The Effects of Regional Characteristics on Population Growth in Korean Cities, Counties and Wards*

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***This work was supported by Korean Research Foundation Grant(KRF-2003-042-B00033).**

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Abstract

This paper investigates the regional characteristics that influence the population growth rates in Korean cities, counties and wards during 1980~2000. Our results indicate that regions followed the fortunes of the industries to which regions were exposed initially. The level of education at the initial year is found to be a key determinant of region's population growth suggesting that higher education levels influences population growth through productivity externalities and knowledge spillovers. The share of manufacturing employment at the initial year is found to positively affect the population growth even though the degree of impact trends downward being consistent with the work of Glaeser et al (1995). Our results also support the convergence hypothesis in Korea.

JEL Classification Code: R11

Keywords: Population Growth, Education, Manufacturing Industry, Fortunes of the Industries

[1] The authors are grateful to three anonymous referees for their valuable suggestions.

1. Introduction

In parallel with the remarkable economic growth during last four decades, Korea has experienced rapid urbanization. Development policy has been focused on the maximum utilization of limited resources in the shortest period of time as possible exploiting the merits of agglomeration economies. Developments of politically and geographically strategic areas were the top priority resulting in the wide range of social, economic and cultural disparities between urban and rural areas and among many different parts of the country. Economies of Large cities grew rapidly experiencing rapid population growth while rural areas suffered the drastic drain of the population. Concentration of the population and industries in large cities and in the Capital Region which includes Seoul, Incheon and Gyunggi Province brought about various urban problems such as congestions and pollutions.[2]

What are the main driving forces for the unequal population growth rates of cities in Korea? Finding out the determinants of the city's population growth rate and analyzing the causal relationship of them are prerequisite for solving the unequal regional development problems in Korea. This paper investigates these issues.

Sjaasted (1962) proposed a framework by which one can analyze the economic cost and benefit of migration in the context of utility maximization in the long run. It is based on the neo-classical economic theory, which views the problem of regional growth in the perspective of human capital theory. Sjaasted regards the movement across the regions as the distribution of resources and contends that it is the result of investment decisions of an individual who wants to increase the productivity of the human capital. Migration investment occurs when the present value of the expected benefit of moving is larger than the present value of the expected costs of moving.

Todaro (1969) also presents an empirical model that explains the population movement in the context of human capital theory. In this model, population in the rural area first moves into the informal sector of the cities, and only later moves into the modern sector after adjusting to the city lifestyle. The movement to the cities from the rural areas is a function of the probability of

[2] Gyunggi Province surrounds Seoul and Incheon is the 4th largest city in Korea located in the vicinity of Seoul.

employment in the cities and wage differences between urban and rural areas. Migration to the cities is assumed to depend on the difference between the *expected* income to be earned while working in the city and the real income currently earned by the worker residing in the rural area, not on the actual real income difference between the city and the rural area.

Lowry (1966) was able to explain the 68% of the variation of migrations in metropolitan areas (SMSA) in the United States using the gravity embedded regression model, which is based on neoclassical economic theory in which the unemployment rates and wage rates are equalized among the regions through the movements of workers. Workers move to the higher wage regions from the lower wage regions and to the low unemployment regions from the high unemployment regions. The theory also presupposes that the migration occurs in proportion to the size of the labor market while moving inversely to the distance between the regions.

Most of the studies on the growth of cities in Korea, especially on population growth, focus on the population concentration problem in the Capital Region of Korea which includes Seoul, Inchon, and Gyunggi Province. There are few studies that examine the population growth of all the regions of Korea, considering both the social and economic aspects. Lee and Kang (1989) analyzes the relationship between the population growth and the manufacturing industry growth of cities, counties (*gun*s), and wards (*gu*s) in the Capital Region in 1985. They employed variables such as population, manufacturing related indexes, distance from Seoul, population density and volume of commuting traffic to identify the determinants of population growth. Their findings suggest that population and manufacturing related indexes such as number of manufacturing firms, and the values of manufacturing product are highly correlated with each other.

The current paper investigates the entire country of Korea and search for the determinants of the regional population growth employing comprehensive data on all the cities, counties (*gun*s) and wards (*gu*s) in Korea. Various kinds of regional characteristics that are hypothesized to affect the economic growth of cities, counties (*gun*s), and wards (*gu*s) are analyzed. Based on the results we present some implications for policy with regards to the balanced development of Korea.

This paper is organized as follows. Section 2 presents the theoretical framework for our empirical analyses. Section 3 describes the data and the regression analysis results are presented in section 4. Section 5 concludes the paper.

2. Modeling Framework

Following Glaeser et. al (1995), cities will be treated as separate economies that share common pools of labor and capital. Unlike countries, cities are completely open economies and therefore, it is reasonable to assume the perfect mobility of capital, labor, and ideas among cities. A large number of studies have investigated population growth across countries. However, one benefit of analyzing population growth in cities is that cities are more specialized economic units than countries, and hence one may gain more insight into the movements of resources and convergence across cities than across countries.

In the context of cities, differences in urban growth experiences cannot be the result of differences in saving rates or exogenous labor endowments. Because of the assumption of mobile labor and capital movement, cities differ only in the 'level of productivity' and the 'quality of life'.

Total output in a city is given by

$$Y_{i,t} = A_{i,t} f(L_{i,t}) = A_{i,t} L_{i,t}^{\sigma} \qquad (1)$$

Where $Y_{i,t}$ represents the total output in city i at time t, $A_{i,t}$ represents the level of technology in city i at time t, $L_{i,t}$ denotes population of city i at time t, f(.) is a common Cobb-Douglas production function, and σ is a parameter.[3]

Under perfect competition, the labor income, namely, wage rate ($W_{i,t}$) of a potential migrant will be equal to the marginal product of labor.

$$W_{i,t} = \sigma A_{i,t} L_{i,t}^{\sigma-1} \qquad (2)$$

[3] As for nonmanufacturing sectors the data on capital stock is not avaiable. This is why equation (1) does not include capital stock variable. Therefore, we can assume that capital stock is implicitly included in both technology, $A_{i,t}$ and labor, $L_{i,t}$. We also assume that technology is neutral with capital stock and labor and capital stock is complement for labor.

Total utility for an individual in each city equals wages multiplied by a quality of life index. Quality of life is meant to capture a wide range of factors including crimes, housing prices, and traffic congestion.

Quality of life = $Q_{i,t} L_{i,t}^{-\delta}$ (3)

where $\delta > 0$. We assume that the quality of life index declines as the size of the city increases.

Total utility of a potential migrant to city i is given in (4) below and is determined by the productivity of labor (implicitly along with capital stock) and quality of life.

