HIGHER EDUCATION EXPANSION AND ECONOMIC GROWTH IN JAPAN AND SOUTH KOREA

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The concept of linking higher education and economic growth was diffused throughout the world in the 20th century. Responding to the needs of industries during that period, higher education expanded approximately 200 times beyond the enrollment level in 1900 (Schofer & Meyer, 2005). Empirical studies dealing with the individual benefit of higher education have flourished but little was known about the effect of higher education composition on economic growth. This research investigates contributions of higher education composition—institutional sector and major—to the growth of national wealth.

This study chose Japan and South Korean cases that exemplify rapid growth in the economies through higher education development. The study collected the panel data about higher education and the economies from 1959 to 2009 for Japan and from 1965 to 2011 for South Korea and applied an ARIMA model regression for time series analysis. The effect of public and private sectors on overall economic growth and of four major groups on GDP per capita and GDP sectors—agriculture, industry, service et al.—were examined.

In result, Japanese and South Korean higher education showed a positive effect on their economic growth, and a bidirectional relationship of higher education development and economic growth was examined in both countries' industrialization periods. The public sector in Japanese higher education contributed to their economic growth. Among four major groups, the

Japanese science major group had a positive effect on the increase of their GDP value added by industry and service et al., but the South Korean science major group showed the least effect on their economic growth among four major groups. In South Korea, the social science major group contributed to the economic growth through affecting on the increase of their industrial and service GDP. For deeper understanding about the relationship between higher education composition and economic growth, this study suggests an analysis on the effect of institutional levels as well as major composition in higher education on economic growth.

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GLOSSARY of TERMS AND ABBREVIATIONS

ACF	Autocorrelation Function
ARIMA	Autoregressive Integrated Moving Average
G7 Countries	Canada, France, Germany, Italy, Japan, United Kingdom, and United States
GDP	Growth Domestic Product
IMF	International Monetary Fund
IFS	International Financial Statistics
KOSPI	Korea Composite Stock Price Index Korean stock market index for the Seoul Stock Exchange
LCU	Local Currency Unit
MIAC	Ministry of Internal Affairs and Communications, Japan
MITI	Ministry of International Trade and Industry, Japan
MOE	Ministry of Education
NEKKEI 225	Japanese stock market index for the Tokyo Stock Exchange (TSE)
OECD	Organization for Economic Co-operation Development
OLS	Ordinary Least Squares
PACF	Partial Autocorrelation Function
RIHE	Research Institute for Higher Education in Hiroshima University, Japan
SCAP	Supreme Commander of the Allied Powers

SPSS	Statistical Program of Social Sciences
UNESCO	United Nation Educational, Scientific and Cultural Organization
WDI	World Development Indicators

1.0 INTRODUCTION

Education and the economy have a substantive relationship that has changed over time in terms of characteristics and intensity. In the technological society of today, education is more tightly coupled with the economy than it was in the Middle Ages. In the past two centuries, the attention on education has shifted from primary education to higher education in terms of connecting to the economy.

The 20th century marks a period of economic growth and higher education development. Economic output (per capita) grew roughly fivefold worldwide in this era, and it is skewed in the latter half the century. Even though overall economic growth in the world is remarkable, the growth is distributed differently among countries by the level of their industrialization. Industrialized wealthier countries tend to develop more economically than less industrialized countries (Goodwin, Nelson, & Harris, 2007).

Higher education has been an engine of economic growth in the 20th century (Milne, 1999). Many higher education institutions have been established in order to respond to the needs of industries and trade (Gray, 1999). Therefore, the "expansion of higher education is a worldwide phenomenon" in the 20th century (Schofer & Meyer, 2005, p. 899). During this time, higher education has undergone an increase in the number of students and in the size and number of institutions all over the world. Higher education institutions globally had about 500,000 students in 1900, representing approximately one percent of the college age cohort. Exploding by two hundred-fold, the total enrollment in higher education reached 100 million in the next century, representing about 20 percent of the college age cohort (Banks, 2001; Schofer & Meyer, 2005).

Among many countries that achieved economic growth in the 20th century, development scholars pay particular attention to East Asian countries. Outside of the Western countries, Japan was the first country to become an industrialized one (Bawumia, 1998). Lucas (2002) refers to Korea as a model for economic growth, likening its success to the success of Michael Jordan in basketball. Both countries have transformed from less developed countries to developed ones in a relatively short period, over the course of several decades.

Many studies from different disciplines research the factors that drive economic growth in Japan and South Korea. Not only academic researchers but also policy administrators in other countries call attention to the education of Japan and South Korea in order to uncover implications for their educational and economic development (Goodman, Hatakenaka, & Kim, 2009). However, little is known about what amount and how higher education contributes to the economic growth in these countries. This research intends to explore the contribution of higher education development to economic growth in Japan and South Korea during the industrialization period of the 20th century.

1.1 PURPOSE OF RESEARCH

This study investigates the effect of higher education development on the growth of national wealth in Japan and South Korea. Even though development of higher education is essential for social and economic development in a nation, broader societal or national benefits of higher education attracts less attention (Baum & Payea, 2004). Unlike primary and secondary education, the discourse of higher education has highlighted individual benefit rather than national benefit; there are many studies on individual returns to higher education but a rather small number of studies on the contribution of higher education to national economic growth.

In an industrialized society, the quantity and quality of higher education is a generator of economic growth. East Asian countries, especially Japan and South Korea, exemplify how economic growth can be achieved through educational development. This research applies a longitudinal approach in order to examine how higher education contributed to the economic achievement in Japan and South Korea during their industrialization of the latter half of the 20^{th} century.

Along with the overall contribution of higher education to economic growth in Japan and South Korea, this study inquires into the relationship between the composition of their higher education and economic growth, which has scarcely been analyzed. Even though some studies explore the impact of higher education on the economic development in Japan and Korea, most of them deal with higher education as a related variable or sub-factor of the main factor on which they concentrate.In order to explore how their higher education contributes to economic growth, this study examines the effect of the institutional sectors (public or private) in higher education on economic growth and relationship between college major composition and industry development in Japan and South Korea.

Japan and South Korea are located at the north-eastern edge of the Asian continent and share a great deal in terms of cultural and philosophical foundations. Therefore, they have some similarities to each other in the systems of education and its characteristics. For example, the private sector in higher education occupies approximately 75 % in both Japan and South Korea.However, these countries have different patterns in the major composition of higher education during the period of industrialization. Similar and dissimilar aspects in higher education between Japan and South Korea need to be explored based on their relationship with the economies.

Therefore, this study develops the following research questions:

1. What is the relationship between higher education development and economic growth in Japan and South Korea?
2. What is the effect of composition of higher education on economic growth in Japan and South Korea?
3. What are the similarities and differences between Japanese and South Korean higher education in terms of their respective contributions to economic growth?

2.0 LITERATURE REVIEW

Empirical studies dealing with the relationship between education and the economy have been performed mainly by economists. Therefore, most of the research has been conceived in terms of development of economic growth theories, moving from exogenous growth theory to endogenous growth theory. This section will review the discourse on the relationship between education and economic growth and empirical studies dealing with it. Human capital, the concept that provides a base of connecting education to economic growth, will also be discussed. Along with the review on the relationship between overall education and economic growth, the relationship by the level of education is to be revisited. After touching on the relationship between economic growth and characteristics of higher education related to majors, a review on the empirical studies on Asian countries will complete this section.

2.1 EDUCATION AND ECONOMIC GROWTH

Overall, the discourse on the effect of education on economic growth is rooted in human capital. The history of human capital goes back to Adam Smith, the father of economics. Although he did not use the term human capital, he sketched the concept in *An Inquiry into the Nature and Causes of the Wealth of Nations* published in 1776. He addressed the concept of human capital as a type of fixed capital (Smith, 2007), defining it as “the acquired and useful abilities of all the inhabitants or members of the society" (Smith, 2007, p. 179). He explained that people attain and maintain their talents through education, studies, or apprenticeship; that people and their society benefit from their talents; and that these talents incur a cost and requite individual and society. Even though Smith provided the concept of human capital in the 18th century, it was not until 1928 that an English economist, Pigou, actually coined the term "human capital." Increased attention to economic growth after World War II led economists to focus more on human capital development(Van Leeuwen & Foldvari, 2008). However, research on economic growth continued to focus on physical capital accumulation until social development indicators, such as literacy, life expectancy, and health, were introduced by Mincer in 1958 and Schultz in 1961. In 1964, Becker enriched the concept of human capital by publishing a book titled *Human Capital*, which deals with forming theory and doing empirical research on human capital.

Human capital includes the knowledge, techniques, capabilities, and characteristics individuals have that allow them to improve their personal, social, or economic welfare(O'Brien & Paczynski, 2006). Human capital factors are important for explaining differences in productivity among countries (Hicks, 1979). There is an overall consensus that the improvement of human capital supports economic growth, especially long-run growth (Van Leeuwen & Foldvari, 2008).

Along with theoretically framing the relationship between human capital and economic growth, empirical studies tried to test "the conventional wisdom that output growth and human capital are positively correlated" (Judson, 2002, p. 210). Easterlin (1981) observed that the spread of education preceded modern economic growth in most countries though the sudden expansion of schooling in some countries had not been followed by economic development. He suggested that a certain type of schooling was critical for linking education and economic performance. He argued that the economic success in Northwestern European countries at a time when few countries in the world had achieved economic development was due to their education with a Protestant-based foundation. Interested in the impact of expanded schooling, Stevens and Weale (2004) plotted GDP per capita in 1913 with the primary school enrollment rates in 1882 using data from eight countries provided by Maddison (1991). Although they could not claim a causal relationship between education and economic growth due to data constraints, their figure showed a pattern of relationship where high levels of GDP per capita were correlated with high enrollment levels in primary education 30 years previously.

The effort to discover the relationship between education and economic growth encompasses not only an investigation of schooling but also of literacy. For an example, Azariadis and Drazen (1990) examined the effect of education on the growth among four groups of countries with different levels of educational development. They observed 71 countries in terms of annual growth ratio GDP per capita, GDP, and literacy rate. In their results, the group that had higher literacy rates compared to GDP, including countries such as Japan and South Korea, showed a higher growth ratio than the other groups. In other words, countries with more human capital compared to their GDP level demonstrated higher growth rates than other countries.

Over the past few decades, economists have provided some theoretical frameworks to explain the relationship between education and economy. A large number of empirical studies have been conducted to test the suggested frameworks. However, the economists who are interested in linking education and economy can be divided into two main camps. The first studies the individual returns of education, which is related to the individual aspects of economic growth. The second accounts for economic growth(Hicks, 1987; Mincer, 1984).

2.1.1 Individual Return

Education generates economic benefit to individuals in a society and this group of individuals has some effect on the national economy (Stevens & Weale, 2004). This microeconomic understanding has provided a clearer picture of the monetary benefits of education. In Mincer's (1974)classic study dealing with individual earnings and education, he examined individual earnings in terms of the years of education, age, experience, etc.. His results showed that for white males who were not working on farms, an additional year of education raised an individual's earnings by about 7 percent. The effect of the number of years of schooling varied with the length of experience and field of work.

Psacharopoulos (1994) provided a cross-country comparison for individual returns from education. His study covered 78 countries and examined the return rate of education as determined by the level of schooling. The return of primary education ranged from 42 percent per year in Botswana to 2 percent per year in Yemen. The scope of the return from secondary education varied from 47.6 percent per year in Zimbabwe to 2.3 percent per year in the former Yugoslavia. Compared with primary and secondary education, higher education's range of returns was rather narrow. The highest return of higher education was 24 percent per year in Yemen and the lowest was -4.3 percent per year in Zimbabwe. In addition to the returns of education, Psacharopoulos' study also revealed differences in the social return rate among schooling levels by utilizing the mean of the aggregates by income level. His results showed that social returns decreased as the level of individual education increased. He also discovered that social returns of education could be related to the wealth of the country. In low income countries, the social rates of return per year were 23.4, 15.2, and 10.6 percent for primary, secondary, and higher education, respectively. In upper-middle income countries, the social rate of return was

14.3 percent per year in primary education, 10.6 percent per year in secondary, and 9.5 percent per year in higher education. He attributed these decreases in social return rates to the abundance of educated labor that higher education provides.

There is also some empirical research on the individual returns from education at the country level (Ashenfelter & Krueger, 1994; Ashenfelter & Rouse, 1996; Denny & O'Sullivan, 2007; Dockey, 2005; Heckman, Lochner, & Todd, 2007; Y. L. Lee, 2000; Walker & Zhu, 2003). For example, Acemoglu and Angrist (1999) showed that average years of schooling in the United States had a strong positive effect on individual wages. In their results, a one-year increase in the average year of schooling raised average individual wages by 7 percent. They also found the level of schooling was related to state wage levels even though the returns at the societal level were less than 1 percent. They estimated the societal returns after controlling for the direct benefit of schooling on individual wages.

Using longitudinal data from Australia, Dockey (2005) also provided empirical evidence regarding individual returns to education. In his results, there was no doubt that education offered returns to students who had a higher ability in schooling. However, he claimed that students having the same level of schooling may not have corresponding benefits from education. For academically low-achieving students, Dickey suggested that traineeships and apprenticeships could give them more benefits than traditional schooling in terms of employment.

2.1.2 Accounting Economic Growth: Exogenous and Endogenous

Macroeconomic studies on growth accounting offer the most representative framework for examining the effect of education on economic growth (Stevens & Weale, 2004). Solow

(1956)provided a basic model with one aggregate output(*Y*) by the function of labor(*L*) and capital(*K*). This model can be expanded in many ways with multiple inputs and outputs. He added total factor productivity(*A*) to the basic equation in order to account for efficiency. This model of economic growth, called the exogenous growth model, is not closed, because the growth of *A* is regarded as exogenous, coming from outside.

$$Y = AF(K,L)$$

If a country increases the average number of years of education, then the effective labor is supplied, resulting in an output increase in production. The countries carrying a high level of education tend to possess more capital per worker. As a result, overall output increases in proportion to the number of effective workers who are educated (Stevens & Weale, 2004). Other researchers (Chrys Dougherty & Jorgenson, 1996, 1997; Matthews, Feinstein, & Odling-Smee, 1982)have provided similar empirical examples that show economic growth results from education development and a broader variable, labor quality. Matthews et al. (1982)found that an improved level of education offered a 0.3 percent increase per year in the growth of UK output during the time from 1856 to 1973. Another research is a case study on the G7 countries: Canada, France, Germany, Italy, Japan, United Kingdom, and United States. It revealed that the labor quality of the G7 countries was related to overall economic growth (Chrys Dougherty & Jorgenson, 1997). Especially, Japan exerted the highest improvement in labor quality, 1.16 from 1960 to 1989, while the overall mean of the labor quality improvement in all seven countries was .60. This improvement in labor quality in Japan contributed to its growth by .79, although the mean of contribution to growth among the seven countries was .41.

Along with research on labor quality, a number of studies compare output per worker internationally. Among them, Mankiw, Romer, and Weil (1992)are known for dividing educated and uneducated labor, defining educated labor as the portion of the workforce with a secondary education. They tested the augmented Solow model with the data of 98 countries by including human and physical capital to explain differences in output per person. They confirmed that accumulation of human capital contributed to economic growth, though their way of calculation was imprecise(Stevens & Weale, 2004). Additionally, they found that developing countries grew faster than rich, OECD countries as long as the former countries maintained population growth and capital accumulation.

Based on Solow's model, there has been a constant discussion about the impact of the initial level of education. Some studies found that the initial level of education, rather than growth of education, was a stronger determinant of economic growth (Barro, 1997; Benhabib & Spiegel, 1994; Young, 1995). However, Krueger and Lindahl (2001) questioned measurement error in first-differenced cross-country education data. They proposed this measurement error was related to imposing linearity and constant-coefficient assumptions on the estimates. After relaxing linearity and this assumption, the initial level of education had little effect on economic growth for the countries in Krueger and Lindahl's study. On the other hand, their results showed that growth of education had a positive effect on GDP growth and that the estimated social rate of return was high. Therefore, they argued that effect of education development on economic growth at the macro level exceeded micro-econometric return of schooling.

Nonetheless, in Solow's growth model the productivity is exogenous. In the exogenous growth model, the rate of growth is determined by exogenous factors, such as savings rate, technical progress, or improved productivity, which are not explained but are regarded as given.

Because the rate of productivity growth is dependent on the level of education, the contribution of education is under-estimated in this growth accounting model.

To overcome the limits of the exogenous growth model, Lucas and Romer developed an alternative perspective called the endogenous growth model to explain the engine of economic growth. They suggested that endogenous forces primarily drive economic growth. Compared to the former understanding of growth, which confines its focus to the function of technology and productivity, endogenous growth theory highlights investment in human capital, innovation, and knowledge as contributors to economic growth. The simplest equation from the endogenous growth model can be found below. Y represents the total production in an economy, and K embodies capital, both physical and human capital. A is a positive constant, representing the level of technology.

$$Y = AK$$

Putting the sphere of education at the heart of the growth process, Lucas (1988) ascertained the metaphysical variable human capital to be a main factor in the growth model whereas former growth theories considered education as a variable linked with productivity. In Lucas's endogenous model, the level of total productivity is decided by the function of the level of human capital. Although human capital is assumed to be related to educational attainment, Lucas's model does not mean that education attainment is the only way to increase human capital. Rather, his conceptual model concentrates on knowledge, a public body of which exists; accumulation of human capital through increased school attainment can add to this knowledge. Because he puts a focus on the production of people with knowledge, he develops the model to show that the growth rate of human capital affects the growth rate of aggregate income. The stock of human capital leads to more economic growth through higher aggregate income(Lucas, 1990). Lucas (1990) also claimed that the technology flow from rich countries cannot take place if poor countries do not have a certain level of human capital

In addition to Lucas (1988), Romer (1990) provided another view on the role of human capital in economic growth: facilitating innovation and technology development. He assumed that productivity growth relies on the accumulation of ideas and the number of people who devote their time to the development of new ideas. He suggested that a higher level of human capital drives innovation and efficiency to improve technology, and that this improvement of technology is transformed to physical capital accumulation.

While the view of Lucas foregrounded the qualitative aspect of labor through human capital, Romer's perspective highlighted the technological advance driven by the high quality of human capital. Van Leeuwen and Foldvari (2008)applied the hypotheses of Lucas and Romer to Asian countries at different levels of development. They reported that Lucas's model fitted the less developed countries, such as India and Indonesia, while Romer's approach explained Japan's economic miracle in the latter half of the 20th century.

Human capital has also been discussed in terms of its functions in facilitating the adoption of foreign technology in developing countries and in creating new technologies in developed countries(Sianesi & Reenen, 2003). Focusing on the role of human capital, Barro's studies(1991, 1997) provided possible explanations for how poor countries catch up with rich countries. Initial human capital positively correlated with the growth rate of GDP per capita in 98 countries in the time period from 1960 to 1985(Barro, 1991). In another study, Barro (1997) looked at the influence of education on the rate of growth in terms of implementing technology. He proposed that one extra year of education increased the growth rate by 1.2 percent per year.

He suggested that the effect of levels of education on economic growth in developing countries was higher than the average contribution of education among countries overall. Thus, the catch-up rate among countries was positively related with the number of years of education. This is because a high level of education made people better at learning and utilizing high-level technology.

Stevens and Weale (2004) measured the return rate of an additional year of education, arguing that in the labor force, the level of education changes slowly as the young educated workforce successively displaces the older and less educated workforce. After balancing the foregone output in the early years against the additional output generated in the later years, they presented the return rate of the additional education as 14 percent per year.

Oulton (1997) focused on the role of human capital to explain economic growth in terms of total factor productivity. He eliminated the possible effect of interactions between human capital and physical capital in the dataset presented byBarro and Lee (1993). His results showed that a one percent increase in human capital per working person in 1965 raised the rate of economic growth by 0.0365 percent. In other words, a one-year increase in education from five to six years raised economic growth by 0.73 percent per year.

However,Benhabib and Spiegel (1994)did not examine any significant effect of human capital when they added lagged GDP per capita to explanatory variables, even though their method of measurement was the same as Barro's. Therefore, they suggested an alternative model based on the research of Nelson and Phelps (1966). They claimed that secondary education functions as a critical element for economic growth rather than the general factor, human capital. This is because people with secondary education tend to have a capacity to utilize technology (Kneller & Stevens, 2002). Benhabib and Spiegel (1994)also suggested an equation to explain the relationship among GDP, labor force, capital stock, and level of education. In their regression equation, average level of education, rather than growth in the labor force and capital stock, explains increase in GDP. They also found evidence of their equation from the dataset of 78 countries from 1965 to 1985. In their results, a country with half the initial per capita income of the highest income country's showed only a small effect, specifically, that an extra year of education raised GDP per capita by 0.35 percent in that period.

On the other hand, Krueger and Lindahl (2001) found a positive relationship between education and growth only in the countries having the lowest levels of education. They divided countries into three groups by level of education. A statistically significant connection was found between education and growth in a positive direction in the group with the lowest level of education. They also examined a quadratic relationship between years of education and economic growth. In countries with lower levels of education, education contributed to the growth of the economy. In countries with higher levels of education, however, education pulled the rate of growth down. Using a rather different way of estimation, Kneller and Stevens (2002) also observed a positive effect of human capital on economic growth. They measured the distance between a follower country and a technical frontier country in income and level of human capital. Van Leeuwen (2007) summarized major studies dealing with human capital (see Table 1). Most of the studies in Table 1 using pooled Ordinary Least Squares (OLS) identified significantly positive effect of schooling on economic growth.

Table 1. Overview of studies with Human Capital

Author	Human Capital Variable	Technique	Coefficient
Krueger &Lindahl (2001)	Average years of schooling	Pooled OLS	0.003
Benhabib& Spiegel (1994)	Average years of schooling	Pooled OLS	0.010
Barro& Lee (1993)	Average years of schooling	Pooled OLS	0.057
Cohen & Soto (2001)	Average years of schooling	Pooled OLS	0.0032
Portela*et al*. (2004)	Average years of schooling	Pooled OLS	0.0037
Levine &Renelt (1992)	Initial Secondary school enrolment rate	Pooled OLS	0.032 *

* Insignificant

Note: From Van Leeuwen (2007, p. 38)

From Adam Smith until now, the discourse on human capital and economy seems to be in agreement that both are related but need to be explored in more detail. Recent research claims that education is an endogenous factor for economic growth while the older tradition of growth accounting has been arguing that education has an effect on growth through other factors, such as technology. Compared to exogenous growth theory, endogenous theory takes account of higher education more seriously in terms of connection to knowledge or innovation, although the mechanism linking education and economic growth is not clearly revealed and is still located in a metaphoric black-box (Resnik, 2006).

2.2 LEVEL OF EDUCATION AND ECONOMIC GROWTH

The effect of each level of education on economic growth has not been revealed as much as the overall effect of education on economic growth. Levels of education can be divided into literacy, primary education, secondary education, and higher education. Depending on time periods, levels of development, scales of economy, and levels of technology, the attention has been focused on the relation between a particular level of education and economy.

For example, Azariadis and Drazen (1990)conducted research dealing with literacy rates and economic growth. From the dataset of 71 countries, they observed that countries with higher literacy rates compared to their level of GDP exerted higher growth rates than other countries. They also suggested other variables for further research. They pointed out that variables which contribute to economic growth may change from period to period. Therefore, higher education could explain part of the difference in recent economic performance among the most economically advanced countries.

Psacharopoulos (1994), as mentioned above, summarized the result of the literature using Mincer’s equation. On a global scale, he claimed that both individual and social returns were the highest with investment in primary education. Private returns in primary, secondary and higher education were 29.1, 18.1, and 20.3, respectively. Social returns were 18.4 in primary education, 13.1 in secondary education, and 10.9 in higher education worldwide.

For the last two decades, some studies have assumed that secondary education is critical to increase economic growth and found evidence of its effect on the economy. For example, as mentioned before, Mankiw et al. (1992)divided the labor force into an educated group and an uneducated group. Using secondary education for this division, they defined the educated workforce as the labor force which finishes secondary education. They found an accumulation of an educated workforce contributed to growth. Similarly, Krueger and Lindahl (2001) presented 7.5 years as the point of marginal effect of education. In their results, a quadratic relationship was confirmed between years of education and economic growth. The effect of education on economic growth was positive only if the average years of education in the labor force were less than 7.5 years.

Instead of focusing on a single type of education for economic growth, some studies claimed that the level of development in a country determines what kind of education would be the most beneficial for economic development. For example, Wolff and Girrleman (1993) explored the roles of three different kinds of education. They proposed an equation to explain growth in output per capita, the initial level of GDP per capita, and groups having different levels of education. They used six indicators to estimate standing of education: enrollment rates from primary, secondary, and higher education, and workforce attainment rates given a primary, secondary, and higher education. Between these two factors, enrollment rate and attainment rate of the workforce, enrollment rate proved to be a better indicator explaining subsequent economic growth. Wolff and Girrleman categorized countries into two groups. The first was the industrial and upper-middle income countries as defined by the World Bank, and the second was lower-middle income and poor countries. In upper-middle income countries, higher education explained economic growth more than primary and secondary education. In addition, only higher education had a statistically significant effect on economic growth. In lower-middle income and poor countries, primary education was statistically significant to explain economic growth while higher education provided little explanation.

