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Demographic Changes and Economic Growth in Korea

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Abstract

By using the fully modified ordinary least squares (FMOLS) method and annual data for the period 1970-2003 for Korea, we can find that there exists the demographic dividend of economic growth in Korea. This result implies that the miraculous economic performance of the Korea during the period 1970-2003 can be explained by the influence of demographic changes as well as trade and industrial policies, technological progress, saving and capital accumulation, governance, education, geography and culture etc. However, advantage of the age structure will disappear in the near future. Due to the slowdown of the decreasing young age dependency ratio and rapid increase of the old age dependency ratio, the dependency ratio decrease with increasing rate and is expected to increase after mid 2010s. This may lead the slowdown in the growth rates of the economy. To reverse this trend, an increase in productivity is required but with an aging population this might need particular and persistent effort.

Key Words: Demographic Change, Age Structure, Demographic Dividend, Fully Modified Least Squares

JEL classification: J11, O40, O50

I. Introduction

Since 1970, Korea is one of the most rapidly developing countries in the world. GDP per capita increased from 85,727 Korea Won in 1970 to 14,370,715 Korea Won in 2003 (an average 16.79% a year). This miraculous economic performance was explained by trade and industrial policies, technological progress, saving and capital accumulation, governance, education, geography and culture etc. However, even if the demographic changes are thought to have a powerful impact on the rate of economic growth, there exist few attempts to explain the economic growth of Korea by demographic changes. In this paper, thus we pay attention to the influence of demographic changes on economic growth.

Generally, we can divide the demographic transition into three stages: high fertility/high mortality, high fertility/low mortality, and low fertility/low mortality.[1] And An and Jeon(2006) have empirically found that this kind of demographic transition may affect economic growth with an inverted U-shaped relationship; so called the demographic U-hypothesis. In the first and second stages of the demographic transition, the labor supply and saving rate continuously increase, thus the demographic effect on economic growth may appear to be positive; so called "demographic dividend" of economic growth. But in the third stage, a large population mass keeps moving upward to the older generation as the labor supply and saving rate decrease.

During the last 30 years, Korea's demographic status is in the first and second stages. This implies that remarkable economic performance of Korea may explained by demographic dividend of economic growth in Korea. In recent years, however, Korea has experienced the most rapidly aging in the world. It is predicted to take only 19 years that the ratio of the population aged 65 and over rises from 7% (in 2000) to 14% (in 2019), i.e. Korea's age structure changes from the second stages to the third stages. Such a drastic demographic change is thought to have a powerful impact on the Korean economy and demographic dividend may disappear and saving rate and growth rate may be decreased. So, we attempt to investigate whether there exit a demographic dividend in Korea or not. And we discuss how changes of age structure affect the economic performance in the future

The remainder of this paper is organized as follows. In chapter II, we analyze the changes of the age structure and economic performance in Korea. In chapter III, we investigate whether the economic performance in Korea can be explained by the changes of

[1] See Lee (2003). "The classic demographic transition starts with a mortality decline, followed after a time by reduced fertility, leading to an internal of first increased and then decreased population growth and, finally, population aging."

age structure or not; that is whether there exit a demographic dividend in Korea or not. Well-defined index that represents the overall shape of the age structure used in our analysis and econometric method are also explained in chapter III. In chapter IV, by using the results of the population projection and the estimation results in chapter III, we discuss how demographic change will affects economic growth in the future. Finally, we conclude in chapter V.

