



Does Population Aging Slow Down Per Capita Income Growth?

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1. Background

- One of the salient features of the Korean economy =>
Fast speed of demographic transition by any international norm
 - e.g., working - age population: 1.5 in 1965 => 2.5 in 1999
- However, Korean demographic transition is entering a new phase.
 - Population aging is expected to proceed at the same phenomenal rate as the past increase in working - age population ratio.
- Under these circumstances, there is a wide - spread belief that population aging will substantially slow down future growth of per capita income in Korea.
 - Is it really true?



- This study aims to assess empirically whether per capita income growth will slow down substantially due to population aging, utilizing cross - country data since 1960s.
 - 1) Overview and identify key features of demographic transition in Korea in international perspective.
 - 2) Examine whether per capita income growth is systematically related to the *level* of demographic structure (working - age population ratio) or to *the speed of its changes* or to both?
 - * Also consider fertility rate, population growth as demographic indicators.
 - * Simple correlations and cross - country regressions



Two Contrasting Theoretical Frameworks on Demography and Per Capita Income Growth

1) Neoclassical Overlapping Generations Models

- Mills (1999), Aucherbach and Kotlikoff (1987)
- Population aging, or decrease in working -age population ratio, *decreases* per capita income growth rate.

➔ Hypothesis 1: A country with lower working -age population ratio experiences lower rate of per capita income growth.



2) Growth Theories with Fertility Choice

- Becker, Murphy, Tamura (1991), Lucas (2002)
 - Under the trade-off between the number and quality (human capital) of children, a country experiencing changes in household's decision in the direction of favoring quality, rather than quantity, of children, experiences *both demographic transition and sustained increase in per capita income*.
 - => Demographic transition and sustained growth in per capita income might be two different manifestations of the same one phenomenon.
- ➔ Hypothesis 2: A country with faster speed of demographic transition experiences higher rate of per capita income growth.



Contrasting Implications of the Theoretical Frameworks on Data Analysis

- Hypothesis 1: The *level* of per capita income growth rate is systematically related to the *level* of working-age population ratio.
=> lower working-age population -> lower per capita growth
=> Key presumption underlying the argument that population aging will slow down per capita income growth
- Hypothesis 2: The *level* of per capita income growth rate is systematically related to the *speed of change* in working-age population ratio.
=> Faster aging -> higher per capita growth
=> Population aging *by itself* is not likely to reduce per capita growth



II. Key Features of Demographic Transition in Korea

III. Empirical Analysis

III. 1. Simple Correlations

- Levels of Demographic Indicators and Per Capita Income Growth
- Changes of Demographic Indicators and Per Capita Income Growth

III. 2. Regressions

IV. Summary and Concluding Remarks

5. Key Features in Demographic Transition in Korea



Table 1. The Demographic Change in Korea

Year	Fertility rate	Death rate	Life expectancy (Age)	Population growth rate (%)	Working age population ratio
1960	5.67	13.46	54.15	3.09	1.21
1965	4.87	11.24	56.68	2.46	1.15
1970	4.27	9.44	59.93	2.13	1.20
1975	3.32	7.42	63.89	1.93	1.42
1980	2.56	6.38	66.84	1.56	1.64
1985	2.04	6.24	68.65	0.99	1.92
1990	1.77	6.26	70.28	1.15	2.24
1995	1.75	5.30	71.77	1.21	2.46
2000	1.43	5.73	73.15	0.89	2.54
2001	1.30
2002	1.17

Note:

- a. The fertility rate is the number of babies that one woman gives birth to throughout her life.
- b. The death rate is the number of the deceased per 1,000 people.
- c. The working age population ratio is the reciprocal of dependency ratio, which is the number of working age people aged 15-64 per one dependent person aged under 15 or over 65.

Sources:

- a. World Bank, World Development Indicator, various issues
- b. Korea National Statistical Office, Annual Report on the Vital Statistics, 2001, 2002