Similarly, Keller (2006) analyzed the effects of the three levels of education on economic growth along with enrollment rates, expenditures per students, and public expenditure in education. She used cross-country panel data from 1960, dividing countries into two groups, developing and developed. Primary education showed no significant effect on per capita growth, but demonstrated indirect effects on lower fertility rates and increased investment in physical capital. The effect of secondary education on per capital growth was identified in both developing and developed countries. However, she did not find a significant effect of higher education enrollment. Furthermore, because she recognized a negative effect of public expenditures in higher education on per capital growth, she argued that public investment should be first focus on basic education (i.e., primary or secondary, depending on the degree of universalization of primary education) before focusing on higher levels of education.

Moreover, Petrakis and Stamatakis (2002) found that each level of formal education had a different effect on economic growth. They suggested that the effect of a certain level of education varied among countries with different levels of economic maturity. In developed countries, higher education was more important. On the contrary, primary education had more importance in undeveloped countries rather than secondary education or higher education.

Focusing more on the developing stage, Kiso (1993) and Esim (1994) marked the importance of secondary education in the economic growth of Asian countries. McMahon (1998) also identified the roles and serial functions of the three levels of education in East Asia. For developing economies in the initial stages of development, primary education enrollment was highly significant. Once primary education became universal, secondary education had more importance for economic growth by contributing to production and the manufacture of goods to export. He also provided a tentative conclusion regarding higher education. An early increase of higher education enrollments in East Asia did not tend to be effective for increasing growth. This ineffectiveness was because higher education was usually related to growth later on.

Rather than primary and secondary education, higher education plays a greater role in stimulating economic growth in developed countries unlike less developed countries (Sianesi & Reenan, 2002). Gemmell (1996) examined different roles of secondary and higher education, exploring the effect of school enrollment in 98 countries. He examined the relevance of primary education for the poorest undeveloped countries, secondary education for intermediate low developed countries, and higher education for OECD countries, and claimed that enhancement of higher education had a direct impact on growth while secondary education was important for stimulating investments.

In empirical research, however, it is not hard to find studies in which higher education has insignificant or negative effects on economic growth (Barro & Sala-i-Martin, 2004; McMahon, 1998). These effects seem to be attributed to the fact that these studies dealt with the overall mean of education attainment among countries that had different levels of development or did not use recent data of developed countries (Sianesi & Reenen, 2003).

Within the past few decades, empirical studies dealing with OECD countries have given much attention to higher education in terms of its connection to economic activity. The ratio of highly-skilled white collar and educated workers with university degrees has increased over the last 25 years (Katz & Autor, 1998). This trend pervades most developed countries and seems to be linked to the changes in skills required in developed industries (Bredt & Sycz, 2007). Along with a change to a knowledge-driven economy, the role of higher education is crucial and human capital that leads innovation is regarded as the key to future economic growth (Mattoon, 2006).

For example, Jenkins (1995) examined the relationship between stock of human capital and economic output in the United Kingdom. She used time series data from 1971 to 1992 and tests the impact of workforce qualifications on economic performance. In her results, highly-qualified workers showed twice as much productivity as unqualified workers. Thus, her results supported the idea that investment in human capital, especially for higher education, increases productivity. Similarly, Jorgenson and Fraumeni (1992) measured the impact of investment on education in the U.S. economy. They found that investment in human and physical capital explained an overwhelming proportion of the growth of the U.S. economy during the post World War II period. By utilizing a new measure of aggregate output, they also showed that the contribution of improved labor quality to economic growth (26%) surpassed that of physical capital (22%).

Using U.S. domestic data, Baum and Payea (2004) tried to examine the benefits to both individuals and society from state investment in higher education. Their results are that higher levels of education were correlated with higher income, and the income gap between workforce with secondary education and workforce with higher education had increased over time. They claimed that college graduates contributed to the society by increasing public monies including higher tax revenue as well as in ways that were not easily quantified, such as lower needs on social support programs, lower rates of confinement, and higher levels of civic participation. Even though the simple description of a correlated relationship between input and output may amplify the effects of higher education, their study reminded us that societal benefits of higher education attract less attention than individual benefits, which mean higher levels of education are related to higher income in a general sense.

For a different perspective on states' investment in American higher education,Vedder (2004) questioned whether more public funding in higher education would automatically provide a larger return to the economy at the local level. He pointed out that there were some states investing more on higher education, but failing to achieve faster economic growth than other states that spent less on higher education. He conceded, however, that higher education was critically important for economic growth.

In addition, Moretti (1999) estimated external returns to higher education by comparing the effect levels of education on wages in certain U.S. Cities. After controlling the private return to education, he found that a one percent increase in the share of college graduates in the labor force raised wages of high-school drop-outs by 1.3 percent, wages of high-school graduates by 1.2 percent, and wages of college graduates by 1.0 percent. A one year increase in the average level of education in a city also raised the corresponding figures of the three groups by 22.2 percent, 11.7 percent, and 9.8 percent. Moretti explained that the reason for declining rates of increases in income as level of education increases was due to the impact of a supply and demand. In his result, both high school drop-outs and high school graduates benefited from an increase of college graduates in the workforce. In a broader aspect, Moretti's study confirmed that there were additional benefits of higher education to society as well as direct benefits to an individual in advanced economies.

For another example of a case at the country level, Asteriou and Agiomirgianakis (2001) investigated Greece through time series analysis in terms of the relationship between human capital and economic growth. They looked at primary, secondary, and higher education and their effect on economic growth. First of all, GDP was integrated with all educational levels in Greece. Unlike primary and secondary education, however, the direction of causality between level of education and GDP per capita was opposite for higher education. GDP had an effect on the increase of higher education enrollment. Including Asteriou and Agiomirgianakis's (2001), Table 2 shows studies that dealt the relationship between higher education and economic growth at a level of country.

Table 2. Overview of studies on relationship between higher education and national economic growth

Author	Country	Method	Relationship between higher education and economic growth
Asteriou & Agiomirgianakis (2001)	Greece	Cointegration test Causality test	No effect of higher education on economic growth, Positive effect of GDP on higher education
Cheng & Hsu (1997)	Japan	Time series analysis	Bidirectional causality between higher education and economic growth
Self & Grabowski (2003)	Japan	Vector auto regression analysis	Positive effect of higher education not in the prewar but in the postwar period
C. W. Jang (2007)	South Korea	Cross-section and time series analysis	Negative effect of higher education on economic growth
Huang, Jin, & Sun (2009)	China	Cointegration test, Vector error correction model, Granger causality test	Long-term cointergration relation between higher education and economic growth Lagging effect of higher education on economy

Evidence of a positive effect of higher education on economic growth was found among developing countries as well. Using time series analysis with African data from 1960 to 2000, Gyimah-Brempong, Paddison, and Mitiku (2006) showed different results from earlier studies about the relationship between higher education and economic growth in Africa. Earlier studies, which used cross-sectional analysis among many countries, supposed that higher education had an insignificant or even negative effect on economic growth in less developed countries while primary education was considered critical in these countries. At the same time, these studies assumed higher education had a positive effect on the economy in developed countries. However, Gyimah-Brempong, Paddison, and Mitiku demonstrated that all levels of education, including higher education, had positive effects on the growth rate in African countries that were regarded as less developed countries. Furthermore, these effects were statistically significant. They found the impact of higher education on economic growth was almost twice that of the physical capital investment in African countries.

Not only does the impact of each level of education need to be considered, but so does resource allocation for different levels of education. In order to investigate resource allocation, Judson (1998) developed a model of education that sees students' abilities as heterogeneous and trains those students to reveal their suitability for further training. Using panel data on 138 countries for 31 years (from 1960 to 1990), she calculated the relative returns to both actual allocations and optimal allocations and evaluated the efficiency of the allocations of investment in education. She found there was a substantial gap between actual and optimal enrollment rates in many countries. In her results, countries which inefficiently allocated their investment to education showed insignificance in the correlation of human capital accumulation and GDP growth. However, countries which better allocated investments to education showed a significant positive correlation. Her study suggested a policy implication in terms of the importance of the allocation of educational resources.

Being interested in how higher education institutions can contribute to innovation in the local economy, an international research consortium named Local Innovation Systems Project (here after called MIT project) was undertaken by The Massachusetts Institute of Technology in the US and Cambridge University in the UK (Lester, 2005). This project revealed that the roles of the university in contributing to innovation for local economies were to support firms 1) to respond to the changes in the market, 2) to produce of new products and services, or 3) to create innovative production methods. The first role of universities was to be a public forum for sharing ideas and a platform to provide opportunities for companies to apply new technology. The second role was to educate and develop the workforce. It was also mentioned that being in tune with a local economic structure was the key factor for universities to play their roles effectively in their local economies. The MIT project also proposed four types of specific supports that higher education provided for a local economy: providing or strengthening local human capital, increasing local capacity for problem solving (e.g., consulting), offering public space and hosting meetings, and providing substantial references.

With a specific focus on the Midwestern region in the United States, Mattoon (2006) highlighted the importance of higher education. This region did not have rapid population growth, but had mature industries that needed innovation in management and technology for transforming the economy. In other words, higher education was essential for economic growth in the Midwest in terms of increasing productivity. Mattoon (2006) pointed out that US land-grant universities developed agricultural extension systems and local farmers utilized their research for their farming. He claimed that higher education institutions extended their old role to manufacturing, services, or management strategies. He also argued that diversity among higher education institutions was necessary in order to support a wide range of companies and economic activities.

Various and even conflicting findings may be attributed to measurement issues and the complex relationship between education and economy. In addition, because there are sub-sectors in both education and economy, overall discourse would be controversial unless specific combinations of each sub-sector within them are provided. As I have discussed, different links between levels of education and economic maturity are the focus of much research. The three levels of formal education seem to have different effects on economic growth depending on economic maturity and level of development. As industries have developed, higher education has been more highlighted. Therefore, in terms of contribution to economic growth, effect of different contents and majors in higher education needs to be examined

2.3 MAJOR COMPOSITION OF HIGHER EDUCATION AND ECONOMIC GROWTH

There has been much debate about the purpose and content of higher education (Ratcliff, 1992). In general, there has been a general agreement toward what should be taught in higher education institution in a society in a certain period. However, the content of higher education tends to change with the periods and with the people to be educated. This change can be explained by the different focuses on higher education curriculum in two streams, liberal education and vocational education.

2.3.1 Liberal Education and Vocational Education

Liberal education traces back to the Greek philosopher, Plato, who suggested a liberal arts education to develop citizenry's intellect and morality. Liberal arts encompasses language and literature, history and philosophy, mathematics, and music and the fine arts (Unger, 2007a). During the Middle Ages, universities taught mainly liberal arts, and modern higher education has stemmed from this tradition. Liberal education in higher education institutions aims to "educate the whole student and emphasize education for its own sake rather than for job preparation" (Jacob, 2003, p. 1476).

Liberal education has been at the center of higher education(Silver & Brennan, 1988). However, during the 20th century, liberal education has declined while overall higher education has expanded. For example, in the United States, the number of liberal arts institutions and proportion of college students majoring in liberal arts have decreased in the latter half of the 20th century (Unger, 2007a).

Unlike liberal education, vocational education traditionally highlights preparation for jobs and concentrates on occupational training. Apprenticeship in the Middle Ages could be referred to as the first vocational education (Gordon, 2003). Vocation education is involved in the "practically illustrated and attempted job or career skill instruction" and bridges both demand from industry and the job necessity of individuals (Gordon, 2003, p. 2636). Originally, vocational education meant instruction and training for secondary students to prepare them for their occupations, but it has stretched out its sphere to college-involved programs since the late 20^{th} century (Unger, 2007b).

Vocational education institutions at the level of higher education tend to provide "programs [that] are planned, implemented, and evaluated in relation to the nature and needs of the nation's workplaces" (Copa & Copa, 1992, p. 1505). As the industry sector has developed and expanded, vocational education in higher education has generated and provided new programs to prepare students for newly emerging occupations, such as computer programming and health care.

Contrasting philosophical differences in South Korean higher education curriculum, J. Kim (2000) provided controversial aspects of liberalism and vocationalism. Liberalism in higher education admits that:

> 1) the basic objective of a college is to produce a liberal, free, and creative person and to cater to the need for individual self-realization; 2) the long tradition of human history shows that liberalism is a permanent phase of college education; and 3) a truly education person under the liberal tradition will be able to adjust easily to the changing needs of society, including vocational preparation. (p.81)

Vocationalism in higher education concedes that:

> 1) educational institutions should prepare students for the reality of life, the main goal of which is employment; 2) the long tradition of humanistic liberalism did more harm than good to the national life of the Korean people, which now should be corrected; and 3) in order to cope with new demands in an era of scientific and technological revolution, vocational as well as scientific-technological education are essential. (p.82)

Regarding a level of higher education institutions, vocational education usually but not necessarily refers to the education provided by two- or three- year junior colleges among several levels of higher education institutions. However, whatever its level, the main concern of vocational higher education can be described as “preparation for gainful employment” (Copa & Copa, 1992, p. 1505). In the societies where higher education is universalized, demand of vocational education at the level of higher education has been raised in junior colleges first and in four year universities later (Han, 1996).

As industrialization proceeded, “demand for specialization, new scientific knowledge, and new occupations” have been substantially increased (Ratcliff, 1992, p. 1568). Therefore, compared to the traditional one, recent vocational education require students to be instructed with more reading, writing, applied mathematics, and science that new technologies and industries demand (Castro, 2003). In the transfer of technologies from developed countries to developing countries, higher education has a critical role for training highly skilled technicians and engineers. Therefore, higher education in some developing countries tends to lean toward vocational education rather than liberal education. Advocates of vocational education tend to believe that more science and engineering are beneficial to the economy as well.

Within the recent several decades, social demand for industrialization, economic growth, or national defense has lead higher education to institute or increase a vocational curriculum (Ratcliff, 1992). For example, higher education reform in African countries in the 1980s primarily focused on the match between the needs of society and the role of higher education (McFadden & Nzo-Nguty, 1983). Especially for developing countries, international development agencies have supported the increased expenditure in technical rather than liberal education in order to achieve economic growth (Psacharopoulos, 1982). The tensions between the United States and the Soviet Union in the period of the Cold War drove more efforts and investments on science and mathematics, including vocational education such as engineering (Unger, 2007a).

2.3.2 Science and Engineering in Higher Education

Along with vocationalism in higher education, attention to the matter of graduates' employment fosters changes in the composition of majors in higher education. The certain fields of studies that command better job prospects have increased enrollment in many countries (Teichler, 1987; G. Williams, 1985). The changes in the composition of field of studies are initiated by individuals, institutions, or government(Teichler, 1992). However, the trend of vocationalism in higher education does not satisfy both opposing perspectives; academia criticizes the decline of academic knowledge in higher education(Geiger, 1980), and industry complains of slower speed of the curricular changes and unqualified graduates (Brint, Proctor, Murphy, & Hanneman, 2011). Therefore, Boys et al. (1988) claimed that combination of general and vocational education is beneficial in higher education.

As mentioned above, even though the composition in the field of studies in higher education is induced by individuals, institutions, and government, most studies dealing with the issue of college majors in economic perspective have been done from a micro perspective, in other words, on an individual level(Pascarella & Terenzini, 2005). They include college major and job match (Robst, 2007); major choice and expected earnings (Berger, 1988); uncertainty in choosing college major (Altonji, 1993); non-price preference in college majors (Easterlin, 1995); college major and graduation rates (Montmarquette, Cannings, & Mahseredjian, 2002); economic returns to college majors (Rumberger & Thomas, 1993); and major and unemployment (Nunez & Livanos, 2010) among others.

Exploring the effect of college majors, institutional quality, and educational performance, Rumberger and Thomas (1993) distinguished between the effect of individuals and that of institutions on earnings utilizing Hierarchical Linear Modeling. They found all three factors affected graduates' initial earning, but the effect of the institution quality and individual performance in higher education were different among six major groups. For example, institutional quality or grade point average did not have a different impact on the earnings of graduates majored in engineering. Rumberger and Thomas also confirmed the effect of majors on individual earnings as most of the other studies did; the group with the highest earnings was graduates of engineering and health, the second group was graduates from science/mathematics and business, and the last group was graduates from education, social science, and humanities.

Pointing out the importance of the content of higher education as well as the years of schooling for the match between education and job, Robst (2007) examined the relationship between college majors and the occupation of graduates in the United States. Through an analysis of the National Survey of College Graduates, he found that about 20 percent of the college graduates worked in field unrelated to their majors. The rate of mismatch between major and work was higher in the fields of study that develop general skills rather than the field of study that promote specific skills for certain occupations. But, graduates from the field of study focusing on general education could transfer to other work with relatively low costs. Otherwise, the fields of study that were related to specific occupation, such as computer science, health professions, and engineering technology, showed lower rates of mismatch but higher costs if a mismatch should occur.

With the case of European countries, Nunez and Livanos (2010) examined the relationship between higher education (levels and majors) and unemployment. In 15 European countries, graduates from health and welfare, education, and engineering had the least probability of unemployment. On the contrary, graduates of humanities and arts had less probability of employment than graduates of other majors. Nunez and Livanos confirmed that some majors had more value in the labor market than other majors and suggested higher education institutions should offer their composition of majors “in order to effectively meet the actual demand for skills” (Nunez & Livanos, 2010, p. 484).

Contrasted with the most studies with micro analysis, Murphy, Shleifer, and Vishny (1991) employed a macro analysis to compare the impacts of specific majors (law and engineering) on economic growth in order to estimate an effect of the type of human capital. They concluded that countries having a higher proportion of engineering majors grew faster, whereas countries having a higher proportion of law cluster grew more slowly. Through their auxiliary regressions, they also found that most effects of lawyers on economic growth were direct but most engineers had indirect effects on economic growth at a large scale. The increase of engineers was correlated with a raise of investments in human and physical capital, low government consumption, and high political stability.

As the field of study in higher education affects economic aspects of individuals, the changes of enrollment composition affect the relationship between the economy and education (Van Leeuwen, 2007). In other words, change of enrollment composition as well as increased enrollment and quality of higher education is important for economic growth. As industry has developed, the knowledge and techniques required for the business sector have changed. Unless the enrollment composition in higher education catches up to the changes in industry, attempts to increase enrollment in higher education may not have any effect on economic growth.

More specifically, there are studies that focus on science and engineering education in higher education institutions (Drori, Meyer, Ramirez, & Schofer, 2003; Momete, 2010). Linking student achievement to national growth, Ramirez, Luo, Shofer, and Meyer (2006) investigated the effect of students' achievements in science and mathematics on economic growth. Their cross-national analysis examined the positive effect of academic achievement in mathematics and science on economic growth. However, their results were different depending on the period of time and the case of countries. When 'Asian Tigers' (Hong Kong, Singapore, South Korea, and Taiwan) data in the time period from 1980 to 2000 were excluded, the effect of student achievement on economic growth almost disappeared.

Ramirez et al. (2006)hypothesized science and engineering education on the level of higher education served as a medium between achievement in math and science and national economic development. They presented a figure (see Figure 1) of a causal chain including factors and their flow in explaining impact of science education on national economic growth based on a National Research Council document (Guilford, 1993). In Figure 1, Curriculum with emphasis on science and mathematics encourage students to accomplish a higher achievement in these subjects. This experience of students drives more students majoring natural sciences and engineering. Thus, the labor force has more scientists and engineers who show higher productivity. By extension, they contribute to economic growth at the national level. Among steps toward economic growth, productive and highly skilled scientists and engineers are crucial, and they are educated and trained in higher education institutions (Guilford, 1993).

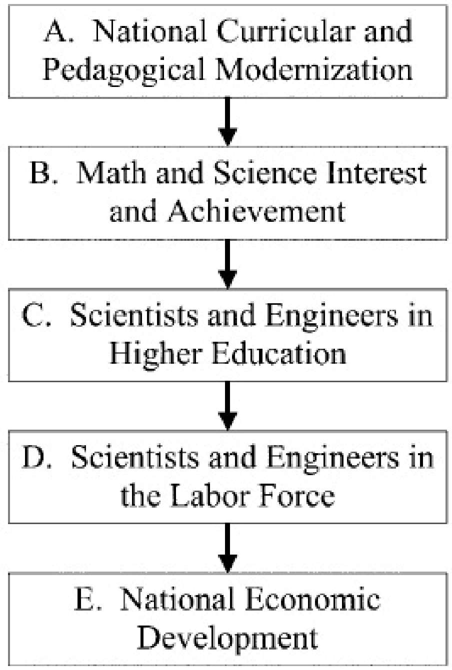


Figure 1. Focus of curriculum and national economic growth

Note: From Ramirez et al. (2006, p. 4)

Specifically focusing on the transfer of technology, Hanson (2008) emphasized the importance higher education, especially science and engineering, during industrialization. He pointed out that graduates from higher education increased the capacity of their economy to transform into a technology-based economy. OECD (2003) also addressed significance of science and technology in higher education. Graduates of higher education lead the competence of their country and consist of a highly skilled workforce in the knowledge-based economy.

There is another group that mentioned mathematics and science in order to investigate the role of human capital in economic growth in detail (Hanushek & Kim, 1995; Hanushek & Wosmann, 2008). Hanushek and Kim (1995) focused on the quality of a nation's labor force and measured this quality by cognitive skills in mathematics and science. Furthermore, Hanushek and Wosmann (2008) showed that cognitive skills, corresponding to quality of education, were significantly related with long-term economic growth rather than quantity of education.

The common belief that teaching and research on science and engineering in higher education will drive economic growth has been widely accepted (Woodhall, 1992). Majors that are connected to specified skills and knowledge seem to have received more attention, not because they are more valuable than other majors, but because they are related with industrial needs during industrialization. Nonetheless, as industry has rapidly developed into specialized segments recently, aspects of general education, such as attitude to learn, analytical capacity, leadership, and communication ability, have become important. In order to cope with rapid changes in industry and technology, the workforce needs to be prepared with basic abilities that could be applied to continuing changes as well as specific skills that could be out of date easily (Teichler, 1992). Therefore, “new vocationalism,” which maintains a balance between liberal and vocational education, has emerged (Bourner, Greener, & Rospigliosi, 2011; Silver & Brennan, 1988).

In conclusion, the emphasis among the field of studies in higher education has moved from liberal arts to vocational majors. Industrial development has affected changes in the composition of majors in higher education in the last several decades. More specifically, developments in technology have created more need for science and engineering majors in higher education. International organizations and government officers in developing countries have rhetorically emphasized an increased proportion of science and engineering in higher education curriculum, believing that more scientists and engineers will promote economic growth.

In an industrialized society, the quality of higher education is one of the determinants of human capital. Even though human capital has been regarded as a critical component for growing economies, empirical inquiry has explored only a small part of its dimensions and suggested very few implications for policy (Hanushek & Kim, 1995). There are a small number of studies on the effect of majors on economic growth on a macro level even though the composition of majors has changed. The effect of college majors on economic growth needs to be more thoroughly investigated with empirical studies.

2.4 EDUCATION AND ECONOMIC GROWTH IN ASIAN COUNTRIES

In the latter half of the 20th century, several Asian countries experienced a relatively high rate of economic growth. Scholars have introduced several metaphors to explain characteristics of growth in Asia. For example, Akamatsu (1962) uses the term "Flying Geese Formation" to refer to technical development in Asia with Japan as a leader. Vogel (1991) describes newly industrialized countries with high growth rates and rapid development in Asia (Singapore, Hong Kong, South Korea and Taiwan) as "the Four (Little) Dragons," also referred to as "the Four (Asian) Tigers." WorldBank (1993) also published a report titled *The East Asian Miracle*, which explores public policies driving economic growth in Asian countries.

Along with other factors, much of the literature that has observed growth in these Asian economies pointed out the function of human capital accumulation for the economic growth(Chuang & Lai, 2010; Esim, 1994; Hayami, 1999; J.-I. Kim & Lau, 1994; McMahon, 1998; Self & Grabowski, 2003; Van Leeuwen, 2007). J.-I. Kim and Lau (1996) attempted to understand the miraculous growth in East Asia and to provide empirical evidence. Their results showed that investment in education became a key factor for rapid rates of economic growth in East Asia if countries had political stability. However, they did not find any significant relationship between overall education and technological progress.

Furthermore, in order to estimate the real impact of human capital in the extraordinarily rapid growth in Asian countries, Young (1995) accounted for growth in the four tigers (Singapore, Hong Kong, Taiwan, and South Korea) by focusing on two aggregate inputs, capital and labor. His results showed that the increase of educational attainment in the workforce in these countries contributed to the additional growth in labor input by about 1 percent per year. If the dramatic rise of input was counted, Young pointed out that the estimated total factor productivity growth rates in these countries were close to that in OECD and Latin American countries. Thus, he concluded that the unprecedented rapid growth in East Asia was explained more by a dramatic increase of input rather than improvement in productivity.

As previously mentioned, World Bank published *The East Asian Miracle*, explaining the fast growth in eight Asian countries (Japan, Hong Kong, Republic of South Korea, Singapore, Taiwan, Indonesia, Malaysia, and Thailand). It concluded that "private domestic investment and rapidly growing human capital" played a significant role for economic growth in those countries (WorldBank, 1993, p. 5). Specifically in education, more attention on primary and secondary education imbued subsequent labor forces with skills. Higher education in the eight countries tended toward vocational education rather than liberal education. Funding matter in higher education steered the focus on vocational and technical skills. In addition, demand for higher education and limited government funding forced private system to support higher education.