II. Age structure and Economic Growth in Korea

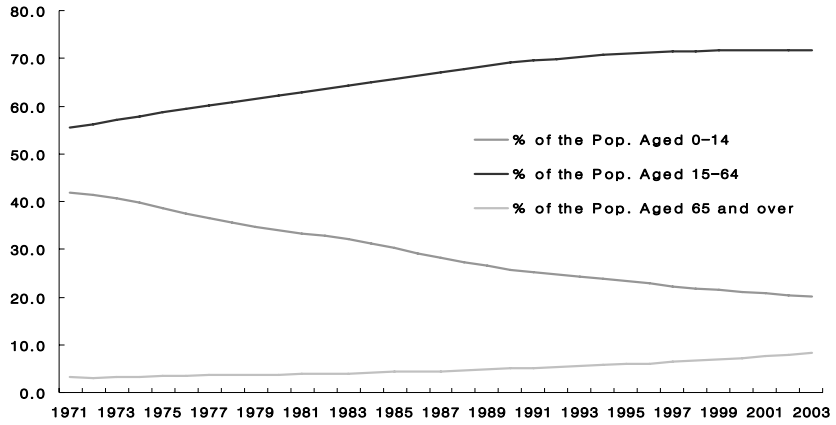
1. Age Structure in Korea

Here, we attempt a data analysis exploring the age structure in Korea. At first we present how the population is distributed across different age groups and the change of the share of the each age group during the period 1970~2003. Second, we present how economic burden of the working-age person, which is calculated by the ratio of the dependent to non-dependent, has been changed.

Figure 1 shows the share of the young (population aged 14 and less), working age group (aged 15~64), and the old (65 years old and above) in the total population. Since 1970, the share of the young have changed considerably; from 42.5% in 1970 to 20.0% in 2003. This is because of the decline of the fertility rate. Fertility rate in Korea have declined from 4.53 in 1970 to 1.19 in 2003. The share of the working age group has increased from 54.4% in 1970 to 71.7 in 2003. This is because the baby boom generation started work in the mid 1970s[2]. Recently, due to the decline of the fertility rate, share of the working age group increase with decreasing rate. The most noteworthy recent changes in the age structure in Korea is the increasing the share of the old. The share of the old was 3.1% in 1970. However, due to the dramatic increasing of the life expectancy- from 62 in 1970 to 77 in 2003- along with the decreasing of the fertility rate, the share of the old has increased. In 2000, the share of the old was over 7% and Korea became the aging society. The share of the old is 8.3% in 2003.

[2] In Korea, baby boom generation was born during the period 1954~1960.

Figure 1 Changes of the Age Structure in Korea

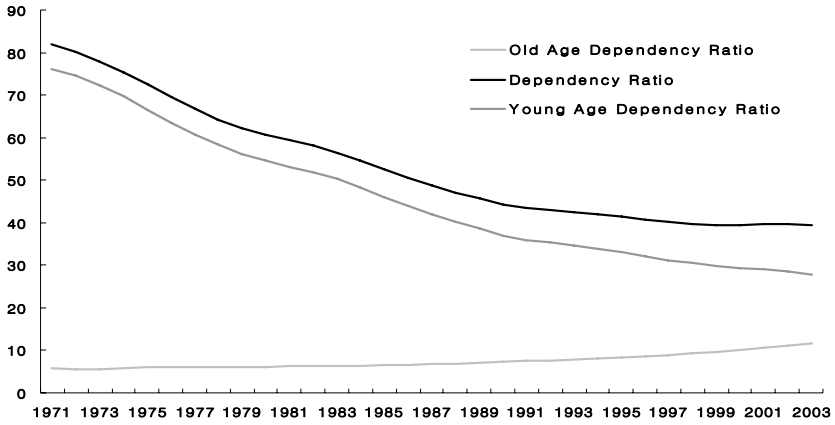


Among the age groups, working age group bears the responsibility for supporting the dependents. Thus, Increasing (or decreasing) of the dependent may increases (or decrease) the economic burden of the working age group, i.e. changes of the age structure change the economic burden of the working age group.

Figure 2 shows the changes of the working-age person's economic burden in Korea during the period 1970~2003. Young age dependency ratio which is the ratio of the aged 14 and less to aged 15~64 has drastically decreased from 78.2 in 1970 to 27.9 in 2003 due to the decreasing of the share of the young along with the increasing of the share of the working age group. Although the share of the working age group has increased, the old age dependency ratio which is the ratio of the population aged 65 and over to the population aged 15~64 has gradually increased from 5.7 in 1970 to 11.6 to 2003. This is because the share of the old has increased more rapidly than the share of the working age group. The dependency ratio (or the age dependency ratio) is the sum of the young age dependency ratio and the old age dependency ratio. The dependency ratio has decreased from 83.8 in 1970 to 39.5 in 2003.

