THE IMPACTS OF POPULATION AGING ON THE DEVELOPING AND DEVELOPED COUNTRIES ECONOMIC GROWTH

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MASTER OF ECONOMICS

GRADUATE SCHOOL
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A THESIS SUBMITTED TO CHIANG MAI UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ECONOMICS

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THIS THESIS HAS BEEN APPROVED TO BE A PARTIAL FULFILLMENT OF
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Chayanit Kaewtacha

หัวข้อวิทยานิพนธ์ ผลกระทบของประชากรผู้สูงอายุต่อการเจริญเติบโตเศรษฐกิจในประเทศกำลังพัฒนาและประเทศพัฒนาแล้ว

ผู้เขียน นางสาวชญานิศ แก้วเตชะ

ปริญญา เศรษฐศาสตรมหาบัณฑิต

คณะกรรมการที่ปรึกษา ผศ.ดร.อนัสปรีย์ ไชยวรรณ อาจารย์ที่ปรึกษาหลัก
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บทคัดย่อ

ปริญญานิพนธ์ฉบับนี้มีมีวัตถุประสงค์เพื่อดูภาพรวมและเปรียบเทียบผลกระทบของประชากรผู้สูงอายุต่อการเจริญเติบโตเศรษฐกิจในประเทศกำลังพัฒนาและประเทศพัฒนาแล้ว ในการศึกษาครั้งนี้ใช้ข้อมูลพาแนล โดยประกอบด้วยข้อมูลอนุกรมเวลาทั้งหมด 15 ปี ตั้งแต่ปี 2543 ถึงปี 2557 และข้อมูลเชิงภาคตัดขวางทั้งหมด 40 ประเทศ ตัวแปรที่ใช้ในการศึกษามีอัตราการเติบโตของผลิตภัณฑ์มวลรวมในประเทศต่อหัว, อัตราการเติบโตของกลุ่มประชากรอายุ 0 ถึง 14, อัตราการเติบโตของกลุ่มประชากรอายุ 15 ถึง 65, อัตราการเติบโตของกลุ่มประชากรอายุ 65 ขึ้นไป, การสะสมทุนเบื้องทุน และการออมในประเทศกำลังพัฒนาและประเทศพัฒนาแล้วอย่างละ 20 ประเทศ ข้อมูลทั้งหมดเป็นข้อมูลทุติยภูมิจากธนาคารโลก

ผลจากการศึกษาใน Hausman test และ the redundant fixed effects test พบว่า Fixed Effect Model (FEM) เป็นตัวทดสอบที่เหมาะสมกับข้อมูลพาแนลของทั้งประเทศกำลังพัฒนาและประเทศพัฒนาแล้ว จากการทดสอบ panel regression model ทั้งประเทศกำลังพัฒนาและประเทศพัฒนาแล้วพบว่า ปัจจัยที่มีผลกระทบทางลบที่มากที่สุดต่ออัตราการเติบโตของผลิตภัณฑ์มวลรวมในประเทศต่อหัวคือปัจจัยอัตราการเติบโตของกลุ่มประชากรอายุ 0 ถึง 14 และปัจจัยอัตราการเติบโตของกลุ่มประชากรอายุ 65 ขึ้นไปในประเทศกำลังพัฒนามีผลกระทบเป็นทางบวกแต่มีผลกระทบเป็นทางลบในประเทศที่พัฒนาแล้ว

Thesis Title	The Impacts of Population Aging on The Developing and Developed Countries Economic Growth

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ABSTRACT

This thesis aims to examine and compare the impacts of population aging on the developing and developed countries economic growth. This study will be conducted using a panel data. Including time series, the data is annualized of 15 years within the period from 2000 to 2014 and cross sectional the data of 40 countries are the growth rate of real GDP, the population ages 0 to 14, the population ages 15 to 64, the population ages 65 and above, the gross saving and the gross capital in each 20 developing and developed countries. All data are gathered from the World Bank.

The results in the Hausman test and the redundant fixed effects test show that the Fixed Effect Model (FEM) is efficient and consistent in both of developing and developed countries. From the finding shows that the results of panel regression model in both developing and developed countries. The most negative effect factor to the growth rate of GDP per capita is the growth rate of population ages 0-14. And the growth rate of population ages 65 and above in developing countries that have positive effect to the growth rate of GDP per capita. And in developed countries the growth rate of population ages 65 and above in developed countries that have negative effect to the growth rate of GDP per capita.

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CHAPTER 1

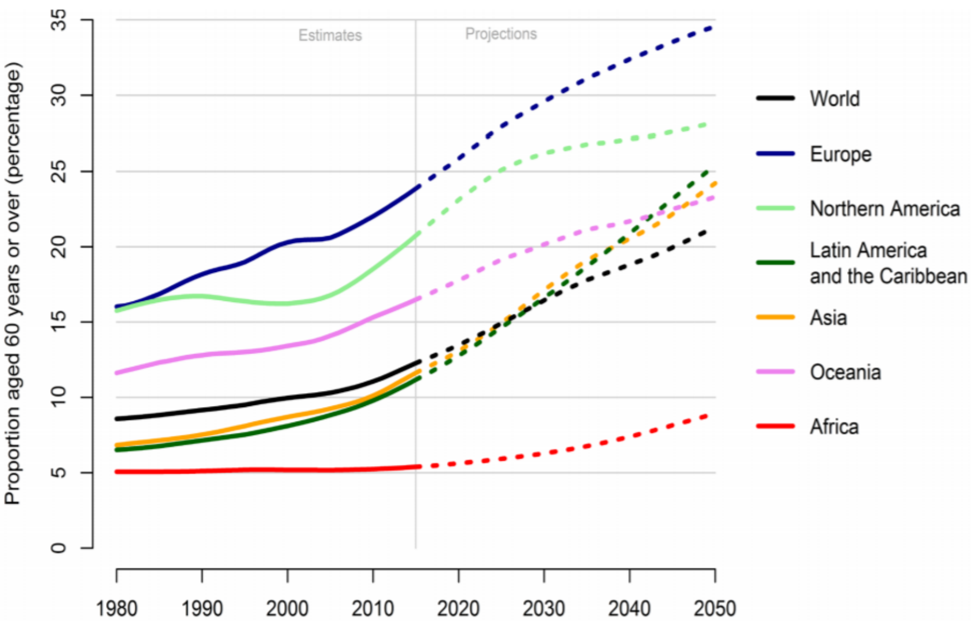
Introduction

1.1 The Rationale Background

Population aging is group of people age more than 65 years old. Nowadays Population aging is increasing due to the technology has been improved from the past that make everyone can easily access the better medical health care. Aging affects economic growth through three main mechanisms: consumption and saving pattern, public expenditure and human capital. Countries with the population aging the government have more public expenditure on the medical system will be higher than the spending on education and other forms of development. And decline the number of people who is paying tax and the country with a younger population economy will grow faster than the country with aging population because the younger population is a group of people working to keep the economy moving

A high proportion of the aging population might make slower economic growth because a large share of resource must be allocated to help the less productive population. The developed and developing countries are experiencing an increase in the average age of its citizens associated with a growing proportion of elders in the population

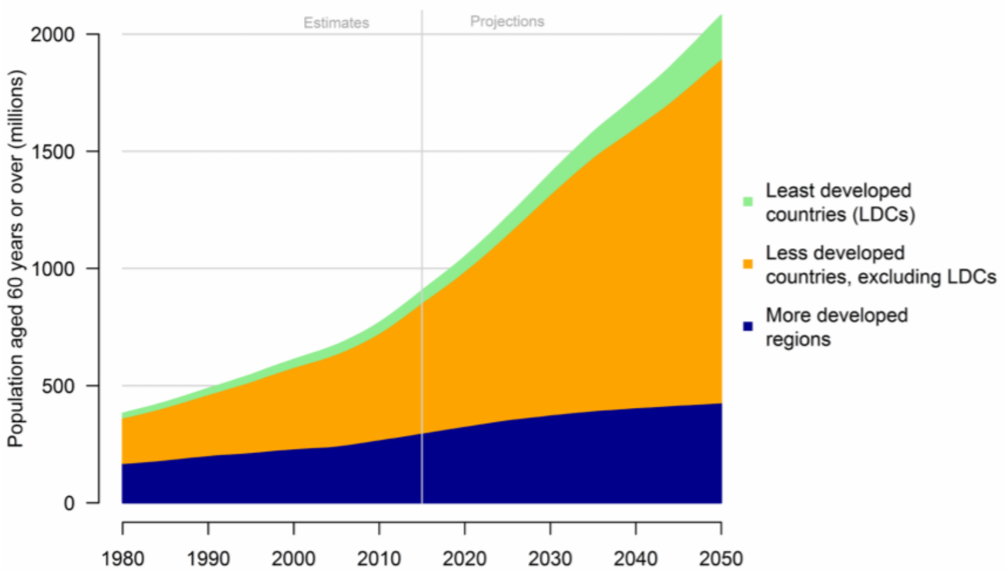
And will lead to households with more individuals tend to save more for their retirement that make the country have less attractive for foreigner to invest so, the FDI has decreased. The imbalance in the government budget shows increase deficit. Furthermore, the aging can increase in the dependency ratio – the dependency ratio is the ratio of dependents – people younger than 15 or older than 64 – to the working aging population on these ages 15-64. A group of people who works is lower. So, it means the people may pay tax in higher rate because the declining in workforce. Shortage of workers as it had to be because the old is getting older and nowadays the fertility rate is lower than the past. Changing sector within the economy – the business may create about aging may increase e.g. retirement homes, the options of insurance are more. Higher saving for pensions may reduce capital investment – People prepare their money in their retired life and it could reduce the amount of savings available for more productive investment, leading to lower rates of economic growth.



Source: United Nations (2017). World Population: the 2017 Revision.