As mentioned above, Petrakis and Stamatakis (2002) pointed out that all levels of education do not have the same impact on economic growth and suggested that optimal resource allocation for education depends on the level of economic development. Unlike McMahon (1998), who focused on development stage in East Asian countries, Petrakis and Stamatakis looked at Japan and South Korea, which were in later stages of development than other Asian countries. They classified Japan into the advanced group and South Korea into the developed group among three groups (advanced, developed, and less developed). They suggested that higher education was critical in countries in the higher two stages of development.

Concentrating on the higher education of Japan, Cheng and Hsu (1997) examined bidirectional causality between higher education and economic growth. Using time series analysis with the data from 1952 to 1993, they found that the increase of the number of college graduates had a positive effect on the GDP in Japan and vice versa. Cheng and Hsu pointed out that the Japanese desire for knowledge contributed to the rapid expansion of their education and economy. They concluded Japanese higher education was “a vehicle to facilitate the use, transfer and spread of higher technologies” (Cheng & Hsu, 1997, p. 395).

Concerning different periods in Japanese history, Self and Grabowski (2003) explored the impact of levels of education on economic growth. Looking at both the prewar and postwar periods, they divided levels of education into primary, secondary, higher, and vocational education and utilized average years of schooling at each level of education. In their results, all education levels in Japan had statistically significant influence on the postwar economy except for vocational education. Self and Grabowski found that secondary and higher education had a causal relationship with Japanese growth only in the postwar period, while primary education had a causal impact on growth in both the prewar and postwar periods. More specifically, in the postwar period, they found that higher education had a strong impact on the Japanese economy but secondary education had a weak impact on it. As mentioned above, Van Leeuwen and

Foldvari (2008)examined effects of education on economic growth in three Asian countries (India, Indonesia, and Japan) at different levels of development. Their results agreed with Self and Grabowski. Leeuwen and Foldvari suggested that technology and innovation by highly educated human capital contributed to Japan's economic miracle in the latter half of the 20th century.

Similarly, Y.-H. Kim (1997, 2004) analyzed the process of expanding education in terms of matching the industrialization plans in South Korea. She divided the history of coordination between industrialization strategies and education into the three periods of labor intensive, heavy industry centered, and technologically intensive industrialization. In the labor intensive period of 1950s and 1960s, expanding primary education and achieving adult literacy contributed to South Korean economic growth. The increase of people with secondary education and vocational education also contributed to the South Korean economic growth by supplying skilled workers for heavy industry in the 1970s. In the 1980s, the period of technologically intensive industrialization, the enrollment of higher education increased and met the demand for highly skilled industrial labor. She also provided interpretations on the culture of South Korean education, claiming the "uniformity, collectivism, and socialization" that were attempted in the period of early industrialization may be contrasted with the "creativity, spontaneousness, and competitive power" that are deficient in the period of technology and knowledge driven industry (Y.-H. Kim, 1997, p. 63).

Providing more empirical data with statistical analysis, Exploring the role of South Korean education to enhance industrial competitiveness, S. Jang, Kong, and Lee (2005) did not identify any causal relationship between the quantity of higher education and economic growth; instead they claimed the quality of South Korean higher education is more important for economic growth. For further research, they suggested others to explore the relationship between the technologically advanced workforce and the structure of South Korean industry. C. W. Jang (2007) estimated contributions of each educational level to economic growth in South Korea by setting up an equation with five contributors (education, physical capital, R&D capital, labor, and initial level of technology) based on the data of seven East Asian countries. In his results, the overall contribution of education representing human capital to South Korean economic growth was 40.7% and the contribution of physical capital was 39.6% from 1975 to 2004. More specifically in education, he showed the contribution of primary, secondary, and higher education to economic growth as 6.6%, 87.0%, and -52.9%, respectively. He pointed out that the contribution rate of each level of education had changed over the time observed.

Most of the studies on Asian economic growth seem to identify the role of human capital on economic growth as well as physical capital. Researchers have also identified different factors to contribute to Asian economic development, such as government leadership, technology transfer, and focus on export. Hall and Jones (1999) highlighted the important role of government and national institutions in promoting a productive environment for economic growth. They found that differences in physical and human capital seemed to explain only a small amount of the difference in economic growth across 127 countries, and suggested that social infrastructure, such as institutions and government policies, drove output per worker. Looking at the impact of social infrastructure on productivity, Hall and Jones claimed that countries with high capital intensities, high human capital and high productivity had good social infrastructures. Examining the mechanism of rapid growth in the Asian economies, Sengupta (1991, 1993, 2011) also pointed out the leading role of government in Asian economic development along with physical and human capital. Specifically, Sengupta (1993) explored the case of South Korea and identified three important factors in South Korean economic growth: increased physical input to initiate innovation in technology, well-developed human capital, and government policy to focus on export.

An aspect of technology also explains subsequent amount of Asian economic growth (Hanson, 2008; L. Kim, 1997; Lall, 2000). Technology transfer from developed countries and technology innovation are critical for economic growth during the period of industrialization (Becker, 1964; Milne, 1999). For example, Japan and South Korea accomplished technology transfer in the initial period of industrialization and have innovated their technology continuously afterward. The highly educated workforce in those countries is crucial for absorbing and developing technology and enables rapid economic growth. Specifically, some studies highlighted the importance of expansion of graduates from two or three year junior colleges to support human resource for technical development in corporations (Sengupta, 2011).

In conclusion, most of the studies referring to Asian economic achievement recognized the contribution of education. Among several levels of education, a critical level of education for economic development varies among the studies. Even though studies disagree on the effect of higher education on economic growth in overall countries, the economic growth in more developed Asian countries tends to be attributed to not only other social and technological factors but also the development of higher education.

2.5 HIGHER EDUCATION AND ECONOMIC GROWTH IN EAST ASIAN COUNTRIES

East Asian countries, especially Japan and South Korea, are examples of countries that have achieved economic growth through increasing human capital. Both Japan and South Korea showed outstanding economic growth in 1960s-70s and 1980s-90s respectively. Prior to the economic achievement, primary education was universalized in these countries and secondary and higher education was expanding more rapidly than those of other countries.

The different levels of human capital are highlighted with the different developmental status: lower levels of education such as primary education have more importance in the initial period of development, and higher levels of education deserve more attention in the period of advanced development. As mentioned above, Azariadis and Drazen (1990) investigated the effect of education on growth among countries with different levels of human capital development. They concluded that countries with higher human capital compared to their economic level like Japan and South Korea showed higher growth ratio. Azariadis and Drazen suggested other variables for further research: because variables that contribute to economic growth may change from period to period, higher education could explain some of the difference in recent performances among the most economically advanced countries.

Among Asian countries that have achieved economic growth, Japan and South Korea have similarities with each other. Both countries have "competent and insulated civil servants" (WorldBank, 1993, p. 26) that have implemented strategies for economic growth successfully. Another common component between these two countries is that their people are eager for knowledge and education, which functions as an engine of economic growth (Marlow-Ferguson, 2002a, 2002b). This high value on learning has facilitated higher education development in both countries within a relatively short period of time.

Even though most studies dealing with the relationship between education and the economies in East Asian countries have confirmed the role of education, they showed conflicting results on the effect of higher education. Furthermore, little is known about the relationship between the composition of higher education and economic growth in East Asia. Therefore, this section discusses the relationship between the expansion of higher education and economic growth in Japan and South Korea over the 20th century, based on the characteristics of their higher education.

2.5.1 Higher Education and Economic Growth in Japan

During the first half of the 20th century, the Japanese economy experienced a gradual growth in manufacturing and heavy industries and a decline in agriculture. However, World War II destroyed the wealth of Japan that had been established by the *Meiji* Restoration in 1868. Right after the war, the Japanese suffered from inflation, unemployment, and a shortage of living necessaries. As a sponsor of the Supreme Commander of the Allied Powers (SCAP) from 1945 to 1952, the United States assisted the recovery of the Japanese economy; these efforts for economic recovery had focused on rebuilding industrial facilities and infrastructure that were lost during the Second World War. Furthermore, the procurement of military supplies and bases for the U.S. during the Korean War fostered more Japanese production capabilities. Consequently, Japanese production reached what was in the prewar period in the mid-1950s(Allen, 1958).

Based on its economic recovery, Japan enhanced manufacturing and mining and marked a miraculous economic growth—annually about 10% of GDP growth rate—in 1960s, which is called the “Golden Sixties.” From the mid-1960s, industries began to focus on heavy and chemical manufactures: light manufacturing competed internationally, and the new manufacturing of automobiles, electronics, and machines emerged (Hane, 1996). The experience of overcoming the world oil crisis in 1973 encouraged Japanese leaders and also guided a change of industrial structure toward energy-intensive industries (Odaqiri, 1996).

In the 1980s, Japan established promising industries in areas such as semiconductors and distinguished itself in electronics and computers. Furthermore, the Japanese economy was transformed into a knowledge-based economy in this period: both the service sector and manufacturing based on high-level technology increased. However, the 1990s is called the “lost decade” in Japanese economics: Japan experienced a collapse in the asset price bubble, and its rapid economic growth ended in deflation after 1989. The Japanese stock market’s Nikkei 225 stock index rebounded in April 2003, breaking a long economic recession (MIAC, 2012).

The growth of the Japanese economy over the latter half of the 20th century is closely related with the changes in its industrial structure. While more than one third of the Japanese labor force worked in agriculture in 1955, that figure dropped to about 19% in 1970, 7% in 1990, and 5% in 2000(MIAC, 2012). Along with the population working in agriculture, the proportion of agriculture in Japanese GDP decreased over the second half of the 20th century. However, the proportion of the Japanese labor force working in the second sector—manufacturing, construction, and mining—increased by 1970, but started to decline slightly from the 1970s on. From the late 1970s, the third sector—finance, retail, communications, etc.—started to emerge and continues to increase (Vestal, 1993).

Figure 2 shows the changes in the proportion of GDP generated by the three industry sectors from 1970 to 2008. The contribution of agriculture in Japanese GDP decreased to 1 % in

2005. The contribution of industry also decreased but gradually from 46% in 1969 to 29% in 2006. The third sector (service et al.) already occupied half of the GDP in Japan at the beginning of the 1970s and increased to 69% in 2006 (WorldBank, 2012).

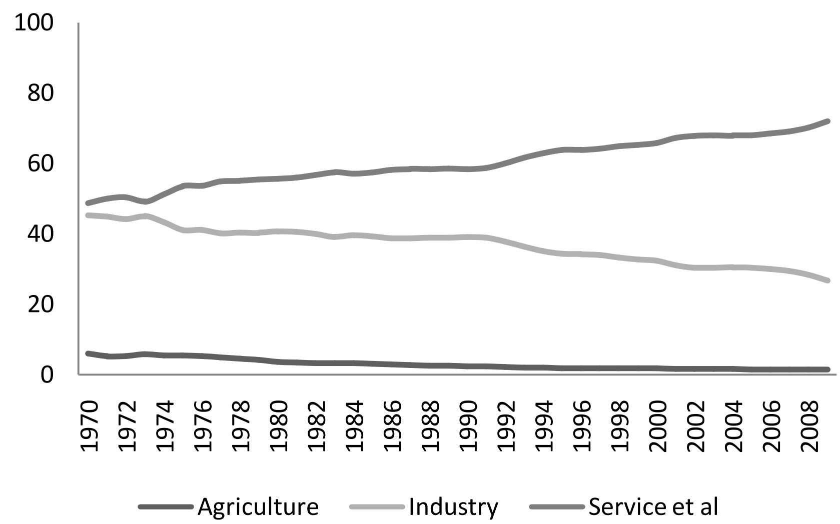


Figure 2. Proportion of economic sectors in Japanese GDP

Note: Data from World Development Indicators (World Bank)

Studies referring to Japanese economic growth have claimed that the factors leading the miracle of the Japanese economy include cooperation between government and corporation as well as the high quality of the labor force (C. H. Lee & Yamazawa, 1990). The Japanese government actively contributed to its own economic development; the Ministry of International Trade and Industry (MITI) applied protectionism, instituted regulations, and encouraged private sector growth (Johnson, 1982). The Japanese government had a close relationship with “keiretsu”—large enterprise groupings—and supported them in developing strategic industries such as steel. The Japanese are among the most educated late comers to modernization. This educated workforce as well as the high level of capital investment contributed to its rapid economic growth. Just as the size and quality of the workforce grew with the development of Japanese industries, the Japanese higher education system followed suit by supporting the needs of industries.

A modernized, westernized version of Japanese higher education is less than 150 years even though Japan provided a traditional education for the elite at the national level for several centuries. Japanese higher education had expanded rather gradually for 100 years from its beginning. In 1877, the *Meiji* government established the University of Tokyo with schools of medicine and western studies. The Japanese government issued laws and started to implement policies in order to expand higher education in 1918. Along with Japanese government initiatives, groups and individuals also established private higher education institutions in order to respond to the demand of industry and commerce in the early period of industrialization of Japanese economy (Kobayashi, 1992). Eventually, in 1937, Japan had 20 public universities, 25 private universities, and 356 various kinds of institutions, and these institutions allowed 6 percent of the population ages 17-22 to have opportunities for higher education (Kitamura, 1991).

After World War II, the U.S. government that occupied Japan for seven years implemented a radical reform on education; the multi-track and hierarchical education system in the prewar period was reorganized largely into a binary and egalitarian system: universities and junior colleges. Because of a transition to a higher education system that aimed for the removal of social stratification, approximately 240,000 students enrolled in 210 universities and 149 junior colleges in 1950. In the 1960s and 1970s, Japan experienced a heavy boost of enrollment in higher education (See Table 3). Baby-boomers had enrolled in higher education institutions from the late 1960s to the early 1970s. On the other hand, since the 1950s, the industry sector has called for more graduates and research for industrial development from higher education institutions (Kobayashi, 1992).

Table 3. Changes in Japanese higher education: enrollment and number of institutions

Year	Total Enrollment	Ratio of total enrollment in population	Population	Number of Universities	Number of Junior Colleges
1950	238,595	0.28 %	84,115,000	210	149
1960	694,144	0.74 %	94,302,000	245	280
1970	1,628,783	1.56 %	104,665,000	382	479
1980	2,152,444	1.84 %	117,060,000	446	517

Note: Total enrollment from Research Institute for Higher Education (RIHE),
Number of universities and junior colleges from Kitamura (1991, p.492-493),
Population from Japan Historical Statistics (MIAC).

Along with quantitative expansion, Japanese higher education faced a change in its structure. In the 1970s, the Japanese government set forth development plans and administrative actions for higher education. Most of all, the government made an effort to expand higher education mainly by the public sector (Beauchamp, 1991). The Japanese government started to change its stance toward the private sector in higher education. The *Private School Promotion Subsidy Law* passed in 1975, letting private institutions in Japanese higher education receive substantial subsidies but relinquished some control to the Japanese government. In the vocational education sector in higher education, a newly passed *Special Training Schools Law* institutionalized various postsecondary vocational institutions into a sort of higher education (Kitamura, 1991).

Current institutions in Japanese higher education are divided into five groups by levels: graduate schools, universities, junior colleges, special training schools, and technical colleges.

Universities serve graduates from secondary schools and offer basically a four year education for the bachelor's degree. Graduates schools provide advanced academic education, such as Masters and Doctoral levels and require an undergraduate degree from four year institutions for admission. Unlike other kinds of institutions, graduate schools are not necessarily separate institutions from universities. Universities may have different levels of institutions, undergraduate level and graduate level, under a single name of institution. Junior colleges usually provide a two or three year program that is based on training and traditionally attended by mostly women. Special training schools, about 90 percent of which are private institutions, concentrate on specific vocational needs. Traditionally, even though special training schools are post-secondary vocational schools, the Japanese government did not regard special training schools as higher education institutions until the 1990s. Therefore, special training schools could operate their education programs reflecting the changing needs of Japanese industry, outside of control of rigid government regulation (Goodman et al., 2009). Technical colleges are a combined form of secondary and higher education with five or five and half year program (two years secondary, the rest postsecondary) in order to serve students by providing specific skills for their vocational lives. There are only three private institutions among 62 technical colleges (Marlow-Ferguson, 2002b).

Even though the Japanese government initiated a modern higher education system with the first national university, the private sector has grown steadily and now occupies about three-fourths of Japanese higher education (Marlow-Ferguson, 2002b). It is partially because limited government funding could not match Japanese zeal for higher education in spite of the efforts of the Japanese government to expand the public sector. For example, only about 12 percent of all expenditures of Japanese education were allocated to higher education in 2000 contrary to the 42 percent allocated for secondary education (UNESCO, 2000).

Due to steady expansion of higher education, in 1987, Japanese people with higher education consisted of about 58 percent of the workforce while people with primary (8.35 percent) and secondary (33.3 percent) education amounted to 42 percent of the workforce (Kobayashi, 1992). It also means that Japanese education supports Japanese economic development from an agriculture base to a technology and industry base by providing highly educated workforce.

Figure 3 illustrates annual Growth Domestic Product (GDP) per capita and enrollment in higher education institutions from 1960 to 2008, demonstrating an overall increase of both GDP and higher education enrollment. Enrollment in Japanese higher education had moderately increased in the 1960s and 1970s and was followed by a sharp increase of GDP per capita that leveled off in the 1990s. In the same period GDP increased, but at lower rate, before also leveling off.

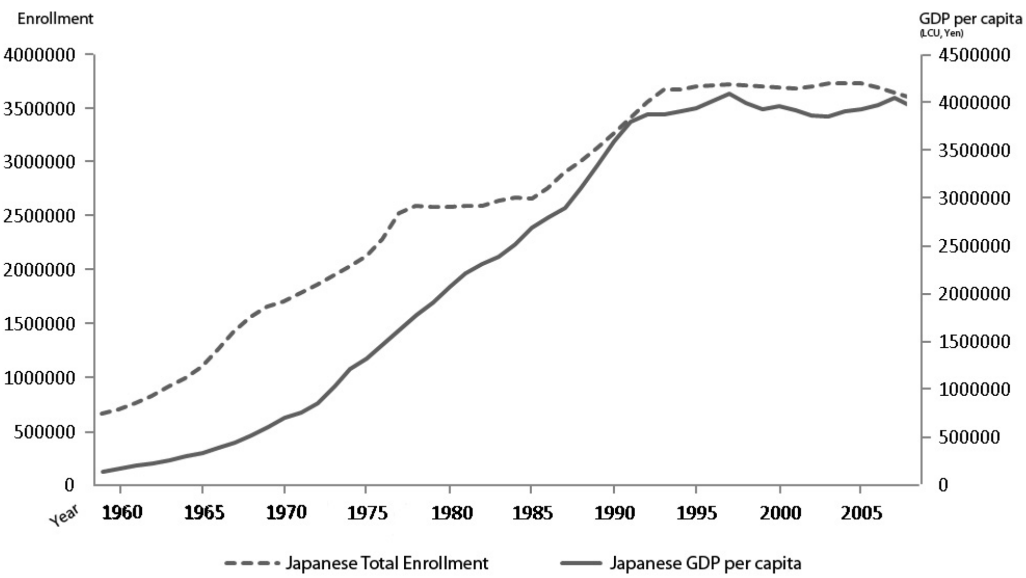


Figure 3. Changes of GDP per capita and higher education enrollment in Japan

Note: GDP per capita from International Monetary Fund (IMF).
Enrollment from Research Institute for Higher Education (RIHE)

Along with the overall flow of Asian higher education enrollment, some studies refer to specific majors, such as science and engineering, affecting economic growth (Lall, 2000; Milne, 1999; Ramirez&Lee, 1995). In order to explore the changes in the composition of students' academic majors in Japan, Table 4 presents the percentages of six fields of studies over a span of 20 years. Japanese higher education has retained a pattern in the enrollment composition with minor changes over the 40 years since 1960s.

In recruiting graduates of higher education institutions, Japanese corporations have a tendency to "hire their employees from the same universities" (Marlow-Ferguson, 2002b, p. 698). The academic achievement or majors of graduates are not as important factors in Japan as they are in other countries. Japanese companies highly regard the trainability of future employees rather than work related experience because they emphasize their own education and training (Arai, 1990; Goodman et al., 2009). A strong tradition of apprenticeship and lifetimeemployment in Japanese society seem to affect consideration of graduates from higher education institutions.

Table 4. Changes in composition of majors in Japan

Field of Studies	1965	1985	2005
Art & Athletics	1.9%	3.0%	3.0%
Humanities	13.7%	16.2%	16.0%
Social Science	46.2%	39.7%	39.6%
Science & Engineering	24.7%	23.3%	22.2%
Health	4.4%	6.6%	7.5%
Education	7.9%	10.1%	7.5%
Others	1%	1.1%	4.2%

Note: Calculated from Research Institute for Higher Education (RIHE).

However, since the period of Japanese economic recession in the 1990's, Japanese corporations have started to change their recruitment methods and demand reforms of Japanese higher education (Arimoto, 1997; Goodman et al., 2009). Japanese industry has requested certain characteristics of graduates as well as more graduates with specific skills (Negishi, 1993; Takeuchi, 1997). As the Japanese economy has come into the period of knowledge and technology based industry, Japanese corporations are "calling for a new type of graduate: one that is better educated, more autonomous, more creative, more influential, more international, and one possessing a spirit of challenge" (Doyon, 2001, p. 448).

Comparative studies in education have shown interest in Japanese education in the last couple of decades in the 20th century, and many of them suggest that the highly educated Japanese contribute to the economic success in Japan (Amano & Poole, 2005). Doyon (2001) also points out that Japanese higher education "has served the needs of industry" and "has done so well" until the 1980's (Doyon, 2001, p. 447). However, recent studies have criticized Japanese education as a machinery and as machine-like behind the needs of the Japanese economy in the 21st century (Amano & Poole, 2005; Doyon, 2001; McVeigh, 2002).

2.5.2 Higher Education and Economic Growth in South Korea

The Korean peninsula faced many years of hardship in the first half of the 20th century: Japan occupied Korea from 1910 to 1945, an unified Korea was partitioned into North and South Korea right after its independence, and the Korean War (1950-1953) decimated their economy and society. Because most industries as well as more than 90 percentage of power plants were located in North Korea, the South Korea economy primarily depended on agriculture and light industry after the partition (K. S. Kim & Roemer, 1979). Therefore, "in 1960, [South] Korea was a poor developing country with a small manufacturing sector and heavily dependent on foreign aid" (Collins, 1990, p. 104).

Nonetheless, South Korean government set a goal of industrialization and vigorously executed the *Five-Year Economic Development Plan* four times from 1962 to 1981. South Korean tried to learn from the Japanese economic miracle from the mid-1950s to the mid-1960s and realized its version of economic growth from the mid-1960s to the mid-1970s (C. H. Lee & Blumenthal, 1990). For ten years from 1966 to 1975, the averaged GDP growth rate in South Korea was nine percent (WorldBank, 2012).

Since the beginning of the 1960s South Korea strategically choose a policy of "outward-looking growth," focusing on external markets by increasing exports (Song, 2003). During the early period of export, the Korean economy relied on labor-intensive manufacturing.

Maintaining the export-oriented development strategy, South Korea achieved rapid growth rates during the 1960s and 1970s.

Construction was a crucial source for earning foreign currency since the 1960s in the South Korean economy. In the 1970s, South Korean corporations commenced various manufacturing industries including electronics and later became business conglomerates called "chaebol," which is similar to the Japanese *keiretsu*. Heavy industries such as shipbuilding emerged in the mid-1970s, and automobile industries also played an important role in the South Korean export from the 1980s. The South Korean economy grew steadily during the first half of the 1990s, but it faced the Asian Financial crisis in 1997. The non-performing loans from foreign countries became a severe problem due to the depreciation of the Korean currency, *Won*. Recuperating from this crisis, the South Korean economy began to grow again from 2000 onward.

The South Korean government has been an active player in industry and the economy. Over the period of industrialization, it has played a crucial role in planning and orchestrating role in planning economic development and leading all parts of South Korean society (L. Kim, 1997). The early economic plans emphasized agriculture and infrastructure; the latter was closely tied to construction. Later, the emphasis shifted consecutively to light industry, electronics, and heavy and chemical industries. Recently, from the 1990s, knowledge-intensive and high-technology industries became the focus.

Figure 4 shows the changes of three economic sectors' contribution to South Korean GDP from 1965 to 2009. While the proportion of agriculture in generating GDP considerably decreased from 37% in 1965 to 3% in 2008, the contribution of the third sector to GDP continued to increase gradually until 2009. Starting at 20% in 1965, the proportion of industry in

GDP increased up to 43% in 1991, but began to decrease from the mid-1990 (WorldBank, 2012).