Utility = $\sigma A_{i,t} Q_{i,t} L_{i,t}^{\sigma-\delta-1}$ (4)

We assume free migration across cities. This ensures constant utility level across space at a point in time. So each individual's utility level in different cities must equal to the reservation utility level at time t, which we denote as U_t^0

Thus, for each city:

$$\log(\frac{U_{t+1}^0}{U_t^0}) = \log(\frac{A_{i,t+1}}{A_{i,t}}) + \log(\frac{Q_{i,t+1}}{Q_{i,t}}) + (\sigma - \delta - 1)\log(\frac{L_{i,t+1}}{L_{i,t}}) \quad (5)$$

We also assume that

$$\log(\frac{A_{i,t+1}}{A_{i,t}}) = X_{i,t}^{'} \beta + \varepsilon_{i,t+1} \quad (6a)$$

$$\log(\frac{Q_{i,t+1}}{Q_{i,t}}) = X_{i,t}^{'} \theta + \xi_{i,t+1} \quad (6b)$$

Where $X_{i,t}^{'}$ is a vector of city characteristics at time t, which simultaneously determine the growth in both the quality of life and the growth of technology within the city. Lastly, combining equation (2), (5), (6a), and (6b) yields

$$\log(\frac{L_{i,t+1}}{L_{i,t}}) = \frac{1}{1+\delta-\sigma} X'_{i,t}(\beta+\theta) + \chi_{i,t+1} \quad (7)$$

$$\log(\frac{W_{i,t+1}}{W_{i,t}}) = \frac{1}{1+\delta-\sigma} X'_{i,t}(\delta\beta+\sigma\theta-\theta) + \omega_{i,t+1} \quad (8)$$

Where $\chi_{i,t+1}$ and $\omega_{i,t+1}$ are error terms uncorrelated with urban characteristics[4]. Formally, $\chi_{i,t+1}$ represents $(-\log(U^0_{t+1}/U^0_t) + \varepsilon_{i,t+1} + \xi_{i,t+1})/(1+\delta-\sigma)$

and

$\omega_{i,t+1}$ represents $((1-\sigma)\log(U^0_{t+1}/U^0_t) + \delta\varepsilon_{i,t+1} + (\sigma-1)\xi_{i,t+1})/(1+\delta-\sigma)$

Population growth rate is the dependent variable in our regression model and our goal in this paper is to estimate equation (7). In the case of cross-countries comparison, the difference in the population growth rates is determined by the birth rate due to the restriction on the immigration, making it difficult to treat the population growth as the primary indicator of the economic growth of a country. However, in the case of cities, population growth may signal the favorable living environments measured by the quality of life index and the abundant job opportunities measured by the productivity of labor in that city. People may compare the migration costs such as monetary and psychological costs with the benefits, and decide to migrate when the difference between the expected benefits obtained from living in the new city and the benefits enjoyed in the currently residing city is greater than the migration costs. This leads us to select the ratio variable of the current year population to the initial year population as the main indicator of the economic growth of the cities (a dependent variable in the regressions).

[4] As mentioned above, it is very important to remember that free migration across cities ensures constant (identical) utility level across cities at a point in time. Therefore, $\log(U^0_{t+1}/U^0_t)$, which is included as a component of the error terms, $\chi_{i,t+1}$ and $\omega_{i,t+1}$ is a constant, not a function of $\log(L_{i,t+1}/L_{i,t})$l. Thus one cannot argue that our empirical specification is flawed because, in equation (7), $\log(L_{i,t+1}/L_{i,t})$ appears in both sides of the equality, namely, log $\log(L_{i,t+1}/L_{i,t})$ appears explicitly in the left-hand side of (7) and implicitly in the right-hand side of (7) through the error term, $\chi_{i,t+1}$.

In the cross-country studies where the labor movement across countries is restricted, the income growth (wage growth) can be interpreted as the increase in the labor productivity. However, the situation changes when we conduct the cross-cities analysis where labor can move freely across the cities. Migration occurs on the basis of the growth opportunities. Moreover, income (wage) growth may reflect the compensation for the decrease of the quality of living environments as well as reflecting productivity increases. Income growth therefore is a less clear indicator of the economic growth of cities compared to population growth. Accordingly, equation (8) which uses wage (income) growth as an dependent variable is not estimated in this study.

3. Data and Descriptive Statistics

This study identifies the city's characteristics which contribute to the growth of city population using the data on cities, counties (*gun*s), and wards (*gu*s) from the Korean Population Census 2% sample tape for the five years, 1980, 1985, 1990, 1995 and 2000.

A number of new administrative units have been created during the sample periods, where some regions were merged into a larger region horizontally or vertically, while some regions were divided into smaller districts. In order to track down the changes in the population composition for identical geographical regions, data are transformed in this regard.

How many are cities, wards and counties separately? 57 cities, 94 counties (*gun*s), and 43 wards (*gus*) are analyzed for the long term analyses over the period of 1980-2000. The wards (*gus*) in the six mega-cities (Seoul Special City, Busan, Daegu, Incheon, Gwangju, and Daejeon) are treated separately. For the sake of convenience cities, counties (*guns*), and wards (*gus*) are called "cities" from now on.

In order to investigate the effect of the local tax burden on the city population growth, data from the *Main Statistical Indices for Cities, Counties (guns) and Wards (gus) of 1999* are used. Per capita local tax burden (100,000 won) in 1990 is used as one of the independent variables since it represents the amount of the tax collected by local government.[5]

[5] Because of the unavailability of the data, we used the data on the per capita local tax burden for 1990 (from Korea National Statistical Office, *Main Statistics for Cities, Counties (guns), and Wards (gus)*of 1999) rather than data for 1980.

In order to investigate the effect of land-use regulations on the population growth of the city, green belt ratio (defined as the ratio of the area in which development is restricted to the whole area of a city) and 5 zone dummies such as "Restricted Development Subregion(RDS)", "Controlled Development Subregion(CDS)", "Encouraged Development Subregion(EDS)", "Environmental Protection Subregion(EPS)", and "Special Development Subregion(SDS)" in the Capital Region are used. The greenbelt areas were designated in early 1970. The five zones were designated during 1984-1994 as a measure of "Capital Region Spatial Concentration Control Policy". We may expect these population concentration control policy measures would have had impact on the population migration.

We first conduct a long-term analysis over the period 1980-2000 and then conduct sub-sample period analyses over the sub-periods 1980-1985, 1985-1990, 1990-1995, and 1995-2000, in order to capture the sub-sample period variations of the impact of the regional characteristics on city population growth.

Before we look at the descriptive statistic, we have checked the nonstationarity of the data with 5 panel unit root tests such as Levin, Lin and Chu (2002), Breitung (2000), Im, Pesaran and Shin (2003), Fisher-type tests using ADF and PP tests, following Baltagi and Kao (2000). By adding the cross-section dimension to the time-series dimension offers an advantage in the testing for non-stationarity. Tests such as Livin, Lin & Chu and Breitung assumes common unit root process across cross sections while the rest of the tests assumes individual unit root process across different cross sections. Only individual intercept is included in the specification of the model considering the simulation results of Choi (1999a) which report decrease of the test power when a linear time trend is included in the model. Table below shows the test results. Five panel unit root tests reject the null of unit root for the population growth data while only Im, Pesaran and Shin rejects the null of unit root for the mean education data. We assume all the data we use are stationary and proceed with individual regression equation instead of focusing on the panel data set. [6]

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[6] Panel regression has been attempted but the test resulted in the singularity problem, which is presumed to be due the small T in our panel data set. Usually the panel data econometrics are geared to studying the asymptotics of macro panels with large N cross section data and large T length of time series data. However, the data set we use here are typical micro panel data set with large N with small T which is only 5.