Figure 1.1: Number of persons aged 60 years or over by development group, from 1980 to 2050

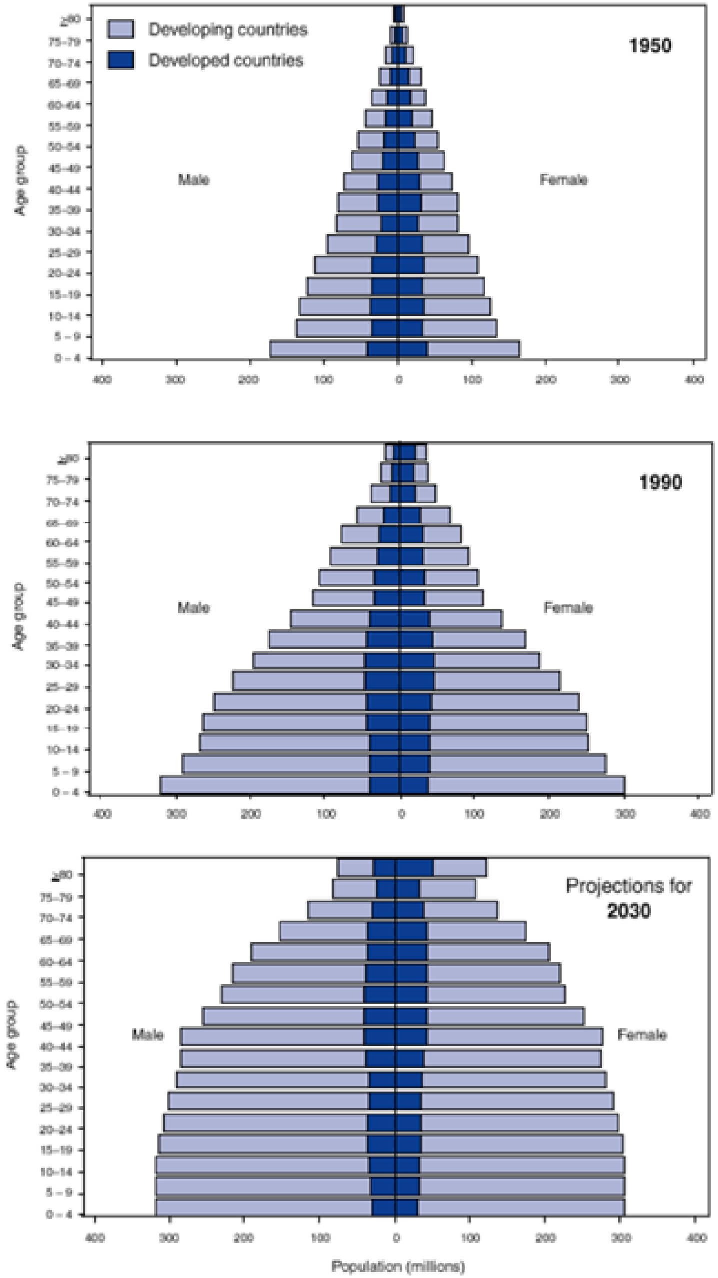
From the figure1.1 shows the percentage of population aged 60 years or over by region, in 2017 one in eight persons was aged 60 or over but in 2050 the people who are age 60 or over are projected to account for one in five persons. The population aging has risen continuously from 1980 to 2050. Europe and Northern American, where more than one in five persons were aged 60 or over in 2017, are the highest projected aging population. In 2050, the aging population is expected to account for 35 percent of the population in Europe, 28 percent in Northern America, 25 percent in Latin America and the Caribbean, 24 percent in Asia, 23 percent in Oceania and 9 percent in Africa.



Source: United Nations (2017)

Figure 1.2: Number Of persons aged 60 years or over by development group, from 1980 to 2050

The figure 1.2 shows the number of persons aged 60 years or over by development group, from 1980 to 2050 which is the aging population in the developing countries obviously increase faster than the developed countries. In 1980 the number of aging of developing countries was one third of the world's aging population aged 60 years or over and in 2017 is more over two third. During 1980 to 2050 the number of aging of developing countries is expected to increase more than twofold, from 652 million to 1.7 billion, while the number of aging of developed countries is projected to a 38 percent increase from 310 million persons aged 60 years or over in 2017 to 427 million in 2050. In addition to the number of projections show that in 2050, 79 percent of the world's population aged 60 or over will be living in the developing countries. Provide that the least developed countries effect the world's aging population aged 60 years or over are slightest but the number of aging of the least developed countries is gradually increase continuously.



Source: United Nations, 1999, and U.S. Bureau of the Census, (2000)

Figure 1.3: Population age distribution for developing and developed countries, by age group and sex – worldwide, 1950, 1990, and 2030

The figure1.3 shows the bottom of the pyramid is larger than its past size and the top of the pyramid is smaller than its past size in both of developing and developed countries. But it shows clearly in the developing countries. And the top of pyramid is enlarged obviously that means the expansion of aging population more over than the past.

In this thesis, the data is divided into three range based on the dependency ratio, dependency ratio is the ratio of the economically dependent part of the population to the productive part. Total dependency ratio: persons under age 15 plus persons aged 65 or older per 100 persons aged 15 to 64, Including the population ages 0 to 14, the population ages 15 to 64 and the population ages 65 and above. Every range of ages have a different influence in the growth rate of GDP per capita. Furthermore, in developing and developed countries tend to effect differently in the growth rate of GDP per capita. Consequently, changing in population age structure can have a large impact on economic growth because labor supply and saving rates may vary over their life cycle as well.

This thesis studies about the impact of population aging on the developing and the developed countries economic growth. The further study is the model specification of this study is dividing into two models are the developing countries and the developed countries to the result will be clearly to compare what factors that impact to the growth rate of GDP per capita. To create the policy what is the actual problem for each developing and developed countries. These countries can solve the problem in a better way.

So, this research is to study the impact of the aging population on economic growth to overview and describe the aging population situations and economic growth in developed and developing countries. Moreover, to compare the impacts of the aging population on the economic growth between developed and developing countries which countries has more effect to the economic growth.

1.2 Purposes of the study

This thesis focuses on three main objectives as follows:

1. To overview and describe the aging population situations and economic growth in developed and developing countries.

2. To examine on impacts of the aging population on the economic growth in developed and developing countries.

3. To compare the impacts of the aging population on the economic growth between developed and developing countries.

1.3 Advantage of study

The result could be beneficial for some people who is the policy makers about aging population. The policy maker can use the result to see how different of aging population has impact to economic growth in developing and developed countries

1.4 Scope of the Study

This study focuses on a panel data. Including time series, the data is annualized of 15 years within the period from 2000 to 2014 and cross sectional the data of 40 countries in each 20 developing and developed countries. The countries in this study are chosen from the top three highest percentage of aged 60 years and over in both of developing and developed countries from every continents and if there are no countries that on the conditional which the data is available in each continents This study will take the number of those countries divided by the number of the remaining continents.

This study dividing the countries in developing and developed countries follows the International Monetary Fund (IMF) and dividing the countries in each continent follows the United Nations (UN).

CHAPTER 2

Theory and Literature Reviews

2.1 Theory

1) Endogenous Growth theory

By Robert E. Lucasand Paul M. Romer, (1990). The models that generate steady growth even without technological progress are called models of endogenous growth. The output per worker is measured by the level of both physical capital per worker and human capital per worker. The physical capital and the human capital can be accumulated through physical investment and given education and training which increase the saving rate and the fraction of output per worker in the long run. On the contrary, given the rate of technological progress, such measures do not lead to a permanently higher growth rate. Note the given the rate of technological progress is related to the level of human capital because the better education can improve the better technological and it can lead to a permanently higher growth rate.

The endogenous growth theory is that the rate of growth of the economy in the long term de pends on saving, particularly investment directed towards human capital such as subsidies for research and development or education increase the growth rate in some endogenous growth models by increasing the incentive for innovation. So, the return to investment in endogenous model is a constant. The endogenous growth can be shown with a simple algebraic model leading to endogenous. a production function with a constant marginal product of capital and with capital as the only factor. Specifically, let

$$Y = aK \tag{2.1}$$

where, Y is output that is proportional to the capital sto

a is the marginal product of capital is simply the constant.

Assume the saving rate is constant at s, and there is neither population growth nor depreciation of capital. Then all saving go to increase the capital stock

$$K = sY = saK \text{ or } \frac{\Delta K}{K} = sa \qquad (2.2)$$

The growth of capital is proportional to the saving rate. Further, since the output is proportional to capital, the growth rate of output is

$$\frac{\Delta Y}{Y} = sa \qquad (2.3)$$

In this example, the higher the saving rate, the higher growth rate of output

2) The production function

The production function describes the relationship between the quantity of inputs used in production and the quantity of output from production. A production functions have a property called constant returns to scale. A production function has constant returns to scale, which means that output will rise by the same proportionate increase as all inputs. If all inputs rise by ten percent output will also rise by ten percent. Mathematically, a production function has constant returns to scale. To see what happens when $1/L$ in both side of equation.

$$Y/L = Af(1, K/L, H/L, N/L) \qquad (2.4)$$

where Y/L is output per worker, which is a measure of productivity

K/L is physical capital per worker

H/L is human capital per worker

N/L is natural resources per worker

This equation says that productivity depends on physical capital per worker, physical capital per worker, human capital per worker, natural resources per worker, and also the state of technology, as reflected by the variable A.

3) The human capital

The human capital is divided in two forms are the human capital in the form of health and the human capital in the form of education. Human capital is the economist's term for the knowledge and skills that workers acquire through education, training, and experience. Human capital includes the skills accumulated in early childhood programs, grade school, high school, college, and on-the job training for adults in the labor force. As a well-established that education creates citizens better and helps to upgrade the standard of living in a society. Therefore, the positive social changed seems to be involved with the production of quality citizen. This increasing faith in education as an agent of change in many developing countries Education is the basic objective of development. Education play the key role in the ability of a developing country to gain modern technology and to develop the capacity for self-sustaining growth and development, according to Todaro and Smith (2009). In many developing countries providing people a higher education by public perception of financial reward. Generally, this goes with the belief that expanding education promotes economic growth. In the term of economic Human capital is use for education, health, and other human capacities to increase productivity of the workers. Recall the production function pointed by Mankiw (2006):

$$Y = Af(L, K, H, N) \tag{2.5}$$

where $Y =$ output

A = level of technology

L = the quantity of labor

K = the quantity of physical capital

H = the quantity of human capital

N = the quantity of natural resource

From the equation shows that economic growth is sustainable in the long run, it does not depend on only investment in physical capital, but it also depends on the human capital such as education. The productivity is the increasing of the production of the countries could be analyzed as the one's ability to produce. There are three main ways that education could influence productivity as follows:

1. Increasing in productivity
2. The cost of adjustment inputs and outputs of production decrease
3. Ability of workers to use new technology increase.

Education is the standard measurement that the firm will hire people to work because the firm wants to hire people with knowledge and skill. So, education may the first choice to critical to consider.