5. Key Features in Demographic Transition in Korea

Figure 2. Trends of Population Growth Rate in Major Regions

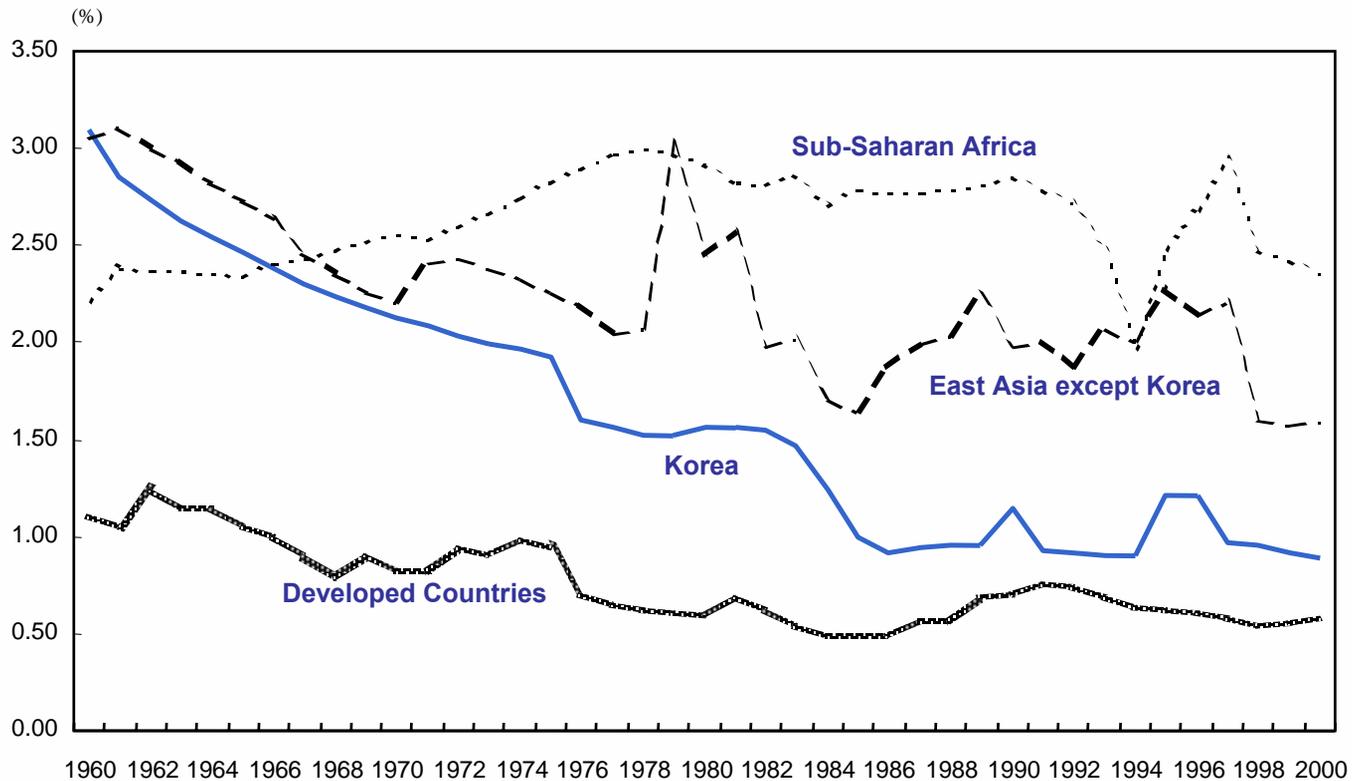




Figure 3. Trends of the Fertility Rate in Major Regions

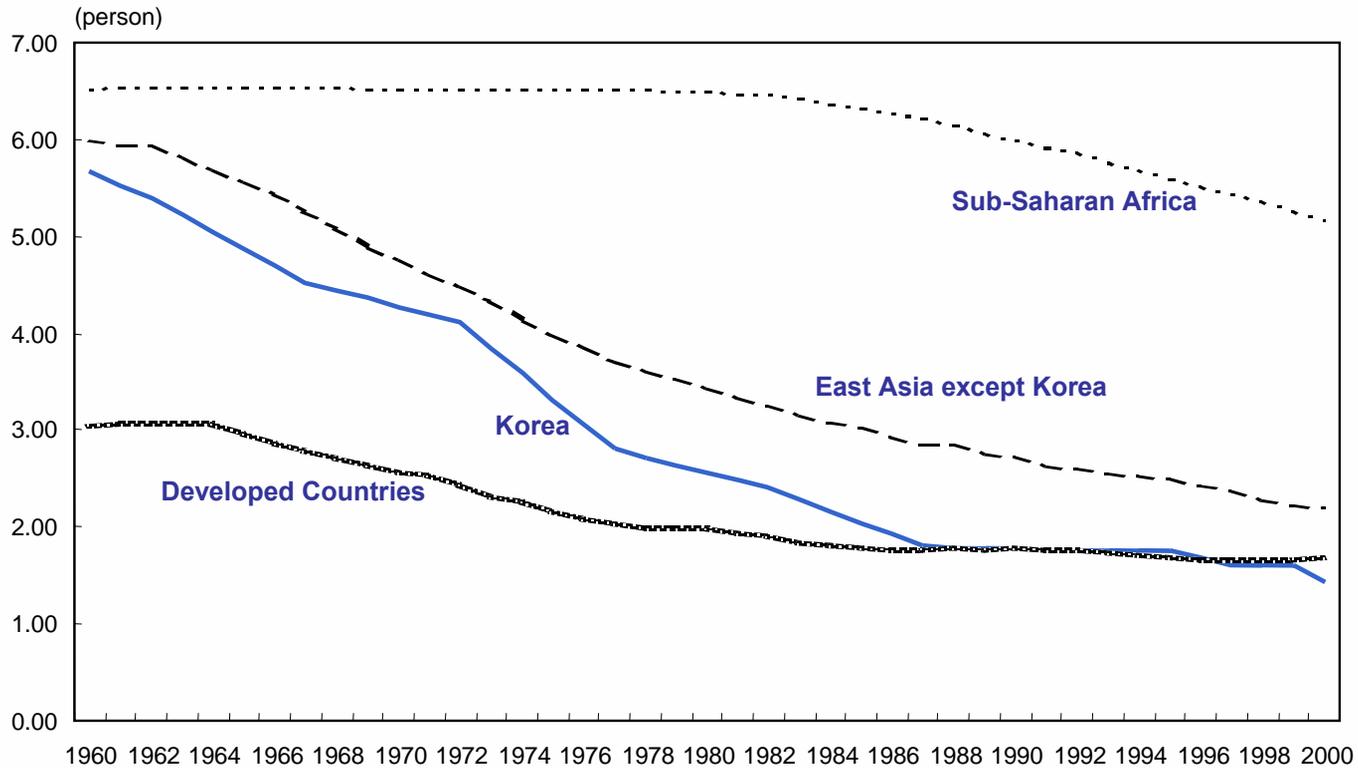




Figure 4. Trend of the Death Rate in Major Regions

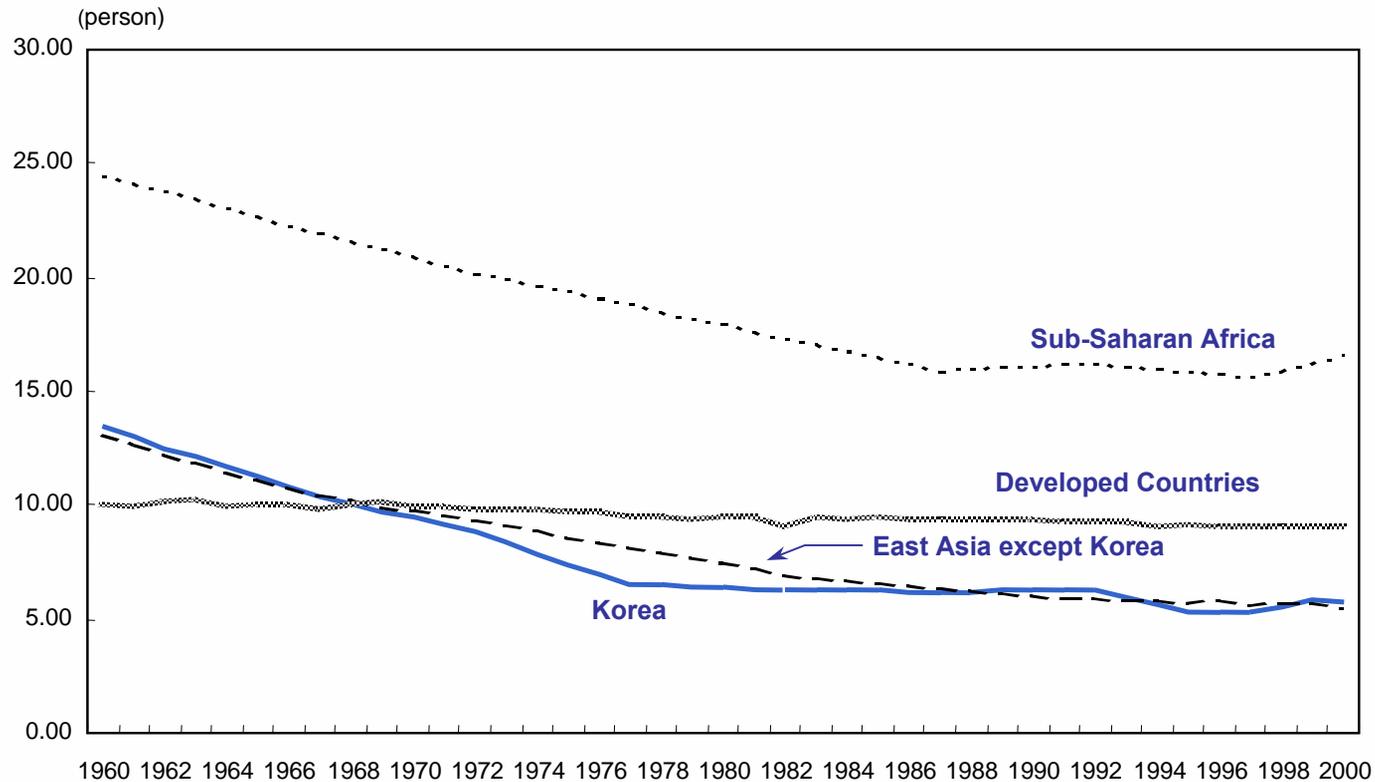
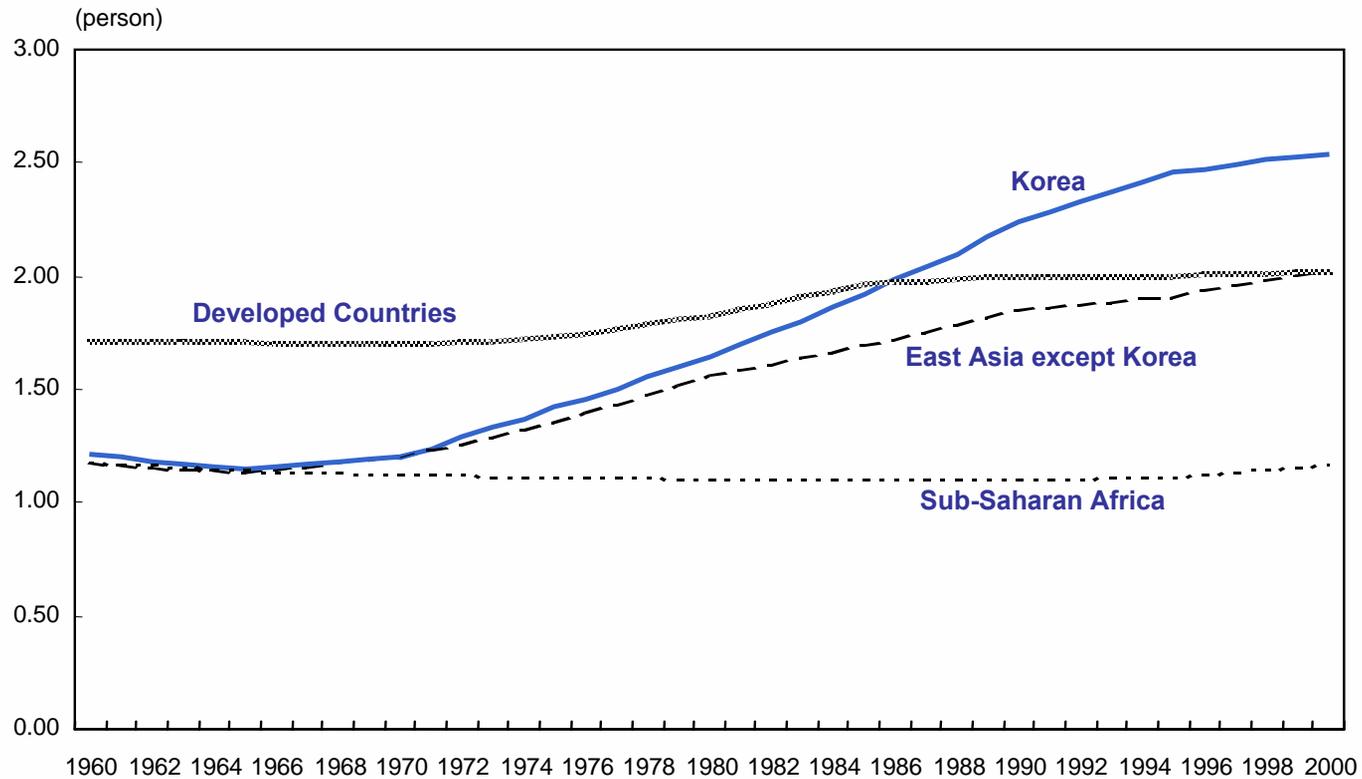




Figure 5. Trend of Working-age Population Ratio in Major Regions





- In terms of demography, what distinguishes Korea most from other regions is not the level, but the speed of changes, of various demographic indicators.
 - In terms of levels, the levels of period-average demographic indicators of Korea stands only in between developed and sub-Saharan African countries.



Table 2. Correlations between Levels of Demographic Indicators

	Population growth rate	Fertility rate	Working age population ratio
Population growth rate	1.00 (0.0000)	0.88 (0.0001)	-0.84 (0.0001)
Fertility rate	0.88 (0.0001)	1.00 (0.0000)	-0.92 (0.0001)
Working age Population Ratio	-0.84 (0.0001)	-0.92 (0.0001)	1.00 (0.0000)

Note: a. Numbers in parentheses are P-values.
 b. All variables used for correlation analysis are average values between 1961 and 1990.



Table3. Correlations between Changes in Demographic Indicators

	Δ (Population growth rate)	Δ (Fertility rate)	Δ (Working age population ratio)
Δ (Population growth rate)	1.00 (0.0000)	0.67 (0.0001)	-0.55 (0.0001)
Δ (Fertility rate)	0.67 (0.0001)	1.00 (0.0000)	-0.71 (0.0001)
Δ (Working age population ratio)	-0.55 (0.0001)	-0.71 (0.0001)	1.00 (0.0000)

Note: a. Numbers in parentheses are P-values.
 b. All variables used for correlation analysis are average values for 1976-1990 minus average values for 1961-1975.



- Strong correlations between changes in demographic indicators: Countries with rapid rise in working-age population ratio tend to be countries with rapid decline in fertility and population growth rate.
- => Not only movements of working-age population ratio, but also movements of fertility and population growth rate should be taken into account, when discussing the effects of population aging.