<Results of Panel Unit Root Tests>

Variable	Test Methods	Statistic(Prob*)	Cross-sections	Obs
Population growth	Null: Unit root (assumes common unit root)			
	Levin, Lin and Chu	-11.85(0.00)	179	708
	Breitung	-5.46(0.00)	179	529
	Null: Unit root (assumes individual unit root)			
	Im, Pesaran and Shin	-16.94(0.00)	179	708
	ADF-Fisher	560.43(0.00)	179	708
	PP-Fisher	572.37(0.00)	179	708
Mean Education level	Null: Unit root (assumes common unit root)			
	Levin, Lin and Chu	67.88(1.00)	234	936
	Breitung	47.51(1.00)	234	702
	Null: Unit root (assumes individual unit root)			
	Im, Pesaran and Shin	-2.11(0.02)	234	936
	ADF-Fisher	378.47(0.99)	234	936
	PP-Fisher	26.09(1.00)	234	936

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

Table 1 presents means and standard deviations of the major variables used in the long-term analysis of the 1980~2000. Average population across cities increased by 25.3% from 189,835 people in 1980 to 237,814 people in 2000. The average ratio of 2000 population to 1980 population across cities, the log of which is the dependent variable in the regression is shown to be 1.11[7]. The average year of education at the initial year, 1980 was 7.28 year, while the average unemployment rate was 12% in 1980 and the per capita local tax burden in 1990 was 106,000 won.[8] The average manufacturing share in the city's total employment was 18% in 1980. The average of the population's average ages

[7] Average of the ratios of the current year population to the initial year population is

$$[\sum_{i=1}^{194} RATIO_i]/194,$$

where

$$RATIO_i = \frac{pop_{t+1,i}}{pop_{t,i}}$$

and $pop_{t,i}$ represents the total population of the city i in initial year. Therefore, it should be noted that 1.11, the average of ratios of the current year population to the initial year population across cities differs from the value obtained by dividing the average current year population across cities (237,814 people) by the average initial year population across cities(189,835 people).

[8] The Korean currency unit, won, was recently valued at 1,000 won per US$1.

across cities is 26.21[9]. This is the average of the average ages of each city's population, which is calculated by deriving the average age over the whole population in the particular city.

Table 1 also shows the shares of humanity high school graduates, business high school graduates, junior college graduates and college graduates are 31%, 17%, 4%, and 10%, respectively. In order to investigate the effect of the proximity to metropolitan area on city's population growth we measure the distance (in km) from the nearest metropolitan area, namely, the central ward of the Mega-cities or the center of the largest city in the province. The average value of the distance is 45 km.

Table 2 shows the city's characteristics at the initial year for the top 10 fastest growing cities and for the bottom 10 slowest growing cities. Prominent population increases are observed in Ansan, Ulsan, Goyang, Siheung(including Kwacheon, Kunpo, Euwang, Kwangmyung) and Bucheon. On the other hand, the slowest growing cities observed are all counties (*gun*s) such as Jeongseon, Sinan, Imsil, Jian and Bonghwa.[10]

Fastest growing cities are those where the housing complexes in large scales were constructed based on the Government's development plans such as 'Two Million Housing Project' during 1980-1995 and the construction of the 'New Cities'. The Theory of 'housing filtering process' which suggests that the dwelling is occupied by households with progressively lower incomes predicts that the increase in the number of housings has a positive effect on population migration (Ha, 1991). Whenever new housings facilities were built, the population moved into the newly built houses and another new population moved into the old houses which the previous population had left. The fact that the top 10 fastest population growing cities include the cities with those characteristics supports the housing filtering process theory.

Peripheries of Seoul, such as Incheon (Bukgu including Bupyeonggu, Gyeyanggu and Seogu), Ansan, Goyang, Siheung, Bucheon, and Suwon have experienced rapid growth since 1970.

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9 The average of the population's average ages across cities, $\bar{A}\bar{A}$.

$$\bar{A}\bar{A} = [\sum_{i=1}^{194} (\frac{\sum_{j=1}^{n_i} AGE_{i,j}}{n_i})]/194$$

where n_i is the total population of the city i and $AGE_{i,j}$ is the age of the jth individual of the city i

10 In Korea a county (*gun*) does not include any urban area, but includes rural areas only.

Manufacturing sector growth outside the Capital Region such as Ulsan and Changwon (top 11th fastest population growing city with the ratio of 2000 population to 1980 population, 2.59) have been encouraged through the factory redistribution policies in pursuit of the dispersion of the Seoul population and balanced national land development.

Incheon attracts factories as the seaside factory park while Suwon, Siheung and Bucheon attract factories as parks for urban-type factories. Ulsan and Changwon also have grown in population as a result of the government's strategy of developing the southeastern seaside region. Factory parks were developed along the southeastern seaside around the harbor cities under the dispersion policy of the Capital Region's population and industry facilities. These cities emerged as the largest heavy chemical factory parks in Korea. Growth in the manufacturing sector in these cities (Ulsan and Changwon) is supported by the data showing high manufacturing shares (0.51 for Ulsan and 0.29 for Changwon) in these cities as shown in Table 2.

The city's characteristics at the initial year show the significant differences between the top 10 fastest population growing cities and bottom 10 slowest population growing cities. The average education levels (in years) of the fastest growing cities are higher when compared to those of all cities in the sample, and are particularly high when compared to those of the bottom 10 cities. In addition, the manufacturing employment shares at the initial year for the top 10 cities turn out to be significantly higher when compared to those of the lowest growing cities. The average age of the city dwellers is found to be lower in the cities where population growth is higher.

4. Regression Results

1) Long Term Period Analysis over the Period 1980-2000

As stated above, the objective of our study is to search for the determinants of the population growth in the cities. Table 3 reports the regression result of the effects of the city's basic characteristics at the initial year on the city population growth over the period 1980-2000.[11] The basic

[11] An anonymous referee pointed out that our regression anayses are based on the notion that the initial conditions of regional characteristics determine the future trajectory of population growth in the region. The referee criticized our paper that we ignore the dynamics of city development. To correct this problem, this referee suggested us to use simultaneous equations of population-job creation-living environment dynamics and nexus. We agree fully with this referee's criticism

variables are those such as average years of education, average age of the residents, the square of the average age, the per capita local tax burden, the unemployment rate, the manufacturing employment share, the 1st industry employment share, the distance from the nearest metropolitan area, the ward (*gu* in the mega-cities) dummy, the city dummy and regional dummies. We run four different kinds of regression equations in Table 3 depending on our interest in the particular variables. Equation (1) is a benchmark regression equation, whereas equation (2) especially investigates the effect of givernment's land use regulation and equation (3) investigates the effect of education in more detail. Finally, equation (4) shows the results of equation (1) for the data which include six mega-cities instead of 43 wards.