According to the dependency-rate hypothesis proposed by Leff (1969), as the dependency rate increases, the working generation has a heavier family consumption burden, which then decreases the family saving rates and physical capital accumulation. Thus, decreasing the dependency ratio during the period 1970-2003 may produce the demographic dividend of economic growth in Korea.

Figure 2 Changes of the Dependency ratio

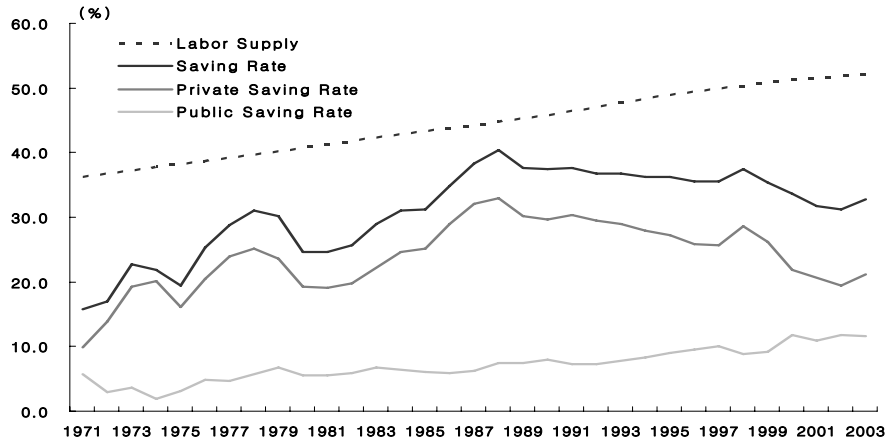


2. Economic Growth in Korea

Figure 3 shows the changes of the labor supply and saving rate during the period 1970-2003. Due to the increase of the working age group, the labor supply increased considerably: form 35.7% in 1970 to 52.1% in 2003.

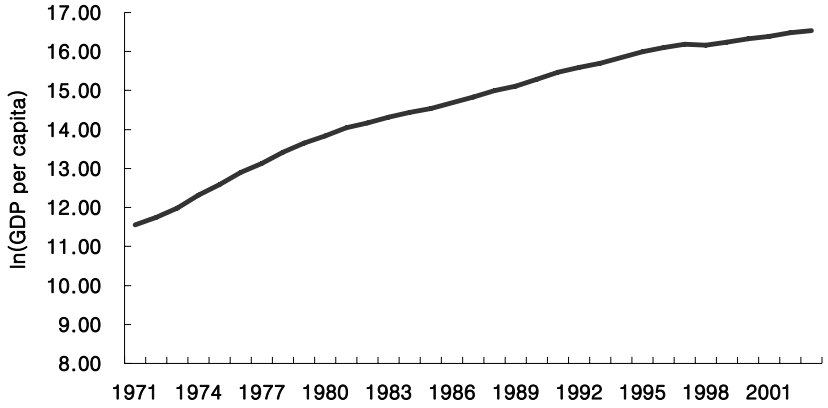
Saving rate has increased with decreasing rate and has decreased since 1988. Decline of the saving rate is due to the decrease of the private saving rate. Until 1988, private saving has increased; from 10.9% in 1970 to 33.0% in 1988. Since 1988, however, private saving has decreased: from 33% to 21.1% in 2003. During the period 1970-2003, public saving has increased gradually: from 6.8% to 11.6%.

Figure 3 Changes of the labor supply and saving rate in Korea



Since 1970, Korea is one of the most rapidly developing countries in the world. GDP per capita increased from 85,727 Korea Won in 1970 to 14,370,715 Korea Won in 2003 (an average 16.79% a year).

Figure 4 Changes of the log(GDP per capita)



III. Empirical Evidence of the Effect of the Demographic Changes in Korea

1. Methodological Issues and Data

1.1. Index that Represents the Overall Shape of the Age Structure

To explore the effect of the demographic change on economic performance, we must use the well-defined index represented the overall shape of the age structure. In recent years, many researchers use the fertility rate birth rate, death rate, and life expectancy as indices that represent the age structure. But those variables cannot reflect overall shape of demographic change, since age structure has been changed due to the combined effect of the fertility rate and life expectancy (or birth rate and death rate.) For example, although the fertility rate is high, we can divide the demographic transition into 2 stages as mortality rate changes from high levels to low levels.