7. Levels of Demographic Indicators and Per Capita Income Growth

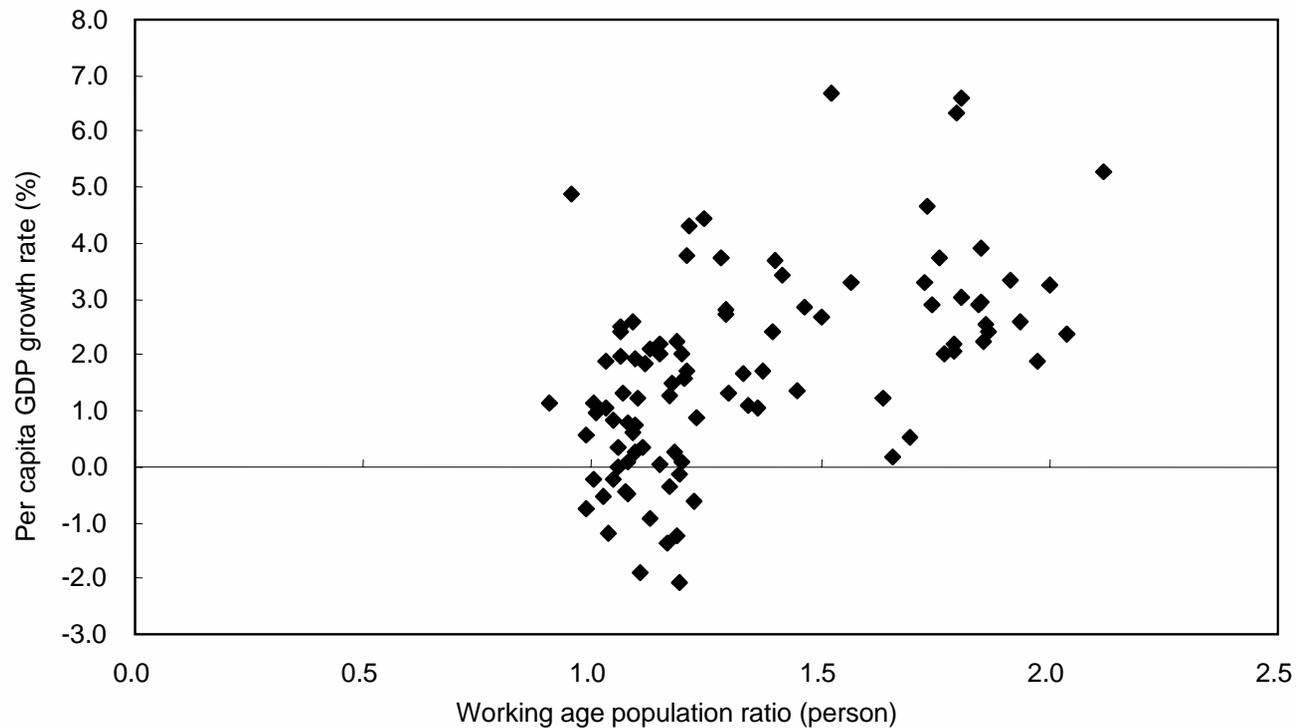
Table 4. Correlations Between Levels of Demographic Indicators and Per Capita Income Growth Rate

	Population growth rate	Fertility rate	Working age population ratio
Per capita GDP growth rate	-0.36 (0.0003)	-0.57 (0.0001)	0.54 (0.0001)

Note: Numbers in parentheses are P-values.

7. Levels of Demographic Indicators and Per Capita Income Growth

Figure 6. Correlation between Working-age Population Ratio and Per Capita Income Growth Rate



7. Levels of Demographic Indicators and Per Capita Income Growth

- Positive correlation between working-age population ratio and per capita income growth rate => apparently supportive of Hypothesis 1
- However, countries with lower fertility rate or population growth rate grew faster on a per capita basis.
=> Is decline in fertility rate, for example, a threat to growth of income per capita?

7. Levels of Demographic Indicators and Per Capita Income Growth

- A supplementary exercise:

If there exist significant correlations between g and D , are there also significant correlations between *change in g* and *changes in D* over time?

7. Levels of Demographic Indicators and Per Capita Income Growth

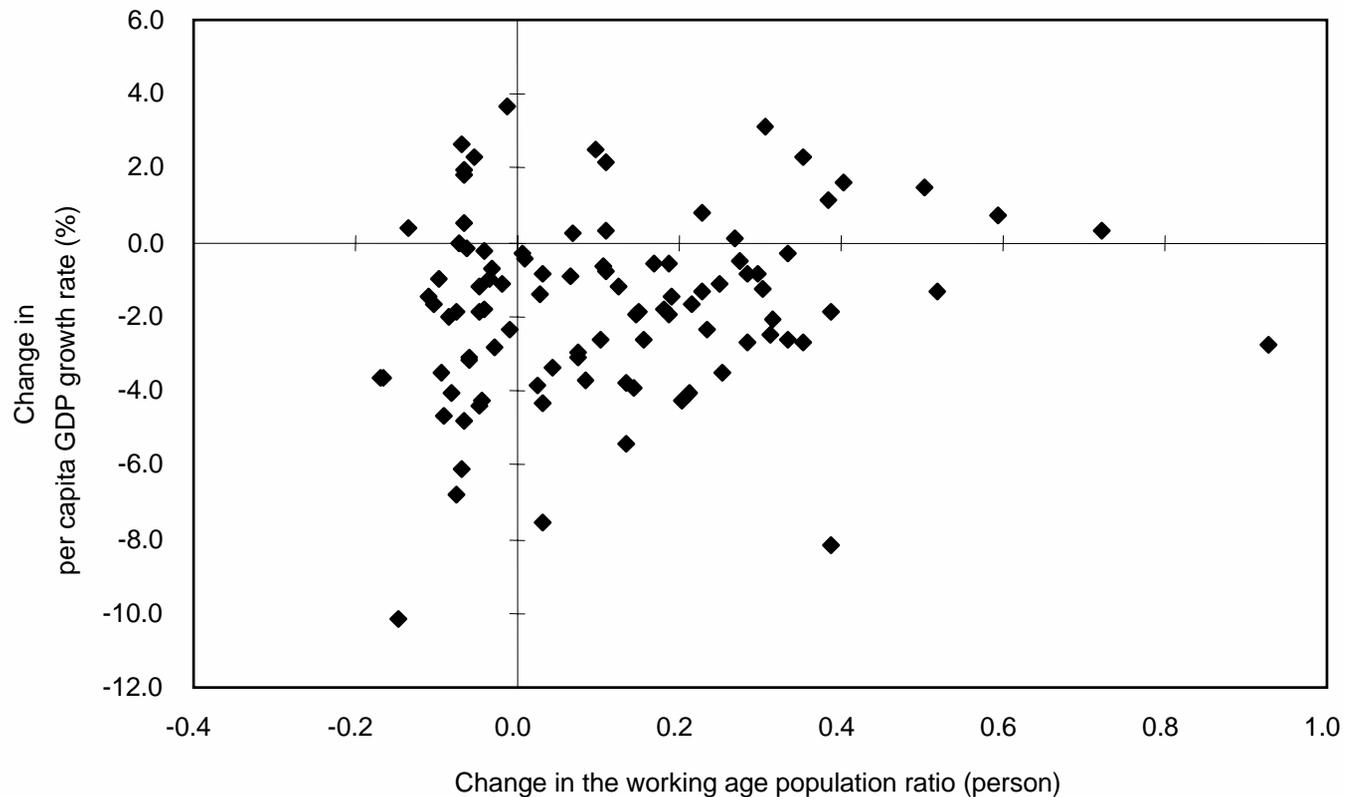
Table 5. Correlations between Changes in Demographic Indicators and Change in Per Capita Income Growth Rate

	Δ (Population growth rate)	Δ (Fertility rate)	Δ (Working age population ratio)
Δ (Per capita GDP growth rate)	-0.10 (0.3347)	-0.06 (0.5642)	0.17 (0.0918)

Note: Numbers in parentheses are P-values.

7. Levels of Demographic Indicators and Per Capita Income Growth

Figure 7. Correlation between Change in Working-age Population Ratio and Change in Per Capita Income Growth Rate



7. Levels of Demographic Indicators and Per Capita Income Growth

- No significant correlations between changes in g and changes in D
- => Positive cross - country correlation between per capita income growth rate and the age structure of population reflects country fixed effects?
- => Then, the empirical support for the argument that population aging will slow down per capita income growth seems to be weakened.