Regression results of equation (1) shows that the average education level at the initial year has a significant positive effect on the city's population growth.

Also it shows that the average age of the resident variable has statistically significant negative effect on population growth, while it's squared variable has a statistically insignificant positive effect. City population growth requires abundant human capital to be used in production in addition to the existence of the highly productive and prosperous industries and abundant capital stock. In the case of Korea, the young and middle-aged population with a large amount of human capital has moved out of rural areas, leaving the aged behind. This reduces productivity in rural areas, which reinforces the population decline in rural areas creating a vicious circle.

Per capita local tax burden has a positive effect, but is not statistically significant. Cities with higher tax revenue spend more on public goods such as sanitary and public facilities and therefore cities with higher tax burden can be inferred to have a favorable living environments compared to those cities with lower tax burden, resulting in faster population growth.

Higher unemployment rate at the initial year has a negative effect on population growth but is not statistically significant. Unemployment rate can represent underutilized human capital. High unemployment rate may imply lack of the skilled labor force, which is the main forces of the growth of the city and thereby resulting in a decrease in the labor productivity. Therefore a higher

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and would like to point out that dynamic issues should be our future research areas.

unemployment rate is inferred to provide higher incentive of the population outflow rather than population inflow[12].

The manufacturing employment share has a statistically significant positive effect on the city population growth, contrary to what found by Glaeser et al (1995) who analyzed data for the United States. Over the sample periods of 1960~1990 in United States, the initial manufacturing employment share had been found to have a significantly negative effect on the city's growth.

According to Glaeser et al. (1995), the future of the city, (i.e. the growth of city population), depends on the fortunes of the initial industries of the city. Non-manufacturing production activities do not move into the cities where the manufacturing shares are high. The populations in these cities tend to decline due to the migration and income follows the same path. These can be explained by the vintage capital model. Capital invested in the city becomes obsolete, however it is not replaced by new capital. The reason for this can be explained as follows: first, the existing capital becomes the sunk cost and second, the existing capital crowds out the new capital. This theory suggests that as capital deteriorates, labor's marginal productivity and wage growth decrease, resulting in the population decrease.

Nevertheless, it is too early to argue that the Glaeser's theory does not hold in the case of Korea. In Korea, manufacturing industry was regarded as having the great development potential with higher productivity. In addition, manufacturing was selected as a core strategic industry strongly encouraged by the Korean Government.

Also the 2nd industry share of employment can be used as a proxy for job opportunities according to Lee (1980) and a city based on manufacturing offers higher job opportunities and attracts more population. Therefore, the regression analysis results of manufacturing share of employment in Korea having a positive effect on population growth maybe assumed to be reasonable.

[12] We should however bear in mind that the unemployment rate is a stock measure, which means that unemployment rate comprises the several different flow measures such as new employment, layoffs, temporary layoffs. The usages of these individual flow measures rather than the stock measures would be more logical in assessing the impact of the unemployment on the population migration. Unfortunately, data on these individual flow measures are hard to obtain and are not used in this study.

The coefficient which shows the effect of the distances from the nearest metropolitan areas on population growth has a significant negative value. The proximity to metropolitan area appears to bring a greater job opportunities for resident in the region.

The negative but insignificant coefficient for the ward (in the mega-city) dummy and the significant positive coefficient for the city dummy imply that the population in the wards in the mega-cities do not grow faster than those of rural areas, but the population in the cities grow substantially faster than those of rural areas.

The regional dummies[13] reflect the regional characteristics such as climate and location, which are the important contributing factors for migration and city population growth. Population growths in the Capital Region which includes Seoul, Incheon and Gyunggi Province are relatively higher when compared to that in Chungbuk Province, which is used as a comparison variable. The population growths in Junbuk Province and Junnam Province are significantly lower in comparison with that of Chungbuk province.

The coefficient estimate for the population at the initial year 1980 in Table 3 shows the effect of past population size on future population growth which enables us to test the convergence hypothesis [See Barro and Sala-I-Martin (1992)]. The significant negative coefficient for the initial year's population size of equations (1), (2) and (3) indicates that cities with the large population size at the initial year 1980 are experiencing slow population growth rates. The rate of its population growth in the future period may become lower due to the externalities resulting from large population sizes such as traffic congestions, pollutions and increase of the land prices.

Equation (2) of Table 3[14] especially reports the impact of land-use regulations such as the Capital Region Spatial Concentration Control Policy'[15] and 'the greenbelt'[16] on the city's population growth.

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[13] Following the suggestion by one of referees we combined regions so that we can minimize the use dummy variables.

[14] We did not include regional dummy variables in equations (2) because the effect of the Capital Region Spatial Concentration Control Policy on population growth cannot be assessed when the regional dummy variables including the Capital Region dummy are included in the equation.

[15] "Restricted Development Subregion(RDS)" includes Seoul, Eugeongbu, Goori, Namyangjoo, Hanam, Goyang, (part of) Yangju Gun, (part of) Pochon Gun. This is the measure against concentration and encourages the outflow of the population inducing facilities. "Controlled Development Zone(CDS)" includes Inchoen, Suwon, Sungnam, Anyang, Boocheon, Kwangmyung, Gwachoen, Ansan, Osan, Euwang, Goonpo, Seeheung, (part of) Yongin, (part of) Hwasugn gun, (part of)

Effect of the greenbelt ratio presented in all three equations (1) , (2) and (3) has a statistically significant positive effect on the city's population growth. Specially the effects of the Capital Region Spatial Concentration Control Policy is represented in the regression analyses of equation (2). The dummy variables for 'Controlled Development Subregion' and 'Encouraged Development Subregion", and "Environmental Protection Subregion" are found to have the positive effect, and all of these coefficients are statistically significant. Other dummy variables such as 'Restricted Development Subregion' and 'Special Development Subregion' are found to be statistically insignificant..

These findings suggest that the demarcation of the Capital Region according to the Capital Region Rearrangement Plan did not have any significant impact on the city's population growth. It has been found that population growth has occurred despite these land-use regulations. The similar result was found in other researches[See Lee, Sosin and Hong (2005)]. Our empirical results suggest the ineffectiveness of the Capital Region Spatial Concentration Control Policy whose main intention was to slowdown the concentration of the population in the Capital Region. This can be also interpreted that the policies such as designation of five zones by the Capital Region Spatial Concentration Control Policy and the greenbelt areas were confined to the cities where excessive population growth had been already progressed substantially.