In summary, the theory of endogenous growth is a concept that suggests the economy run in the long term and prioritize to invest in human capital and physical capital first. It will make the economy sustainable growth and focuses on the role of government to promote investment in both of human capital and physical capital

2.2 Literature Review

Garry young, (2002) this paper study about the impact of demographic change on the UK economy on the GDP growth and GDP per head. In this study conclude whether there are three ways that make the demographic change. The firstly is aging population is determinant all over the world to assist a shift from public to private that the increase of the retirement age that faced the risk of market price and rate of return. The secondly is the size of group people in every groups tend to grow larger as result of aging. And the third any side effects from the demographic changes are likely to be felt in the old age example when people live longer is that they have to save their money for their retirement that mean they need to save money more in today when they are working. If they do not save their money. So, they have to less consume than they are younger than consumption will be lower in old age than is the case the case if there is a suitable provision for retirement

Seryoung Park, (2007) this paper study about the impact of demographic changes on a regional economy that the impact is important will be in the future. In this study quantifies the impact of the aging population and retirement migration straight to Chicago regional economy in terms of its impact on economic growth, income (asset) distribution, and welfare benefits by using the method general equilibrium (CGE) model and overlapping generations (OLG) framework. The result of investigation is the gross regional product in Chicago region is reduced by mainly the aging population. From the dissimulation, there are two possible determinants at play for this result. The first determinant is the aging population reduces labor's disposal income who are important a significant part of the total saving due to the high rate of social security tax rate in working age. The second the aging population is important contributed to increase the share of the older generations, who spend money more than their income. These two determinants bring to reduce the capital stock, and thus the economic growth.

Donghyun Park and Kwanho Shin, (2011) this paper study about the projection of the impact of the demographic transition on the economic growth of 12 developing Asian include China, people's Rep., Hong Kong China, India, Indonesia, Korea, Rep., Malaysia, Pakistan, Philippines, Singapore, Taipei China, Thailand, Vietnam from 2011 to 2020 and from 2021 to 2030. They divided the age range into two ranges is the old-age dependency ratio and the young-age dependency ratio on three factors of economic growth: labor force participation, capital accumulation and the growth of total factor productivity (TFP). The result of this investigation indicated that the young-age dependency ratio is significant positive on the economic growth and the old-age dependency ration is significant negative on the economic growth. Therefore, the study suggests that there is a tremendous economic impact in the case of an increasing number of elderly people.

David E. Bloom, David Canning and Günther Fink, (2011) this paper study about the effect of population aging on economic growth in UN population aged 60 and over is projected to increase in nearly every country in the world during 2005-2050. The result indicated that the aging population is the main to reduce the labor-force participation and saving rates, therefore the aging population this is problem to worry in the future in the OECD countries. Moreover, this study suggests that changing the behavioral working force is the participation of women worker more and policy reorganization that is expanding the range of working age can reduce the economic impact of an aging population has increased. In addition to the non-OECD countries the rate of fertility is decreasing to make labor ratio on population increase due proportion of young people is more than compensate for the distortion of an adult towards the elderly. Consequence, the developing countries aging population will not be an obstacle to economic growth.

Hyeon-seung Huh and Hyun-Hoon Lee, (2014) the main purpose of this paper is to assess the impact of population aging on economic growth. This paper utilizes the panel data for 72 countries for the period 1950-2000 and applies three different specifications such as random effects, fixed effects and the vector decomposition (XTFEVD). The results show that both old-age shares and youth-age shares are negatively associated with economic growth. The size of the coefficient on the old-age share is not smaller than that on the youth-age share. Specifically, when estimates are made for non-African countries only, it appears that the size of coefficient for the elderly is larger. This suggests that behavioral change does not seem to add up to mitigate the adverse impact of aging on economic growth. This result is in contrast with Bloom, Canning and Finlay (2008)'s regression result which indicates that old-age share is not negatively associated with economic growth in the long run.

Ki-Houng Choi, Sungwhee Shin, (2015) in this paper study about the impact of aging population on the growth of labor supply, capital stock and economic growth by using the overlapping generations (OLG). The results indicated the aging population mainly decrease the growth of labor supply that is the reason why the wage rate increase. So, the promotion of investment in human capital and physical is important because the growth of physical capital can offset the decreasing in labor supply growth. Moreover, if the GDP per capita decrease that effect to the investment in human capital. In Korea have problem about the aging population too.

MaiQi Zhao, (2016) this paper run a cross-country growth rate regression on the growth rate of the percent of population of 65 and overusing data of 97 sample countries from 1960 to 2010. The data used mainly come from the World Bank and Penn World Tables. Real GDP, population, employment, real consumption of households and government, the human capital variables and TFP come from the Penn World Tables. Data measured in dollars are all calculated in 2005 U.S. dollars. On the other hand, the key variable, the share of population of age 65 and over and other variables, including the age structure variables, population density, life expectancy, birth rate, and population share of age over 65, the share of urban population, and the share of trade to GDP, are from the World Bank. This paper runs both fixed and not fixed effect. In the regression with fixed effect, time trend variable and country-fixed effect are added to capture time trend and country-specific characteristics. They also run the regression with five-year intervals to allow for more variation in the key variable. All the regression results show that population aging has no economically nor statistically significant relationship with economic growth. To check for the possibility that the effect of aging on the economy varies with time, they also run regressions including time interaction term. The results imply that aging has a statistically significant impact on economy, but the impact is time varying. And the second part is a case study of China and Japan. The author compares China with Japan and fined that the current age distribution in current China is similar to Japan in 1986. What is going to happen in China is unsure. If China follows Japan's path, China's economy will eventually deteriorate. But the differences between the two countries might save China and actions could be taken by the government to relieve the aging problem.

Table 2.1: The summary of literature reviews

Authors	Titles	Variables	Results
Garry young, 2002	The implications of an aging population for the UK economy	- GDP growth and GDP per head - Saving and capital investment - Interest rates - Asset prices and the distribution of national income	Growth of GDP depend on three factors, is the supply of labor available, capital and technological progress. The amount of labor is scarcely to found. Technological advances is linked a little to the demographic change, But the accumulation of capital is linked closely to the behavior of savings which will be affected by age. Aging population is the important issue around the world that reduce domestic savings are increasingly in other countries, and this will put pressure on interest rates between countries. While the impact of demographic changes on asset prices is small fluctuations in asset prices and yields important.
Seryoung Park, 2007	Demographic changes and regional economy: simulation results from the Chicago CGE Model	- Asset holdings - Income - Saving - Consumption	Asset holdings is not big enough, especially during the working period, most assets accumulated continued unchanged. The before and after aging population. The changes of total revenues. But the change in the direction of the unexpected. Changing in the elderly population to reduce savings after capital stocks included in the economic system. Consumption decreased significantly except for the oldest, which reflects the reduction of income include motivation and savings.

Table 2.1: The summary of literature reviews (continued)

Authors	Titles	Variables	Results
Donghyun Park and Kwanho Shin, 2011	Impact of population aging on Asia's future growth	- Savings - Capital accumulation - Labor force participation - Total factor productivity	The youth dependency ratio maintains a positive effect on economic growth while the old-age dependency ratio maintains a negative effect. The results indicate that there will be a sizable adverse economic impact where population aging is more advanced. The results show that more elderly people, there is the greater the negative impact on the economy.
David E. Bloom, David Canning and Günther Fink, 2011	Examines the effect of population aging on economic growth.	- Consumption to production - Labor supply - Productivity - Consumption - Savings	Population aging will tend to lower both labor-force participation and savings rates, thereby raising concerns about a future slowing of economic growth.

Table 2.1: The summary of literature reviews (continued)

Authors	Titles	Variables	Results
Hyeon-seung Huh and Hyun-Hoon Lee, 2014	Impact of population Aging on economic growth : A panel analysis	- Physical capital - Human capital - Population aged below 15 (% of total) - Population aged above 65 (% of total) total trade divided by GDP) - Landlocked dummy - Crude oil producing country dummy - Log of air distance to big cities - Colony dummy - East Asian country	Level of income per capita is negative and significant at the one percent level, show that high-income countries grow slower than low-income countries. The countries with larger share of capital investment in GDP have higher rate of economic growth. Average schooling years appear to have only a limited impact on economic growth. Oil producing countries and East Asian countries appear to have faster economic growth, while countries, which are landlocked, located father from the big cities, and had colonial experience in the past, appear to have grown slower than others. The economic growth is obstructed by the large shares of the population of children and the elderly. The size of the coefficient on the old-age share is not smaller than that on the youth-age share. Especially the only non-African countries show that the size of coefficient for the elderly become larger. Moreover, the behavioral change dose not seen to add up to mitigate the adverse impact the adverse impact of aging on economic growth.

Table 2.1: The summary of literature reviews (continued)

Authors	Titles	Variables	Results
Ki-Houng Choi, Sungwhee Shin, 2015	Population aging, economic growth, and the social transmission of human capital : An analysis with an overlapping generations model	- The change of aggregate work time - The growth of labor productivity and the effective labor supply - The growth of capital stock - The growth rate of wages and the interest rate - The GDP and per-capita GDP	The population of the elderly reduces the growth rate of labor supply and make increased wage rates. The growth of human capital is lower than the population situation and increasing in the growth rate of some physical capital can compensate for the reduction in labor supply growth. The decrease of GDP and GDP per capita than this if there are no changes in the investment in human capital. Without the need to increase the human capital.
Maiqi Zhao, 2016	Population aging and economic growth in China	- Trade ratio of real GDP - The population - The employment to total population ratio - The share of population of 14 and below	All the regression results show that population aging has not economically nor statistically significant relationship with economic growth. To check for the possibility that the effect of aging on the economy varies with time, the author also run regressions including time interaction

Table 2.1: The summary of literature reviews (continued)

Authors	Titles	Variables	Results
		- Total factor productivity - Human capital - Total factor productivity* The share of population of 65 years old and over	term. The results imply that aging has a statistically significant impact on economy, but the impact is time varying. The second part the Chinese government is working on postponing the retirement age and has announced the abolishment of the One-child policy and increase labor by relaxing restrictions