8. Changes in Demographic Indicators and Per Capita Growth

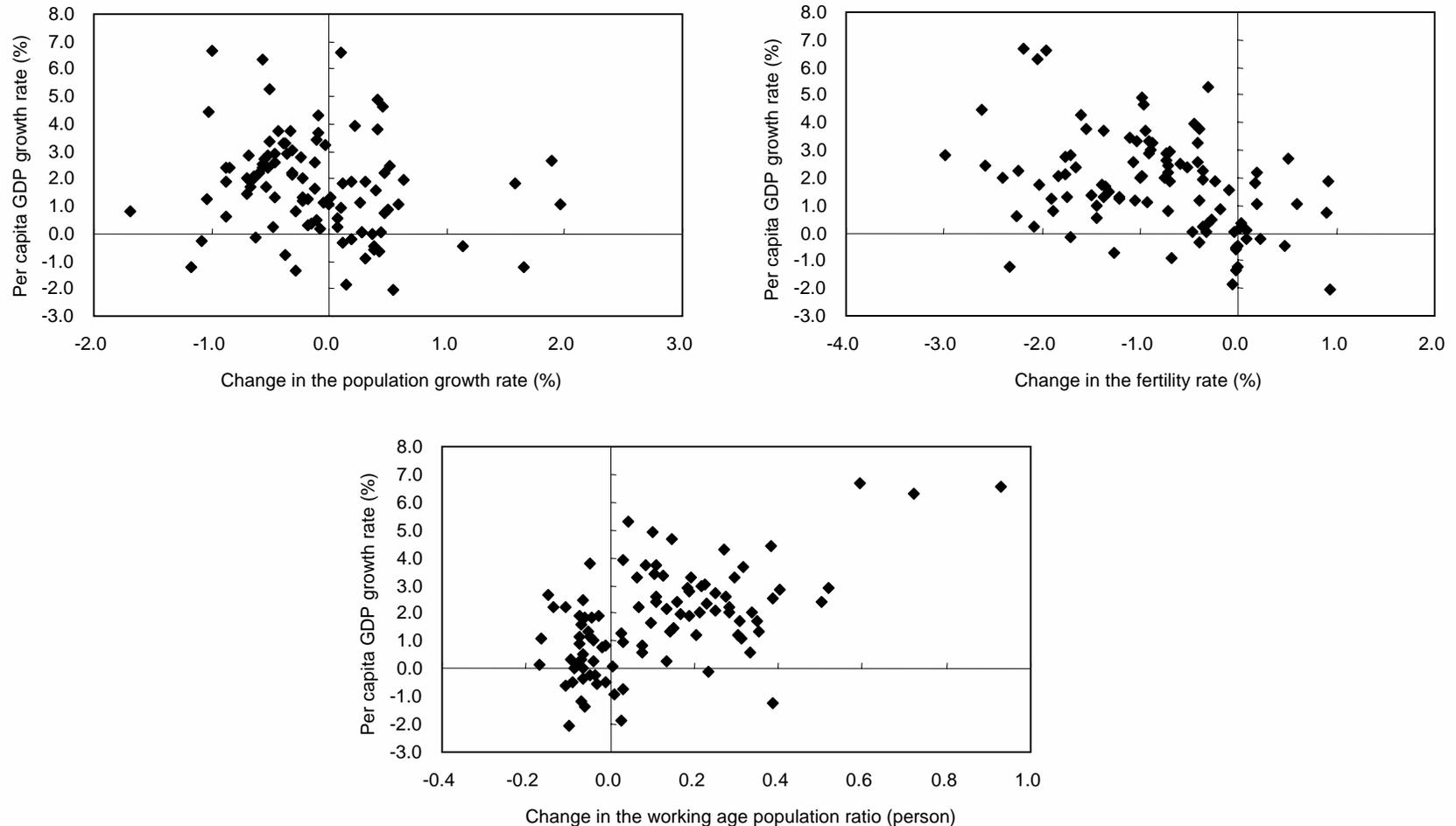
Table 6. Correlations Between Changes in Demographic Indicators and Per Capita Income Growth Rate

	Δ (Population growth rate)	Δ (Fertility rate)	Δ (Working age population ratio)
Per capita GDP growth rate	-0.21 (0.0378)	-0.38 (0.0001)	0.56 (0.0001)

Note: Numbers in parentheses are P-values.

8. Changes in Demographic Indicators and Per Capita Growth

Figure 8. Correlation Between Changes in Demographic Indicators and Per Capita Income Growth Rate



8. Changes in Demographic Indicators and Per Capita Growth

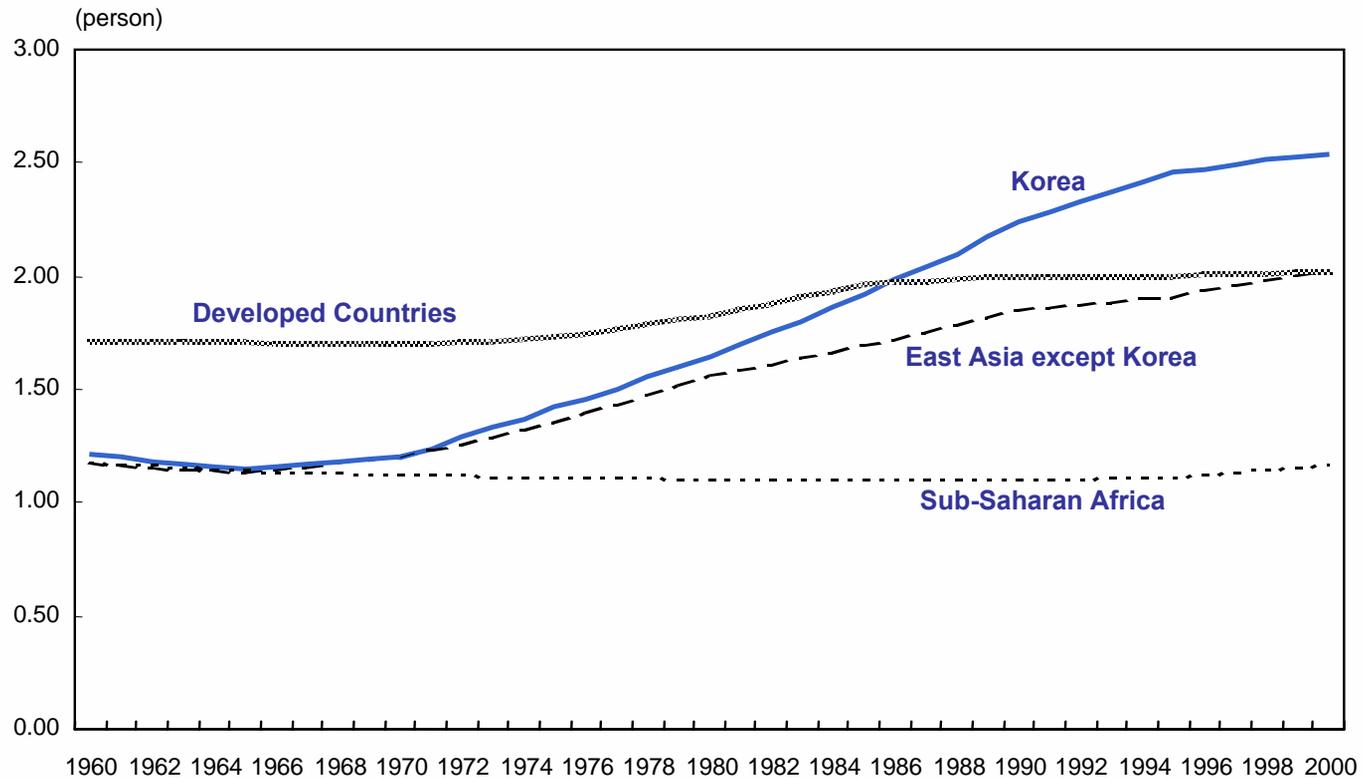
- Evidence are consistent with the Hypothesis 2 that countries with *faster speed of demographic transition* experience *higher* rate of per capita income growth.
 - Higher per capita GDP growth rate with faster change in working - age population ratio, faster decline in fertility rate, or faster decline in population growth rate.