In recent days, many researchers used the old age dependency ratio. However, old age dependency ratio represents only one side of the age structure. For example, although old age dependency ratio increases, economic burden of the working age group may decrease due to

the decreasing of the young age dependency ratio. I.e. old age dependency ratio shows the changes of share of the old, but it does not show the changes of the share of the young.

In this paper, therefore, we use dependency ratio as an index that represents the overall shape of the age structure. Dependency ratio shows both the changes of the share of the old and the changes of the share of the young.

1.2. Estimation Method and Model

In the empirical analysis we test for the effect of the aging structure on the economic performance in Korea by using the method of FMOLS. FMOLS was originally designed in work by Phillips and Hansen(1990) to provide optimal estimates of cointegrating regressions. This method modifies least squares to account for serial correlation effects and for the endogeneity in the regressors that result from the existence of a cointegraing relationship[3]

To apply the FMOLS for estimating long-run parameters, the condition that there exists a cointegrating relation between a set of I(1) variables is satisfied. Therefore we have to verify the presence of the unit root and test the cointegrating relation. Standard tests of the presence of the unit root based on the work of dickey and Fuller(1979, 1981), Phillips and Perron(1988), Kwiatkowski, Phillips, Schmidt, and Shin(1992) are used to investigate the degree of integration of the variables. The combined of the three tests employed to investigate the degree of integration of the series may result to four possible outcomes. First, rejection by the ADF and PP statistics and non-rejection by the KPSS test gives strong evidence of stationarity, I(0). Second, non-rejection by both ADF and PP and rejection by the KPSS is a strong evidence of non-stationarity, I(1). Third, non-rejection by all tests suggests that the data is non sufficiently informative on the long-run characteristics of the series. Fourth, rejection by all tests indicates that the series is neither an I(1) nor an I(0) process. To test cointegrating relation, we use the Johansen maximum likelihood approach (Johansen 1988; Johansen & Juselius 1990, 1992). The Johansen-Juselius estimation method is based on the error-correction representation of the VAR model with Gaussian errors.

1.3. Data

The empirical analysis has been carried out using annual data for the period 1970 to 2003 for Korea. Saving rate is total saving per GDP, the dependency ratio is the number of the young and the old to the number of the working aged group. The Variable that represents

[3] See Phillips and Hansen(1990), Hansen(1995) for detail.

the economic performance is the real per capita GDP. The variable saving rate and real per capita GDP are obtained from the *National Account* issued by the Bank of Korea and the data of dependency ratio is obtained from *Population Projections* published by Korea National Statistical Office. Real per capita GDP is expressed in logarithmic form.

2. Empirical Results

2.1. Unit root tests

Table 1 presents the ADF, PP, and KPSS tests for the four variables, log(GDP per capita), Saving Rate, Dependency Ratio in levels. The ADF statistic suggests that all variables are integrated of order one, I(1). Therefore, the hypothesis that the time series contains an autoregressive unit root is accepted in all cases. The PP test gives the same results. Finally, the KPSS statistics test rejects the null hypothesis that the variable is stationarity. Therefore, the combined results form all the tests suggest that all the series under consideration appear to be I(1) process.

Table 1 Results of the Unit Root Test

	ADF	PP	KPSS
Log(GDP per capita)	-0.568	-0.6576	0.1928 **
Saving Rate	-2.1885	-1.5676	0.1765 **
Dependency Ratio	-0.0207	0.4794	0.204 **

Note: **: 5% significance level

2.2. Co-integration analysis

Table 2 summarizes the results of the cointegration analysis between log(GDP per capita), Saving rate, Dependency ratio. To test for cointegration we use the Johansen maximum likelihood approach employing both the maximum eigenvalue and trace statistic. To determine the lag length of the VAR, Three versions of the system were initially estimated: a four, a three, and a two-lag version. Then, and Akaike Information Criterion(AIC), a Schwarz Bayesian criterion(SBC) were used to test that all three specifications are statistically equivalent. All tests reject the null hypothesis that all the specifications are equivalent. In particular, the tests suggest that VAR = 2 should be used in

the estimation procedure of cointegration to avoid over-parameterization of the estimated models.