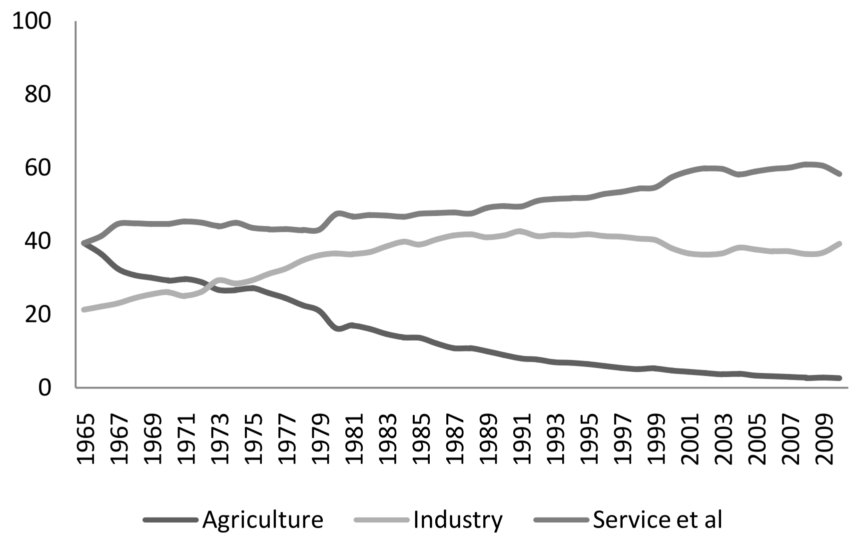


Figure 4. Proportion of economic sectors in South Korean GDP

Note: Data from World Development Indicators (World Bank)

The South Korea economy was able to grow rapidly by stable macroeconomic policy and (physical and human) capital accumulation (Collins, 1990). During the period of industrialization, physical capital was supplied by the debts from foreign countries and domestic savings. The rapid economic growth in South Korea could not be accomplished without the suitable increase of the graduates from higher education institutions. South Korea is among the countries that achieved a rapid development in higher education as well as in the economy. The increase of enrollment in South Korean higher education was concentrated during the 1980s and 1990s, while Japanese higher education has developed rather constantly over time during the 20th century. This is because the opportunities of South Korean higher education were limited by the colonial administration of Japan from 1910 to 1945 and by the Korean War from 1950 to 1953.

South Korean higher education had 7,819 students with one (national) university and 18 colleges in 1945 at the time of liberation. About 40 years later, in 1987, more than 200 higher education institutions existed in South Korea(J. H. Park, 1992). In 2000, furthermore, 1,434,259 students enrolled in 536 higher education institutions in South Korea (Marlow-Ferguson, 2002a). This explosion of higher education seems to be enabled by opportunities for education that were not provided in previous decades even though South Koreans have a zeal for education (Ch'oe, Lee, & Bary, 2000; R. Kim, 1991).

Responding to the need for more space in higher education, many private institutions have been established and expanded because primary and secondary education have held priorities in government funding for education. For example, 8 percent of government expenditures in South Korean education was allocated to higher education in 2000 (UNESCO, 2000). Excess demand was met by expanding the proportion of private institutions in South Korean higher education by 1990, reaching about 75 percent of total enrollment(J. H. Park, 1992).

In terms of levels of higher education institutions, there are junior colleges, universities, and graduate schools in South Korea. Junior colleges provide two or three year postsecondary programs of study focusing on technological skills and vocational training for mid-level technicians. Universities are usually four year institutions that offer programs for various academic majors. Graduate schools aim to train professionals and academic scholars.

However, it should be noted that the system of South Korean higher education is centralized and the Ministry of Education has a strong control on higher education institutions. The South Korean Ministry of Education strictly controls the establishment of private institutions and provides only small amount of subsidies to them (R. Kim, 1991; S. H. Lee, 1997). Unlike other countries, South Korea controls over the total student enrollment of each institution (public and private) as well as allocation of students among departments by establishing admission quotas (J. H. Park, 1992). The South Korean government has decided the admission quotas of higher education institutions based on economic development plans and estimated demands for workforce since the late 1960s (Yoon, 1979). Therefore, N. Park and Weidman (2000)suggest that the expansion in South Korean higher education is explained by the South Korean government (human resource development) planning for economic growth and social change on the national level.

Vocational education in South Korean higher education had been encouraged by the South Korean government since the early 1950s and was related to the government plan for economic development in the 1960s (Goodman et al., 2009; J. Kim, 2000). As heavy industries arose, the South Korean government expanded junior colleges to increase numbers of technicians in the 1970s. Since the 1980s, the industry sector has showed its interest in employing graduates with high-level and information technology skills, and education and research in science and technology have been prioritized in South Korean higher education since then. South Korean and Taiwanese higher education showed higher percentages of students majoring in engineering among the newly industrialized Asian countries—more than 0.8% of population in the early of the 1990s—but that in all other newly industrialized Asian countries and most of the Organization for Economic Co-operation and Development (OECD) countries the percentage was less than 0.5% (Lall, 2000).

Enrollment in South Korean higher education has increased dramatically and supported the needs for human capital in South Korean industry (Choo, 1990; N. Park & Weidman, 2000). The amount of enrollment in formal education is not a perfect indicator but provides bases for later learning and acquisition of industrial skills (Lall, 2000). Including South Korea, economic growth in Asian countries has been attributed to education. Furthermore, with regard to the rapid economic growth, studies emphasize the role of technology transfer, which is enabled by higher education supplying educated graduates (Milne, 1999; WorldBank, 1993).

Figure 5 illustrates annual GDP per capital and enrollment in South Korean higher education from 1954 to 2007, presenting an overall increase of GDP per capita and a corresponding increase in higher education enrollment. South Korean higher education experienced a sharp increase in the 1980s and was succeeded by an increase of GDP per capita in the 1990s. The educated population grew more rapidly than GDP per capita in South Korea (Choo, 1990).

Figure 5. Changes in GDP per capita and higher education enrollment in South Korea

Note: GDP per capita from International Monetary Fund (IMF).
Enrollment from the Ministry of Education (MOE), South Korea

The South Korean industry sector has called for a highly educated workforce able to generate economic growth over the period of industrialization. Responding to the increasing need from industry, in the 1980s, the South Korean government has raised the total quota of enrollment in higher education (J. Hwang, 1980; Y. Kim, 1979). Higher education related to technology has expanded due to the increased industrial needs for a highly skilled workforce (B. Hwang, 1990).

However, since the 2000s, the number of graduates from South Korean higher education has started to exceed the labor market demand from South Korean industry. From the perspective of higher education, this is because the enrollment in South Korean higher education has rapidly expanded and the rate of enrollment has passed over 80 percent of the college age cohort. From the industrial perspective, unbalance between the supply and demand of college graduates is also due to the reduced recruitment from industry after the economic crisis in 1997 (Goodman et al., 2009).

Table 5 shows the changes in the composition of South Korean students' academic majors, demonstrating the percentages of six fields of studies over a span of 20 years. Unlike Japanese higher education, South Korean higher education has changed substantially in terms of academic composition of graduates. The proportion of science and engineering has increased while humanities and social sciences have decreased.

Table 5. Changes in composition of majors in South Korea

Field of Studies	1965	1985	2005
Art & Athletics	4.2%	6.9%	11.6%
Humanities	15.8%	10.6%	10.4%
Social Sciences	35.2%	21.1%	24.7%
Science & Engineering	28.9%	39.1%	37.9%
Health	8.2%	7.8%	6.9%
Education	7.5%	14.5%	8.4%

Note: Calculated from the Ministry of Education (MOE), South Korea.

Overall, South Korean higher education has provided a sufficient pool of educated workers(Marlow-Ferguson, 2002a). On the other hand, rapid increase of enrollment in higher education is "driven by the widespread belief in South Korean that development of higher education is a major factor in national development" as well as by demands for a more technologically skilled workforce from South Korea industry (J. Kim, 2000, p. 56).

Nonetheless, similarly with Japanese higher education, South Korean higher education is facing concerns about quality of education (Goodman et al., 2009). As useful technologies in industries were more challenging, South Korean corporations began to request that South Korean higher education prepare graduates with "more specific technical, engineering and scientific skills" and "different kind of skills that involve team work and multitasking" (Lall, 2000, p. 27). This shows that South Korean higher education has had difficulties in responding to the rapid change in South Korean industry in terms of quality of education.

In conclusion, both Japan and South Korea have achieved rapid economic growth after the increase of higher education enrollment in about 10 years. Because economic growth for higher education and economic growth are enormous and complicated subjects by themselves, I claim that development of human capital through higher education is a requisite component rather than a sufficient one. Moreover, for more cogency, this descriptive analysis of the relationship between higher education development and economic growth needs to be attested with advanced research methods.

Japan and South Korea share similarities in higher education: their higher education and economic growth have a positive relationship, and the development of higher education is mainly attributed to the expansion of the private sector. Japan and South Korea have different aspects in higher education as well: while Japan has retained a pattern in the composition of enrollment with minor changes over 40 years since the 1960s, South Korea has experienced a major change in the proportion of enrollment fields. While Japan and South Korea have had different patterns of enrollment composition, both countries have a positive impact of higher education expansion on national economic growth by providing a highly educated workforce during industrialization.

Some countries did not achieve economic growth as much as their higher education developed, but it is rare for developed countries to grow economically without highly educated human capital. The increase of overall higher education and the details in the higher education composition are both critical for their effects on the economy. However, studies dealing with higher education and its relationship with the economy have yet to explore the composition of higher education. Studies have investigated the overall impact of factors like total enrollment or number of graduates in higher education on economic growth, but they have not screened the composition of majors or institutions such as differences among majors in terms of contribution to the increase of GDP. In order to disclose the relationship of higher education and economic growth, the contents of higher education need to be examined based on a certain developmental level of the economy and industrial needs. Therefore, this study intends to analyze the impact of higher education composition on economic growth with Japanese and South Korean cases.

3.0 RESEARCH METHOD

This study delves into the relationship between higher education development and economic growth in Japan and South Korea and takes a quantitative approach to the panel data of higher education and the economies of these countries. This is a longitudinal analysis with a panel data repeating observations over time (Christopher Dougherty, 2006). Specifically, this study will apply a time series analysis in order to examine the relationship between higher education and the economy over both Japan and South Korea's period of industrialization. Japan began its outstanding economic development in the middle of the 20th century, and South Korea jump-started its economic growth at the end of the 1970s.

There is a substantial amount of research that deals with statistical data on education and the economy. However, because most of this research applies cross-sectional regressions, it is less able to control for unobserved heterogeneity among different countries (Krueger & Lindahl, 2001; Sianesi & Reenan, 2002). Furthermore, the averaged results they report are "significantly different from those obtained from single cross-country regressions" (Islam, 1995, p. 1127) and ultimately give too little information about the relationship between education and economic growth (Pritchett, 2001). Additionally, most results of cross-country regressions that deal with variables of economic growth are unstable due to small changes (Levine & Renelt, 1992) and the estimated coefficient on education is highly sensitive to measurement errors (Temple, 1998). Moreover, even though some studies do use panel data, most of them analyze data only at five year intervals (Rizavi, Rizvi, & Naqvi, 2011). Finally, because they use averaged results and five year intervals, cross-sectional regressions show significant limitations to explain the relationship between education development and economic growth. Consequently, a specified model approach based on a country case is suggested for examining the relationship between education and economic growth (Cheng & Hsu, 1997).

Therefore, instead of cross-county regressions, this study will apply a time series analysis to investigate the contribution of higher education development to economic growth on each panel data of Japan and South Korea.

3.1 DATA

This research used annual data dealing with higher education and the economy in Japan from 1959 to 2009 and in South Korea from 1965 to 2011. Because of limited data access, the data for the South Korean case span 47 years, while the data for Japanese case cover 51 years. Annual data about higher education and the economy in Japan and Korea were collected from several sources.

For the economic data, Gross Domestic Product (GDP) per capita with constant 2000 United States Dollar (USD) was obtained from the World Development Indicators (WDI) provided by the World Bank. Out of multiple potential economic variables, one of GDP variables was chosen because this study intends to track national benefit rather than individual benefit (Birdsall, 1996). GDP per capita is calculated by dividing GDP by population reflecting the relative wealth of a nation. Other demographic data, such as population, were also acquired from the International Financial Statistics (IFS) provided by the International Monetary Fund (IMF).

In order to explore the channels through which higher education contribute to the increase of GDP, three different sector adding value to GDP—agriculture, industry, and service et al.—were obtained from World Development Indicators (WDI) provided by World Bank. The GDP (constant 2000 USD) by agriculture in Japan and South Korea from were available from 1965 to 2010. The GDP (constant 2000 USD) by both industry and service et al. in Japan and South Korea were available from 1970 to 2010.

This study chose two control variables. First, the annually averaged stock market index was used as a proxy of condition of the economies, because the stock market index reflects various social and political situations. Therefore, Nikkei 225, the Stock Market Index in Tokyo Stock Exchange from 1968 to 2004, was obtained from Japanese Historical Statistics, and its base date was January 4th in 1968 (=100). The Korea Composite Stock Price Index (KOSPI) from 1976 to 2011 was collected from Korean Statistical Information Service, and January 4^{th}, 1980 was the base date (=100). Their stock market indexes are total average, meaning they are averaged from all stock indexes in each year.

The second control variable covers the demography in Japan and South Korea. Even through their populations was accounted in the GDP per capita (GDP / population), number of graduates also are related with their demographic characteristics. Because the number of graduates means the amount of educated human capita added to the existing human stocks, this study occupied difference in population as a proxy of demographic changes and calculated it by subtracting the population in the previous year from the population in the current year.

The Japanese education data, consisting of total enrollment, total number of graduates, number of graduates by institutional sector (national, public, private), and number of graduates by majors (humanities, arts& athletics, social science, science, engineering, health, education, home economics, others) were obtained from the Statistics of Japanese Higher Education provided by the Research Institute for Higher Education at Hiroshima University. Because the original data source occupied different categories depending on the level of institutions, I combined the categories with the same major grouping (see Table 6).

Table 6. Combined majors in Japanese higher education

Group of Majors	Levels of Institutions (period of data)			
	Graduate (1963-2009)	Undergraduate (1960-2009)	Junior colleges (1960-2009)	Specialized (1976-2008)
Humanities	human science	human science	human science liberal arts	human science liberal arts
Arts	arts others	arts others	arts others	arts others
Social science	social science home economics	social science home economics	social science secretarial studies home economics	business practical business cultural studies fashion home economics
Education	education	Education	education	education social welfare
Science Engineering	science Masters: engineering agriculture mercantile marine Doctors: engineering agriculture	science engineering agriculture mercantile marine	science engineering	science engineering agriculture
Health	health care	health	health care	Health medical services

South Korean education data, consisting of total enrollment, total number of graduates, number of graduates by institutional sector (national, public, private), and number of graduates by majors (humanities, arts& athletics, social science, science, engineering, health, education), were obtained from the Statistical Yearbook of Education provided by the Ministry of Education of South Korea. This study digitized Korean analogue data of higher education from 1965 to 1990 combined them with the data from 1991 to 2011. For the statistical analysis, seven majors were organized into four major groups: humanities (including arts), social science, education, and science (including engineering and health).

In both Japanese and South Korean higher education, number of graduates from national and public institutions in the original data were combined and named as “public” sector. Even through the original data show three different sectors—“national,” “public,” and “private”—both the national and public sectors represent the public support that this study intends to compare with private support in higher education.

In this study, the number of graduates from higher education institutions were used for estimating higher education development (Cheng & Hsu, 1997; Lucas, 1993). The number of graduates shows “the addition to the existing educated human capital stock than the gross or net enrollment ratios” that are utilized by other studies (Wang & Yao, 2002, p. 40).

Annual data of Japanese and Korean education data were cross-checked with United National (UN) DATA database, United Nations Education, Scientific, and Cultural Organization (UNESCO) Statistical Yearbook, and Organization for Economic Cooperation and Development (OECD) data. Table 7 shows the variables that were used in this study with their indicators and their sources.

Table 7. Variables, indicators, and sources

Variables	Indicators	Sources
Economy		
GDP per capita	Economic Growth	International Financial Statistics World Development Indicators
Stock Market Index	Condition of Economy	Government Statistics of Japan and South Korea
GDP by Sectors (Agriculture, Industry, Service et al.)	Contributing Sector to Economic Growth	World Development Indicators
Higher Education		
Total Enrollment	Trend of Higher Education Development	Statistics of Japanese Higher Education Korean Statistical Yearbook of Education
Total Number of Graduates	Higher Education Development	Statistics of Japanese Higher Education Korean Statistical Yearbook of Education
Number of Graduates (Enrollment for Japan) by Institution Sector (Public, Private)	Higher Education Development by Institutions Sector	Statistics of Japanese Higher Education Korean Statistical Yearbook of Education
Number of Graduates by Major (Humanities, Social Science, Education, Science & Engineering)	Higher Education Development by Major	Statistics of Japanese Higher Education Korean Statistical Yearbook of Education
Others		
Population 18-year-old population	Demographic Change College Age Cohort	International Financial Statistics World Development Indicators

3.2 METHOD OF ANAYSIS

Because lagged linear relations generate a correlation, “classical regression is often insufficient for explaining all of the interesting dynamics of a time series” (Shumway & Stoffer, 2011, p. 83). The Autoregressive Integrated Moving Average (ARIMA), a stochastic process based on observations at equally spaced intervals, explains the underlying process forming a series (Box & Jenkins, 1976). This method “differences the series to stationarity to yield a comprehensive model amenable to forecasting” (Yaffee & McGee, 2000, p. 70). Therefore, the ARIMA model is appropriate for extrapolating time trends in economic variables that usually have a serial correlation (Lutkepohl, 2004). Furthermore, the ARIMA model is good at formulating incremental changes of variables.

This study used the ARIMA regression method to explore the relationship between higher education development and economic growth. This study deals with the economic and educational variables covering a half century, and the variables have serial correlation and incremental changes. Therefore, ARIMA regression method was fit to the analysis of this study.

The ARIMA method needs to be satisfied by three requirements: “weak stationarity, equal-spaced intervals of observations, and at least 30 to 50 observations” (Yaffee & McGee, 2000, p. 87). The data that this study used fulfilled these assumptions. Some scholars suggest a time period of thirty years as a minimum for a reliable time series analysis of annual data (French & Stanley, 2005; Peters, 2008; Yaffee & McGee, 2000). For an ARIMA model, however, a data with at least 50 observations is recommended for a rigorous analysis (Box & Jenkins, 1976). More observations in a longer period are preferable to model a time series precisely (Otero & Smith, 2000).

The ARIMA has a generalized form, ARIMA (*p*,*d*,*q*), which includes three processes, autoregressive (AR), integrated (I), and moving average (MA) processes. Therefore, in a ARIMA (*p*,*d*,*q*) model, *p* stands for the order of the autoregressive component, *d* represents the number of differences required for stationarity, and *q* is the order of the moving average component (Peters, 2008; Shumway & Stoffer, 2011; J. T. Williams, 2001).

Conducting the ARIMA analysis, this study intends to first identify a pattern of GDP per capita. After reflecting on the effect of other economic condition indicated by the stock market index and on the effect of demographic situation showed by changes in population, the amount that the number of college graduates contributes to any additional explanation was estimated over the pattern of GDP per capita. In order to identify the contribution of higher education by different institutional sectors, the amount of any explanation that the number of college graduates from public and private sectors adds over the pattern of GDP per capita was compared.

For the impact of higher education composition, the individual effect of different majors previous year on GDP per capita was examined by the same method above. Because the number of graduates in the previous year represents the addition of human capital contributing in the economy over the previous year, it needs to examine the effects of college graduates on economic growth with a time lag. Even though a time lag with several years would explain the contribution of college graduates on the economies more accurately, due to a data constraint, this study estimated the effect of number of graduates on their economies with a year lag.

Furthermore, in order to inquire a specific sector of economic growth on which major composition has an impact, the effects of major groups on agriculture, industry, and service & et al. sectors in GDP were analyzed. After identifying the patterns of each sector in GDP, this study examined additional amount of explanation by college major groups over their patterns. Table 8 shows the summarized analysis that this research conducted.

Table 8. Summary of analysis

Theme	Analysis	Method	Variables
Higher education development & economic growth	Effect of higher education on economic growth	ARIMA regression	GDP per capita Number of graduates
	Effect of higher education on economic growth after controlling economic condition and demographic changes	ARIMA regression	GDP per capita Stock index Population changes Number of graduates
	Bidirectional effect between higher education and economic growth	ARIMA regression	(lagged) GDP per capita (lagged) Number of graduates
Composition of higher education & economic growth	Effect of public and private higher education on economic growth	ARIMA regression	GDP per capita Number of graduates by institutional sector
	Effect of lagged majors on economic growth	ARIMA regression	GDP per capita (lagged) Number of graduates by major
	Effect of lagged majors on GDP by agriculture	ARIMA regression	GDP by Agriculture (lagged) Number of graduates by majors
	Effect of lagged majors on GDP by industry	ARIMA regression	GDP by Industry (lagged) Number of graduates by majors
	Effect of lagged majors on GDP by service et al.	ARIMA regression	GDP by Service et at. (lagged) Number of graduates by majors

4.0 FINDINGS

This chapter presents the findings of this study with the statistical output that was generated by the Statistical Program of Social Sciences (SPSS). These findings consist of three sections that include the comparison between Japan and South Korea. In the first section, the overall relationships between higher education development and economic growth in Japan and South Korea are investigated. The contribution of higher education composition by institutional types—public and private—is analyzed in the second section. The last section includes the analysis of the relationship between the composition of majors in higher education and the economies of Japan and South Korea.

4.1 RELATIONSHIP BETWEEN HIGHER EDUCATION AND EOCNOMIC GROWTH

The same analysis process was applied on both Japanese and South Korean cases in order to explore differences and similarities between them. First of all, the fit model of Japanese GDP per capita over the time period from 1960 to 2008 was examined, and ARIMA (1,0,0) model was fitted to the data. The residual autocorrelation function (ACF) and partial autocorrelation function (PACF) plots for the model ARIMA (1,0,0) of GDP per capita are presented in Appendix B. The model ARIMA (1,0,0,) means the lagged one time unit is a predictor of the variable following time unit. In this ARIMA (1,0,0) model of the pattern of GDP per capita, in other words, GDP per capita from the previous year was a main predictor of GDP per capita and explained 94.5% of the GDP per capita for the following year (R^2=.945) (see Table 9). Figure 6 shows the pattern of the Japanese GDP per capita from 1960 to 2008. Japanese GDP per capita increased sharply from 1960 to 1990, but the economic growth in Japan was slowed in the 1990s.

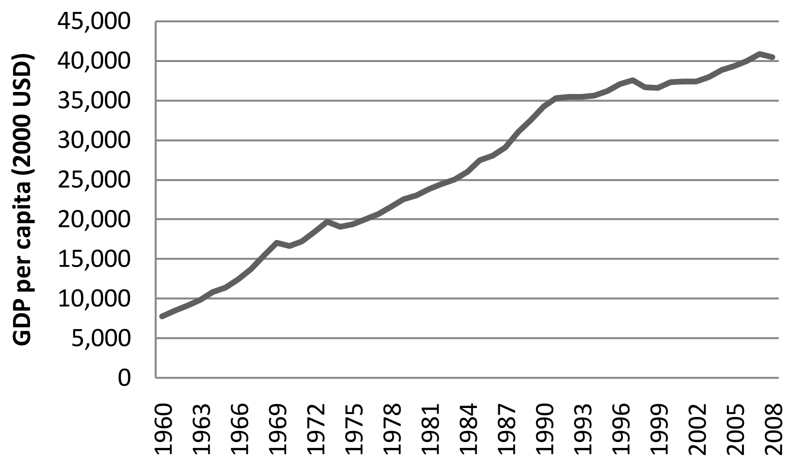


Figure 6. Japanese GDP per capita from 1960 to 2008

This study observed the changes of the stationary R^2 in ARIMA regression when the number of graduates in Japanese higher education was added to ARIMA regression. The stationary R^2 increased by .027 from .945 to .972: the number of graduates added a 2.7% explanation to Japanese GDP per capita over the pattern of it. On every hundred increase of the number of graduates, the Japanese GDP per capita increased by $ 1.3 (USD) (see in Table 9). Table 9 shows the summarized statistical output of ARIMA regression without predictors (number of graduates) and with predictors consecutively.

Table 9. ARIMA model parameter for Japanese GDP per capita (1960-2008)

Modeling of GDP per capita	R2	Parameter for GDP per capita	Coefficient	Standard Error
ARIMA (1,0,0), excluding predictors	.945	GDP per capita previous year	.998**	.010
		Intercept	23553.869	38018.055
ARIMA (1,0,0), including predictors	.972	Number of graduates	.013**	.002
		GDP per capita previous year	.998**	.014
		Intercept	16908.585	36442.031

** $p< .01$

In order to examine the effect of higher education on economic development controlling for the condition of the Japanese economy and demography, in addition to the number of graduates, both stock index and population changes in Japan were added to the ARIMA model of the GDP per capita. Table 10 presents the summarized output of ARIMA model of Japanese GDP per capita both before and after these variables were included as ARIMA model parameters. The stationary R^2 in the ARIMA model of Japanese GDP per capita was raised by .059 after including stock index, population change, and number of graduates; after accounting for the effect of control variables, the number of graduates added a 5.9 % of explanation to Japanese GDP per capita. In other words, the expansion of higher education contributed to the economic growth in Japan with the economic and demographic conditions accounted for. On every hundred increase of the number of graduates, the Japanese GDP per capita increased by $ 1.9 (USD) (see Table 10).