8. Changes in Demographic Indicators and Per Capita Growth

- Here, a question might be raised as to whether the “magnitude of increase,” rather than the “speed of change” in working-age population ratio matters for per capita income growth.
 - That is, will East Asian countries’ per capita income growth “significantly” slow down with “significant” amount of decline in working-age population ratio expected in the future?
- => If this is true, then the per capita income growth rates of East Asian countries should become, at least in statistical sense, even lower than those of sub-Saharan African countries.
- Not a likely scenario

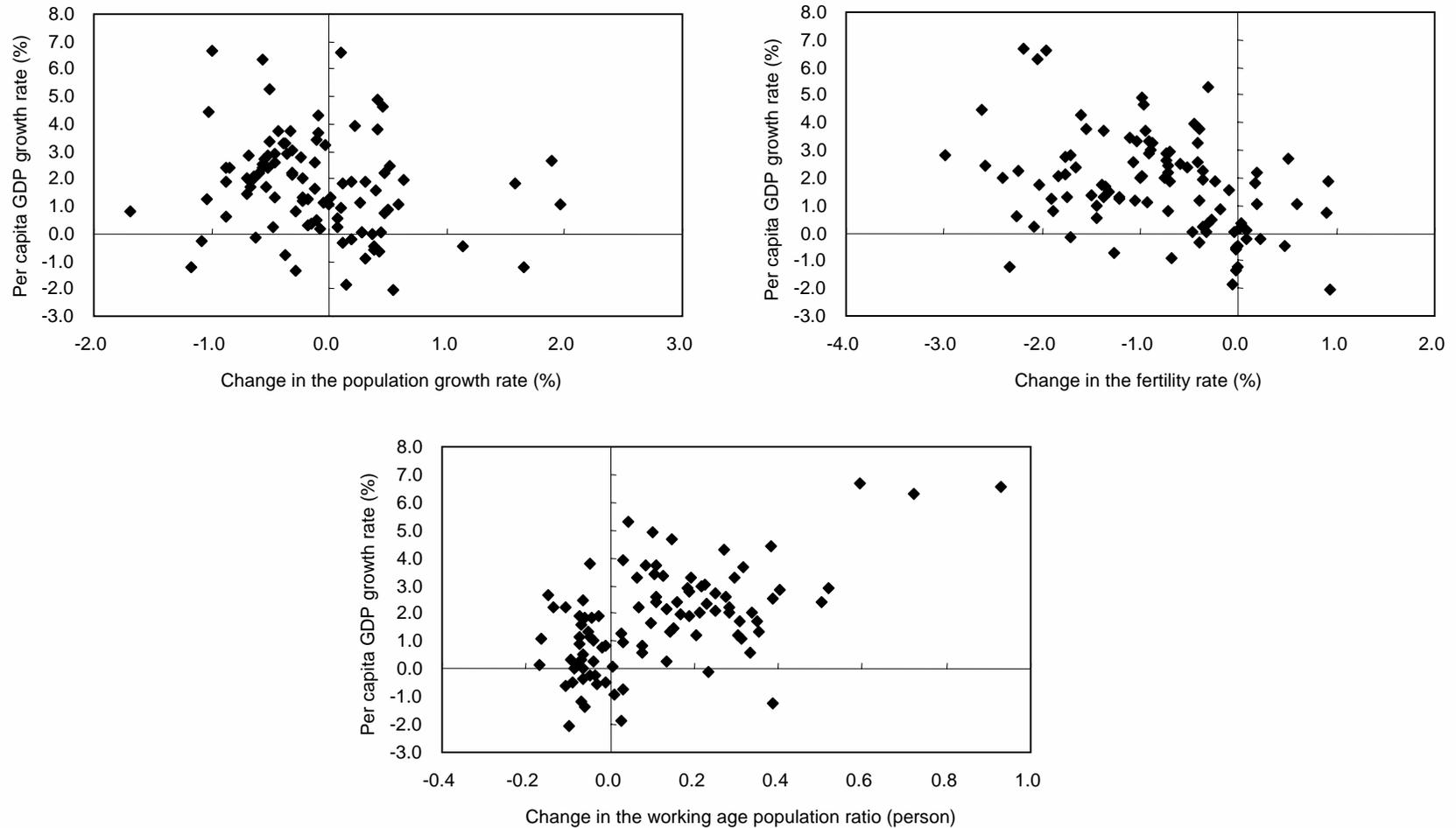


Figure 5. Trend of Working-age Population Ratio in Major Regions



8. Changes in Demographic Indicators and Per Capita Growth

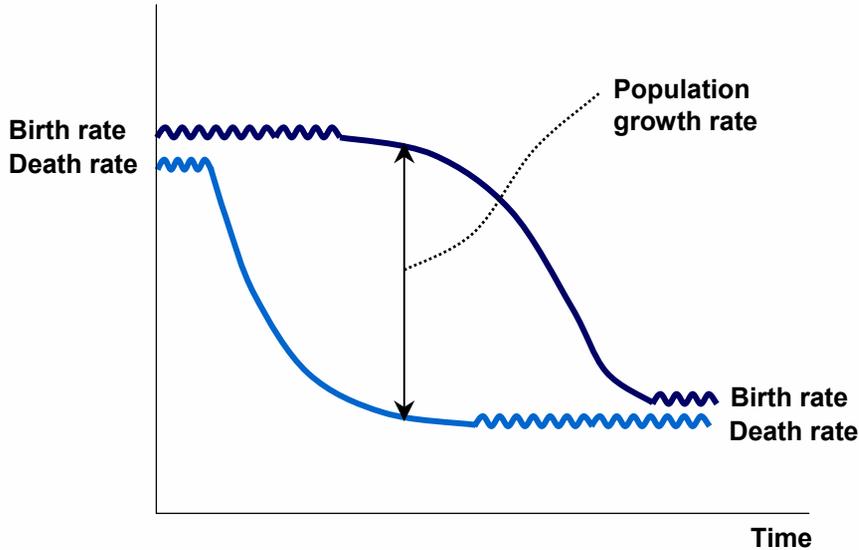
Figure 8. Correlation Between Changes in Demographic Indicators and Per Capita Income Growth Rate