CHAPTER 3

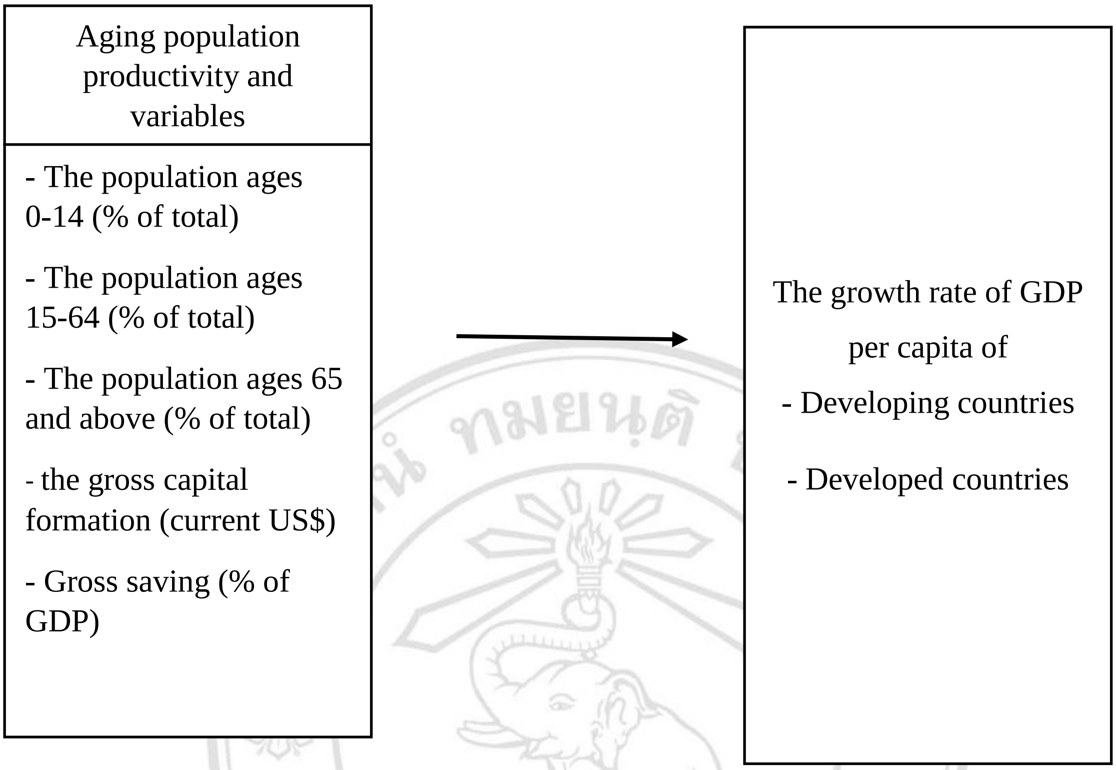
Data and Methodology

3.1 data collection

The study of the effect of aging population on economic growth in developing and developed countries. This study will be conducted using a panel data. Including time series, the data is annualized of 15 years within the period from 2000 to 2014 and cross sectional the data of 40 countries are the growth rate of real GDP, the population ages 0 to 14, the population ages 65 and above, human capital, total factor productivity and gross saving in each 20 developing and developed countries. The human capital and total factor productivity are gathered from the Penn world tables and the population ages 0 to 14, the population age 65 and above and gross saving are gathered from the World Bank.

The countries in this study are chosen from the top three highest percentage of aged 60 years and over in both of developing and developed countries from every continent and if there are no countries that on the conditional which the data is available in each continent. This study will take the number of those countries divided by the number of the remaining continents.

3.2 Conceptual framework /Model



3.3 Research assumption

The period studies show the relationship between the growth rate of GDP per capita and other variables. Their studies will be generating an assumption of this thesis

- The population ages 0-14 (% of total)

E. Wesley and F. Peterson, 2017 High population growth rates mean that the average age of the population will be young and there will be high dependency rates. The large number of children will slow growth.

- The population ages 15-64 (% of total)

S. Sarker, K. Arifuzzaman, and M. Rezwan, 2016 the labor force participation rate, total (% of total population ages 15-64) as well as population ages 15-64 (% of total) can explain the major variations. The implication of findings is that in Bangladesh the growth of working age portfolio is likely to increase our economic growth in the long run.

- The population ages 65 and above (% of total)

David E. Bloom, David Canning and Günther Fink, 2011 People aged 60 or above usually have different needs and behaviors than younger. Individuals. Older individuals tend to work and save less, meaning that they offer less labor and capital to economies. They also require more health care and, in many countries, rely on social pensions for a large part of their income.

- Gross saving (% of GDP)

Reza Najarzadeh, Michael Reed and Mona Tasa, 2014 There is a positive and significant impact of saving on every country and non-oil economic growth for Iran. Both types of economic growth are found to have positive and significant effect on saving.

- the gross capital formation (current US$)

Plossner, Levine and Renelt, 1992 the gross capital formation affects the economic growth either increasing the physical capital stock in domestic economy directly or promoting the technology indirectly.

Table 3.1: Research Assumption

Effected on the Economic Growth	**Direction**
The growth rate of population ages 0-14 (% of total)	–
The growth rate of population ages 15-64 (% of total)	+
The growth rate of population ages 65 and above (% of total)	–
The growth rate of gross savings (% of GDP)	+
The growth rate of gross capital (% of GDP)	+

Table 3.2: List of countries

Developing countries	Developed countries
Africa: Mauritius, Morocco, Egypt, South Africa, Lesotho **Asia:** Thailand, Armenia, China, Sri Lanka, Israel, Turkey **Europe:** Bulgaria, Hungary, Croatia, Lithuania, Poland, Romania, Serbia **Latin America and Caribbean:** Barbados **Oceania:** Fiji	**Asia:** Hong Kong, Japan, Korea, Singapore, Cyprus, Macao **Europe:** Italy, Portugal, Germany, Estonia, Finland, Latvia, Greece, Slovenia, Czech, Malta **North America:** Canada, United States of America **Oceania:** Australia, New Zealand

Source: Adapted from IMF (2018)

Table3.3: Variables detail

Notation	Definition	Data Source
$gGDP$	The growth rate of GDP per capita is gross domestic product divided by midyear population.	World Bank
$Pop14down$	The growth rate of population between the ages 0 to 14 as a percentage of the total population	World Bank
$Pop15to64$	The growth rate of population between the ages 15 to 64 as a percentage of the total population.	World Bank
$Pop65up$	The growth rate of population ages 65 and above as a percentage of the total population.	World Bank
S	The growth rate of gross savings as a percentage of the GDP	World Bank
GC	The growth rate of the gross as a percentage of the GDP	World Bank

3.4 Research Methodologies

This study employs the panel regression base on Huasman test to check whether the panel data is proper in Fixed Effect Model (FEM) or Ramdom Effect Model (REM) and then compare coefficient of each variable in developing and developed countries whether how much impact of variables on GDP per capita.

Model specification

- Developing countries

$$gGDP_{it} = \alpha_i + \beta_1 Pop14down_{it} + \beta_2 Pop15to64_{it} + \beta_3 Pop65up_{it} + \beta_4 S_{it} + \beta_5 GC_{it} + \varepsilon_{it} \quad (3.1)$$

- Developed countries

$$gGDP_{jt} = \alpha_j + \delta_1 Pop14down_{jt} + \delta_2 Pop15to64_{jt} + \delta_3 Pop65up_{jt} + \delta_4 S_{jt} + \delta_5 GC_{jt} + \varepsilon_{jt} \quad (3.2)$$

where $gGDP_{it}$ is a growth rate of GDP per capita in country *i* at time *t*.

$Pop14down_{it}$ is the growth rate of population between the ages 0 to 14 at in country *i* at time *t*.

$Pop15to64_{it}$ is the growth rate of population between the ages 15 to 64 in country *i* at time *t*.

$Pop65up_{it}$ is the growth rate of population ages 65 and above in country *i* at time *t*.

S_{it} is the growth rate of gross savings (% of GDP) in country *i* at time *t*.

GC_{it} is the growth rate of gross capital in country *i* at time *t*.

i is cross sectional data, *i* = 1, 2, 3, …, 20 in developing countries

j is cross sectional data, *i* = 1, 2, 3, …, 20 in developed countries

t is time series data, *t* = 2000, 2001, …., 2014

ε_{it} is the error term

α_i is constant parameter

Data Analytical method and estimation

This study has two steps: first, a panel unit root test for checking the stationary of data will be used. Second, Panel estimation are as follow:

Panel unit root test

Every variable in this study were tested by employing Levin, Lin and Chu (LLC), Im, Pesaran and Shin, Breitung, Fisher type test, and Hadri. After that compare the results and choose the best type which given data with the same level associated with I(0) or I (1). If which variable is not in the same level as others, it would be eliminated because it does not meet the criteria for analysis. So, to find specific information with I (0) or I (1) in order to estimate the model.

1) **Levin, Lin, and Chu test (LLC) (2002)**

Given the y_{it} is the panel data which $i = 1, 2, \dots, N$ is the cross sectional and $t = 1, 2, \dots, T$ is the time series. The hypotheses is each data has the same feature all respect

$$\Delta y_{it} = \delta_{i,t-1} + \sum_{L=1}^{p_i} \theta_{iL} \Delta y_{it-L} + \alpha_{mi} d_{mt} + \varepsilon_{it} \tag{3.3}$$

where Δy_{it} is the difference term of y_{it}

y_{it} is panel data

δ is $\rho - 1$

p_i is lag order of different terms

d_{mt} is exogenous variables

ε_{it} is an error term

There are three steps. First, regress the Augmented Dickey-Fuller (ADF) for each cross-section on the equation Second, run two auxiliary regression:

1. Δy_{it} on $\Delta y_{i,t-L}$ and d_{mt} to obtain the residuals $\hat{e}_{it}$.
2. $y_{i,t-1}$ on $y_{i,t-L}$ and d_{mt} to get residuals $\hat{v}_{i,t-1}$.

involves standardization of the residuals by performing

$$\tilde{e}_{it} = \frac{\hat{e}_{it}}{\hat{\sigma}_{\varepsilon_i}} \tag{3.4}$$

$$\hat{v}_{i,t-1} = \frac{\hat{v}_{it}}{\hat{\sigma}_{\varepsilon_i}} \tag{3.5}$$

where, σ_{ε_i} denotes the standard error from each ADF. And the third step estimate by t-statistics by the pooled estimation

$$\tilde{e}_{it} = \rho\tilde{v}_{i,t-1} + \tilde{\varepsilon}_{it} \tag{3.6}$$

Means that the alternative hypothesis is rejected, and the data is non stationary. However, if the t-statistic is not significant, means that the alternative hypothesis is accepted, and the data is stationary.