Regression analysis of equation (3) of Table 3 includes the share variables of humanity high school graduates, business high school graduates, junior college graduates, and university graduates in place of the average years of education.

Some important implications can be drawn from the regression results of equation (3). The share of high school graduates, especially business high school graduates has a statistically significantly

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Pyungtaek, and (part of) Kimpo gun. This measure intends to rearrange activities within the city and to adjust industrial zones for the purpose of restraining on the excessive congestion. "Encouraged Development Subregion(EDS)" includes Pyungtaek, (part of) Hwasung gun, (part of) Ansung gun. This measure intends the formulation of the base for the corporate transfer plan. "Environmental Protection Subregion(EPS)" includes Icheon, (part of) Yongin, Gapyung gun, Yangpyung gun, Yujoo gun, Kwangjoo gun, (part of) Ansung gun and mainly intends to preserve the quality of Han River and designate resort areas. "Special Development Subregion(SDS)" includes Dongdoochoen, Pajoo, Yunchoen gun, Gangwha gun, Ongjin gun, (part of) Pocheon gun, (part of) Yangjoo gun, (part of) Kimpo gun and its object lies in the improvement of the residential life.

[16] Green belt area is around 5,397 km^2 comprising 5.4% of the total land of 99,300 km^2 in Korea.

positive effect implying that the larger the share of high school graduates of the city dwellers, the faster the city growth rate is. The share of junior college graduates has a negative effect, even though statistically insignificant. High school graduates share in the city's population contributes more to the city's growth in population than the share of university graduates. This underlines the importance of a decently educated (high school graduates) labor force rather than labor force with higher education (college graduates). Enhancing the average level of education in the region as a whole is more important for the growth of the city than increasing population shares with college educations.

The result of equation (1) of Table 3 indicates a significant positive coefficient for the city dummy variable and an insignificant negative coefficient for the mega-city dummy variable. The population growth rates are much faster for cities compared to those for rural areas. However, the result showing an insignificant negative impact of the mega-city dummy on population growth could be misleading because it is possible that the mega-cities themselves might have been growing even though many individual wards belonging to the mega-cities are not growing. In order to resolve this problem the regression equation (4) of Table 3 shows the results of equation (1) for the data which include six mega-cities, namely, Seoul, Busan, Daegu, Incheon, Gwangju, and Daejeon instead of 43 individual wards. The result shows a significant positive coefficient for the mega-city dummy variable which implies that the mega-cities by themselves grow faster than rural areas even though many individual wards belonging to the mega-cities do not grow fast because of continuous redistribution of population among wards within the same mega-city. The substantially higher adjusted R^2 of equation (4) compared to that of equation (1) (0.8411 versus 0.6583) of Table 3 implies that much smaller variance of population growth rates can be explained by our independent variables for the case of wards compared to the case of mega-cities by themselves.

There is no significant difference between coefficient estimates of equation (1) and those of equation (4) of Table 3 except the coefficients for the local tax burden variable, the two age variables, and the share of greenbelt areas. The significant positive coefficient for the local tax burden variable for equation (4) unlike the case of equation (1) implies that the difference in local tax burden does not reflect any significant difference in social infrastructure investments in the case of different wards belonging to the same mega-city because many of infrastructure investments, for example, subway train system will be performed by the mega-city government rather than by individual ward government. The difference in age variables' coefficients between equation (1) and equation (4) can be explained by the results in Table 4 which show that the age variables have significant (negative) nonlinear effect on population growth rates only for wards in the mega-cities, not for cities or rural areas. Since equation (4) does not allow any room for the variation in the effect of old ages on population growth among wards belonging to the same mega-city it is natural to observe that the coefficients for the age variables become insignificant for equation (4). Finally, the fact that the coefficient for the share of greenbelt areas variable becomes insignificant in equation (4) of Table 3 indicates that the variations in the shares of greenbelt areas among different wards within the same mega-city are important in explaining the difference in population growth rates among the wards. Since we are very much interested in explaining the determinants of population growth rates for different wards in the mega-cities we prefer the equation (1) over the equation (4).

The results of Table 4 show the coefficient estimates for the interaction terms between the explanatory variables (of both dummy variables and continuous variables) and various kinds of dummy variables which reflect different sizes of regions, namely wards (*gu*) in mega-cities, cities and rural areas(*gun*)[17] or reflect whether the city belongs to the Capital Region or not. The results of Table 4 are summarized in the following Table.

	Wards (Mega-city)	City	Rural areas
Average education years		+**	+***
Share of humanity high school graduates	-**	+	+**
Share of business high school graduates	-	+**	+**
Share of junior college graduates	+	-**	+
Share of university graduates	+	+	+
Average age	-***	+	+
Squares of average age	+***	-	-
Tax burden	-	+***	+***
Unemployment rate in 1980	-**	-	-
Distance from urban center (in Km)	+***	-**	-

[17] We are grateful to one of referees who suggested that instead of using the dummy variables only for intercept of regression equation we should impose dummies to explanatory variables to have more interesting results and interpretation on both significant and insignificant factors.

	The Capital Region	Non-Capital Region
Share of green belt area	+***	+
Share of employees in manufacturing sector in 1980	-	+*
Share of employees in 1^{st} industry in 1980	-	-

For equation (1) of Table 4 we added the interaction terms between the average year of education variable and one of three size classes of regions, wards (*gu*) in mega-cities, cities and rural areas (*gun*) to our benchmark regression equation (1) in Table 3. The education level reveals a significant positive effect in cities and rural areas, which represents the population stimulating effect of higher education in these areas.

To the equation (1) in Table 3, we added the interaction terms between one of the three size classes of regions and each of the two age variables, namely, average age of the city population and its squared variable and these are represented in equation (2). The average age of population has a highly statistically significant negative effect and the age squared variable has an insignificant positive effect on population growth in the case of mega-cities.

For equation (3) of Table 4, the average years of education variable in equation (1) of Table 4 has been replaced by sub-categories of education level variables, namely, humanity high school graduates, business high school graduates, junior college graduates and college graduates. The share of humanity high school graduates has a significantly positive effect in the rural areas, while the share of business high school graduates has statistically positive effect in cities and rural areas. On the other hand, share of humanity high school graduates and shares of business high school graduates have negative effect on the meg-cities population growth even though it is not statistically significant for the case of share of business high school graduates.

The share of junior or college graduates has a significant negative effect on population growth in the cities and while share of university graduates does not have statistically significant effect on the population growth for all three different size classes of regions.

For equation (4) of Table 4 we added the interaction terms between the variables such as burden of local tax per capita (100,000won), the unemployment rate in 1980 and the distance from the nearest metropolitan area (in km) and one of three size classes of regions, namely, wards (*gu*) in mega-cities, cities and rural areas (*gun*) to our benchmark regression equation (1) in Table 3.