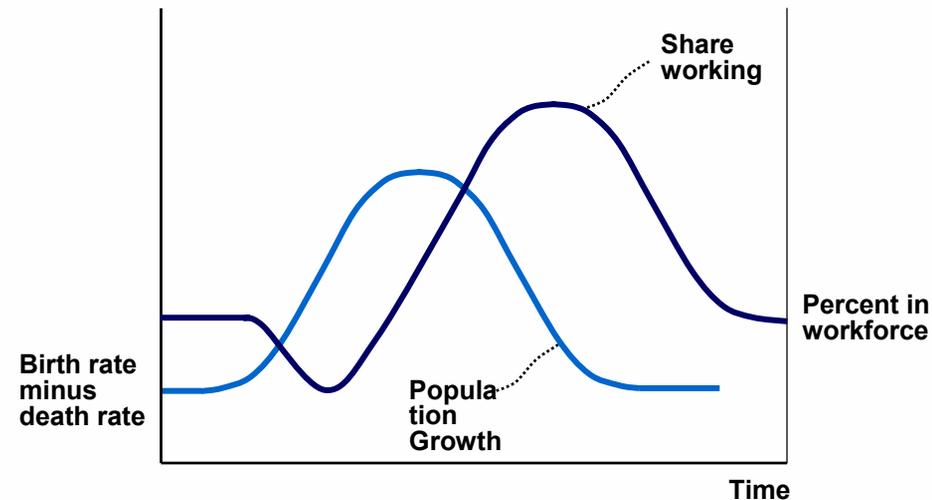
8. Changes in Demographic Indicators and Per Capita Growth

Figure 1. Patterns of Demographic Indicators in A Demographic Transition

Demographic transition



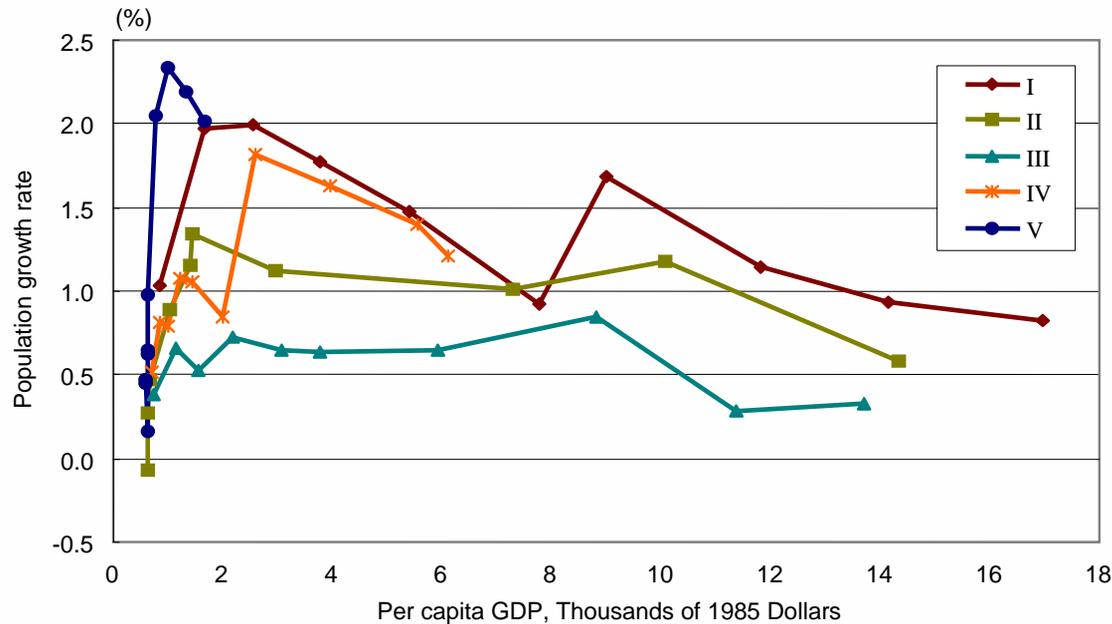
Population growth and the age structure



Source: Bloom and Williamson (1998)

8. Changes in Demographic Indicators and Per Capita Growth

Figure 9. Demographic Transitions by Region, 1750-1990



UK, USA, Canada, Australia, New Zealand

Japan

France, Germany, Netherlands, Scandinavia

Rest of Western Europe, Latin America, Eastern Europe, Soviet Union

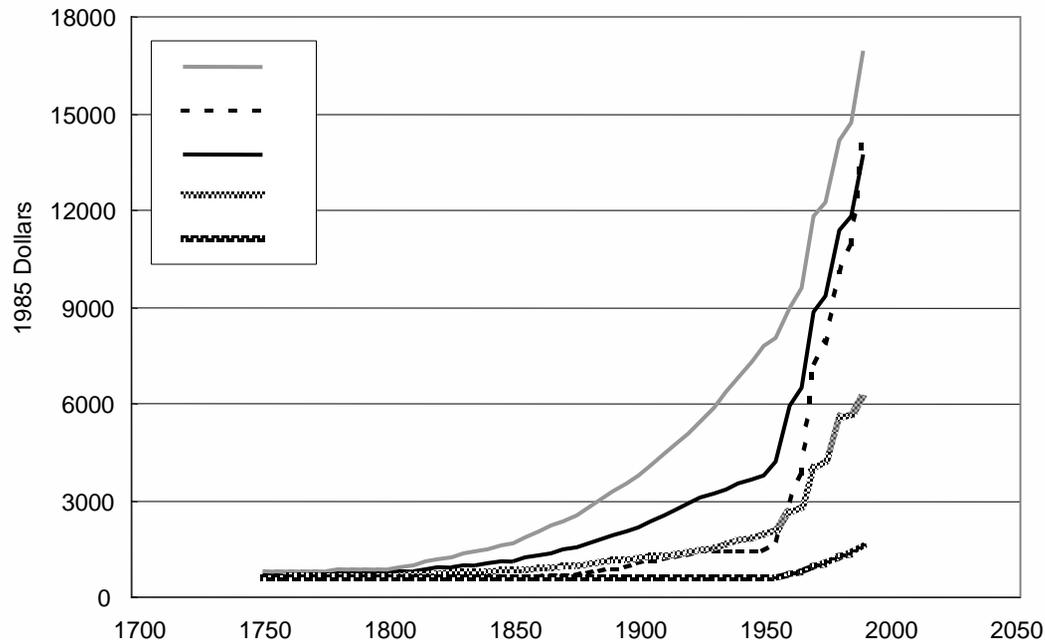
Asia (except Japan), Africa

Note: Each curve connects 10 points, indicating the average population growth rate of the country groups over the years 1800, 1850, 1875, 1900, 1925, 1950, 1960, 1970, 1980, and 1990.

