.4732
	1973-1975	117	1.7230	0.3160	0.7097	2.1209	-1.4591	4.5317
	1976-1978	118	1.6854	0.3399	0.6746	2.1368	-1.2425	3.8002
	1979-1981	118	1.6424	0.3727	0.6457	2.1951	-1.1024	3.2964
	1982-1984	119	1.6078	0.3774	0.6030	2.2203	-0.9173	2.8733
	1985-1987	119	1.5648	0.3852	0.6061	2.2096	-0.7641	2.5440
	1988-1990	117	1.5201	0.3917	0.5779	2.1746	-0.6825	2.4494
	1991-1993	120	1.4397	0.4229	0.4121	2.1164	-0.5978	2.4245
	1994-1996	118	1.3788	0.4496	0.2443	2.0578	-0.5853	2.5340
	1997-1999	120	1.3016	0.4761	0.1339	2.0597	-0.4333	2.3301
	2000-2002	120	1.2462	0.4825	0.1017	2.0417	-0.2862	2.1610
	2003-2005	120	1.2044	0.4751	0.1832	2.0330	-0.1548	2.0370
	2006-2008	119	1.1765	0.4596	0.3067	2.0274	-0.0662	1.9504
	2009-2011	119	1.1449	0.4478	0.3460	2.0260	-0.0001	1.9406
	2012-2014	119	1.1180	0.4369	0.3404	2.0239	0.0492	1.9633
LnGCF	1970-2014	1456	20.8601	2.2584	0.0946	29.0803	-0.7669	11.0901
	1970-1972	66	19.2677	1.8762	14.5491	24.2174	0.1030	3.1269
	1973-1975	66	19.8495	1.9441	15.0931	24.6371	0.0133	2.9475
	1976-1978	74	20.1041	2.0700	15.3945	24.7374	-0.0736	2.7062

1979-1981	85	20.4180	2.0688	16.1194	24.9010	0.1136	2.3500
1982-1984	89	20.3047	2.0950	16.6335	25.0887	0.2465	2.2503
1985-1987	90	20.3258	2.0137	16.5194	25.0708	0.3086	2.4126
1988-1990	106	20.6218	1.8950	16.8665	25.0422	0.2800	2.4511
1991-1993	107	20.7158	1.9171	16.8327	25.4329	0.3621	2.6918
1994-1996	107	20.8718	1.9435	17.4779	25.9181	0.4308	2.7042
1997-1999	109	20.4268	3.2869	0.0946	24.7450	-3.9239	24.6284
2000-2002	115	20.8319	1.9938	16.7414	26.5629	0.2122	2.8324
2003-2005	116	21.2383	2.0108	17.1620	27.4334	0.3070	3.0467
2006-2008	113	21.8626	2.0481	17.5747	28.0628	0.2141	2.9667
2009-2011	107	22.1527	2.0042	17.8245	28.7060	0.3081	3.3527
2012-2014	106	22.3442	2.0966	17.6524	29.0803	0.1777	3.2505

Table 2: Description Statistics (Continued)

Varible	Periods	N	Mean	STD	Min	Max	Skewness	Kurtosis
	1970-2014	1776	60.5531	10.1768	20.2901	79.9876	-0.4408	2.3476
	1970-1972	117	53.5234	9.9703	33.0865	71.0098	-0.0192	1.9196
	1973-1975	117	54.7288	10.0026	28.2027	71.7627	-0.1814	2.1558
	1976-1978	117	55.9045	10.0472	20.2901	72.9537	-0.4661	3.0225
	1979-1981	117	57.1997	9.5792	29.9199	73.8176	-0.3524	2.3939
	1982-1984	119	58.7068	9.1405	40.0809	74.3301	-0.2688	1.9800
	1985-1987	119	59.7866	9.0322	39.8472	74.8595	-0.3453	1.9943
LE	1988-1990	117	60.3419	9.2315	36.9293	75.5217	-0.5036	2.2444
	1991-1993	120	61.1017	9.6224	27.6515	76.1420	-0.7622	3.0565
	1994-1996	117	61.2324	9.5748	31.5445	76.7673	-0.6738	2.7262
	1997-1999	120	62.0693	9.6305	36.9101	77.3699	-0.5490	2.1697
	2000-2002	120	62.7660	9.8090	38.8682	77.8915	-0.5388	2.0293
	2003-2005	119	63.5333	9.6810	41.3215	78.3142	-0.5662	2.0538
	2006-2008	119	64.6495	9.2942	43.4922	78.7399	-0.5866	2.1287
	2009-2011	119	65.7743	8.8401	44.8143	79.2839	-0.6099	2.2314
	2012-2014	119	66.5993	8.5767	45.4400	79.9876	-0.6346	2.3337

Edu	1970-2014	1321	49.8396	28.3930	1.6076	123.4997	0.2113	1.9773
	1970-1972	90	23.7860	19.7513	1.6076	91.1925	1.5573	5.4229
	1973-1975	84	29.2093	21.5804	2.1822	96.2493	1.0926	3.8285
	1976-1978	81	34.5749	23.7147	2.5141	93.1729	0.6793	2.6062
	1979-1981	81	41.7127	27.5992	3.1517	123.3160	0.8511	3.2188
	1982-1984	79	39.8640	23.3520	3.9658	101.3454	0.5810	2.4763
	1985-1987	85	45.4377	27.6516	4.4838	121.0331	0.6409	2.7730
	1988-1990	83	44.2084	26.9722	5.1652	123.4997	0.7213	2.9566
	1991-1993	79	48.7766	27.4817	6.0574	119.9678	0.3351	2.2545
	1994-1996	69	48.4844	25.1185	5.8100	119.9712	0.1496	2.4583
	1997-1999	95	53.5880	25.5545	6.2417	96.0706	-0.1564	1.8644
	2000-2002	102	57.9068	26.0488	8.6378	109.1375	-0.1100	1.9513
	2003-2005	99	61.7199	24.8446	11.1247	105.3434	-0.3026	2.0031
	2006-2008	103	65.7412	25.3960	10.0630	113.8940	-0.3120	2.1066
	2009-2011	99	68.6354	23.5550	16.5348	109.2203	-0.3675	2.0715
	2012-2014	92	70.7733	23.2827	20.4035	107.2746	-0.3942	2.0459