The estimation procedure assumes unrestricted intercepts and unrestricted trends in the VAR estimation. The test-statistics give similar results. Both trace test and max-eigenvalue test indicate 2 cointegrating equations at 1% levels. On the basis of the results, the long-run relationship between log(GDP per capita), Saving rate, Openness, Dependency ratio finds statistical support in Korea over the period under examination.

Table 2 Result of the Cointegration test

#of CE(s)	Trace test			Maximum eigenvalues test		
	Statistics	Critical value		Statistics	Critical value	
		5%	1%		5%	1%
0	66.86 ***	29.68	35.65	41.23 ***	20.97	25.52
At most 1	25.63 ***	15.41	20.04	24.55 ***	14.07	18.63
At most 2	1.08	3.76	6.65	1.08	3.76	6.65

Note: ***: 1% significance level

2.3. Estimation Results of the FMOLS

The pre-condition for applying the FMOLS for estimating long-run parameters is that there exists a cointegrating relation between a set of I(1) variables is satisfied for our sample data. Therefore, we can apply the FMOLS procedure to estimate the cointegrating vector.

Table 3 shows the estimation results from the FMOLS analysis. The lag variable of the Log (GDP per capita) has a positive sign and is statistically significant at the 10% level. The sign of the Saving Rate is positive and significant ate the 1% level.

The sign of the Dependency ratio is negative and significant at the 1% level, which implies that the changes of the aging structure encourage the economic performance because dependency ratio rapidly decreased in Korea during the sample period. This is the strong evidence that there exists a ‘demographic dividend’ in Korea.

Table 3 Results of the FMOLS estimation

	Log(GDP per capita)	
	Coefficient	Standard error
Constant	1.0931	0.024 ***
Log(GDP per capita)$_{t-1}$	0.0032	0.002 *
Saving Rate	0.0175	0.003 ***
Dependency Ratio	-2.2182	0.553 ***
Adj. R-square	0.999	

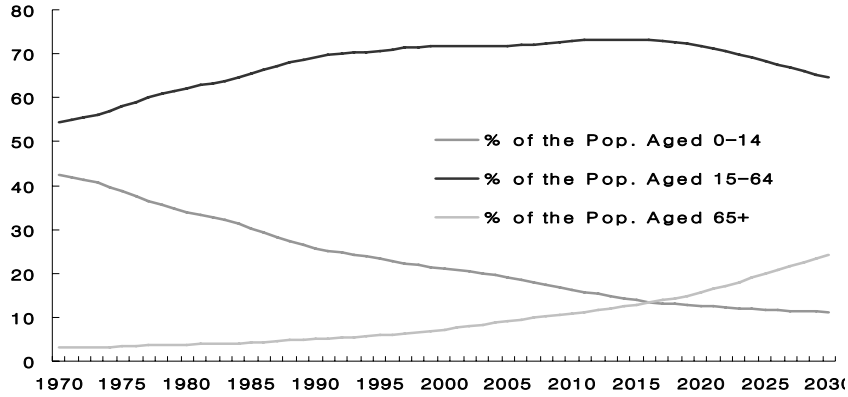
note: *: 10%, ***: 1% significance level

IV. Population Projection and Economic Growth in Korea

During the Period 1970-2003, age structure had a positive effect on economic performance in Korea. However, advantage of the age structure is expected to disappear in the future. Due to the low fertility rate and long life expectance, the share of the working age group is predicted to decrease, and the share of the old is predicted to increase.