Table 10. ARIMA model parameter for Japanese GDP per capita including other variables

Modeling of GDP per capita	R2	Parameter for GDP per capita	Coefficient	Standard Error
ARIMA (1,0,0), excluding predictors	.928	GDP per capita previous year	.997**	.016
		Intercept	26921.551	31460.190
ARIMA (1,0,0), including predictors	.987	Stock Index	1.065*	.519
		Population change	.000	.000
		Number of graduates	.019**	.003
		GDP per capita previous year	.987**	.041
		Intercept	13545.518	7441.264

* $p < .05$ ** $p < .01$

For South Korean case, this study conducted a time series analysis with ARIMA model and confirmed ARIMA (1,0,0) as a fit model of South Korean GDP per capita from 1965 to 2010. The ACF and PACF plots for the ARIMA (1,0,0) model of GDP per capita are included in Appendix B. In South Korea, the GDP per capita from the previous year was a main predictor of GDP per capita and explained 93.8% of the GDP per capita for the following year (R^2=.938) (see Table 11). Figure 7 shows the pattern of the GDP per capita in South Korea during the observed period (1965-2010). The South Korean GDP per capita has increased fast and continuously from the 1980s apart from the economic crisis that occurred around 1998.

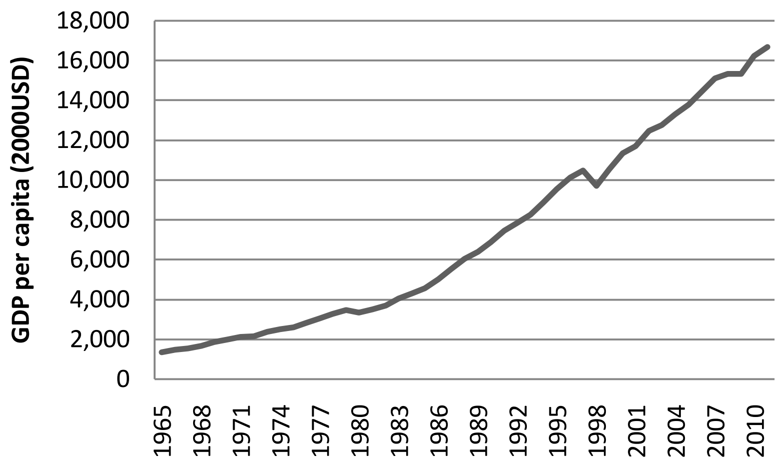


Figure 7. South Korean GDP per capita from 1965 to 2011

When the number of graduates was added to the ARIMA model regression, the stationary R^2 increased by .042 from .938 to .980: the number of graduates added a 4.2% explanation to the GDP per capita over the pattern of South Korean GDP per capita. The GDP per capita in South Korea grew by \$ 1.2 (USD) on every increase of hundred graduates (see Table 11). The statistical output of ARIMA regression without predictors (number of graduates) and with predictors consecutively are presented in Table 11.

Table 11. ARIMA model parameter for South Korean GDP per capita

Modeling of GDP per capita	R2	Parameter for GDP per capita	Coefficient	Standard Error
ARIMA (1,0,0)	.938	GDP per capita previous year	.998**	.016
		Intercept	9005.422	36210.409
ARIMA (1,0,0), including predictors	.980	Number of graduates	.012**	.003
		GDP per capita previous year	.995**	.032
		Intercept	4657.784	12574.475

** $p < .01$

This study intends to estimate the effect of higher education expansion on economic development controlling for the condition of the South Korean economy and demography. Therefore, the stock index and population changes as well as number of graduates were added to the ARIMA model of South Korean GDP per capita. Table 12 shows the summarized output of ARIMA regression of South Korean GDP per capita both before and after these variables were included as parameters. After including stock index, population change, and number of graduates in the ARIMA regression, the stationary R^2 increased by .067. After accounting for the effect of control variables, the number of graduates added a 6.7% of explanation to South Korean GDP per capita. In South Korea, the contribution of higher education expansion to the economic growth was statistically significant. The South Korean GDP per capita was raised by $ 1.3 (USD) on the increase of every hundred graduate.

Table 12. ARIMA model parameter for South Korean GDP per capita including other variables

Modeling of GDP per capita	R2	Parameter for GDP per capita	Coefficient	Standard Error
ARIMA (1,0,0), excluding predictors	.920	GDP per capita previous year	.997**	.021
		Intercept	9642.272	27266.874
ARIMA (1,0,0), including predictors	.987	Stock index	1.552**	.332
		Population changes	.000	.001
		Number of graduates	.013**	.002
		GDP per capita previous year	.979**	.053
		Intercept	3350.283	2538.274

** *p*< .01

In both Japan and South Korea, the number of graduates presented positive effects on their GDP per capita. After accounting for the economic and demographic situation, this study found the contribution of number of graduates on GDP per capita was still effective. Based on the analysis of this research, higher education and expansion and economic growth have positive relationship in both Japan and South Korea. The impact of higher education was slightly higher in South Korea than in Japan.

4.1.1 Recurrent Relationship between Higher Education and Economic Growth

Higher education and economic growth were related over the period of time that this study examined, and the previous section (4.1) found the positive effect of higher education on economic growth. However, the positive effect of higher education on economic growth may not imply the causality of higher education toward economic growth. Therefore, in order to identify the direction of impact between higher education and economic growth, this study generated lagged variables of both the number of graduates and the GDP per capita and analyzed the effect of the lagged variables on the original variables. For Japanese and South Korean cases, the effect of the number of graduates from the previous two years on the GDP per capita for the following two years was examined, and, in reverse, the effect of the GDP per capita from the previous two years on the number of graduates for the following two years was also studied.

In the Japanese data, first of all, the ARIMA (1,0,0) model of the GDP per capita from 1962 to 2008 showed .932 as its stationary R^2. After adding the number of graduates from the previous two years, the stationary R^2 was .977. The change of R^2 was .045: the number of graduates from the previous two years added a 4.5% explanation over the pattern of the GDP per capita. For every hundred of the number of graduates from the previous two years, the Japanese GDP per capita was raised by $ 1.7 (USD) (see Table 13).

Table 13. ARIMA model parameter in a bidirectional analysis with a time lag (Japan)

Modeling of GDP per capita	R2	Parameter for GDP per capita	Coefficient	Standard Error
ARIMA (1,0,0), excluding predictors	.932	GDP per capita previous year	.998**	.012
		Intercept	25213.888	52226.732
ARIMA (1,0,0), including predictors	.977	Lagged no. of graduates by 2 years	.017**	.004
		GDP per capita previous year	.995**	.023
		Intercept	15235.642	20480.345
Modeling of No. of graduates	**R2**	**Parameter for No. of graduates**	**Coefficient**	**Standard Error**
ARIMA (1,0,0), excluding predictors	.944	No. of graduates previous year	.997**	.011
		Intercept	605848.134	932113.957
ARIMA (1,0,0), including predictors	.989	Lagged GDP per capita by 2 years	21.519**	4.828
		No. of graduates previous year	.972**	.038
		Intercept	126531.247	160923.979

** *p*< .01

For the other direction of impact from the GDP per capita to the number of graduates, lagged GDP per capita was computed. The ARIMA (1,0,0) model also was fitted to the number of graduates in Japanese higher education. The ACF and PACF plots for the ARIMA (1,0,0) model of the number of graduates are included in Appendix B. Figure 8 shows the pattern of the number of graduates in Japan during the observed period. The number of graduates in Japan grew gradually from 1960 and rapidly increased in the late 1970’s. It reached its peak in the mid of the 1990s and started declining slightly after them.

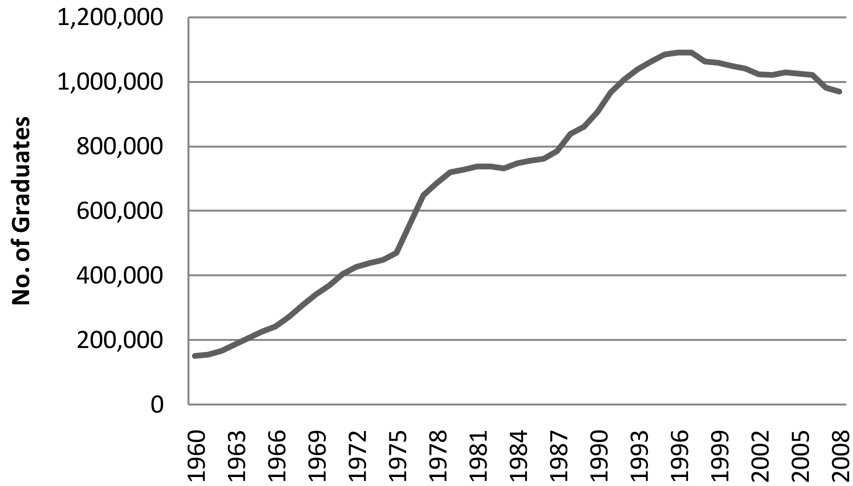


Figure 8. Number of graduates in Japan from 1960 to 2008

In the ARIMA (1,0,0) model of the number of graduates, the stationary R^2 was .944: the number of graduates from the previous year explains 94.4% of the number of graduates for the following year. When the GDP per capita from the previous two years was included into the ARIMA regression, the stationary R^2 increased by .045 (R^2=.989): the GDP per capita from the previous two years added a 4.5% of explanation over the pattern of the number of graduates in Japan. On every $1 increase of South Korean GDP per capita from the previous two years, the number of graduates was raised by 21.5 (See Table 13).

In Japanese data of higher education and the economy, the number of graduates from the previous two years increased R^2 in the ARIMA regression of GDP per capita by .045, and on the other side, the GDP per capita from the previous two years raised R^2 in the ARIMA regression of the number of graduates by .045. The effect of Japanese higher education expansion on their economic growth and the effect of Japanese economic growth on their higher education expansion showed the same amount of effect on each other with a time lag of two years.

Table 14. ARIMA model parameter in a bidirectional analysis with a time lag (South Korea)

Modeling of GDP per capita	R2	Parameter for GDP per capita	Coefficient	Standard Error
ARIMA (1,0,0), excluding predictors	.934	GDP per capita previous year	.998**	.017
		Intercept	9164.306	34617.829
ARIMA (1,0,0), including predictors	.985	Lagged no. of graduates by 2 years	.014**	.003
		GDP per capita previous year	.993**	.041
		Intercept	4070.436	9575.417
Modeling of No. of graduates	**R2**	**Parameter for No. of graduates**	**Coefficient**	**Standard Error**
ARIMA (1,0,0), excluding predictors	.906	No. of graduates previous year	.998**	.014
		Intercept	490790.521	1612979.504
ARIMA (1,0,0), including predictors	.989	Lagged GDP per capita by 2 years	28.734**	8.495
		No. of graduates previous year	.986**	.033
		Intercept	105828.965	182732.555

** $p < .01$

In the case of South Korea, the ARIMA (1,0,0) model of GDP per capita from 1967 to 2010 showed .934 as its stationary R^2. After adding the number of graduates from the previous two years, the stationary R^2 became .985. The change of R^2 was .051: the number of graduates from the previous two years added a 5.1% explanation over the pattern of GDP per capita. The South Korean GDP per capita grew by $ 1.4 (USD) for every hundred of the number of graduates from the previous two years (see Table 14).

For the other direction of the impact from GDP per capita to number of graduates, lagged GDP per capita was computed in the South Korean data. The ARIMA (1,0,0) model also was a fit model for the number of graduates in South Korean higher education. The ACF and PACF plots for the ARIMA (1,0,0) model of the number of graduates are included in Appendix B. The number of graduates from the previous two years explained 90.6% of the number of graduates for the following two years (R^2=.906). Figure 9 shows the pattern of the number of graduates in South Korea during the observed period. Notably, the number of graduates sharply increased from the beginning of the 1980s to the beginning of the 2000s.

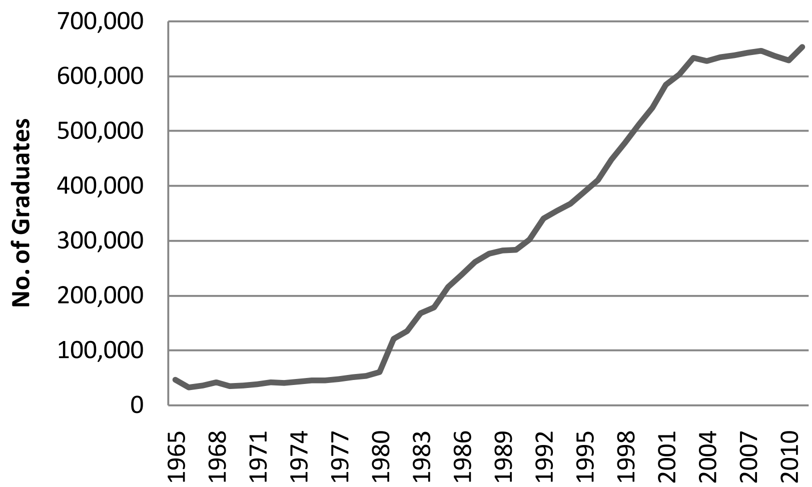


Figure 9. Number of graduates in South Korea from 1965 to 2011

The stationary R^2 (.906) of the ARIMA (1,0,0) model of the number of graduates in South Korea became .989 after the GDP per capita from the previous two years was included into the ARIMA regression. The South Korean GDP per capita from the previous two years added an 8.3% explanation over the pattern of their number of graduates. The number of graduates in South Korea grew by 28.3 on every $1 increase in their GDP per capita from the previous two years (see Table 14).

From the data of higher education and the economy of South Korea, the number of graduates from the previous two years increased R^2 in the ARIMA regression of GDP per capita by .051. On the opposite side, the GDP per capita from the previous two years raised R^2 in the ARIMA regression of the number of graduates by .083. The economic growth and higher education expansion in South Korea showed a positive effect on each other with a time lag of two years. However, the effect of economic growth on higher education expansion was greater than the effect of higher education expansion on their economic growth.

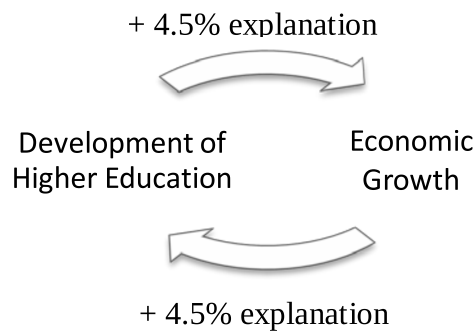


Figure 10. Recurrent relationship between higher education and the economy in Japan

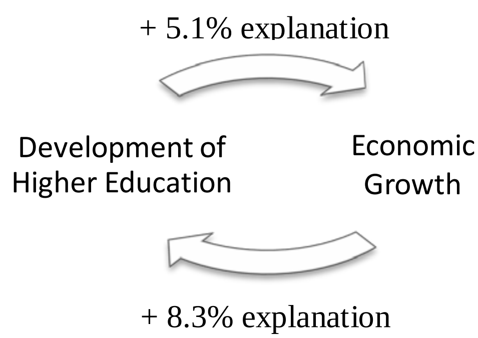


Figure 11. Recurrent relationship between higher education and the economy in South Korea

Both Japan and South Korea showed a recurrent relationship between higher education and economic growth. Figure 10 exhibits the bidirectional effects between higher education and economic growth in Japan. The expansion of Japanese higher education added a 4.5%

explanation over the pattern of economic growth for the following two years; Japanese economic growth also added a 4.5% explanation over the pattern of their higher education expansion for the following two years. For the South Korean case, Figure 11 presents the bidirectional effects between higher education and economic growth. The higher education expansion in South Korea added a 5.1 % explanation over the pattern of their economic growth for the following two years; the economic growth in South Korea added an 8.3% of explanation over the pattern of their higher education expansion for the following two years.

Japanese higher education developed gradually from the first half of the 20th century, but South Korean higher education developed only during several decades in the second half of the century. Japanese higher education was able to communicate with industries and reflect their needs for educated labor. Therefore, a balanced reciprocal relationship between higher education and economic growth was established in Japan. In South Korea, however, economic growth had a greater impact on the expansion of higher education than higher education contributed to their economic growth. Not only industrial needs for qualified labor but also individual eagerness for education seemed to facilitate higher education expansion. The expansion of economic growth in South Korea in general and the increase in household income more specifically may have made it for individual households to support the higher education of their children.

This study observed that the overall pattern of recurrent relationship of economic growth and higher education was similar between Japan and South Korea. However, while the Japanese economy and higher education had the same size of effect on each other, the effect of South Korean economic growth on higher education was greater than that of higher education on the economy.

the effect size of South Korean economic growth on higher education expansion was higher than that of higher education on the economy.

4.2 EFFECT OF INSTITUTIONAL SECTORS IN HIGHER EDUCATION AND ECONOMIC GROWTH

On the basis of examining the positive relationship between higher education and economic growth, this study intends to investigate the effect of contribution of higher education composition to the economic growth. The composition of higher education includes various combinations of several kinds of components, such as majors, characteristics of institutions, and levels of institutions. Among them, this study inquires into the effect of composition of institutional characteristics—public and private—and students' majors on economic growth. This section covers the characteristics of institutions, more specifically, institutional sectors, and the next section (4.3) deals with the composition of majors in higher education.

This study utilized enrollment in public and private sectors as indicators of Japanese institutional characteristics due to data constraints, while the numbers of graduates from public and private sectors were used for the South Korean case. Figure 12 shows Japanese enrollment by public and private over the period from 1960 to 2008. Both of public and private sectors expanded, but the private sector grew more dramatically than the public sector: the public sector increased its enrollment by about 3.5 times and the private sector multiplied it by more than 5.8 times from 1960 to 2008.

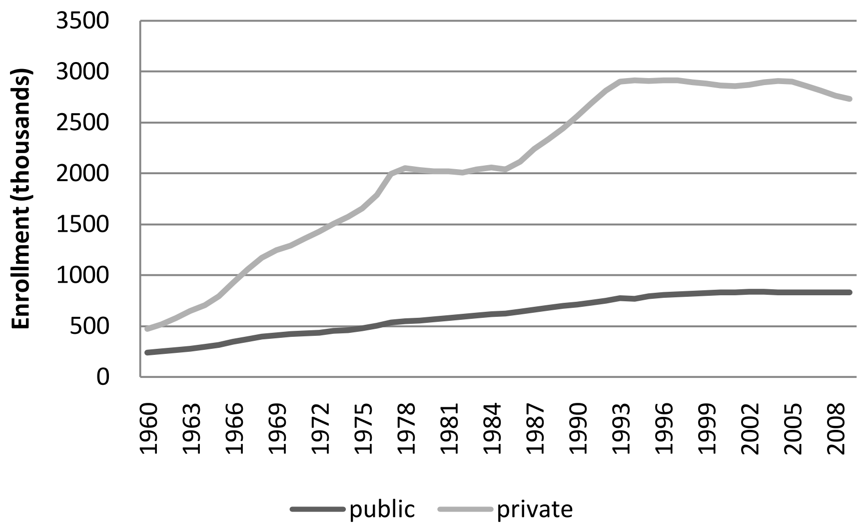


Figure 12. Japanese enrollment in public and private sectors (1960-2009)

In order to estimate the contribution of Japanese public and private sectors to their economy, this study estimated how much public and private sectors, each one separately and both together, add an explanation on the ARIMA (1,0,0) model of Japanese GDP per capita (for the pattern of GDP per capita, see Figure 6 in the previous section). The stationary R^2 changed from .948 to .997 after adding public enrollment as a parameter; enrollment of the public sector added a 5.2% explanation over the pattern of the Japanese GDP per capita. For every thousand students in Japanese public sector, Japanese GDP per capita increased by \$ 52 (USD). After adding private sector enrollment to the ARIMA regression of Japanese GDP per capita, the stationary R^2 changed from .945 to .987; it added a 4.2% explanation over the pattern of the Japanese GDP per capita. Japanese GDP per capita increased by \$ 8 (USD) on every thousand students in Japanese private sector (see Table 15).

Both public and private sectors in Japan separately added a statistically significant explanation to the ARIMA regression of GDP per capita. However, the public sector in Japanese higher education showed a higher positive effect on Japanese economic growth than the private sector. In addition, when both public and private enrollments were added to the ARIMA regression at the same time, only the effect of the public sector was significant; the effect of the private sector disappeared. The stationary R^2 was .997 when both public and private were added to the ARIMA regression; it is the same amount of R^2 of having only public not private sector as a parameter. The Japanese GDP per capita grew by $ 54 (USD) on every thousand increase in their enrollment of the public sector (see Table 15).

Table 15. ARIMA model parameter for Japan GDP per capita by institutional sectors

Modeling of GDP per capita	R2	Parameter for GDP per capita	Coefficient	Standard Error
ARIMA (1,0,0), excluding predictors	.945	GDP per capita previous year	.998**	.010
		Intercept	12379.767	50055.058
ARIMA (1,0,0), including public sector	.997	Enrollment in public sector	.052**	.002
		GDP per capita previous year	.863**	.081
		Intercept	-4830.187	1521.317
ARIMA (1,0,0), including private sector	.987	Enrollment in private sector	.008**	.001
		GDP per capita previous year	.994**	.024
		Intercept	10736.127	14879.289
ARIMA (1,0,0), including public and private	.997	Enrollment in public sector	.054**	.009
		Enrollment in private sector	.000	.002
		GDP per capita previous year	.857**	.083
		Intercept	-5086.651**	1761.037

** $p < .01$

For the South Korean case, the numbers of graduates from public and private sectors were used for analyzing the effect of institutional type to economic growth. Figure 13 shows the number of graduates from public and private sectors over the period from 1965 to 2010. For 35 years, the number of graduates from public institutions increased by about 12 times the number of graduates in 1965, and those from private institutions grew by about 14 times. In order to estimate the contribution of public and private sectors to the South Korean economy, this study estimated how much public and private sectors, each one separately and both together, add an explanation on the ARIMA (1,0,0) model of South Korean GDP per capita (for the pattern of GDP per capita, see Figure 7 in the previous section).

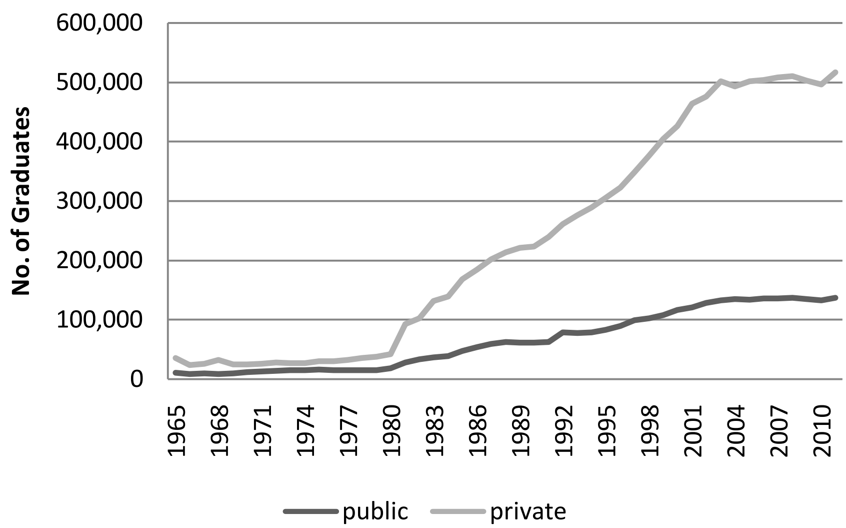


Figure 13. Number of graduates by public and private sectors in South Korea

The stationary R^2 changed from .938 to .977 after adding the number of graduates from public sector in the ARIMA parameters. The number of graduates from public sector added a 3.9 % explanation over the pattern of the South Korean GDP per capita. For every thousand increase in graduates from South Korean public sector, South Korean GDP per capita grew by $ 52 (USD). Adding the number of graduates from private sector, the stationary R^2 changed from .938 to .979: the number of graduates from private sector added a 4.1% explanation over the pattern of the South Korean GDP per capita. South Korean GDP per capita increased by $ 15 (USD) for every thousand increase in graduates from private sector (see Table 16).

Both public and private sectors in South Korea separately added a statistically significant explanation to the ARIMA regression of GDP per capita. The public and private sectors in South Korea showed a similar size of effect on South Korean economic growth. Nonetheless, when the numbers of graduates from both public and private sectors were added to the ARIMA regression, the effects of both public and privates sectors were insignificant. The stationary R^2 was .981 when both public and private were added to the ARIMA regression (see Table 16).

Table 16. ARIMA model parameter for South Korean GDP per capita by institutional sectors

Modeling of GDP per capita	R2	Parameter for GDP per capita	Coefficient	Standard Error
ARIMA (1,0,0), excluding predictors	.938	GDP per capita previous year	.998**	.016
		Intercept	9005.422	36210.409
ARIMA (1,0,0), including public sector	.977	No. of graduates from public	.052**	.013
		GDP per capita previous year	.996**	.028
		Intercept	5053.065	14580.650
ARIMA (1,0,0), including private sector	.979	No. of graduates from public	.015**	.004
		GDP per capita previous year	.995**	.031
		Intercept	4897.914	13278.422
ARIMA (1,0,0), including public and private	.981	No. of graduates from public	.031	.020
		No. of graduates from private	.008	.006
		GDP per capita previous year	.995**	.032
		Intercept	4534.515	12599.181

** $p < .01$

In brief, as higher education in Japan and South Korea expanded during the latter half of the 20th century, the private sector grew more sharply than public sector in both countries. In the analysis of institutional composition, each sector had a significant positive effect on economic growth in both Japan and South Korea. But, only the effect of the Japanese public sector remained significant when both public and private sectors were accounted for in the ARIMA regression. Even though private sector in Japan and South Korea dramatically expanded, they showed a similar size of effect on their economic growth regarding the public sector. Furthermore, the effect of private sector disappeared when it was adjusted with public sector. The growth of the private sector in higher education does not seem to have a strong tie with economic growth in Japan and South Korea.