The burden of local tax per capita has a significant positive effect on population growth for cities and rural areas where the level of local tax per capita appears to reflect the level of social infrastructure investments. The unemployment rate in the region has a significant negative effect on population growth only for the mega-cities where a high level of unemployment appears to reflect the lack of skilled workers and the paucity of job opportunities. The distance from the nearest metropolitan center has a significant positive effect on population growth for the mega-cities where the population decline in their central areas has become severe over the last two decades. On the other hand, the distance from the metropolitan center has a significant negative effect on population growth for the cities where the distant location from the large commercial centers provides a severe disadvantage in their economic growth.

Equation (4) of Table 4 also includes the interaction terms between variables such as share of greenbelt areas, share of employees in manufacturing sector and share of employees in 1st industry in 1980 and one dummy between the Capital Region and non-Capital Region.

The share of greenbelt areas in total city areas has a significant positive coefficient for the Capital Region while it has a insignificant positive coefficient for the non-Capital Region. This implies that the greenbelt policy was not effective at all in the redistribution of population from the Capital Region. The share of manufacturing employment in total city employment has a insignificant negative coefficient in the Capital Region while it has a significant positive coefficient in the non-Capital Region. This implies that a large share of manufacturing employment at the initial year has a significant positive effect on population growth only for the non-Capital Region. The share of 1st industry employment in total city employment has insignificant positive coefficients in both the Capital Region and the non-Capital Region.

2) Sub-sample Period Analyses

Sub-sample period analyses enable us to compare the magnitudes of the coefficients for the city's characteristic variables over time. Table 5 reports results of sub-sample analysis during the four sub-periods, 1980-1985, 1985-1990, 1990-1995, and 1995-2000.

Regression results of equations (1) - (4) for which our preferred regression equation, equation (1) of Table 3 is estimated for four sub-sample periods show that the effect of the manufacturing employment share has been highest during the years 1985-1990. The value of the coefficient on the manufacturing employment share during 1990-1995 (.473) and during 1995-2000 (.406) are substantially smaller compared to that during the years 1985-1990 (.637), showing a decreasing effect of the manufacturing share variable on the city's population growth. This suggests that Glaeser's argument may indeed apply to Korea. [see Glaeser et al. (1995)]. The negative effect of the manufacturing employment share on population growth found in the United States (where the manufacturing is a declining industry) may imply that we can project a declining effect of the manufacturing share variable on city's population growth in Korea in the future.

Another notable point is the changes in the significance of the coefficient for the average education year variable (See regression results of equations (1) - (4)). The sign of the coefficient on this variable has been positive and significant during all four sub-sample periods. This shows that the effect of the education on population growth has consistently been strong and positive.

The unemployment rate variable had a significant negative coefficient for the sub-sample period 1980-1985, but the variable had insignificant negative coefficients for the sub-sample periods 1985-1990 and 1990-1995 and insignificant positive coefficients for the sub-sample periods 1995-2000. These results indicate that the negative influence of high unemployment rates in the cities on population growth rates has weakened over the period.

The population growth rates of wards of the mega-cities was significantly higher than those of rural areas during the period 1980-1985, then the coefficient became an insignificant negative during the period 1985-1990 and finally the coefficients became significant negative during 1990-1995 and 1995-2000. These results imply that the population growth rates for the wards in the mega-cities have declined substantially over the periods.

The population growth rates of the Capital Region which includes Seoul, Incheon and Gyunggi Province were significantly higher than those of Chungbuk Province during the period 1980-1985, then the coefficients became insignificant positive during the periods 1985-1990 and 1990-1995 and finally the coefficient became significant positive again during the period 1995-2000. These results imply that the effectiveness of the Korean government's population control policy for the Capital Region has substantially weakened during the recent period 1995-2000 during which Korea suffered severely from the 1997 Asian financial crisis.

The coefficient estimates for two southwestern provinces of Korea, namely, Junbuk Province and Junnam Province indicate that the population growth rates of these two provinces fluctuate widely over the periods. The population growth rates of these two provinces were significantly lower than those of Chungbuk Province during the period 1980-1985, and then the coefficients became insignificant positive during the periods 1985-1990. Again the coefficients became significant negative during the period 1990-1995. Finally, the coefficients became insignificant again during the period 1995-2000.

5. Conclusion

During the past 40 years, Korea has achieved remarkable economic growth. In parallel with this development, however, various economic and social problems have occurred. Large cities have suffered the urban problems such as traffic jams, shortages of housing and water, pollution, and increase of crimes. The rural areas, on the other hand, suffered the backwardness of social and economic conditions including a shortage of labor force. Identifying the regional characteristics affecting the population growth of the cities, counties (*guns*) and wards (*gus*) in mega-cities is important if we are to resolve the problem of unequal growth of regions in Korea.

This study tries to do that job using the population growth data of the cities. In this study, initial variables such as average education level and the share of manufacturing employment of total city employment are found to be the important factors for the growth of the city. Average education level at the initial year is found to have a significant positive effect on population growth underlining the positive role that education plays in the development of the regional economy. Most of previous researches have focused on the productive externalities acquired by education when they analyze the relationship between human capital level at the initial period and economic growth across countries. This externality is considered to be more important in the case of the cities than across countries.

Our results show a positive effect of the manufacturing employment share at the initial year on city's population growth. The future of the city, namely, the growth of city population depends on the fortunes of the initial core industries in the city. Many people in the cities with declining core industries will move out of the cities resulting in decline in population and consequent declines in income. Manufacturing in Korea was considered to be the core strategic industry and had a bright prospect of rapid development attracting more population consequently. Policy variables regarding land-use regulations such as greenbelt ratio and demarcation of the regions under 'the Capital Region Spatial Concentration Control Policy' are found to be ineffective on the net movements of population.

Our sub-sample period analyses uncover some interesting findings. The impact of the manufacturing sector on population growth is on a declining trend as argued by Glaeser et al. (1995). On the other hand, the effect of education level (measured in years) remains an important factor contributing to population growth over the time. The growth rates of cities which grew fast in past slowed down supporting the convergence hypothesis in Korea.