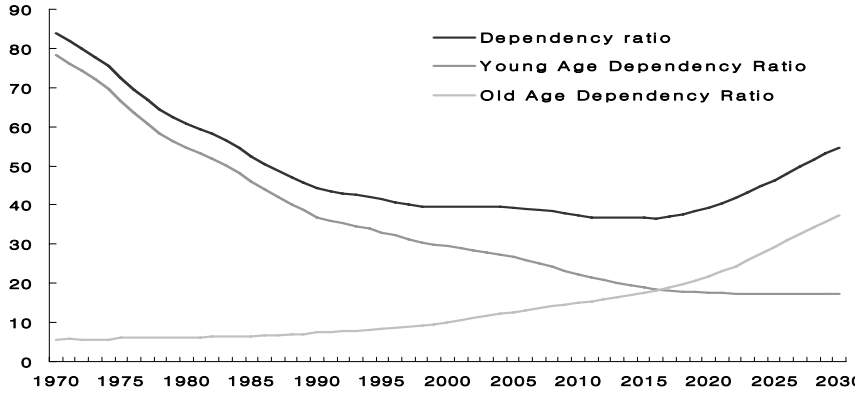
Figure 7 shows the result of the population projection in Korea during the period 1970-2030. Due to the low fertility rate, the share of the young is expected to decrease considerably; from 20.3% in 2003 to 11.2% in 2030. The share of the working age group is expected to increase with decreasing rate. Until 2016, the share of the working age group is predicted to increase. After that, the share of the working age group is predicted to decrease from 73.2 in 2016 to 64.7 in 2030. This is because of the low fertility and long life expectancy. The most noteworthy recent changes in the age structure in Korea is the increasing the share of the old. The share of the old is expected to increase rapidly. In 2019, the share of the old will be over 14% and Korea will become the aged society. In 2026, the share of the old will be over 20% and Korea will become the super-aged society. The share of the old is predicted to be 24.1% in 2030.

Figure 5 Population Projection: 1970-2030



Changes of the age structure change the economic burden of the working age group. Figure 8 shows the changes of the working-age person's economic burden in Korea during the period 1970~2030. Young age dependency ratio which is the ratio of the aged 14 and less to aged 15~64 will decrease from 27.9 in 2003 to 17.4 in 2030 due to the decreasing of the share of the young. The old age dependency ratio which is the ratio of the population aged 65 and over to the population aged 15~64 will gradually increase from 11.6 in 2003 to 37.3 to 2030. This is because the share of the old will increase more rapidly than the share of the working age group. Due to the slowdown of the decreasing young age dependency ratio and rapid increase of the old age dependency ratio, the dependency ratio will decrease with increasing rate and is expected to increase after mid 2010s. The dependency ratio has increased from 39.5 in 2003 to 54.7 in 2030.

Figure 6 Dependency Ratio Projection: 1970-2030



This kind of demographic changes may lead the slowdown in the growth rate of the economy because, according to the estimation result in chapter III, changes of dependency ratio and economic growth are negatively correlated. Labor supply will decrease and, as the old might save less, saving rate and physical capital accumulation are expected to decrease.

This forecasting is consistent with the result of recent researches. According to the An and Jeon(2006) investigated the shape of the relationship of population aging and economic growth in 25 OECD countries, the GDP per capita increased at the decreasing rate as old age dependency rate rose. Cutler et al. (1990) concluded that demographic changes could improve American standards of living in the near future, but lower them slightly over the very long term. Turner et al. (1998), McMorrow and Roeger (1999), and Kotlikoff et al. (2001) found that the standard of living, which is approximated by GDP per capita, grows well if demographic pressures were absent.[4] These results imply that demographic changes may have a positive impact on the countries which dependency ratio has increasing trend and may have a negative impact on the countries which the dependency ratio has a decreasing trend.

V. Conclusion and Policy Implications

By using the fully modified ordinary least squares (FMOLS) method and annual data for the period 1970-2003 for Korea, we can find that there exists the demographic dividend of economic growth in Korea. This result implies that the miraculous economic performance of the Korea during the period 1970-2003 can be explained by the influence of demographic changes as well as trade and industrial policies, technological progress, saving and capital accumulation, governance, education, geography and culture etc. However, advantage of the age structure will disappear in the near future. Due to the slowdown of the decreasing young age dependency ratio and rapid increase of the old age dependency ratio, the dependency ratio decrease with increasing rate and is expected to increase after mid 2010s. This may lead the slowdown in the growth rates of the economy.