2) Im, Pesaran and Shin Tests (2003)

Use the Augmented Dickey-Fuller(ADF)

The hypothesis is H$_0$: $\rho_i = 0$, $\forall_i$ panels contain unit roots

H$_1$: $\rho_i \neq 0$ panels are stationary

The averages of t-Statistic for a_i from (7) is

$$\bar{t} = \frac{\left(\sum_{i=1}^{N} t_{iT_i}\right)}{N} \tag{3.7}$$

By $\bar{t}_{NT}$ has normal distribution and can rewrite as

$$W_{\bar{t}NT} = \frac{\sqrt{N}\left[\bar{t}_{NT} - N^{-1}\sum_{i=1}^{N} E\left(\bar{t}_{iT}(p_i)\right)\right]}{\sqrt{N^{-1}\sum_{i=1}^{N} Var\left(t_{iT}(p_i)\right)}} \to N(0,1) \tag{3.8}$$

If the t-statistic of $W_{\bar{t}NT}$ is significant, so it rejects hypothesis or panels are stationary Otherwise, if $W_{\bar{t}NT}$ is not significant, so it accepts hypothesis or panels contain unit root.

3) Breitung test (2000)

Breitung test has the same panel unit root test LLC testing but Breitung test do not include bias adjustment to test Bretiung test following. First, Breitung test has the same panel unit root test LLC testing but the different is run $\Delta y_{i,t-L}$ to get $\hat{e}_{it}$ and $\hat{v}_{i,t-1}$. Second, Forward orthogonalization transformation is applied to the residuals $\hat{e}_{it}$. Third, run the pooled regression

$$e^*_{it} = \rho v^*_{it} + \varepsilon^*_{it} \tag{3.9}$$

The statistic used to test the hypothesis is

$$B_{nT} = \left[\left(\frac{\hat{\sigma}^2}{nT^2}\right)\sum_{i=1}^{n}\sum_{i=2}^{T-1}(y_{it-1}^{*})^2\right]^{1/2}\left[\left(\frac{1}{\sqrt{nT}}\right)\left(\sum_{i=1}^{n}\sum_{i=2}^{T-1}(\Delta y_{it}^{*})\,(\Delta y_{it-1}^{*})\right)\right] \quad (3.10)$$

The hypothesis is H0 : $\rho_i = 0$, $\forall_i$ panels contain unit roots

H1 : $\rho_i < 0$ panels are stationary

4) Fisher-type test (2000)

The hypothesis is H0 = panels contain unit roots

H1 = panels are stationary

From Augment Dickey-Filler (ADF)

$$\Delta y_{it} = \rho_i y_{i,t-1} + \sum_{L=1}^{p_i}\theta_{iL}\,\Delta y_{it-L} + \alpha_{mi}d_{mt} + \varepsilon_{it} \;;\; \text{m} = 1,2,3,\ldots \quad (3.11)$$

where, $d_{1m} = \emptyset$, $d_{2m} = \{1\}$ and $d_{3m} = \{1, t\}$

Fisher-type test is the tests that combine the p-values from individual unit root tests. Define $\pi_i$as the p-value from individual unit root test for cross-section$i$. The null hypothesis is that all N cross-sections have unit root. From this hypothesis,

The asymptotic result is:

$$\bar{\pi} = -2\sum_{i=1}^{N}\ln(\pi_i) \quad (3.12)$$

Choi further demonstrates that:

$$\mathcal{Z}_{INV} = \frac{1}{\sqrt{N}}\sum i = 1^{N}\,\Phi^{-1}(\pi_i) \quad (3.13)$$

where $\Phi^{-1}$is the inverse of the standard normal cumulative distribution function.

5) Hadri test (1999)

Hadri testing test the residual obtained from Ordinary Least Square of y_{it} on constant and trend. And the residual – based LM test.

the residual from the regression is the form of LM Statistic

$$LM_1 = \frac{1}{N}\left(\sum_{i=1}^{N}\left(\sum_t S_i(t)^2/T^2\right)/f_0\right) \quad (3.14)$$

LM statistic in cast of heteroscedasticity can write the equation as

$$LM_2 = \frac{1}{N}\left(\sum_{i=1}^{N}\left(\sum_t S_i(t)^2 / T^2\right) / f_{i0}\right) \quad (3.15)$$

So, use LM_1 when it is homoscedasticity and use LM_2 when it is heteroscedasticity.

The statistic test is Z- statistic

$$Z = \frac{\sqrt{N}(LM - \xi)}{\xi} \rightarrow N(0,1) \quad (3.16)$$

Hypothesis of testing unit is H_0 : Panels contain unit roots

H_1 : Panels are stationary

If Z- Statistic test are significant, so it reject hypothesis or panels contain unit roots Otherwise, if Z- Statistic test are not significant, so it accept hypothesis or panels are stationary

Panel Equation Testing

1. Pooled OLS Estimation

Pooled OLS Estimation is assuming the regression coefficients are the same for all the countries. That is there is no distinction between the countries.

Pooled OLS Model

- Developing countries

$$gGDP_{it} = \alpha_i + \beta_1 Pop14down_{it} + \beta_2 Pop15to64_{it} + \beta_3 Pop65up_{it} + \beta_4 S_{it} + \beta_5 GC_{it} + \varepsilon_{it} \quad (3.17)$$

- Developed countries

$$gGDP_{jt} = \alpha_j + \delta_1 Pop14down_{jt} + \delta_2 Pop15to64_{jt} + \delta_3 Pop65up_{jt} + \delta_4 S_{jt} + \delta_5 GC_{jt} + \varepsilon_{jt} \quad (3.18)$$

where $gGDP_{it}$ is a growth rate of GDP per capita in country *i* at time *t*.

$Pop14down_{it}$ is the growth rate of population between the ages 0 to 14 at in country *i* at time *t*.

$Pop15to64_{it}$ is the growth rate of population between the ages 15 to 64 in country *i* at time *t*.

$Pop65up_{it}$ is the growth rate of population ages 65 and above in country *i* at time *t*.

S_{it} is the growth rate of gross savings (% of GDP) in country *i* at time *t*.

GC_{it} is the growth rate of gross capital in country *i* at time *t*.

i is cross sectional data, *i* = 1, 2, 3, …, 20 in developing countries

j is cross sectional data, *i* = 1, 2, 3, …, 20 in developed countries

t is time series data, *t* = 2000, 2001, …., 2014

ε_{it} is the error term

α_i is constant parameter

2. The Fixed Effect (FEM)

The Fixed Effect Least – Squares Dummy Variable (LSDV) Model allows for Heterogeneity among subjects by allowing each cross-sectional unit has its own intercept.

Fixed Effect Model

- Developing countries

$$gGDP_{it} = \alpha_{1i} + \beta_1 Pop14down_{it} + \beta_2 Pop15to64_{it} + \beta_3 Pop65up_{it} + \beta_4 S_{it} + \beta_5 GC_{it} + \varepsilon_{it} \quad (3.19)$$

- Developed countries

$$gGDP_{jt} = \alpha_{1j} + \delta_1 Pop14down_{jt} + \delta_2 Pop15to64_{jt} + \delta_3 Pop65up_{jt} + \delta_4 S_{jt} + \delta_5 GC_{jt} + \varepsilon_{jt} \quad (3.20)$$

where $gGDP_{it}$ is a growth rate of GDP per capita in country *i* at time *t*.

$Pop14down_{it}$ is the growth rate of population between the ages 0 to 14 at in country *i* at time *t*.

$Pop15to64_{it}$ is the growth rate of population between the ages 15 to 64 in country *i* at time *t*.

$Pop65up_{it}$ is the growth rate of population ages 65 and above in country *i* at time *t*.

S_{it} is the growth rate of gross savings (% of GDP) in country *i* at time *t*.

GC_{it} is the growth rate of gross capital in country *i* at time *t*.

i is cross sectional data, *i* = 1, 2, 3, …, 20 in developing countries

j is cross sectional data, *i* = 1, 2, 3, …, 20 in developed countries

t is time series data, t = 2000, 2001, …., 2014

ε_{it} is the error term

α_i is constant parameter

3. Random Effect Model (REM)

Random Effect Model: The intercept represents the mean value of all the cross sectional and the error component represents the deviation of individual intercept from this mean value

Random Effect Model

- Developing countries

$$gGDP_{it} = \alpha_{1i} + \beta_1 Pop14down_{it} + \beta_2 Pop15to64_{it} + \beta_3 Pop65up_{it} + \beta_4 S_{it} + \beta_5 GC_{it} + \varepsilon_{it} \quad (3.21)$$

- Developed countries

$$gGDP_{jt} = \alpha_{1j} + \delta_1 Pop14down_{jt} + \delta_2 Pop15to64_{jt} + \delta_3 Pop65up_{jt} + \delta_4 S_{jt} + \delta_5 GC_{jt} + \varepsilon_{jt} \quad (3.22)$$

Instead of treating α_{1i} as fixed, this study assumes that it is a random variable with a mean value of α_1 (no subscript i here). The intercept value for an individual company can be expressed as

$$\alpha_{1i} = \alpha_1 + u_i \quad (3.23)$$

$$\alpha_{1j} = \alpha_1 + u_j \quad (3.24)$$

where u_i is a random variable with a mean value of zero and a variance of $\sigma_\varepsilon{}^2$ take Eq. (23) into Eq. (21) and take Eq. (24) into Eq. (22), we obtain

- Developing countries

$$gGDP_{it} = \alpha_{1i} + \beta_1 Pop14down_{it} + \beta_2 Pop15to64_{it} + \beta_3 Pop65up_{it} + \beta_4 S_{it} + \beta_5 GC_{it} + w_{it} \quad (3.25)$$

- Developed countries

$$gGDP_{jt} = \alpha_{1i} + \delta_1 Pop14down_{jt} + \delta_2 Pop15to64_{jt} + \delta_3 Pop65up_{jt} + \delta_4 S_{jt} + \delta_5 GC_{jt} + w_{jt} \quad (3.26)$$

where $gGDP_{it}$ is a growth rate of GDP per capita in country i at time t.

$Pop14down_{it}$ is the growth rate of population between the ages 0 to 14 at in country *i* at time *t*.

$Pop15to64_{it}$ is the growth rate of population between the ages 15 to 64 in country *i* at time *t*.