4.3 EFFECT OF MAJOR COMPOSITION OF HIGHER EDUCATION AND ECONOMIC GROWTH

In order to inquire the effect of major composition on economic growth, this study conducted a time series analysis with Japanese and South Korean data. This study categorized majors into four major groups: humanities, social science, education, and science groups. The humanities group includes humanities, arts, and others; the social science group consists of social science, home economics (in Japan), law, and business; the education group represents education majors with different subjects; and the science group includes math, science, engineering, and health.

4.3.1 Major Composition and GDP per capita

First of all, the effect of major groups on GDP per capita was estimated to explore the relationship between major composition and economic growth in Japan and South Korea. Japanese data from 1960 to 2009 and South Korean data spanning 1965 to 2010 were analyzed by ARIMA regression. The number of graduates from the previous year was used to estimate the impact of major groups because it shows the contribution of college graduates on their economy over the following year. After identifying a pattern of GDP per capita, the amount of any explanation the each major group adds over the pattern was also examined.

In Japanese higher education, the total number of graduates was 150,210 in 1960 and rose to 969,136 in 2008. The number of graduates in 2008 is about 6.5 times that of graduates in 1960. During the period from 1960 to 2006, the science group presented the highest increasing rate, about eleven times the number of graduates in 1960. The growth rates among other major groups (humanities, social science, and education) were similar, about five times the number of graduates by each major group in 1960. During the period observed, the total number of graduates reached its peak (1,090,754) in 1996, and the highest numbers of graduates in humanities (194,648) and social science (423,152) were also in 1996. The number of graduates from science marked its highest point (189,316) in 2006 during the period (1960-2008). Figure 14 exhibits the historical trend of the number of graduates by four major groups in Japan.

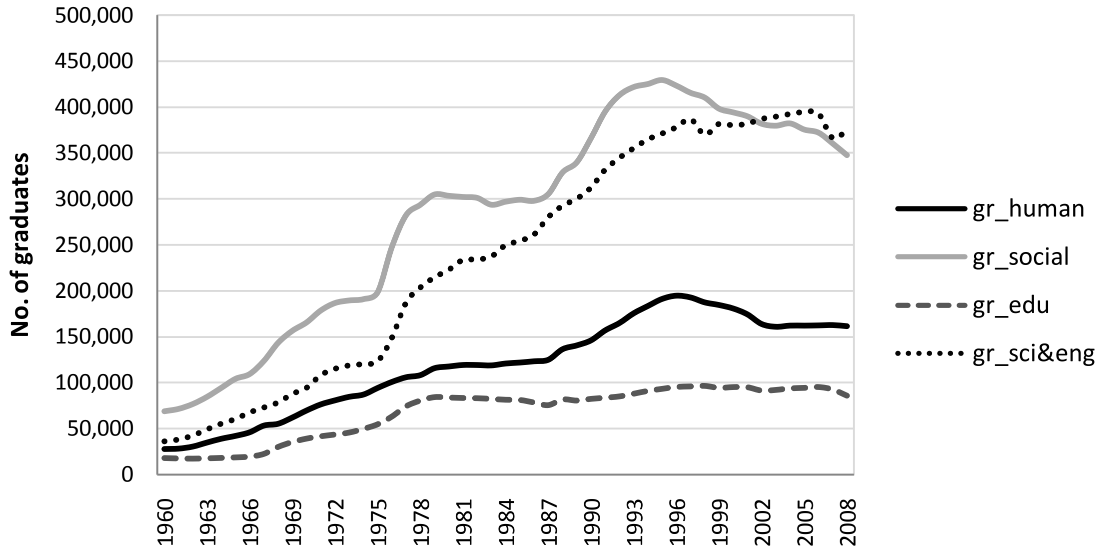


Figure 14. Number of graduates by major groups in Japan

In order to estimate the effect of major groups on economic growth, the number of graduates from the previous year from each major group was added to the ARIMA model of the Japanese GDP per capita (1961-2009). This study found that all four major groups added an explanation over the pattern of GDP per capita, and their positive effects were all statistically significant. Among the four major groups, the science major group (science, engineering, and health) added a more explanation to the ARIMA regression of GDP per capita than other major groups through increasing the stationary R^2 by .035. The science major group added a 3.5% of explanation over the pattern of Japanese GDP per capita; humanities major group, 2.8%; social science major group, 2.6%; and education major group, 2.1% (see Table 17).

Table 17. ARIMA model parameter for Japanese GDP per capita with major groups

Modeling of GDP per capita	R2	Parameter for GDP per capita	Coefficient	Standard Error
ARIMA (1,0,0), excluding predictors	.949	GDP per capita previous year	.998**	.010
		Intercept	23017.732	35242.260
ARIMA (1,0,0), including humanities major	.977	No. of grad. from humanities	.092**	.024
		GDP per capita previous year	.995**	.017
		Intercept	14859.707	15977.504
ARIMA (1,0,0), including social science major	.975	No. of grad. from social science	.038**	.009
		GDP per capita previous year	.996**	.016
		Intercept	15519.614	20457.044
ARIMA (1,0,0), including science major	.984	No. of grad. from science	.049**	.011
		GDP per capita previous year	.991**	.022
		Intercept	13730.340	9875.511
ARIMA (1,0,0), including education major	.970	No. of grad. from education	.123**	.037
		GDP per capita previous year	.997**	.014
		Intercept	16920.688	21987.868

** $p < .01$

In the ARIMA regression of GDP per capita by each major group, the Japanese GDP per capita grew by $ 9.2 (USD) on every 100 increase in their number of graduates from humanities major group. The GDP per capita in Japan was raised by $ 3.8 (USD) for every 100 graduates from the social science major group. Every 100 graduates from science major group raised Japanese GDP per capita by $ 4.9 (USD), and each 100 graduates from education increased Japanese GDP per capita by $ 12.3 (USD) (see Table 17).

To examine the effect of major composition on South Korean economic growth, this study employed the same steps with South Korean data as it did with Japanese data. The data of majors in South Korean higher education span 46 years, from 1965 to 2010. During this period, South Korea expanded its access to higher education fairly rapidly; in those 46 years, the South Korean population increased from 28 million to 48 million, and by 2010 the number of graduates represented an increase of 13.7 times the number of graduates from 1965. Among the four major groups, the social science group showed the lowest increase rate, 11.6 times the number of graduates from this group in 1965. The increase rate of the science group was 14.5 times; the humanities group, 15.1; and the education group, 16.7 times. Even though the humanities major group showed the highest increase rate of the graduates, the science major group marked the largest number of graduates in South Korea. The number of graduates from science major sharply increased around 1980, grew continuously, and reached its peak (304,128) in 2003. While the number of graduates from science started declining from 2004, the number of graduates from other major groups continued its growth or maintained its numbers. The trend of the graduates by major groups from 1965 to 2010 is presented in Figure 15.

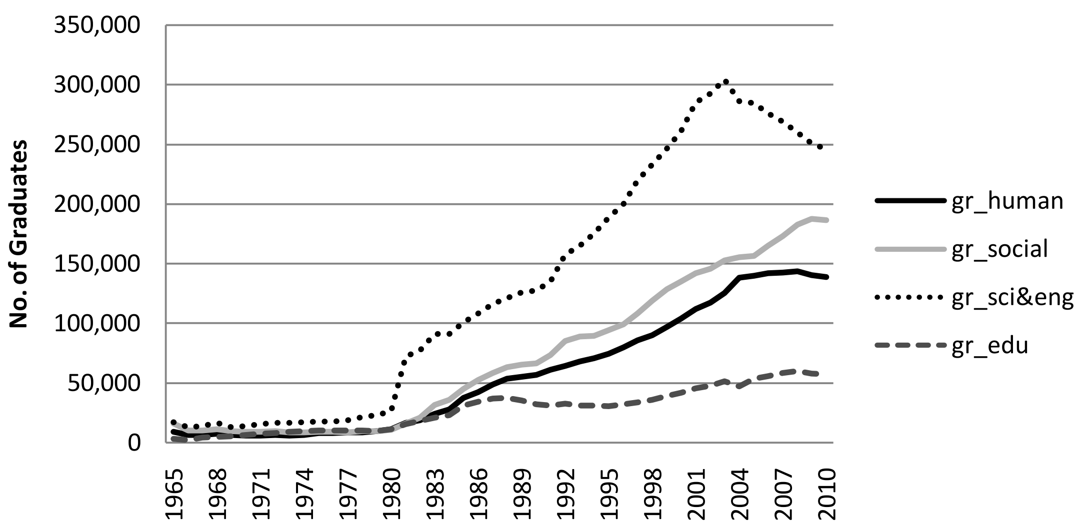


Figure 15. Number of graduates by major groups in South Korea

To explore the effect of major groups on South Korean economic growth, the number of graduates from the previous year from each major group was added to the ARIMA model of the South Korean GDP per capita (1965-2010). All four major groups added an explanation over the pattern of GDP per capita with statistical significance. The graduates from social science and humanities major groups added a more explanation over the pattern of GDP per capita than those of education and science major groups. The graduates from social science major group added a 5.7% of explanation over the pattern of South Korean GDP per capita through raising the stationary R^2 of ARIMA regression by .057; humanities major group, 4.8%; education major group, 2.6%; and science major group, 2.4% (see Table 18).

Table 18. ARIMA model parameter for South Korean GDP per capita with major groups

Modeling of GDP per capita	R2	Parameter for GDP per capita	Coefficient	Standard Error
ARIMA (1,0,0), excluding predictors	.936	GDP per capita previous year	.998**	.016
		Intercept	9129.606	33865.660
ARIMA (1,0,0), including humanities major	.984	No. of grad. from humanities	.065**	.015
		GDP per capita previous year	.993**	.041
		Intercept	4195.578	10328.735
ARIMA (1,0,0), including social science major	.993	No. of grad. from social science	.075**	.005
		GDP per capita previous year	.860**	.087
		Intercept	1840.011**	547.811
ARIMA (1,0,0), including science major	.960	No. of grad. from science	.014*	.006
		GDP per capita previous year	.997**	.022
		Intercept	7126.614	24099.057
ARIMA (1,0,0), including education major	.962	No. of grad. from education	.069*	.026
		GDP per capita previous year	.997**	.020
		Intercept	6915.252	20532.464

* $p < .05$ ** $p < .01$

In the ARIMA regression of GDP per capita of South Korea, by each major group, every 100 graduates of social science increased GDP per capita by $ 7.5 (USD). The South Korean GDP per capita rose by $ 6.5 (USD) on every 100 increase in the number of graduates from humanities majors. GDP per capita in South Korea grew by $ 1.4 (USD) on every 100 graduates from science majors, and by $ 6.9 (USD) on every 100 increase in the number of graduates from education (see Table 18).

In both Japan and South Korea, all major groups individually contributed to the economic growth. The highest contributing group to economic growth was the science major in Japan and the social science major in South Korea. The order of effect on Japanese economic growth was science, humanities, social science, and education majors; the order of effect on South Korean economic growth from highest to lowest was social science, humanities, education, and science majors.

In order to reveal the relationship between major groups and economic growth in Japan and South Korea, this study attempted to look into the sub-sectors in GDP. Because GDP consists of the various values generated by their different levels of industries, any permutation linking majors and industries may be hidden in the sum of their GDP. Therefore, in order to explore the relationship among sub-sectors in both higher education and the economies, this study intends to examine further the relationship between major groups and GDP by sectors in the next section (4.3.2).

4.3.2 Major Composition and GDP by Three Sectors

As mentioned in the literature review section (2.5), Japan and South Korea strategically approached developing certain industries based on their respective capacities. For example, they focused on light industry in the early period of industrialization, before shifting their focus on electronics manufacturing, heavy industry, and the service industry. Because the characteristics of industries are related to the level of education required for the workforce, this section explores the relationship between major groups in higher education and three sectors contributing to GDP, agriculture, industry, and service, which represent the first, second, and third industries.

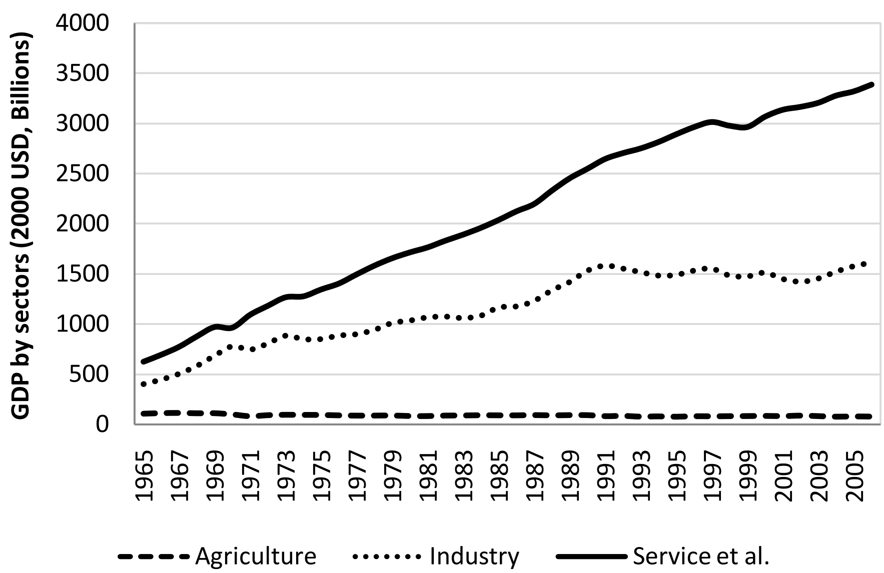


Figure 16. Japanese GDP by sectors

The flow of the value added by each sector in GDP reflects the changes in its economic activities. Figure 16 exhibits the Japanese GDP by three sectors (agriculture, industry, and service et al.) over the period that this study observed. The Japanese GDP generated by agriculture was around 110 billion dollars at the end of the 1960's, but fell below 100 billion dollars (USD) in 1970. After then, the Japanese GDP from agriculture fluctuated with slightly decreasing flow (more specific, see Figure C1 in Appendix B). From the beginning of the period that was observed, the valued added by industry to the Japanese GDP increased by the early 1990s and eventually exceeded 1.5 million dollars (USD). The GDP generated by the Japanese industrial sector grew sharply in the 1960s and increased moderately in the 1970s and 1980s, but has been at a standstill since the 1990s. However, the GDP sector generated by service et al. grew continuously over that period, resulting in more than five times GDP by service et al. in 1965, reaching about 3.5 million dollars (USD).

Table 19. ARIMA model parameter for agriculture GDP with major groups in Japan

Modeling of GDP per capita	R2	Parameter for Agriculture GDP	Coefficient	Standard Error
ARIMA (1,0,0), excluding predictors	.661	Agriculture GDP previous year	.892**	.068
		Intercept	77215.259**	8043.553
ARIMA (1,0,0), including humanities major	.771	No. of grad. human. previous year	-.228**	.056
		Agriculture GDP previous year	.677**	.113
		Intercept	104415.188**	7508.496
ARIMA (1,0,0), including social science major	.776	No. of grad. social previous year	-.104**	.023
		Agriculture GDP previous year	.656**	.656
		Intercept	106460.752*	106460.752
ARIMA (1,0,0), including science major	.766	No. of grad. science previous year	-.090**	.024
		Agriculture GDP previous year	.705**	.107
		Intercept	98500.884**	6695.326
ARIMA (1,0,0), including education major	.757	No. of grad. educa. previous year	-.433**	.082
		Agriculture GDP previous year	.597**	.125
		Intercept	106427.298**	6222.224

* $p< .05$ ** $p< .01$

In order to increase the readability of ARIMA regression result, this study rescaled GDP value added by agriculture, industry, and service by dividing by one million. The model ARIMA (1,0,0) showed good fit for Japanese GDP value added by agriculture: GDP by agriculture previous year explained 68% of that for the following year (R^2=.661). Over the pattern of GDP value added by agriculture, each major group added a statistically significant explanation in the ARIMA regression.

Among the four major groups, the social science major group added a more explanation to the ARIMA regression of Japanese agriculture GDP than other major groups. After the number of graduates from social science major group was added as a parameter to the ARIMA regression, the stationary R^2 changed from .661 to .776, adding an 11.5% of explanation over the pattern of agriculture GDP in Japan. The number of graduates from the humanities major group added an 11.0% explanation over the pattern of agriculture GDP in Japan; science major group, 10.5%; and education major group, 9.6%. All major groups had negative effects on the growth of Japanese GDP by agriculture (see Table 19).

For the second industry, the Japanese GDP value added by industry, the model ARIMA (1,0,0) was a model fit: the GDP by industry from the previous year explained 90.6% of that for the following year (R^2=.906). Each major group added a statistically significant explanation over the pattern of GDP value added by industry in the ARIMA regression.

The graduates from science major group added the most explanation to the ARIMA regression of GDP industry among four major groups. After the number of graduates from science major group was included as a parameter to the ARIMA regression, the stationary R^2 changed from .906 to .960, adding a 5.4% of explanation over the pattern of industry GDP in

Japan. The number of graduates from humanities major group added a 4.9% explanation over the pattern of industry GDP in Japan; social science major group, 4.5%; and education major group, 4.4%. Unlike agriculture GDP, all major groups had positive effects on industry GDP in Japan (see Table 20).

Table 20. ARIMA model parameter for industry GDP with major groups in Japan

Modeling of GDP per capita	R2	Parameter for Industry GDP	Coefficient	Standard Error
ARIMA (1,0,0), excluding predictors	.906	Industry GDP previous year	.984**	.024
		Intercept	1070333.275**	340243.070
ARIMA (1,0,0), including humanities major	.955	No. of grad. human. previous yr	5.443**	1.409
		Industry GDP previous year	.870**	.091
		Intercept	458755.702*	194857.015
ARIMA (1,0,0), including social science major	.951	No. of grad. social previous yr	2.131**	.614
		Industry GDP previous year	.909**	.070
		Intercept	515067.742*	206743.932
ARIMA (1,0,0), including science major	.960	No. of grad. science previous yr	2.458**	.304
		Industry GDP previous year	.739**	.123
		Intercept	528115.298*	87760.736
ARIMA (1,0,0), including education major	.950	No. of grad. educa. previous yr	.946**	2.460
		Industry GDP previous year	7.526**	.047
		Intercept	598344.761**	216260.028

* $p < .05$ ** $p < .01$

For the third sector, the Japanese GDP value added by service et al., the model ARIMA (1,0,0) also was a fit model: the GDP by service et al. from the previous year explained 84.6% of that for the following year (R^2=.840). Each major group added a statistically significant explanation over the pattern of GDP value added by service et al. in the ARIMA regression.

Among the four major groups, the science major group added the most explanation. After the number of graduates from science major group was added as a parameter to the ARIMA regressions, the stationary R^2 changed from .846 to .984, adding a 13.8% of explanation over the pattern of service GDP in Japan. The graduates from humanities added an 11.8% of explanation over the pattern of Japanese GDP by service. The similar amount of explanation with humanities group was added to the GDP by service in Japan by social science major (11.3%) and education major (11.2%) (see Table 21).

Table 21. ARIMA model parameter for service GDP with major groups in Japan

Modeling of GDP per capita	R2	Parameter for Service GDP	Coefficient	Standard Error
ARIMA (1,0,0), excluding predictors	.846	Service GDP previous year	.999**	.012
		Intercept	3044899.243	8619833.590
ARIMA (1,0,0), including humanities major	.964	No. of grad. human. previous yr	7.666**	1.984
		Service GDP previous year	.997**	.017
		Intercept	1443741.090	2502227.704
ARIMA (1,0,0), including social science major	.959	No. of grad. social previous yr	2.824**	.795
		Service GDP previous year	.997**	.016
		Intercept	1552206.813	3171141.835
ARIMA (1,0,0), including science major	.984	No. of grad. science previous yr	4.508**	.720
		Service GDP previous year	.995**	.021
		Intercept	1181496.177	1302817.427
ARIMA (1,0,0), including education major	.958	No. of grad. educa. previous yr	9.582**	3.334
		Service GDP previous year	.997**	.015
		Intercept	1661492.919	2921659.009

** $p< .01$

Comparing the result of overall GDP per capita and the result of GDP sectors, this study found the different roles of science and social science major groups. The science major group presented the most effect on overall Japanese economic growth, and showed more positive effect on the growth of the industry and service sectors in the Japanese GDP than other major group. The social science group showed more negative effect on the Japanese economy in the sector of agriculture. These results support that the science major was linked to the human capital that the industry sector needs and the social major was related to the labor working in the service sector.

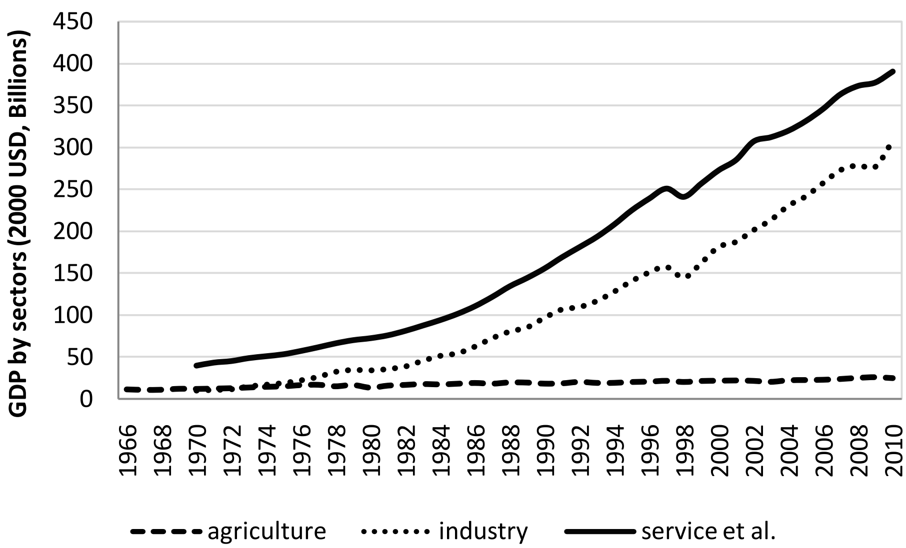


Figure 17. South Korean GDP by sectors

Like the Japanese ones, the South Korean GDP sectors are also divided into three areas: agriculture, industry, service et al. Figure 17 shows the changes in South Korean GDP by three sectors over the period of this study's observation. While the GDP by agriculture covers from 1966 to 2010, the GDP by industry and service et al. spans from 1970 to 2010 due to data constraints. The South Korean GDP value added by agriculture was about eleven billion dollars

(USD) by the end of the 1960's and grew slowly with few fluctuations (for a more specific explanation, see Figure C2 in Appendix B). The agriculture GDP in South Korea marked the highest point in 2009 during the period (1966-2010), surpassing 26 billion dollars (USD). The GDP generated by agriculture increased only about 2.2 times over 45 years, but the GDP value added by industry and service et al. grew constantly over 40 years except during the period of economic crisis around 1998. The South Korean GDP by industry ($ 10 billion USD) was smaller than its GDP by agriculture ($ 12 billion USD) in 1970, but was multiplied about 30 times in 40 years passing $ 300 billion dollars (USD) in 2010. The GDP generated by the service sector in South Korea was less than $ 40 billion dollars (USD) in 1970. By growing about 10 times the GDP by service in 1970, the GDP by service reached $ 391 billion dollars (USD) in 2010 (see Figure 17).

South Korean GDP value added by agriculture, industry, and service was rescaled the same way as the Japanese data, divided by one million in order to increase readability of ARIMA regression result. Before estimating the effect of the number of major groups' graduates, the ARIMA models of the GDP by each sector were examined. The model ARIMA(1,0,0) was a fit model for the GDP value added by agriculture from 1966 to 2010: the GDP by agriculture from the previous year explained 86% of that for the following year (R^2=.860). Over the pattern of GDP value added by agriculture, each major group added a statistically significant explanation in the ARIMA regression.

The education major group added a more explanation than other major groups. After the number of graduates from the education major group was included as a parameter into the ARIMA regression, the stationary R^2 changed from .860 to .937, adding a 7.7% of explanation over the pattern of agriculture GDP in South Korea. The number of graduates from humanities major group added a 6.5% explanation over the pattern of South Korean GDP by agriculture; social science major group, 6.1%; and science major group, 5.5% (see Table 22).