To reverse this trend, an increase in productivity is required but with an aging population this might need particular and persistent effort. To cope with the slowdown of the economic growth, under the condition that the labor supply is expected to decrease, the rate of physical capital accumulation should be increased. However, private saving which is directly related to the capital accumulation has been decreased and is expected to decrease. So, to encourage capital accumulation, tax incentives for private saving should be

[4] Turner et al. considered GNP per capita corrected for changes in the terms of trade,

considered[5]. Increasing the human capital accumulation is also important. According to the Boerch-Supan(2001), negative effect of the population aging on economic growth can be partly offset by the human capital accumulation.

Reference

An, C. and S. Jeon (2006), "Demographic Changes and Economic Growth: An Inverted-U Shape Relationship," *Economics Letters*, forthcoming

Bloom, D. E., David Canning, and Pia N. Malaney (2000), "Demographic Change and Economic Growth in Asia," *Population and Development Review*, Vol. 26 (Suppl.), pp. 257-290.

Bloom, D., and D. Canning (2004), "Global Demographic Change: Dimensions and Economic Significance," NBER Working Paper 10817, Sept. 2004.

Bloom, D., D. Canning, and J. Sevilla (2003), *The Demographic Dividend: A New Perspective on the Economic Consequences of Population Change*, Santa Monica, California: RAND, MR-1274.

Boerch-Supan, A. H.(2001), "Labor Market Effects of Population Aging", *NBER working paper series* No.8640.

Cutler, David M., James M. Poterba, Louise M. Sheiner, and Lawrence H. Summers (1990), *An Aging Society: Opportunity or Challenge?*, Brooking Papers on Economic Activity, Vol. 1.

Dickey, D. A., and Fuller, W. A. (1979), "Distribution of the Estimators for Autoregressive Time Series with a Unit Root," *Journal of the American Statistical Association*, 74, 427-431

Dickey, D. A., and Fuller, W. A. (1981), "The Likelihood ratio Statistics for Autoregressive Time Series with a Unit Root," *Econometrica*, 49, 1507-1072

Johansen, S. (1988), "Statistical and Hypothesis Testing of Cointegration Vectors," *Journal of Economic Dynamics and Control*, 12, 231-254

[5] Public saving has been gradually increased. However, public saving is not directly related to the capital accumulation, but related to the consolidated public finance and social security system

Johansen, S. and Juseluis, K. 1990), “Maximum Likelihood Estimation and Inference on Cointegration- with Applications to the Demand for Money” *Oxford Bulletin of Economics*, 52, 169-210

Johansen, S. and Juseluis, K. 1992), “Testing Structural Hypotheses in a Multivariate Cointegration Analysis at the Purchasing Power Parity and the Uncovered Interest Parity for the UK,” *Journal of Econometrics*, 53, 211-244

Kelly, A. and R. Schmidt (1995), “Aggregate Population and Economic Growth Correlations: the Role of the Components of Demographic Change,” *Demography* 32, 543-555.

Kiwatkowski, D., P. C. Phillips, P. Schmidt, and Y. Shin(1992), “Testing the Null Hypothesis of Stationarity against the Alternative of Unit Root: How sure Are We that Economic Time Series Have a Unit Root?,” *Journal of Econometrics* 54, 159-178

Lee, R. (2003), “The Demographic Transition: Three Centuries of Fundamental Change,” *Journal of Economic Perspectives*, Vol. 17, No. 4 (Fall), 167-190.

Leff, N. H. (1969), “Dependency Rates and Saving Rates,” *American Economic Review,* Vol. 59, 886-895.

Phillips, P. C. B. and Perron, P. (1988), “Testing for a Unit Root in Time Series Regression,” *Biometrica*, 75, 335-346

Phillips, P. C. B. and B. E. Hansen(1990), “ Statistical Inference in Instrumental Variables Regression with I(1) Processes,” Review of Economic Studies, Vol 57, No. 1. pp.99-125.