Source: Lucas (2002)

8. Changes in Demographic Indicators and Per Capita Growth

Figure 10. Trends of GDP Per Capita by Region, 1750-1990



UK, USA, Canada, Australia, New Zealand
 Japan
 France, Germany, Netherlands, Scandinavia
 Rest of Western Europe, Latin America, Eastern Europe, Soviet Union
 Asia (except Japan), Africa

Source: Lucas (2002)

9. Regressions: Level and Change in Working-age Population Ratio

Table 7. The Regressions of Level and Change in Working-age Population Ratio

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GDP per capita (Logged)	-1.892 (-8.217)	-2.022 (-7.983)	-1.921 (-8.262)	-2.050 (-9.046)	-1.913 (-8.893)	-1.988 (-8.988)	-2.214 (-8.920)
Log years of secondary schooling	0.686 (5.064)	0.661 (4.735)	0.521 (3.932)	0.504 (3.953)	0.469 (3.937)	0.506 (4.198)	0.437 (3.777)
Openness	1.969 (3.893)	1.667 (3.251)	1.226 (2.544)	1.008 (2.210)	1.207 (2.813)	1.026 (2.307)	0.499 (1.112)
Quality of institutions	0.492 (6.096)	0.403 (4.507)	0.359 (4.364)	0.366 (4.747)	0.347 (4.813)	0.329 (4.516)	0.437 (5.203)
Working age population ratio		1.397 (2.012)	1.671 (2.623)	1.525 (2.544)	1.060 (1.840)	1.274 (2.176)	0.972 (1.602)
Change in the working age population ratio			2.379 (3.771)	1.915 (3.126)	2.080 (3.633)	2.016 (3.542)	1.421 (2.489)
Government consumption ratio				-7.203 (-2.825)	-4.739 (-1.901)	-4.917 (-1.982)	-4.893 (-2.096)
Natural resource abundance					-3.374 (-3.248)	-3.336 (-3.201)	-2.210 (-2.124)
Terms of trade						0.081 (1.297)	0.085 (1.452)
Latin America dummy							-0.322 (-1.087)
Africa dummy							-1.278 (-3.189)
Sample size	72	70	70	69	69	68	68
Adj. R-square	0.70	0.70	0.75	0.77	0.80	0.80	0.83

Note: a. Dependent variable is average growth rate of real GDP per capita from 1961 to 1990.

b. Numbers in parentheses are t-statistics.

9. Regressions: Level and Change in Fertility Rate

Table 8. The Regressions of Level and Change in Fertility Rate

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GDP per capita (Logged)	-1.892 (-8.217)	-2.458 (-10.063)	-2.420 (-10.844)	-2.514 (-11.913)	-2.388 (-11.567)	-2.551 (-12.216)	-2.488 (-10.725)
Log years of secondary schooling	0.686 (5.064)	0.526 (4.149)	0.393 (3.252)	0.392 (3.452)	0.380 (3.506)	0.427 (4.047)	0.415 (3.932)
Openness	1.969 (3.893)	1.170 (2.525)	0.897 (2.089)	0.689 (1.721)	0.867 (2.240)	0.549 (1.400)	0.368 (0.906)
Quality of institutions	0.492 (6.096)	0.370 (4.974)	0.430 (6.170)	0.421 (6.505)	0.403 (6.513)	0.388 (6.382)	0.398 (5.214)
Fertility rate		-0.677 (-4.916)	-0.673 (-5.356)	-0.623 (-5.335)	-0.544 (-4.724)	-0.623 (-5.438)	-0.525 (-4.054)
Change in the Fertility rate			-0.504 (-3.744)	-0.426 (-3.385)	-0.441 (-3.674)	-0.410 (-3.514)	-0.387 (-2.763)
Government consumption ratio				-7.300 (-3.363)	-5.634 (-2.611)	-5.947 (-2.864)	-5.987 (-2.892)
Natural resource abundance					-2.480 (-2.700)	-2.289 (-2.558)	-1.947 (-2.104)
Terms of trade						0.137 (2.499)	0.131 (2.398)
Latin America dummy							-0.361 (-1.365)
Africa dummy							-0.569 (-1.359)
Sample size	72	70	70	69	69	68	68
Adj. R-square	0.70	0.77	0.81	0.83	0.84	0.85	0.86

Note: a. Dependent variable is average growth rate of real GDP per capita from 1961 to 1990.
b. Numbers in parentheses are t-statistics.

9. Regressions: Level and Change in Pop. Growth Rate

Table 9. The Regressions of Level and Change in Population Growth Rate

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GDP per capita (Logged)	-1.892 (-8.217)	-2.021 (-7.335)	-2.145 (-7.324)	-2.448 (-9.061)	-2.311 (-8.910)	-2.469 (-9.164)	-2.480 (-9.042)
Log years of secondary schooling	0.686 (5.064)	0.707 (4.986)	0.700 (4.950)	0.648 (5.063)	0.607 (4.988)	0.666 (5.421)	0.537 (4.402)
Openness	1.969 (3.893)	1.810 (3.511)	1.675 (3.187)	1.114 (2.321)	1.296 (2.834)	1.007 (2.117)	0.533 (1.137)
Quality of institutions	0.492 (6.096)	0.466 (5.614)	0.499 (5.736)	0.494 (6.416)	0.463 (6.291)	0.451 (6.088)	0.525 (6.256)
Population growth rate		-0.224 (-1.163)	-0.252 (-1.305)	-0.364 (-2.110)	-0.258 (-1.548)	-0.376 (-2.173)	-0.207 (-1.180)
Change in the Population growth rate			-0.363 (-1.216)	-0.522 (-1.963)	-0.546 (-2.174)	-0.564 (-2.262)	-0.263 (-1.046)
Government consumption ratio				-10.718 (-4.102)	-8.268 (-3.175)	-8.772 (-3.408)	-7.250 (-2.944)
Natural resource abundance					-3.198 (-2.930)	-3.089 (-2.856)	-2.012 (-1.887)
Terms of trade						0.118 (1.743)	0.101 (1.600)
Latin America dummy							-0.355 (-1.186)
Africa dummy							-1.410 (-3.209)
Sample size	72	70	70	69	69	68	68
Adj. R-square	0.70	0.69	0.69	0.75	0.78	0.78	0.81

Note: a. Dependent variable is average growth rate of real GDP per capita from 1961 to 1990.
b. Numbers in parentheses are t-statistics.



- The most distinguishing demographic characteristics of the “growth miracle” country of Korea during 1961 - 1990 lies in the miraculous speed of changes in various demographic indicators, not in the levels of such indicators.
- It was found that there exist significant correlations between measures of speed of demographic transition and per capita income growth rate.
 - Countries with more rapid change in working - age population ratio, faster decline in fertility or population growth rate tend to exhibit higher growth of income per capita.

10. Summary of Main Results

- The level of working - age population is also strongly and positively related to per capita income growth rate of countries. However, it is likely to reflect country fixed effects.
=> Then, the claim that countries with older age structure of population grow faster loses empirical ground.
- Although both the level and the speed of change in working - age population ratio were estimated to be positive in cross - country regressions, the level coefficient was not robust.
- Overall, the evidence suggest that population aging by itself is not likely to reduce “significantly” per capita income growth of Korea in the future.