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<Table 1> Means and Standard Deviations of the Variables used in the Long term Analyses for the Period of 1980-2000

Variables	**means**	**Standard deviation**
1980 population	189,835	141,621.
2000 population	237,814	271,638
2000 population/1980 population	1.11	1.42
Independent Variables in 1980 (initial year)		
Log of 1980 population	8.17	0.73
Average education years in 1980	7.28	1.61
Share of humanity high school graduates	0.31	2.38
Share of business high school graduates	0.17	1.27
Share of junior college graduates	0.04	0.33
Share of university graduates	0.10	0.73
Average age	26.21	1.75
Squares of average age	1064.73	151.94
Tax burden (100,000 won) in 1990	1.06	0.78
Unemployment rate in 1980	0.12	0.07
Share of employees in manufacturing sector in 1980	0.18	0.16
Share of employees in 1st industry in 1980	0.45	0.33
Share of green belt area	0.16	0.23
Distance from urban center (in km)	44.96	38.35

Sources: National Statistical Office, *Report on Korean Population and Housings Census* 1980-2000

<Table 2> The Top 10 Fastest Population Growing Cities and the Bottom 10 Slowest Population Growing Cities during 1980-1995

Province or Mega-city	City, County(*gun*) or Ward(*gu*)	20pop/ 80 pop	Pop in 1980	Pop in 2000	Education	Age	Manufacturing ratio	1st industry ratio
Gyongi	Ansan	18.08	31,140	562,920	8.09	25.26	0.24	0.21
Gyungnam	Ulsan	8.68	116,909	1,014,428	8.94	22.70	0.51	0.06
Gyonggi	Goyang	4.91	155,601	763,971	8.09	26.12	0.22	0.35
Gyonggi	Siheung	3.76	288,913	1,087,644	8.48	24.33	0.42	0.16
Gyonggi	Bucheon	3.44	221,463	761,389	9.25	23.68	0.49	0.05
Incheon	Bukgu	3.41	350,142	1,194,107	8.70	23.68	0.53	0.04
Gyonggi	Suwon	3.05	310,476	946,704	9.08	24.29	0.33	0.05
Gyonggi	Yongin	2.85	135,572	386,124	6.89	26.22	0.28	0.52
Gyonggi	Uijeongbu	2.67	133,177	355,380	8.85	24.72	0.31	0.05
Gyonggi	Namyangju	2.62	191,479	501,771	7.58	25.67	0.36	0.32
Chunnam	Hampyeong-gun	0.43	96,358	41,292	5.28	27.70	0.02	0.84
Chunnam	Jangheung-gun	0.43	112,961	48,305	5.61	27.16	0.03	0.85
Chunnam	Sunchang-gun	0.41	73,635	30,515	4.90	27.41	0.02	0.86
Chunbuk	Jangsu-gun	0.40	57,820	23,316	5.53	26.41	0.03	0.78
Gyungbuk	Yeongyang-gun	0.39	52,733	20,735	5.73	27.25	0.0	0.82
Gyungbuk	Bonghwa-gun	0.39	97,513	38,238	5.69	26.25	0.04	0.75
Chubuk	Jinan-gun	0.39	78,485	30,276	5.39	26.77	0.03	0.83
Chunbuk	Imsil-gun	0.37	83,973	30,799	4.67	27.55	0.02	0.90
Chunnam	Sinan-gun	0.35	130,979	46,315	5.57	25.75	0.01	0.93
Gangwon	Jeongseon	0.34	133,843	46,080	6.38	23.87	0.03	0.73

<Table 3> Regression Analyses on the Determinants of the Population Growth of the City (1980-2000)

Variables	(1)	(2)	(3)	(4)
Constant	4.71** (2.13)	0.42 (0.22)	5.28** (2.35)	-0.696 (-0.40)
Log of 1980 population	-0.17** (-2.45)	-0.13* (-1.91)	-0.12* (-1.73)	-0.160** (-2.99)
Average education years in 1980	0.15** (2.26)	0.16** (2.39)		0.115** (2.00)
Share of humanity high school graduates			2.14 (1.61)	
Share of business high school graduates			4.46*** (3.11)	
Share of junior college graduates			-12.90* (-1.75)	
Share of university graduates			0.93 (0.75)	
Average age in 1980	-0.30* (-1.83)	-0.04 (-0.28)	-0.29* (-1.82)	0.031 (0.24)
Squares of average age in 1980	0.00 (1.47)	0.00 (0.18)	0.00 (1.35)	0.000 (0.03)
Local Tax burden in 1990	0.02 (0.55)	0.02 (0.48)	0.03 (0.78)	0.681*** (8.55)
Unemployment rate in 1980	-1.20 (-1.26)	-1.01 (-1.11)	-1.29 (-1.33)	-0.995 (-1.34)
Share of employees in manufacturing sector in 1980	1.29** (2.27)	1.43*** (2.83)	0.59 (0.90)	1.088** (2.16)
Share of employees in 1st industry in 1980	0.35 (0.86)	0.34 (0.82)	0.13 (0.30)	-0.138 (-0.42)
Share of green belt area in 1980	1.05*** (6.30)	1.12*** (6.74)	1.06*** (6.24)	0.264 (1.33)
Distance from urban center (in km) in 1980	-0.00* (-1.91)	-0.00 (-1.04)	-0.02* (-1.71)	-0.002* (-1.77)
Mega City (Kwangyukshi)	-0.06 (-0.36)	-0.14 (-0.93)	0.04 (0.23)	0.415** (2.14)
City(shi)	0.46*** (5.07)	0.36*** (4.01)	0.49*** (5.31)	0.347*** (5.00)
Capital Region	0.27** (1.98)		0.23* (1.67)	0.171* (1.68)
Gangwon	-0.13 (-0.87)		-0.13 (-0.86)	0.098 (0.87)
Choongnam	0.08 (0.54)		0.07 (0.50)	0.237** (2.17)
Chunbuk	-0.43*** (-2.74)		-0.45*** (-2.81)	-0.066 (-0.55)
Chunnam	-0.27* (-1.81)		-0.26* (-1.77)	0.102 (0.88)
Gyungbuk	-0.08 (-0.64)		-0.04 (-0.27)	0.122 (1.21)
Gyungnam	-0.03 (-0.21)		-0.09 (-0.65)	-0.025 (-0.23)
Cheju	-0.06 (-0.25)		-0.25 (-0.94)	0.051 (0.27)
Moving Acceleration Zone		0.18 (1.56)		
Restrictive Adjustment Zone		0.47.*** (3.56)		
Development Induction Zone		0.53** (2.01)		
Nature Conservation Zone		0.46*** (2.74)		
Development Reservation Zone		0.03 (0.14)		
No. of observations	191	191	191	156
Adj. R-square	0.6583	0.6471	0.6622	0.8411

1) The figures in the parentheses are the t – value

2) *, **and *** indicate being statistically significant at 10% , 5% and 1% level, respectively.
3) The dependent variable is the log of the ratio of the current year population to the initial year population, log (2000 population/1980 population).
4) Chungbuk is used as a comparison variable for regional dummies

<Table 4> Regression Analyses on the Effect of Determinants with Interaction Terms on the Population Growth of the City (1980-2000)