$Pop65up_{it}$ is the growth rate of population ages 65 and above in country *i* at time *t*.

S_{it} is the growth rate of gross savings (% of GDP) in country *i* at time *t*.

GC_{it} is the growth rate of gross capital in country *i* at time *t*.

i is cross sectional data, *i* = 1, 2, 3, …, 20 in developing countries

j is cross sectional data, *i* = 1, 2, 3, …, 20 in developed countries

t is time series data, *t* = 2000, 2001, …., 2014

ε_{it} is the error term

α_i is constant parameter

$w_{it} = \varepsilon_{it} + u_{it}$

To test whether the equation should be test in fixed effect or random effect is more proper than the others. The test are as follows:

Hausman test

Hausman test will be used to compare between fixed effect and random effect which one is more proper. If the is correlated with the explanatory variables, that is, whether ECM is the appropriate model.

$H_0 = w_{it}$ is not related with independent variable and time invariant variable (REM)

$H_1 = w_{it}$ is related with variable and time invariant variable (FEM)

$$H = (\hat{\beta}_{GLS} - \hat{\beta}_F)'(\hat{V}(\hat{\beta}_F) - (\hat{V}(\hat{\beta}_{GLS}))^{-1}(\hat{\beta}_{GLS} - \hat{\beta}_F) \quad (3.27)$$

where $\hat{\beta}_{FE}$ is the estimate of fixed effect model

$\hat{\beta}_{RE}$ is the estimate of random effect model

$\hat{V}(.)$ are the corresponding variance-covariance matrices of these estimated coefficient

Panel estimation

The model estimation by OLS

$$Y_{it} = \alpha_i + \beta_i X_{it} + \varepsilon_{it} \quad (3.28)$$

A Standard Panel OLS Estimator for the Coefficient Given by:

$$\hat{\beta}_{i,OLS} = \left[\sum_{i=1}^{N}\sum_{t=1}^{T}(X_{it} - X_i^*)^2\right]^{-1} \sum_{i=1}^{N}\sum_{t=1}^{T}(X_{it} - X_i^*)(Y_{it} - Y_i^*) \quad (3.29)$$

where i = Cross sectional data and N is the number of cross-sectional data

t = Time series data and T is the number of time series data

$\hat{\beta}_{i,OLS}$ = A Standard Panel OLS Estimator

X_{it} = Exogenous Variable in model

X_i^* = Mean of X_i

Y_{it} = Exogenous Variable in model

Y_i^* = Mean of Y_i

CHAPTER 4

Empirical Results

In this chapter, to examine on impacts of the aging population on the economic growth in developed and developing countries. This study will be conducted using a panel data. Including time series, the data is annualized of 15 years within the period from 2000 to 2014 and cross sectional the data of 40 countries and the results of the study can be divided into 4 parts by following

Part 1: The population aging situations in developing and developed countries

Part 2: Panel unit root test, test the panel data whether the data are stationary or non-stationary by using Levin, Lin and Chu Test (LLC) and PP-Fisher Chi-square. To check the data is appropriate for the statistical approach.

Part 3: Pooled OLS

Part 4: Hausman test, to differentiate whether the panel data should be tested between Fixed Effect Model (FEM) or Random Effect Model (REM)

Part 5: Panel regression, testing the model specifications.

Part 6: The comparison of coefficient (β) between developing and developed countries

4.1 The population aging situations in developing and developed countries

The population aging in both developing and developed countries keep increasing. According to United Nations (2017) World Population Prospects: the 2017 revision said that two thirds of the world's population aging live in the developing countries, and the rate of growth of population aging is growing faster than in the developed countries. In 2050, the share of population aging in the world nearly 8 in 10 will be living in the developing countries. In table 4.1 and table 4.2 are the data of percentage age 60 years or over in 2017 in both developing and developed countries that are chosen in this study

Table 4.1: Percentage aged 60 years or over in developing countries

Continents	Developing countries	Percentage per total population
Africa	Mauritius	16.6
	Morocco	10.7
	Egypt, Arab Rep.	7.9
	South Africa	8.4
	Lesotho	6.7
Asia	Thailand	16.9
	Armenia	16.9
	China	16.2
	Sri Lanka	14.9
	Israel	16.1
	Turkey	12
Europe	Bulgaria	27.7
	Hungary	26
	Croatia	26.8
	Lithuania	25.3
	Poland	24
	Romania	24.9
	Serbia	24.5
Oceania	Fiji	9.9
Latin America and Caribbean	Barbados	21

Source: World Population Ageing 2017

The aging society is the share of group people age more than 65 is more than 20 percentage of total population. According to table 4.1 percentage aged 60 years or over in developing countries indicates the share of aging population in Europe and Latin

America and Caribbean are reaching to the aging society. In Asia, Africa and Oceania the percentage of aging population is increasing trend every year.

Table 4.2: Percentage aged 60 years or over in developed countries

Continents	Developed countries	Percentage per total population
Asia	Hong Kong SAR, China	23.5
	Japan	33.4
	Korea, Rep.	20.1
	Singapore	19.5
	Cyprus	18.5
	Macao SAR, China	16.1
Europe	Italy	29.4
	Portugal	27.9
	Germany	28
	Estonia	25.9
	Finland	27.8
	Latvia	26.2
	Greece	26.5
	Slovenia	26.3
	Czech Republic	25.6
	Malta	26.1
Oceania	Australia	21
	New Zealand	20.8
North America	Canada	23.5
	United States	21.5

Source: World Population Ageing 2017

According to table 4.2 percentage aged 60 years or over in developed countries almost the continents in developed countries are reaching to the aging society. Especially Japan is the countries that being purported to have the highest proportion of aging population.

4.2 Panel unit root test

A panel unit root test for checking the stationary of data will be used every variable in this study were tested by employing Levin, Lin and Chu Test (LLC) and PP-Fisher Chi-square. For both tests, the null hypothesis is that there is a unit root, and another hypothesis is that there is no unit root. If the null hypothesis is rejected, the variable will be considered to be non- stationary. And the results of the test data based on the probability value. If the variables are not significant at the level or I (0), it has to devalue to first difference (1st different) or I (1) followed by the statistical value is statistically significance.

Table 4.3: Panel unit root test results in developing countries

variables	Developing countries (individual intercept and trend at level)	
	Levin, Lin & Chu	PP-Fisher Chi-square
GDP	-9.733 (0.000)***	97.6452 (0.000)***
Pop14down	-115.440 (0.000)***	128.789 (0.000)***
Pop15to64	-5370.62 (0.000)***	257.89 (0.000)***
Pop65up	-2.598 (0.004)***	60.8629 (0.018)**
Saving	-512.831 (0.000)***	207.703 (0.000)***
Gross Capital	-12.019 (0.000)***	148.725 (0.000)***

Source: computed, Significant at 1% = ***, Significant at 5% = **, Significant at 10% = *

The results of panel unit root test in both of Levin, Lin & Chu (LLC) and PP-Fisher Chi-square the null hypothesis was rejected. So, all variables in developing countries that there is no unit root test for panel data and those variables were stationary at level.

In developing countries, the results by using Levin, Lin & Chu (LLC) the growth rate of GDP per capita, the growth rate of population ages 0-14, the growth rate of population ages 15-64, the growth rate of population ages 65 and above, the growth rate of gross savings and the growth rate of gross capital were significant 1% at level

And the results by using PP-Fisher Chi-square the growth rate of GDP per capita, the growth rate of population ages 0-14, the growth rate of population ages 15-64, the growth rate of gross savings and the growth rate of gross capital were significant 1% at level and the growth rate of population ages 65 and above was significant 5% at level

Table 4.4: Panel unit root test results in developed countries

variables	Developed countries (individual intercept and trend at level)	
	Levin, Lin & Chu	PP-Fisher Chi-square
GDP	-9.763 (0.000)***	122.72 (0.000)***
Pop14down	-4.276 (0.000)***	65.8986 (0.006)***
Pop15to64	-5.532 (0.000)***	71.9367 (0.001)***
Pop65up	-1.866 (0.031)**	76.7641 (0.000)***
Saving	-11.595 (0.000)***	187.209 (0.000)***
Gross Capital	-11.546 (0.000)***	146.951 (0.000)***

Source: computed, Significant at 1% = ***, Significant at 5% = **, Significant at 10% = *

The results of panel unit root test in both of Levin, Lin & Chu (LLC) and PP-Fisher Chi-square the null hypothesis was rejected. So, all variables in developed countries that there is no unit root test for panel data and those variables were stationary at level.

In developed countries, the results by using Levin, Lin & Chu (LLC) the growth rate of GDP per capita, the growth rate of population ages 0-14, the growth rate of population ages 15-64, the growth rate of gross savings and the growth rate of gross capital were significant 1% at level and the growth rate of population ages 65 and above was significant 5% at level.

And the results by using PP-Fisher Chi- the growth rate of GDP per capita, the growth rate of population ages 0-14, the growth rate of population ages 15-64, the growth rate of population ages 65 and above, the growth rate of gross savings and the growth rate of gross capital were significant 1% at level

4.3 Pooled OLS estimation

Pooled OLS Estimation is assuming the regression coefficients are the same for all the countries. That is there is no distinction between the countries. The results are as follows:

Table 4.5 Pooled OLS estimation results in developing countries

variables	Pooled OLS estimation Developing countries		
	Coefficient (β)	t-Statistic	p-value
c	1.475	4.626	(0.000)***
Pop14down	-0.825	-5.482	(0.000)***
Pop15to64	0.061	0.138	(0.891)
Pop65up	0.208	1.504	(0.134)
Saving	0.000	0.179	(0.858)
Gross Capital	0.128	10.957	(0.000)***

Source: computed, Significant at 1% = ***, Significant at 5% = **, Significant at 10% = *

According table 4.3 the estimation of the Pooled OLS model shows the growth rate of population ages 0-14 and the growth rate of gross capital were significant 1% at level. The Pooled OLS results in developed countries from table 4.3 can be written a

$$gGDP_{it} = 1.475 - 0.825Pop14down_{it} + 0.128GC_{it} \quad (4.1)$$

According the equation 4.1 which means when there was an increase of the growth rate of population ages 0-14 at 1% the growth rate of GDP per capita decreased at 0.825%.

And when there was an increase of the growth rate of gross capital at 1% the growth rate of GDP per capita increased at 0.128% as well.