Table 22. ARIMA model parameter for agriculture GDP with major groups in South Korea

Modeling of GDP per capita	R2	Parameter for Agriculture GDP	Coefficient	Standard Error
ARIMA (1,0,0), excluding predictors	.860	Agriculture GDP previous year	.979**	.037
		Intercept	18425.117**	6359.232
ARIMA (1,0,0), including humanities major	.925	No. of grad. human. previous yr	.080**	.014
		Agriculture GDP previous year	.797**	.090
		Intercept	13814.885**	1088.607
ARIMA (1,0,0), including social science major	.921	No. of grad. social previous yr	.062**	.012
		Agriculture GDP previous year	.803**	.092
		Intercept	13863.737**	1149.249
ARIMA (1,0,0), including science major	.915	No. of grad. science previous yr	.035**	.007
		Agriculture GDP previous year	.784**	.100
		Intercept	13953.489**	1162.658
ARIMA (1,0,0), including education major	.937	No. of grad. educa. previous yr	.220**	.021
		Agriculture GDP previous year	.620**	.121
		Intercept	12421.576**	703.611

** $p < .01$

For the second sector, the South Korea GDP value added by industry, the model ARIMA (1,0,0) was a fit model: the GDP by industry from the previous year explained 91.9% of that for the following year (R^2=.919). Among all four major groups, three (humanities, social science, and education) major groups added a statistically significant explanation over the pattern of GDP value added by industry in the ARIMA regression. When the social science major was added as a parameter to the ARIMA regression, the stationary R^2 changed from .919 to .992, adding a 7.3%

of explanation over the pattern of South Korean GDP by industry. The number of graduates from humanities added a 7.1% of explanation over the pattern of industry GDP in South Korea; that from education added a 3.5% of explanation over the pattern of South Korean GDP by industry. The science major group added a 3.0% of explanation over the pattern of GDO by industry, but was not significant. However, the effect of the science major group on the South Korean GDP by industry was close to a significant level (*p*=.052) (see Table 23).

Table 23. ARIMA model parameter for industry GDP with major groups in South Korea

Modeling of GDP per capita	R2	Parameter for Industry GDP	Coefficient	Standard Error
ARIMA (1,0,0), excluding predictors	.919	Industry GDP previous year	.998**	.023
		Intercept	159360.763	681619.989
ARIMA (1,0,0), including humanities major	.990	No. of grad. human. previous yr	1.883**	.117
		Industry GDP previous year	.768**	.169
		Intercept	4614.332	8602.321
ARIMA (1,0,0), including social science major	.992	No. of grad. social previous yr	1.505**	.076
		Industry GDP previous year	.775**	.112
		Intercept	4084.296	7829.680
ARIMA (1,0,0), including science major	.949	No. of grad. science previous yr	.266	.133
		Industry GDP previous year	.996**	.032
		Intercept	120114.967	463332.198
ARIMA (1,0,0), including education major	.954	No. of grad. educa. previous yr	1.489*	.610
		Industry GDP previous year	.996**	.028
		Intercept	107136.182	357758.191

** $p < .01$

For the last sector of the South Korean economy under examination in this study, GDP value added by service et al. from 1970 to 2010, the model ARIMA(1,0,0) was also a fit model;

the GDP by service et al. from the previous year explained 93.1% of that for the following year (R^2=.931). Each major group added a statistically significant explanation over the pattern of GDP value added by service et al. in the ARIMA regression. The graduates from humanities (6.4%) and social science (6.5%) showed the similar amount of additional explanation over the pattern of service GDP in the ARIMA regression. The graduates from science (3,1%) and education (3.3%) also added the similar amount of explanation over the pattern of service GDP (see Table 24).

Table 24. ARIMA model parameter for service GDP with major groups in South Korea

Modeling of GDP per capita	R2	Parameter for Service GDP	Coefficient	Standard Error
ARIMA (1,0,0), excluding predictors	.931	Service GDP previous year	.998**	.018
		Intercept	218526.676	807855.200
ARIMA (1,0,0), including humanities major	.995	No. of grad. human. previous yr	2.318**	.111
		Service GDP previous year	.812**	.106
		Intercept	41096.047**	9555.761
ARIMA (1,0,0), including social science major	.996	No. of grad. social previous yr	1.859**	.073
		Service GDP previous year	.773**	.106
		Intercept	39643.159**	7383.800
ARIMA (1,0,0), including science major	.962	No. of grad. science previous yr	.389**	.127
		Service GDP previous year	.997**	.025
		Intercept	162672.197	562374.161
ARIMA (1,0,0), including education major	.964	No. of grad. educa. previous yr	.1.755**	.620
		Service GDP previous year	.997**	.021
		Intercept	152857.63	456206.963

** $p < .01$

The social science major group had the most positive effect on GDP per capita in South Korea, which shows more effect on economic growth in the industry and service sectors than other major groups. The education major showed more effect on the agriculture sector than other majors. The result of South Korean case supports the idea that the social science major has a relationship with service industry in their economy. However, on both overall GDP and GDP sectors, the science group showed the smallest amount of effect among four major groups. This may have been caused by a sudden decrease of the number of science major graduates in the 2000s. Even though the increase of science graduates in the 1980s and 1990s would contribute to South Korean economic growth, its sharp decrease in the 2000s may countervail the effect of science major on overall economic growth. In order to understand the role of the science major in the South Korean economy, it needs to examine the trend of the science major by specific division and institutional levels.

Table 25. Order of effect on economic growth among majors

Japanese economic growth	Order of effect on economic growth			
	1st	2nd	3rd	4th
Overall (GDP per capita)	Science	Humanities	Social sci.	Education
Agriculture sector	Social sci (-)	Humanities (-)	Science (-)	Education (-)
Industry sector	Science	Humanities	Social sci.	Education
Service sector	Science	Humanities	Social sci.	Education

South Korean economic growth	Order of effect on economic growth			
	1st	2nd	3rd	4th
Overall (GDP per capita)	Social sci.	Humanities	Education	Science
Agriculture sector	Education	Humanities	Social sci.	Science
Industry sector	Social sci.	Humanities	Education	Science
Service sector	Social sci.	Humanities	Education	Science

Table 25 summarizes the effect of majors on Japanese and South Korean economic growth by their order. The effect size of majors is based on the amount of R^2 changes when the major are added to the ARIMA regression of GDP. Therefore, if one major has a higher ranking than other majors in a certain GDP sector, the major adds a more explanation over the pattern of the GDP sector. In Japan, the science major group showed the biggest impact on economic growth through contributing to the industry and service sectors. In the agriculture sector of Japanese GDP, all major groups had negative effects; this is because the Japanese GDP by agriculture decreased over the period that this study observed. While the science major had the smallest impact on South Korean economic growth, the social science major demonstrated the most effect on economic growth by contributing to the industry and service sectors.

5.0 DISCUSSION AND CONCLUSION

This study had three principal objectives. The first was to examine the relationship between higher education development and economic growth over the period of industrialization in Japan and South Korea. Second, in order to examine the impact of the higher education on economic growth, this study explored higher education composition in terms of their effects on economic growth. Finally, the study compared Japanese and South Korean cases and lessons from their policies. Based on the findings of the study, this final chapter provides a brief overview, lessons from the findings, and implications for future policies and research.

5.1 OVERVIEW OF THE STUDY

Through reviewing the studies on the contribution of education to economic growth, this study observed the needs of studies having a historical approach. This study intended to deal with specific case studies covering long-term periods in order to inquire into the relationship of higher education development and economic growth over the period of industrialization. Japan and South Korea were chosen as case studies because they purposefully developed higher education on purpose to facilitate their economic growth and they achieved both higher education development and economic growth in the latter half of the 20^{th} century. This study utilized one of time series analysis methods, ARIMA regression analysis in order to examine the relationship between higher education expansion and economic growth in Japan from 1960 to 2008 and in South Korea from 1965 to 2010. The effect of higher education composition (institutional sectors and major groups) on economic growth as well as the overall relationship between higher education and economic growth was explored.

In the findings of this study, both Japanese and South Korean higher education showed significant contributions to their economic growth after accounting for their respective economic and demographical conditions. Over the impact of economic and social circumstances and demographic changes, the higher education in Japan and South Korea exerted its influence on economic growth in the latter half of the 20th century. In other words, one of the most important factors contributing to the economic miracles in Japan and South Korea was the expansion of higher education.

Furthermore, economic growth in Japan and South Korea also facilitated their higher education development. In Japan and South Korea, higher education and economic growth had recurrent relationships over the period of their respective industrializations. Over a period of more than 100 years, Japanese higher education communicated with industries. Therefore, Japanese higher education gradually developed by responding to industrial needs for human resources. This long-term development of Japanese higher education seems to result in the similar effect size of higher education and economic growth on each other. The effect of South Korean economic growth on their higher education was greater than that of higher education on the economy. Because South Korean higher education experienced rapid expansion in a relatively short period, it did not have enough time to interact with industries. It is more likely that economic growth in South Korea led to an expansion in higher education, even through higher education expansion in South Korea contributed to their economic growth as a result.

Increased income as a result of economic growth seemed to help realize South Korean aspirations for higher education.

One of distinguishing characteristics of higher education development in Japan and South Korea is the expansion of the private sector. Therefore, this study examined the contribution of public and private higher education to their economic growth. Among the effects of public and private higher education in Japan and South Korea, only Japanese public higher education showed a significant contribution to their economic growth when public and private sectors were adjusted. This study currently does not have a clear explanation for a reason why the private sector did not have an effect on Japanese and South Korean economic growth when it was adjusted with the public sector.

This study also investigated the relationship between major composition in higher education and economic growth. All major groups positively contributed to economic growth individually. The most effective major group on their economic growth was science in Japan and social science in South Korea. The major group having the least effect on economic growth was education in Japan and science in South Korea. Japanese graduates who majored in natural sciences, engineering, and health were more likely linked with industries and contributed to the growth of their economy. South Korean graduates majoring business, law, public administration, and other social sciences seem to mores directly contribute to the economic growth.

In order to explore specific channels in the relationship between higher education majors and Japanese and South Korean economy, this study examined links between higher education majors and economic growth by GDP sectors (agriculture, industry, and service et al.). In Japan, the social science major group showed the most impact on the decrease of their GDP value added by agriculture, and the science major group contributed the most to the increase of their GDP by industry and service. In South Korea, the education major group contributed to the growth of their agriculture sector in GDP. The social science major group contributed the most to the increase of their industry and service sectors in South Korean GDP. Unexpectedly, the science major group in South Korea had the least effect on all economic sectors including industry sector. The diminished effect of the science major group on economic growth may be attributed to the sudden and sharp decline of number of graduates in the 2000s. The humanities major group did not play a central role in Japanese and South Korean economic growth, but it did show a certain amount of consistent contribution over all sectors of GDP. The effect of humanities major group shows humanities, languages, and arts majors have a path to contribute to the economic growth in their society even though Japanese and South Korea focused on vocational education.

5.2 DISCUSSION

This study found positive and recurrent relationship between higher education and economic growth, and examined specific links among sub-sectors in higher education and economic growth in Japan and South Korea. Based on the results of this study, there are several key points that should be discussed further.

This study intended to investigate the direction of impact between higher education and economic growth. Most precious studies tried to examine the effect of (higher) education on economic growth, and a rather small number of studies attempted to inquire the effect of economic growth on education development. As mentioned in section 2.4, Cheng Hsu's (1997) study examined bidirectional causality between the number of graduates and GDP using Japanese data from 1952 to 1993, finding similar cycling effects between higher education and economic growth in Japanese and South Korean cases with the longer data period. Even though the recurrent relationship between higher education and economic growth was confirmed, this finding does not include any explanation about which one initiated this cycle. Shin (2011) explained higher education development in East Asia using South Korea as a model; he interpreted that economic growth allowed college graduates to have jobs and the South Korean government to invest in higher education. However, as mentioned in the review section (2.5.2), N. Park and Weidman (2000) argued the human resource development of South Korean government lead higher education expansion on a purpose of national economic growth. It seems clear that higher education and economic growth cyclically facilitate each other in East Asian countries, but what initiates this cycle remains unclear.

Additionally, we need to consider other factors affecting education development in East Asian higher education. Some studies have addressed that the widespread Confucianism in Asian society has placed a high value on and desire for higher education, and as a result has facilitated their higher education development (Marlow-Ferguson, 2002b; Peng, 1997; Shin, 2011). The increase of higher education enrollment in East Asia could be explained not only by the need for an educated workforce but also by demands resulting from their educational fervor. In addition, a specific social or political concern at the national level may have a great impact on a country's higher education. For example, the Japanese aspiration for western knowledge in the 19th century encouraged their early development of higher education (Hayami, 1999). In South Korea, the sharp increase of higher education enrollment in the early 1980s could be explained by evolving secondary education policies and changing political situations; in the 1970s, the South Korea government instituted the higher school equalization policy, thereby increasing high school graduates, and it prohibited an increase of higher education enrollment due to students' political activities (Choo, 1990; Shin, 2011). In certain periods or situations, social or political circumstances, rather than economic considerations, may drive higher education development.

By the same token, economic growth cannot be explained by only a single component, such as educational development. In Asian countries, government strategies to restrain wages helped economic growth to a certain extent (Amsden, 1994). Without political stability, countries could not focus on their development and their people could not invest in physical and human capital (Schofer & Meyer, 2005). Higher education would not work by itself but work with other various factors in a society. Therefore, if more economic and social factors surrounding higher education and the economy are included, the relationship between higher education and economic development will be articulated more clearly.

In order to estimate the effect of higher education on economic growth, this study used a time lag between them. A two-year lag was applied between dependent variables and independent variables for an analysis on the recurrent relationship, and the number of graduates by majors was one-year lagged for estimating the effect of major groups on economic growth. If it takes time a certain independent variable to produce any effect on a dependent variable, time lag is applied on the variables based on a research design. For this study, a one- to five-year lag could be chosen and a three- to four-year lag would be ideal to examine the overall effect of higher education expansion on economic growth. However, because of data constraints, this study used a one-year lag to estimate the effect of number of graduates by major from the previous year on sector GDP for the following year. In time series analysis, the time span of variables is critical for robustness. In the future, studies including enough data for a multiple-year lag would provide a deeper understanding of the effect of higher education on economic growth.

One result of this study, the discovery that the science major group showed the most impact on Japan GDP generated by industry and service et al. significantly contrasted with the results of the South Korean data. The science major group had the weakest impact on the industry and service et al. sectors in the South Korean GDP. Currently, this study does not have a clear interpretation of this finding. One hypothesis presumes that South Korean enrollment in the science major group expanded too rapidly in a short period of time, surpassing the needs of the workforce, and so it decreased suddenly in the beginning of the 2000s. This enrollment increase in South Korea was driven by a government plan responding to demands from students as well as needs from industries.

5.3 POLICY AND FUTURE RESEARCH IMPLICATIONS

Based on the results, this study yields valuable implications for policy and future research. These policy implications deal with policies on the macro level and are located at the crossroads of higher education and economic development. Because this study covers the period of development in Japan and South Korea and intends to share their development experiences in higher education, some of lessons could be recommended for developing countries to establish their policies. This study also suggests policy implications with the goal to facilitate the role of higher education in national economic growth in developed countries including Japan and South Korea.

First of all, in order to link higher education and economic growth at the national level, policy makers need to provide a long plan of higher education based on their particular economic situation. An absence of a long plan may cause fluctuations in higher education enrollment and higher cost in higher education financing. Because it needs a great deal of investment at governmental, institutional, and individual levels to set up a certain major group or a certain level of higher education institutions, a long-range blueprint is essential. Changes in higher education composition also need to have soft landing within a long-range plan. Rapid increases or sudden changes in higher education may create mismatches between graduates and the labor market. As discussed earlier, South Korean society faced a social problem with the jobless rate of highly educated young generation. Some claim South Korean higher education developed too rapidly to have a proper allocation to workforce demands (Choo, 1990; J. Kim, 2000).

Second, not only the total amount of higher education but also the composition of higher education is critical for the relationship between higher education and the economy. Major composition in a country needs to fit their economic and social situations. Most especially, the structure of industry should be reflected in the composition of major and level of skills to be educated in higher education. Engineers played a crucial role in the economic development in East Asia, but different levels of knowledge and technologies are required by their sorts of industry (L. Kim, 1997). Japan and South Korea had a number of engineering graduates from 2-year colleges because their heavy and automobile industries required many junior-level engineers in the industrialization period. Japanese higher education developed substantial engineering programs at the level of graduate school because their high-technology industries required a labor force with high degree of technical expertise.

Third, lifelong learning through higher education has more importance in the knowledge-based society than ever. Due to rapid changes, a graduate from a certain major will not be able to work only with what he/she learned at school. In order to support college graduates to prepare for the changes in their jobs, a recurrent system between work and education needs to be established in higher education. In an open system of higher education, college education should focus on building up students' basic capacities—learning ability and attitude—to learn on the job (Lucas, 2002). Japanese higher education retained the same major composition over more than 50 years because higher education took on basic education for the workforce and industries focused on on-the-job training (Arai, 1990).

This study addressed the issue of the relationship between higher education expansion and economic growth and examined it empirically with Japan and South Korean cases. This study, especially, initiated examining the effect of higher education composition on economic growth at the national level. Therefore, more details in higher education composition in terms of affecting economic growth are left for future research.

There are different technological levels in science, engineering, and health, and therefore several levels of institutions—junior, university, graduate etc.—that provide various levels of education in a major field. Because the different levels of industrial technology require the workforce's technological capability at an appropriate level, several levels of higher education institutions provide different workforce. Along with the overall impact of majors that this study discovered, I suggest a further investigation on the effect of the science major in Japan and South Korea by the level of institutions, considering the technological levels of their industries.

Most parts of this study dealt with the higher education and the economy in Japan and South Korea over the period of about a half century. However, the data used in the section of major composition and GDP by sectors (4.3) did not cover the same period of time due to data (GDP by sectors) constraints. Therefore, studies with data spanning longer periods would provide more specific explanations on the relationship between higher education composition and economic sectors. To aid future research, this study provided a crucial step in the exploration of the composition of higher education and its effect on the economy. More empirical cases with substantial data period will be able to deepen our understanding of the relationship between higher education and economic growth.

Finally, this study suggests quality issue and measurement as a factor affecting economic growth as well as higher education composition. Most of studies dealing with the relationship between education and economy have utilized data representing quantitative information. Even though measuring quality in higher education itself is a broad and challenging field, higher education characteristics including quality and quantity will be able to enhance our understanding on education and the economy.

5.4 CONCLUSION

Higher education has more importance in the knowledge based society because the knowledge and human capital generated by higher education are crucial for the economy. This study sketched the relationship between higher education and economic growth and did an empirical research on that relationship in Japan and South Korea. This study intended to answer to the questions that are easily raised by policy makers in developing countries, namely, “Did higher education expansion really contribute to the economic growth in East Asia?” and “How did they reform their higher education in order to achieve economic growth?”

Japan and South Korea, neighboring countries, have similarities and differences in higher education. They were similar in the overall contribution of higher education to their economic growth. However, their major compositions were different and connected to their economies. Even though it is hard to answer in a word to the second question, this study found some clues for it. One of answers to the second question is long-range plan. Japan started promoting their higher education in the 19th century, and this effort eventually bore the fruit of economic prosperity. The South Korean effort for their higher education was condensed in a short period of time. The speed of their rapid expansion in South Korea is related with the current problem of degree inflation.

Japanese and South Korean cases do not provide a magic method for other countries. It is important to understand the characteristics of their higher education and the economies. This study contributed to understanding the relationship between major composition and economic growth in Japan and South Korea. The starting point of the research on linking industry structure and higher education composition is just marked through the Japanese and South Korean cases.

APPENDIX A.

DESCRIPTIVE ANALYSIS

A.1 DESCRIPTIVE ANALYSIS OF VARIABLES

Table A1. Descriptive Analysis of Japanese Variables

Variables	Mean	Std. Deviation	N
GDP per capita (constant LCU)	2856468.81	1078293.83	48
Stock Index	992.10	664.46	37
Proportion of Agriculture in GDP	3.08	1.46	38
Proportion of Industry in GDP	37.40	4.70	38
Proportion of Service in GDP	59.52	6.04	38
Proportion of Manufacture in GDP	24.52	2.80	28
Population(million)	115.71	11.21	48
Total number of graduates	701400.94	321401.08	48
Number of graduates from humanities	96479.33	40784.11	48
Number of graduates from social science	217538.90	99655.03	48
Number of graduates from education	67427.25	28467.16	48
Number of graduates from art & athletics	17098.33	7116.53	48
Number of graduates from science	15648.75	7579.42	48
Number of graduates from engineering	141799.13	68051.27	48
Number of graduates from health	77380.98	54114.71	48
Number of graduates from home	63109.40	25382.85	48
Number of graduates from others	4918.88	7297.00	48
Total enrollment	2629673.21	997398.22	48
Enrollment in public sector	598993.96	195393.69	48
Enrollment in private sector	2030685.06	803379.41	48

Table A2. Descriptive Analysis of South Korean Variables

Variables	Mean	Std. Deviation	N
GDP per capita (constant LCU)	9140560.49	6147160.20	46
Stock Index	663.95	481.60	35
Proportion of Agriculture in GDP	14.54	10.96	46
Proportion of Industry in GDP	35.45	6.28	46
Proportion of Service in GDP	50.01	6.21	46
Proportion of Manufacture in GDP	24.85	4.37	46
Population (million)	40.08	6.16	44
Total number of graduates	288288.00	231852.74	46
Number of graduates from public sector	63014.41	47362.12	46
Number of graduates from private sector	225273.59	184535.63	46
Number of graduates from humanities	30103.98	24054.50	46
Number of graduates from arts & athletics	27185.37	26241.94	46
Number of graduates from social science	71568.07	62051.79	46
Number of graduates from science	29334.63	25032.81	46
Number of graduates from engineering	81500.91	61341.31	46
Number of graduates from health	20506.63	15730.58	46
Number of graduates from education	28040.72	17866.73	46
Total enrollment	1670528.02	1339104.86	46
Enrollment in national institutions	433534.13	349643.21	46
Enrollment in public institutions	18402.46	19322.03	46
Enrollment in private institutions	1218591.43	978636.10	46

A.2 CORRELATION TABLES OF VARIABLES

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table A3. Correlation Table of Japanese Variables (1/3)

Correlation Japanese Data		GDP per capita	stock index	% of agriculture	% of industry	% of service et at.	population	total graduates
GDP per capita	R	1	.788**	-.970**	-.926**	.956**	.980**	.980**
	p		.000	.000	.000	.000	.000	.000
	N	48	37	38	38	38	48	48
stock index	R	.788**	1	-.748**	-.486**	.564**	.760**	.736**
	p	.000		.000	.003	.000	.000	.000
	N	37	37	35	35	35	37	37
% of agriculture in GDP	R	-.970**	-.748**	1	.891**	-.935**	-.983**	-.968**
	p	.000	.000		.000	.000	.000	.000
	N	38	35	38	38	38	38	38
% of industry in GDP	R	-.926**	-.486**	.891**	1	-.994**	-.903**	-.882**
	p	.000	.003	.000		.000	.000	.000
	N	38	35	38	38	38	38	38
% of Service et al. in GDP	R	.956**	.564**	-.935**	-.994**	1	.941**	.921**
	p	.000	.000	.000	.000		.000	.000
	N	38	35	38	38	38	38	38
population	R	.980**	.760**	-.983**	-.903**	.941**	1	.983**
	p	.000	.000	.000	.000	.000		.000
	N	48	37	38	38	38	48	48
Total graduates	R	.980**	.736**	-.968**	-.882**	.921**	.983**	1
	p	.000	.000	.000	.000	.000	.000	
	N	48	37	38	38	38	48	48
graduates from humanities	R	.937**	.736**	-.864**	-.735**	.781**	.947**	.976**
	p	.000	.000	.000	.000	.000	.000	.000
	N	48	37	38	38	38	48	48
graduates from social science	R	.983**	.715**	-.956**	-.892**	.926**	.967**	.994**
	p	.000	.000	.000	.000	.000	.000	.000
	N	48	37	38	38	38	48	48
graduates from education	R	.939**	.630**	-.911**	-.841**	.875**	.980**	.969**
	p	.000	.000	.000	.000	.000	.000	.000
	N	48	37	38	38	38	48	48
graduates from art and athletics	R	.946**	.677**	-.924**	-.844**	.881**	.983**	.973**
	p	.000	.000	.000	.000	.000	.000	.000
	N	48	37	38	38	38	48	48
graduates from science	R	.969**	.582**	-.902**	-.982**	.982**	.935**	.946**
	p	.000	.000	.000	.000	.000	.000	.000
	N	48	37	38	38	38	48	48
graduates from engineering	R	.977**	.772**	-.951**	-.844**	.887**	.970**	.994**
	p	.000	.000	.000	.000	.000	.000	.000
	N	48	37	38	38	38	48	48
graduates from health	R	.963**	.706**	-.976**	-.944**	.971**	.944**	.959**
	p	.000	.000	.000	.000	.000	.000	.000
	N	48	37	38	38	38	48	48
graduates from home	R	.563**	.388*	-.076	.171	-.115	.682**	.659**
	p	.000	.018	.652	.304	.493	.000	.000
	N	48	37	38	38	38	48	48
graduates from others	R	.723**	.318	-.680**	-.872**	.843**	.626**	.636**
	p	.000	.055	.000	.000	.000	.000	.000
	N	48	37	38	38	38	48	48
total enrollment	R	.990**	.733**	-.961**	-.916**	.946**	.986**	.994**
	p	.000	.000	.000	.000	.000	.000	.000
	N	48	37	38	38	38	48	48
enrollment in public sector	R	.994**	.732**	-.975**	-.943**	.970**	.982**	.989**
	p	.000	.000	.000	.000	.000	.000	.000
	N	48	37	38	38	38	48	48
enrollment in private sector	R	.987**	.731**	-.954**	-.906**	.936**	.985**	.994**
	p	.000	.000	.000	.000	.000	.000	.000
	N	48	37	38	38	38	48	48