Variables	(1)	(2)	(3)	(4)
Constant	4.05* (1.88)	-0.31 (-0.14)	4.11* (1.84)	0.72 (0.40)
Log of 1980 population	-0.12* (-1.75)	-0.07 (-1.08)	-0.10 (-1.31)	-0.07 (0.22)
Average education years in 1980		0.11* (1.94)		0.09* (1.80)
Average education years*mega cities	-0.04 (-0.41)			
Average education years*cities	0.18** (2.34)			
. Average education years*rural area	0.36*** (3.76)			
Share of humanity high school graduates*mega cities			-5.40** (-2.24)	
Share of humanity high school graduates*cities			2.20 (1.14)	
Share of humanity high school graduates*rural areas			5.42** (2.31)	
Share of business high school graduates*mega cities			-4.39 (-0.87)	
Share of business high school graduates*cities			4.96** (2.52)	
Share of business high school graduates*rural area			4.33** (2.18)	
Share of junior college graduates*mega cities			8.35 (0.51)	
Share of junior college graduates*cities			-18.22** (-2.06)	
Share of junior college graduates*rural area			-13.65 (-0.69)	
Share of university graduates*mega cities			1.01 (0.59)	
Share of university graduates*cities			2.51 (0.83)	
Share of university graduates*rural areas			10.42 (0.65)	
Average age of population	-0.40** (-2.50)		-0.27* (-1.75)	-0.16 (-1.21)
Average age of population*mega cities		-1.77*** (-6.48)		
Average age of population*cities		0.16 (0.67)		
Average age of population*rural area		0.02 (0.12)		
Squares of the average age	0.00** (0.03)		0.00 (1.41)	0.00 (0.18)
Squares of the average age*mega cities		0.02*** (5.41)		
Squares of the average age*cities		-0.00 (-0.56)		
Squares of the average age*rural area		-0.00 (-0.14)		
Local Tax burden	0.04 (0.87)	0.16*** (3.76)	0.01 (0.25)	
Local Tax burden*mega cities				-0.04 (-0.97)

Local Tax burden*cities				0.81*** (7.54)
Local Tax burden*rural area				0.77*** (6.28)
Unemployment rate in 1980	-1.74* (-1.86)	-1.36 (-1.60)	-1.25 (-1.31)	
Unemployment rate in 1980*mega cities				-3.78** (-2.34)
Unemployment rate in 1980*cities				-0.23 (-0.21)
Unemployment rate in 1980*rural area				-1.00 (-1.11)
Share of employees in manufacturing sector in 1980	0.76 (1.29)	0.65 (1.25)	0.38 (0.55)	
Share of employees in manufacturing sector in 1980*capital region				-0.36 (-0.53)
Share of employees in manufacturing sector in 1980*non capital region				0.97* (1.82)
Share of employees in 1st industry in 1980	-0.01 (-0.02)	-0.32 (-0.77)	-0.08 (-0.18)	
Share of employees in 1st industry in 1980 * capital region				-0.15 (-0.32)
Share of employees in 1st industry in 1980 *non capital region				-0.09 (-0.26)
Share of green belt area	0.99*** (5.94)	0.54*** (2.99)	0.77*** (3.76)	
Share of green belt area*capital region				0.78*** (3.41)
Share of green belt area*non capital region				0.16 (0.84)
Distance from urban center (in km)	-0.00* (-1.68)	-0.00* (-1.85)	-0.00 (-0.97)	
Distance from urban center*mega cities				0.05*** (4.91)
Distance from urban center*cities				-0.00** (-2.23)
Distance from urban center*rural area				-0.00 (-1.27)
No. of observations	191	191	191	191
Adj. R-square	0.6781	0.7315	0.6874	0.7958

1) The figures in the parentheses are the t – value
2) *, **and *** indicate being statistically significant at 10% , 5% and 1% level, respectively.
3) The dependent variable is the log of the ratio of the current year population to the initial year population, log (2000 population/1980 population).
4) Coefficients on the regional dummies were not reported for the sake of simplicity.

<Table 5> Sub-sample Regression Analyses on the Determinants of the City Growth (1980-1985, 1985-1990, 1990-1995 and 1995-2000)

Variables	(1) 1980-1985	(2) 1985-1990	(3) 1990-1995	(4) 1995-2000
Constant	2.60*** (3.37)	0.10 (0.11)	1.10 (1.37)	-0.49 (-0.82)
Log of 1980 population	-0.07*** (-2.74)	-0.09*** (-3.15)	-0.07*** (-3.03)	-0.02 (-1.24)
Average education years in initial year	0.04** (2.02)	0.09** (3.66)	0.08*** (3.90)	0.08*** (5.97)
Average age of population in 1980	+0.14** (-2.49)	-0.01 (-0.08)	-0.09 (-1.48)	-0.05 (-1.05)
Squares of the average age in 1980	0.00* (1.86)	0.00 (0.03)	0.00 (1.48)	0.00 (1.25)
Local Tax burden in 1990	-0.00 (-0.08)	0.02 (0.91)	-0.02 (-1.00)	0.02 (1.50)
Unemployment rate in 1980	-0.93*** (-2.81)	-0.27 (-0.68)	-0.17 (-0.48)	0.29 (1.13)
Share of employees in manufacturing sector in 1980	0.16 (0.81)	0.64*** (2.78)	0.47** (2.30)	0.41*** (2.77)
Share of employees in 1st industry in 1980	0.00 (0.02)	0.24 (1.49)	0.05 (0.33)	0.46*** (4.56)
Share of green belt area	0.31*** (5.07)	0.20** (2.58)	0.33*** (5.26)	0.26*** (5.44)
Distance from urban center (in km)	(-0.17) -0.00	(0.48) -0.00	(-1.18) -0.00	(-1.25)
Mega City (Kwangyukshi)	0.16*** (2.99)	-0.07 (-1.05)	-0.13** (-2.20)	-0.10** (-2.33)
City(shi)	0.16*** (4.96)	0.12*** (2.81)	0.06 (1.45)	0.04 (1.48)
Capital Region	0.08* (1.76)	0.05 (0.84)	0.00 (0.09)	0.07* (1.88)
Gangwon	-0.07 (-1.29)	-0.02 (-0.36)	-0.08 (-1.40)	0.01 (0.30)
Choongnam	0.01 (0.24)	0.09 (1.56)	-0.08 (-1.54)	-0.02 (-0.48)
Chunbuk	-0.11* (-1.96)	-0.04 (-0.58)	-0.12** (-2.04)	-0.06 (-1.17)
Chunnam	-0.10* (-1.85)	0.04 (0.63)	-0.15*** (-2.72)	-0.02 (-0.53)
Gyungbuk	-0.04 (-0.79)	-0.03 (-0.46)	-0.04 (-0.81)	-0.01 (-0.28)
Gyungnam	-0.03 (-0.70)	-0.01 (-0.16)	-0.02 (-0.43)	-0.01 (-0.30)
Cheju	-0.04 (-0.30)	0.06 (0.59)	-0.09 (-0.92)	-0.08 (-1.10)
No. of observations	188	184	186	193
Adj. R-square	0.5961	0.4539	0.5559	0.5403

1) The figures in the parentheses are the t – value

2) *, **and *** indicate being statistically significant at 10% , 5% and 1% level, respectively.

3) The dependent variable is the log of the ratio of the current year population to the initial year population, log (1985 population/1980 population); log (1990 population/1985 population); log (1995 population/1990 population), and log (2000 population/1995 population)..

4) Average education years in initial years represent education years in 1980, 1985, 1990 and 1995 respectively in equation (1) , (2), (3) and (4)