Table 4.6 Pooled OLS estimation results in developed countries

variables	Pooled OLS estimation Developed countries		
	Coefficient (β)	t-Statistic	p-value
c	0.884	2.410	(0.017)**
Pop14down	-0.913	-6.159	(0.000)***
Pop15to64	0.480	2.711	(0.007)***
Pop65up	-0.129	-0.879	(0.380)
Saving	0.041	2.378	(0.018)**
Gross Capital	0.192	14.000	(0.000)***

Source: computed, Significant at 1% = ***, Significant at 5% = **, Significant at 10% = *

According table 4.4 the estimation of the Pooled OLS model shows the growth rate of population ages 0-14, the growth rate of population ages 15-64 and the growth rate of gross capital were significant 1% at level. The growth rate of gross saving was significant 5% at level. The Pooled OLS results in developed countries from table 4.4 can be written as

$$gGDP_{it} = 0.884 - 0.913Pop14down_{it} + 0.480Pop15to64 + 0.041S_{it} + 0.192GC_{it} \quad (4.2)$$

According the equation 4.2 which means when there was an increase of the growth rate of population ages 0-14 at 1% the growth rate of GDP per capita decreased at 0.913%. And when there was an increase of the growth rate of population ages 15-64, the growth rate of gross saving and the growth rate of gross capital at 1% the growth rate of GDP per capita increased at 0.480%, 0.041% and 0.192% as well.

4.4 Hausman test

Hausman test, to differentiate whether the panel data should be tested between Fixed Effect Model (FEM) or Random Effect Model (REM)

The hypothesis is

$H_0 = w_{it}$ is not related with independent variable and time invariant variable (REM)
$H_1 = w_{it}$ is related with variable and time invariant variable (FEM)

Table 4.7: Hausman test results in developing and developed countries

Test cross-section random effects			
Test summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Developing countries	26.378388	5	0.000***
Developed countries	27.998661	5	0.000***

Source: computed, Significant at 1% = ***, Significant at 5% = **, Significant at 10% = *

The results from Hausman tests which test cross-section random effects show the Chi-Square statistic equal 29.325 and 43.489 the probability equal 0.000 and 0.000 in developing and developed countries respectively. The null hypothesis of Hausman is the individual effects are uncorrelated with the other regressors in the model, if correlated (null hypothesis is rejected) a random effect model procedures biased estimator so the fixed effected model is preferred. In this case the null hypothesis was rejected. So, the Fixed Effect Model (FEM) is efficient and consistent in both of developing and developed countries.

4.5 Panel estimation

Panel estimation, testing the model specifications follow the Hausman test and Redundant Tests showed the Fixed Effect Model (FEM) is better to estimate in both of developing and developed countries. So, The Fixed Effect Model (FEM) results the details are as follows:

Table 4.8: Panel regression results in developing countries

variables	Panel Regression (cross-sectional fixed effect) Developing countries		
	Coefficient (β)	t-Statistic	p-value
c	1.650	4.650	(0.000)***
Pop14down	-0.565	-3.703	(0.000)***
Pop15to64	0.107	0.256	(0.798)
Pop65up	0.367	2.158	(0.032)**
Saving	0.000	0.135	(0.892)
Gross Capital	0.114	10.438	(0.000)***

Source: computed, Significant at 1% = ***, Significant at 5% = **, Significant at 10% = *

According table 4.7 the estimation of the fixed effect model shows the growth rate of population ages 0-14, the growth rate of gross capital and the growth rate of population ages 65 and above were significant 1% at level and the growth rate of gross capital was significant 5% at level. The panel regression results in developing countries from table 4.7 can be written as

$$gGDP_{it} = 1.650 - 0.565Pop14down_{it} + 0.367Pop65up_{it} + 0.114GC_{it} \qquad (4.3)$$

According the equation 4.3 which means when there was an increase of the growth rate of population ages 0-14 at 1% the growth rate of GDP per capita decreased at 0.565%. And when there was an increase of the growth rate of population ages 65 and above and the growth rate of gross capital at 1% the growth rate of GDP per capita increased at 0.367% and 0.114% as well.

Table 4.9: Panel regression results in developed countries

variables	Panel Regression (cross-sectional fixed effect) Developed countries		
	Coefficient (β)	t-Statistic	p-value
c	2.051	3.625	(0.000)***
Pop14down	-0.613	-3.279	(0.001)***
Pop15to64	0.940	2.539	(0.012)**
Pop65up	-0.385	-1.864	(0.063)*
Saving	0.035	2.063	(0.040)**
Gross Capital	0.184	13.100	(0.000)***

Source: computed, Significant at 1% = ***, Significant at 5% = **, Significant at 10% = *

According table 4.8 the estimation of the fixed effect model shows the growth rate of population ages 0-14, and the growth rate of population ages 15-64, the growth rate of gross capital and the total factor were significant 1% at level. The growth rate of gross savings was significant 5% at level. The growth rate of population ages 65 and above was significant 10% at level. The panel regression results in developed countries from table 4.8 can be written as

$$gGDP_{it} = 2.051 - 0.613Pop14down_{it} + 0.940Pop15to64 - 0.385Pop65up_{it} + 0.035S_{it} + 0.184GC_{it} \quad (4.4)$$

According the equation 4.4 which means when there was an increase of the growth rate of population ages 0-14 and the growth rate of population ages 65 and above at 1% the growth rate of GDP per capita decreased at 0.613% and 0.385%. And when there was an increase of the growth rate of population ages 15-64, the growth rate of gross saving and the growth rate of gross capital at 1% the growth rate of GDP per capita increased at 0.940%, 0.035% and 0.184% as well

Table 4.10: The comparison of coefficient (β) between developing and developed countries

Variables	Developing countries	Developed countries
Pop14down	-0.565	-0.613
Pop15to64	-	0.94
Pop65up	0.367	-0.385
Saving	-	0.035
Gross capital	0.114	0.184

Source: computed

According to table 4.9 indicated the comparison of developing and developed countries. There are three groups of population that used in this study. The population ages under 14 (Pop14down) in both developing and developed are affected in the same way that is negative to the GDP per capita and the size of effect in developed countries is larger than developing countries. The population ages 15 to 64 is positive effect significantly to the GDP per capita. And the last group is the group of population ages 65 and above (Pop65up) is different between developing and developed countries. In developing countries, the population ages 65 and above (Pop65up) is positive to GDP per capita. Conversely, in the developed countries, the population ages 65 and above (Pop65up) is negative to GDP per capita.

And the other variables that effect to the GDP per capita are the growth rate of saving and the growth rate of gross capital. In developed countries, the growth rate of saving and the growth rate of gross capital are positive to GDP per capita. In developing countries, the growth rate of gross capital is positive to GDP per capita

CHAPTER 5

Conclusions

5.1 Conclusion

In this study aim to examine and compare of the impact of aging population in developing and developed countries economic growth. This study will be conducted using a panel data. Including time series, the data is annualized of 15 years within the period from 2000 to 2014 and cross sectional the data of 40 countries. The data for the investigation were of secondary type of annual from the World Bank. The variables that used are the group of population divided into three group including the population ages under 14, the population ages 15 to 64 and the population ages 65 and above.

This study chooses the result in the panel regression fixed effect model because the significantly variables result in panel regression pooled OLS is lower than the panel regression fixed effect model. So, the result based on the panel regression the fixed effect model indicated that the growth rate of group of population ages under 14 in both developing and developed countries is significant negative to the growth rate of GDP per capita that means having more children will result in decreased GDP per capita. The growth rate of group of population ages 15 to 64 in developed countries is significant positive to the growth rate of GDP per capita that means the increasing of the population ages 15 to 64 will result in increased GDP per capita these relationship proved beneficial for developed countries as most of them enjoyed increase population in this group and militant growth in the working-age population. And the group of population ages 65 and above affect differently between the developing and developed countries. In the developing countries the group of population ages 65 and above is significant positive to the growth rate of GDP per capita that in developing countries having more older people will result in increased GDP per capita On the other hand, in developed countries the group of population ages 65 and above is significant negative to the growth rate of GDP per capita that means in developed countries having more older people will result in decreased GDP per capita.

Moreover, the variables that used in this study include the growth rate of saving and the growth rate of gross capita. The growth rate of gross capita in both developing and developed countries is significant positive to the growth rate of GDP per capita that means having more capital accumulation will result in increased GDP per capita. And the last the growth rate of saving in developed countries is significant positive to the growth rate of GDP per capita that means for saving more will result in increased GDP per capita. When the people who working- age lifetime should think to save more for their retirement and have a greater longevity because if they do not reserve their money enough, they must consume less than when their working age.

5.2 Recommendation

5.2.1 Policy suggestion

From the results of panel regression model in both developing and developed countries. The most negative effect factor to the growth rate of GDP per capita is the growth rate of population ages under 14 means that the policymaker should suggest the population about birth rate control and encourage to concern about family plan to prepare having children because the cost of having children is increasing in every single day.

And the growth rate of population ages 65 and above in developing countries that have positive effect to the growth rate of GDP per capita which not as the review due to the selection countries that used in the study. For example, even Mauritius, Morocco, Egypt, South Africa and Lesotho that are the countries in Africa has pension fund for public sector workers but there is much lower compared to the rest of the world. Data from the International Labour Office's 2014/15 World Social Protection Report estimates that currently only 16.9% of older people. It is still considerably lower than much of the developed world.

And this affects people with low qualifications and skill, who have worked for a long time for the same employer, often in the same job. So, the policymaker should focus on the population ages 65 and above by changing the behavioral working force is the participation of women worker more and policy reorganization that is expanding the range of working age can reduce the economic impact of an aging population has increased. David E. Bloom, David Canning and Günther Fink, (2011) and supporting labor force with high qualifications and skill more than ages 60 such as career about performance management is serious to the proficient use of older worker because older workers cover determination for fear of attracting discrimination, while line managers avoiding deal to poor performance, or encouraging training. (McNair,2011) and in developed countries the growth rate of population ages 65 and above in developed countries that have negative effect to the growth rate of GDP per capita which the results have the same effect that followed by the literature reviews

5.2.2 Future researches

Future research in this field should expand the scope of the data or should add more countries that cover all countries in the world find a more general relationship between demographic change and economic growth. Adding the variable in both developing and developed countries that affect the growth rate of GDP per capita such as total factor of productivity (TFP) and human capital and so on. And some further studies on the reasons that what the effect of population aging is.