Table A4. Correlation Table of Japanese Variables (2/3)

Correlation Japanese Data		graduates, humanities	graduates, social sc.	graduates, education	graduates, art &ath.	graduates, science	graduates, engineering	graduates, health
GDP per capita	R	.937**	.983**	.939**	.946**	.969**	.977**	.963**
	P	.000	.000	.000	.000	.000	.000	.000
	N	48	48	48	48	48	48	48
stock index	R	.736**	.715**	.630**	.677**	.582**	.772**	.706**
	p	.000	.000	.000	.000	.000	.000	.000
	N	37	37	37	37	37	37	37
% of agriculture in GDP	R	-.864**	-.956**	-.911**	-.924**	-.902**	-.951**	-.976**
	p	.000	.000	.000	.000	.000	.000	.000
	N	38	38	38	38	38	38	38
% of industry in GDP	R	-.735**	-.892**	-.841**	-.844**	-.982**	-.844**	-.944**
	p	.000	.000	.000	.000	.000	.000	.000
	N	38	38	38	38	38	38	38
% of Service et al. in GDP	R	.781**	.926**	.875**	.881**	.982**	.887**	.971**
	p	.000	.000	.000	.000	.000	.000	.000
	N	38	38	38	38	38	38	38
population	R	.947**	.967**	.980**	.983**	.935**	.970**	.944**
	p	.000	.000	.000	.000	.000	.000	.000
	N	48	48	48	48	48	48	48
Total graduates	R	.976**	.994**	.969**	.973**	.946**	.994**	.959**
	p	.000	.000	.000	.000	.000	.000	.000
	N	48	48	48	48	48	48	48
graduates from humanities	R	1	.970**	.933**	.963**	.891**	.980**	.888**
	p		.000	.000	.000	.000	.000	.000
	N	48	48	48	48	48	48	48
graduates from social science	R	.970**	1	.941**	.951**	.958**	.994**	.958**
	p	.000		.000	.000	.000	.000	.000
	N	48	48	48	48	48	48	48
graduates from education	R	.933**	.941**	1	.986**	.897**	.941**	.921**
	p	.000	.000		.000	.000	.000	.000
	N	48	48	48	48	48	48	48
graduates from art and athletics	R	.963**	.951**	.986**	1	.904**	.955**	.899**
	p	.000	.000	.000		.000	.000	.000
	N	48	48	48	48	48	48	48
graduates from science	R	.891**	.958**	.897**	.904**	1	.937**	.962**
	p	.000	.000	.000	.000		.000	.000
	N	48	48	48	48	48	48	48
graduates from engineering	R	.980**	.994**	.941**	.955**	.937**	1	.945**
	p	.000	.000	.000	.000	.000		.000
	N	48	48	48	48	48	48	48
graduates from health	R	.888**	.958**	.921**	.899**	.962**	.945**	1
	p	.000	.000	.000	.000	.000	.000	
	N	48	48	48	48	48	48	48
graduates from home	R	.697**	.588**	.759**	.747**	.428**	.628**	.495**
	p	.000	.000	.000	.000	.002	.000	.000
	N	48	48	48	48	48	48	48
graduates from others	R	.502**	.677**	.573**	.542**	.819**	.616**	.777**
	p	.000	.000	.000	.000	.000	.000	.000
	N	48	48	48	48	48	48	48
total enrollment	R	.967**	.991**	.961**	.970**	.958**	.989**	.950**
	p	.000	.000	.000	.000	.000	.000	.000
	N	48	48	48	48	48	48	48
enrollment in public sector	R	.952**	.989**	.948**	.956**	.976**	.984**	.969**
	p	.000	.000	.000	.000	.000	.000	.000
	N	48	48	48	48	48	48	48
enrollment in private sector	R	.969**	.990**	.963**	.972**	.951**	.989**	.943**
	p	.000	.000	.000	.000	.000	.000	.000
	N	48	48	48	48	48	48	48

Table A5. Correlation Table of Japanese Variables (3/3)

Correlation Japanese Data		graduates, home	graduates, others	total enrollment	enrollment, public	enrollment, private
GDP per capita	R	.563**	.723**	.990**	.994**	.987**
	p	.000	.000	.000	.000	.000
	N	48	48	48	48	48
stock index	R	.388*	.318	.733**	.732**	.731**
	p	.018	.055	.000	.000	.000
	N	37	37	37	37	37
% of agriculture in GDP	R	-.076	-.680**	-.961**	-.975**	-.954**
	p	.652	.000	.000	.000	.000
	N	38	38	38	38	38
% of industry in GDP	R	.171	-.872**	-.916**	-.943**	-.906**
	p	.304	.000	.000	.000	.000
	N	38	38	38	38	38
% of Service et al. in GDP	R	-.115	.843**	.946**	.970**	.936**
	p	.493	.000	.000	.000	.000
	N	38	38	38	38	38
population	R	.682**	.626**	.986**	.982**	.985**
	p	.000	.000	.000	.000	.000
	N	48	48	48	48	48
Total graduates	R	.659**	.636**	.994**	.989**	.994**
	p	.000	.000	.000	.000	.000
	N	48	48	48	48	48
graduates from humanities	R	.697**	.502**	.967**	.952**	.969**
	p	.000	.000	.000	.000	.000
	N	48	48	48	48	48
graduates from social science	R	.588**	.677**	.991**	.989**	.990**
	p	.000	.000	.000	.000	.000
	N	48	48	48	48	48
graduates from education	R	.759**	.573**	.961**	.948**	.963**
	p	.000	.000	.000	.000	.000
	N	48	48	48	48	48
graduates from art and athletics	R	.747**	.542**	.970**	.956**	.972**
	p	.000	.000	.000	.000	.000
	N	48	48	48	48	48
graduates from science	R	.428**	.819**	.958**	.976**	.951**
	p	.002	.000	.000	.000	.000
	N	48	48	48	48	48
graduates from engineering	R	.628**	.616**	.989**	.984**	.989**
	p	.000	.000	.000	.000	.000
	N	48	48	48	48	48
graduates from health	R	.495**	.777**	.950**	.969**	.943**
	p	.000	.000	.000	.000	.000
	N	48	48	48	48	48
graduates from home	R	1	-.049	.638**	.577**	.652**
	p		.741	.000	.000	.000
	N	48	48	48	48	48
graduates from others	R	-.049	1	.662**	.709**	.649**
	p	.741		.000	.000	.000
	N	48	48	48	48	48
total enrollment	R	.638**	.662**	1	.994**	1.000**
	p	.000	.000		.000	.000
	N	48	48	48	48	48
enrollment in public sector	R	.577**	.709**	.994**	1	.991**
	p	.000	.000	.000		.000
	N	48	48	48	48	48
enrollment in private sector	R	.652**	.649**	1.000**	.991**	1
	p	.000	.000	.000	.000	
	N	48	48	48	48	48

Table A6. Correlation Table of South Korean Variables (1/3)

Correlation South Korean Data		GDP per capita	stock index	% of agriculture	% of industry	% of service et al.	population	total graduates
GDP per capita (constant LCU)	r	1	.894**	-.884**	.584**	.971**	.928**	.985**
	p		.000	.000	.000	.000	.000	.000
	N	46	35	46	46	46	44	46
stock index	r	.894**	1	-.788**	.202	.800**	.832**	.823**
	p	.000		.000	.244	.000	.000	.000
	N	35	35	35	35	35	33	35
% of agriculture in GDP	r	-.884**	-.788**	1	-.879**	-.877**	-.990**	-.896**
	p	.000	.000		.000	.000	.000	.000
	N	46	35	46	46	46	44	46
% of industry in GDP	r	.584**	.202	-.879**	1	.542**	.845**	.598**
	p	.000	.244	.000		.000	.000	.000
	N	46	35	46	46	46	44	46
% of service et al. in GDP	r	.971**	.800**	-.877**	.542**	1	.899**	.978**
	p	.000	.000	.000	.000		.000	.000
	N	46	35	46	46	46	44	46
population (million)	r	.928**	.832**	-.990**	.845**	.899**	1	.928**
	p	.000	.000	.000	.000	.000		.000
	N	44	33	44	44	44	44	44
total graduates	r	.985**	.823**	-.896**	.598**	.978**	.928**	1
	p	.000	.000	.000	.000	.000	.000	
	N	46	35	46	46	46	44	46
graduates from public sector	r	.986**	.823**	-.900**	.605**	.977**	.932**	.999**
	p	.000	.000	.000	.000	.000	.000	.000
	N	46	35	46	46	46	44	46
graduates from private sector	r	.985**	.823**	-.895**	.596**	.977**	.926**	1.000**
	p	.000	.000	.000	.000	.000	.000	.000
	N	46	35	46	46	46	44	46
graduates from humanities	r	.980**	.855**	-.894**	.611**	.961**	.925**	.993**
	p	.000	.000	.000	.000	.000	.000	.000
	N	46	35	46	46	46	44	46
graduates from arts & athletics	r	.987**	.850**	-.832**	.491**	.973**	.874**	.981**
	p	.000	.000	.000	.001	.000	.000	.000
	N	46	35	46	46	46	44	46
graduates from social science	r	.992**	.869**	-.862**	.544**	.972**	.905**	.992**
	p	.000	.000	.000	.000	.000	.000	.000
	N	46	35	46	46	46	44	46
graduates from science	r	.979**	.805**	-.890**	.592**	.972**	.920**	.995**
	p	.000	.000	.000	.000	.000	.000	.000
	N	46	35	46	46	46	44	46
graduates from engineering	r	.943**	.739**	-.932**	.695**	.944**	.952**	.978**
	p	.000	.000	.000	.000	.000	.000	.000
	N	46	35	46	46	46	44	46
graduates from health	r	.986**	.876**	-.891**	.600**	.967**	.929**	.990**
	p	.000	.000	.000	.000	.000	.000	.000
	N	46	35	46	46	46	44	46
graduates from education	r	.955**	.856**	-.920**	.678**	.938**	.945**	.964**
	p	.000	.000	.000	.000	.000	.000	.000
	N	46	35	46	46	46	44	46
total enrollment	r	.980**	.789**	-.905**	.614**	.977**	.933**	.996**
	p	.000	.000	.000	.000	.000	.000	.000
	N	46	35	46	46	46	44	46

Table A7. Correlation Table of South Korean Variables (2/3)

Correlation South Korean Data		graduates, public	graduates, private	graduates, humanities	graduates, arts & athletics	graduates, social science
GDP per capita (constant LCU)	r	.986**	.985**	.980**	.987**	.992**
	p	.000	.000	.000	.000	.000
	N	46	46	46	46	46
stock index	r	.823**	.823**	.855**	.850**	.869**
	p	.000	.000	.000	.000	.000
	N	35	35	35	35	35
% of agriculture in GDP	r	-.900**	-.895**	-.894**	-.832**	-.862**
	p	.000	.000	.000	.000	.000
	N	46	46	46	46	46
% of industry in GDP	r	.605**	.596**	.611**	.491**	.544**
	p	.000	.000	.000	.001	.000
	N	46	46	46	46	46
% of service et al. in GDP	r	.977**	.977**	.961**	.973**	.972**
	p	.000	.000	.000	.000	.000
	N	46	46	46	46	46
population (million)	r	.932**	.926**	.925**	.874**	.905**
	p	.000	.000	.000	.000	.000
	N	44	44	44	44	44
total graduates	r	.999**	1.000**	.993**	.981**	.992**
	p	.000	.000	.000	.000	.000
	N	46	46	46	46	46
graduates from public sector	r	1	.999**	.993**	.980**	.991**
	p		.000	.000	.000	.000
	N	46	46	46	46	46
graduates from private sector	r	.999**	1	.993**	.981**	.992**
	p	.000		.000	.000	.000
	N	46	46	46	46	46
graduates from humanities	r	.993**	.993**	1	.971**	.988**
	p	.000	.000		.000	.000
	N	46	46	46	46	46
graduates from arts & athletics	r	.980**	.981**	.971**	1	.988**
	p	.000	.000	.000		.000
	N	46	46	46	46	46
graduates from social science	r	.991**	.992**	.988**	.988**	1
	p	.000	.000	.000	.000	
	N	46	46	46	46	46
graduates from science	r	.994**	.995**	.990**	.971**	.984**
	p	.000	.000	.000	.000	.000
	N	46	46	46	46	46
graduates from engineering	r	.977**	.978**	.971**	.927**	.948**
	p	.000	.000	.000	.000	.000
	N	46	46	46	46	46
graduates from health	r	.989**	.990**	.988**	.981**	.993**
	p	.000	.000	.000	.000	.000
	N	46	46	46	46	46
graduates from education	r	.965**	.964**	.968**	.943**	.958**
	p	.000	.000	.000	.000	.000
	N	46	46	46	46	46
total enrollment	r	.995**	.995**	.982**	.971**	.984**
	p	.000	.000	.000	.000	.000
	N	46	46	46	46	46

Table A8. Correlation Table of South Korean Variables (3/3)

Correlation South Korean Data		graduates, science	graduates, engineering	graduates, health	graduates, education	total enrollment
GDP per capita (constant LCU)	r	.979**	.943**	.986**	.955**	.980**
	p	.000	.000	.000	.000	.000
	N	46	46	46	46	46
stock index	r	.805**	.739**	.876**	.856**	.789**
	p	.000	.000	.000	.000	.000
	N	35	35	35	35	35
% of agriculture in GDP	r	-.890**	-.932**	-.891**	-.920**	-.905**
	p	.000	.000	.000	.000	.000
	N	46	46	46	46	46
% of industry in GDP	r	.592**	.695**	.600**	.678**	.614**
	p	.000	.000	.000	.000	.000
	N	46	46	46	46	46
% of service et al. in GDP	r	.972**	.944**	.967**	.938**	.977**
	p	.000	.000	.000	.000	.000
	N	46	46	46	46	46
population (million)	r	.920**	.952**	.929**	.945**	.933**
	p	.000	.000	.000	.000	.000
	N	44	44	44	44	44
total graduates	r	.995**	.978**	.990**	.964**	.996**
	p	.000	.000	.000	.000	.000
	N	46	46	46	46	46
graduates from public sector	r	.994**	.977**	.989**	.965**	.995**
	p	.000	.000	.000	.000	.000
	N	46	46	46	46	46
graduates from private sector	r	.995**	.978**	.990**	.964**	.995**
	p	.000	.000	.000	.000	.000
	N	46	46	46	46	46
graduates from humanities	r	.990**	.971**	.988**	.968**	.982**
	p	.000	.000	.000	.000	.000
	N	46	46	46	46	46
graduates from arts & athletics	r	.971**	.927**	.981**	.943**	.971**
	p	.000	.000	.000	.000	.000
	N	46	46	46	46	46
graduates from social science	r	.984**	.948**	.993**	.958**	.984**
	p	.000	.000	.000	.000	.000
	N	46	46	46	46	46
graduates from science	r	1	.981**	.975**	.939**	.993**
	p		.000	.000	.000	.000
	N	46	46	46	46	46
graduates from engineering	r	.981**	1	.954**	.938**	.980**
	p	.000		.000	.000	.000
	N	46	46	46	46	46
graduates from health	r	.975**	.954**	1	.980**	.980**
	p	.000	.000		.000	.000
	N	46	46	46	46	46
graduates from education	r	.939**	.938**	.980**	1	.949**
	p	.000	.000	.000		.000
	N	46	46	46	46	46
total enrollment	r	.993**	.980**	.980**	.949**	1
	p	.000	.000	.000	.000	
		46	46	46	46	46

APPENDIX B.

ARIMA REGRESSION ANALYSIS

Figure B1. ARIMA (1,0,0) model of Japanese GDP per capita (1960-2008)

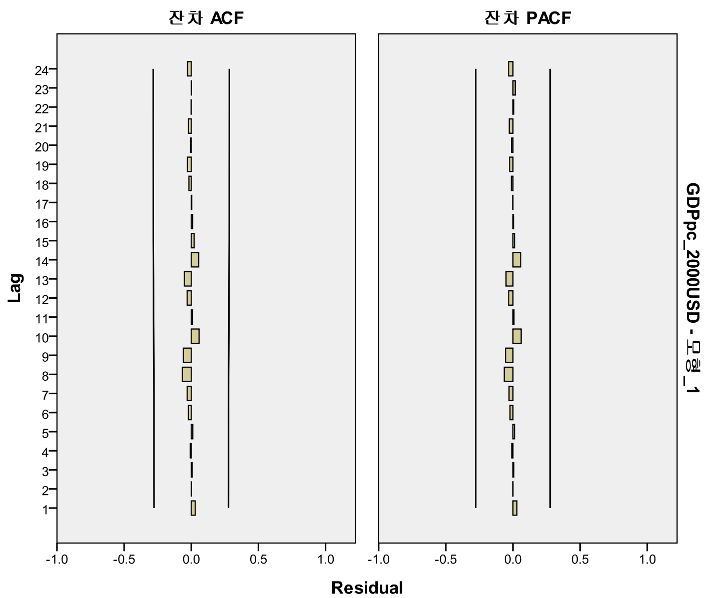


Figure B2. ARIMA (1,0,0) model of South Korean GDP per capita (1965-2011)

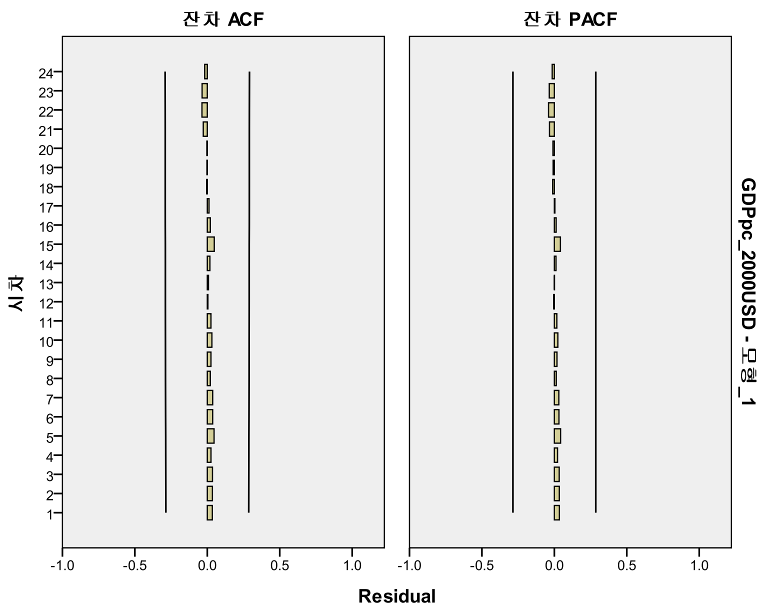


Figure B3. ARIMA (1,0,0) model of Japanese number of graduates (1962-2006)

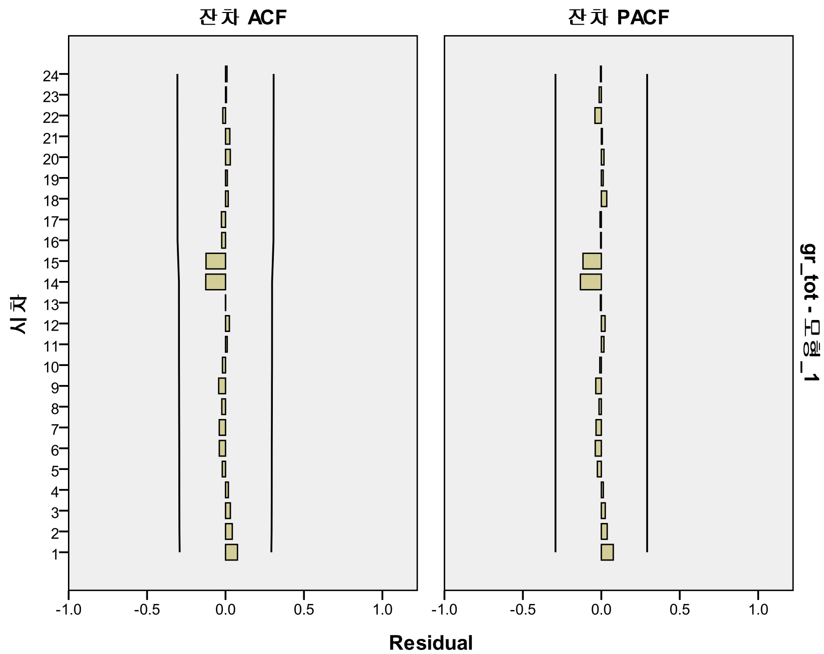
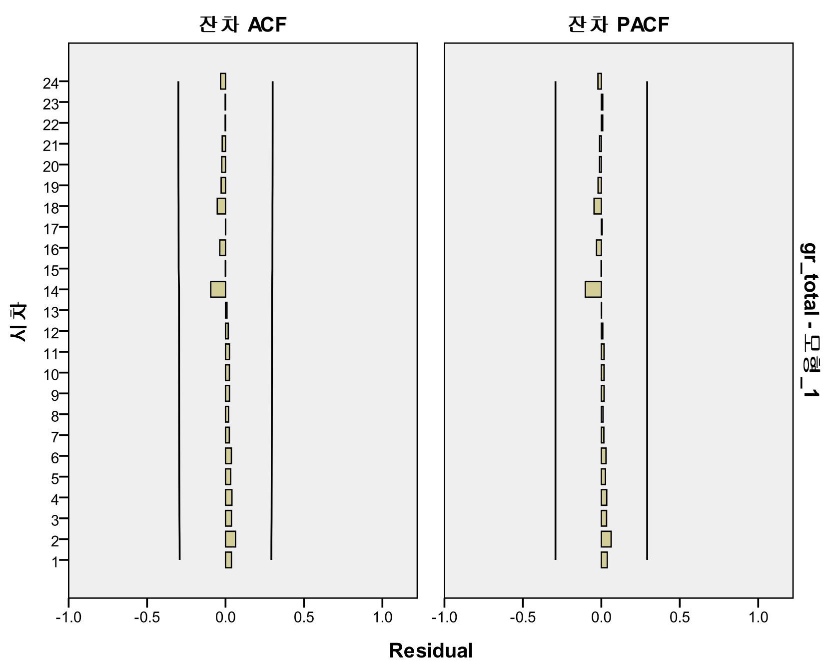


Figure B4. ARIMA (1,0,0) model of South Korean number of graduates (1967-2011)



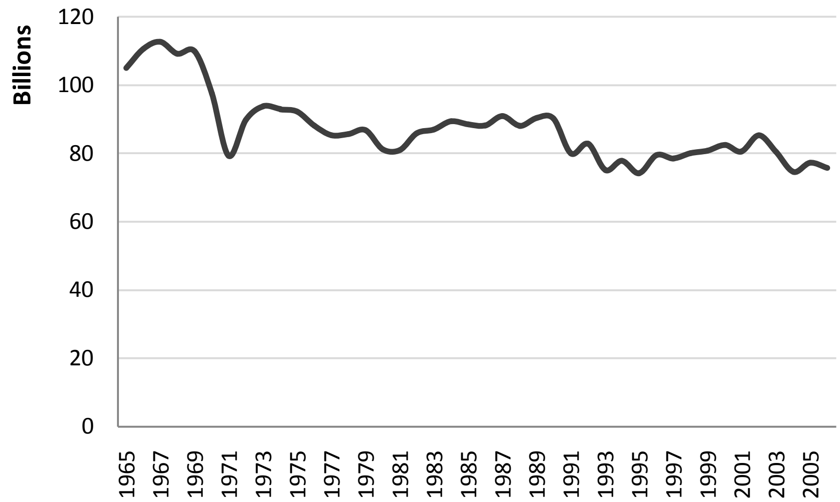


Figure C1. Japanese GDP value added by agriculture

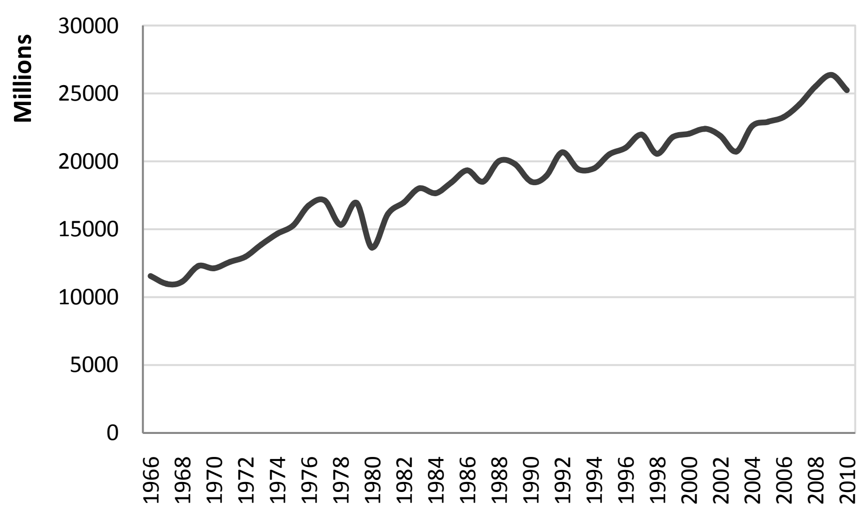


Figure C2. South Korean GDP value added by agriculture

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