References

Blanchard, O., & Johnson, D. R. (2013). *Macroeconomics.* Harlow: Pearson Education.

Bloom, D. E., Canning, D., & Fink, G. (2011). Examines the effect of population aging on economic growth.

Choi, K.-H., & Shin, S. (2015). Population aging, economic growth, and the social transmission of human capital : An analysis with an overlapping generations model.

Comin, D. (2006). Total Factor Productivity.

Dornbusch, R., Fischer, S., & Startz, R. (2001). *Macroeconomics.* New York: McGraw-Hill/Irwin.

Gittleman, M., Raa, T., & Wolff, E. n. (2006). The vintage effect in TFP-growth: An analysis of the age structure of capital. *Strucual change and economic dynamic*.

Gujarati, D. N., & Porter, D. C. (2009). *Basic Econometrics.*

Huh, H. S., & Lee, H. H. (2014). Impact of population Aging on economic growth : A panel analysis.

llmakunnas, P., & Miyakoshi, T. (2012). Explaing Total Factor Productivity.

Maestas, N., Mullen, K., & Powell, D. (2014). The effect of population aging on economic growth.

Mankiw, N., Quah, E., & Wilson, P. (2013). Production and growth. In *Pricniples of Economics an asian edition.* singapore.

McNair, S. (2011). Older people and skills in a changing economy. *UK commission for employment and skills*.

Misztal, P. (2011). The relationship between savings and economic growth in countries with different level of economic development. *Financial internet quarterly*.

Mohan, R. (2006). Causal relationship bewteen savings and economic growth in countries with different income levels . *Economic Bulletin*, 1-12.…

Najarzadeh, R., Reed, M., & Tasan, M. (2014). Relationship between Savings and Economic Growth: The Case For Iran. *International Bussiness and Economics*, 107-124.

Park, S. (2007). *Demographic changes and regional economy : simulation results from the Chicago CGE Model*.

Park, D., & Shin, K. (2011). Impact of population aging on Asia's future growth. Peterson, E. W. (2017). The role of population in Economic Growth.

Song, S. (2013). Demographic Changes and Economic Growth: Empirical Evidence from Asia. *Honors Projucts*, 121.

Young, G. (2002). The implications of an ageing population for the UK economy.

Zhao, M. (2016). Population aging and economic growth in China.

Appendix

Developing countries

The growth rate of GDP per capita

Panel unit root test: Summary
Series: GDPPC_AN_
Date: 05/02/19 Time: 18:40
Sample: 2000 2014
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-9.73315	0.0000	20	280
Breitung t-stat	-6.14520	0.0000	20	260
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-5.60353	0.0000	20	280
ADF - Fisher Chi-square	95.3583	0.0000	20	280
PP - Fisher Chi-square	97.6452	0.0000	20	280

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

The growth rate of population ages 0 to 14

Panel unit root test: Summary
Series: GPOP14
Date: 05/02/19 Time: 18:42
Sample: 2000 2014
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-115.440	0.0000	20	280
Breitung t-stat	1.13129	0.8710	20	260
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-37.1591	0.0000	20	280
ADF - Fisher Chi-square	95.0441	0.0000	20	280
PP - Fisher Chi-square	128.789	0.0000	20	280

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

The growth rate of population ages 15 to 64

Panel unit root test: Summary
Series: G15_65
Date: 05/02/19 Time: 18:42
Sample: 2000 2014
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-5370.62	0.0000	20	280
Breitung t-stat	0.04979	0.5199	20	260
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-3906.78	0.0000	20	280
ADF - Fisher Chi-square	221.048	0.0000	20	280
PP - Fisher Chi-square	257.890	0.0000	20	280

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

The growth rate of population ages 65 and above

Panel unit root test: Summary
Series: GPOP65
Date: 05/02/19 Time: 18:43
Sample: 2000 2014
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-2.59824	0.0047	20	280
Breitung t-stat	4.97723	1.0000	20	260
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	1.71673	0.9570	20	280
ADF - Fisher Chi-square	48.3883	0.1704	20	280
PP - Fisher Chi-square	60.8629	0.0183	20	280

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

The growth rate of gross capital

Panel unit root test: Summary
Series: GC_G_
Date: 05/02/19 Time: 18:44
Sample: 2000 2014
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 0
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-12.0191	0.0000	20	277
Breitung t-stat	-6.73851	0.0000	20	257
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-6.96582	0.0000	20	277
ADF - Fisher Chi-square	113.786	0.0000	20	277
PP - Fisher Chi-square	148.725	0.0000	20	277

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

The growth rate of gross saving

Panel unit root test: Summary
Series: GSAVING
Date: 05/02/19 Time: 18:45
Sample: 2000 2014
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 0
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-512.831	0.0000	20	278
Breitung t-stat	-3.16326	0.0008	20	258
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-118.006	0.0000	20	278
ADF - Fisher Chi-square	163.714	0.0000	20	278
PP - Fisher Chi-square	207.703	0.0000	20	278

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Developed countries

The growth rate of GDP per capita

Panel unit root test: Summary
Series: GDPPC_AN_
Date: 05/02/19 Time: 18:46
Sample: 2000 2014
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-9.76278	0.0000	20	280
Breitung t-stat	-4.55486	0.0000	20	260
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-4.82517	0.0000	20	280
ADF - Fisher Chi-square	88.2981	0.0000	20	280
PP - Fisher Chi-square	122.720	0.0000	20	280

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

The growth rate of population ages 0 to 14

Panel unit root test: Summary
Series: GPOP14
Date: 05/02/19 Time: 18:47
Sample: 2000 2014
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-4.27628	0.0000	20	280
Breitung t-stat	2.06299	0.9804	20	260
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-0.13912	0.4447	20	280
ADF - Fisher Chi-square	42.3631	0.3694	20	280
PP - Fisher Chi-square	65.8986	0.0061	20	280

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

The growth rate of population ages 15 to 64

Panel unit root test: Summary
Series: G15_64
Date: 05/02/19 Time: 18:49
Sample: 2000 2014
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-5.53219	0.0000	20	280
Breitung t-stat	1.09985	0.8643	20	260
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-1.69232	0.0453	20	280
ADF - Fisher Chi-square	66.2573	0.0056	20	280
PP - Fisher Chi-square	71.9367	0.0014	20	280

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

The growth rate of population ages 65 and above

Panel unit root test: Summary
Series: GPOP65
Date: 05/02/19 Time: 18:51
Sample: 2000 2014
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-1.86569	0.0310	20	280
Breitung t-stat	3.02717	0.9988	20	260
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	1.07503	0.8588	20	280
ADF - Fisher Chi-square	44.9863	0.2710	20	280
PP - Fisher Chi-square	76.7641	0.0004	20	280

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

The growth rate of gross capital

Panel unit root test: Summary
Series: GC_G_
Date: 05/02/19 Time: 18:51
Sample: 2000 2014
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-11.5457	0.0000	20	280
Breitung t-stat	-6.19139	0.0000	20	260
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-6.73584	0.0000	20	280
ADF - Fisher Chi-square	110.660	0.0000	20	280
PP - Fisher Chi-square	146.951	0.0000	20	280

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

The growth rate of gross saving

Panel unit root test: Summary
Series: GSAVING
Date: 05/02/19 Time: 18:52
Sample: 2000 2014
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 0
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-11.5946	0.0000	20	277
Breitung t-stat	-7.25157	0.0000	20	257
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-7.38113	0.0000	20	277
ADF - Fisher Chi-square	120.143	0.0000	20	277
PP - Fisher Chi-square	187.209	0.0000	20	277

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

pooled OLS

developing countries

Dependent Variable: GDPPC_AN_
Method: Panel Least Squares
Date: 05/02/19 Time: 20:08
Sample: 2000 2014
Periods included: 15
Cross-sections included: 20
Total panel (unbalanced) observations: 296

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GPOP14	-0.824969	0.150482	-5.482157	0.0000
G15_64	0.061041	0.443331	0.137686	0.8906
GPOP65	0.207631	0.138069	1.503826	0.1337
GC_G_	0.128485	0.011726	10.95709	0.0000
GSAVING	4.88E-05	0.000272	0.179024	0.8580
C	1.475399	0.318964	4.625599	0.0000

developed countries

Dependent Variable: GDPPC_AN_
Method: Panel Least Squares
Date: 05/02/19 Time: 20:02
Sample: 2000 2014
Periods included: 15
Cross-sections included: 20
Total panel (unbalanced) observations: 297

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GPOP14	-0.913493	0.148330	-6.158502	0.0000
G15_64	0.480366	0.177185	2.711097	0.0071
GPOP65	-0.129098	0.146847	-0.879133	0.3801
GC_G_	0.191744	0.013696	14.00005	0.0000
GSAVING	0.041050	0.017262	2.378073	0.0180
C	0.883877	0.366805	2.409664	0.0166

Hausman Test

Developing countries

Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	26.378388	5	0.0001

Developed countries

Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	27.998661	5	0.0000

Fixed effect model

Developing countries

Dependent Variable: GDPPC_AN_
Method: Panel Least Squares
Date: 05/02/19 Time: 20:17
Sample: 2000 2014
Periods included: 15
Cross-sections included: 20
Total panel (unbalanced) observations: 296

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GPOP14	-0.564997	0.152566	-3.703299	0.0003
G15_64	0.106657	0.415857	0.256475	0.7978
GPOP65	0.366577	0.169864	2.158060	0.0318
GC_G_	0.114303	0.010950	10.43825	0.0000
GSAVING	3.48E-05	0.000257	0.135353	0.8924
C	1.649861	0.354823	4.649818	0.0000

Effects Specification

Cross-section fixed (dummy variables)

Developed countries

Dependent Variable: GDPPC_AN_
Method: Panel Least Squares
Date: 05/02/19 Time: 23:40
Sample: 2000 2014
Periods included: 15
Cross-sections included: 20
Total panel (unbalanced) observations: 297

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GPOP14	-0.612763	0.186852	-3.279406	0.0012
G15_65	0.940103	0.370313	2.538671	0.0117
GPOP65	-0.385309	0.206728	-1.863845	0.0634
GC_G_	0.183579	0.014013	13.10023	0.0000
GSAVING	0.035385	0.017152	2.063045	0.0401
C	2.050634	0.565677	3.625095	0.0003

Effects Specification

Cross-section fixed (dummy variables)

Curriculum vitae

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