A Pilot Search for Urban Growth Sources and the Role of Culture -Case of Korean Urban Growth-

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Abstract

Recent studies on economic growth reveal an increasing interest on the role of not only physical factors but also endogenous ingredients linked to technology, R&D, creative ideas, consumer's preference on cultural products (i.e., recreation, music, dancing, movie, and general education, etc.,) as well as cultural diversity (ethnicity, language, religion, and other inherent traits). This paper attempts to analyze the effects (roles) of the overall contributors including cultural variables to the growth of urban areas in Korea. Despite the short history of urban statistics, various specification such as production function, Solow residual equation, and pooling of cross-section and time series data are experimented to identify the marginal effects of theoretically relevant inputs. Also the growth source analysis by both city and pooled data finds the proximate contribution of each variable to the growth of cities under study. Productivity is found to be the first runner in every city, followed by physical capital, citizen's spending on cultural products, and human capital. But the effects of cultural diversity indicators we employ are interestingly promiscuous, possibly due to limited heterogeneity of Korean society. Korean data set does not allow us to test satisfactorily our hypothesis on affirmative role of cultural diversity, but this promises to be interesting path to explore further.

Key words: City Growth, Cultural Diversity, Decomposition, Hetrogeneity, Multicollinearity, Pooling Cross-section and Time-series, Sensitivity, Solow Residual
JEL Classification: O11, O40 O53, R11, R50.,Z10

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1. Introduction

Recent studies on economic growth tend to increasingly focus on not only physical factors but also endogenous innovation advances linked to R&D, creative ideas, education, and cultural diversity. We assume the differences not only in factors endowments, but also in social capital including technology, institutions and cultural factors exist across regions in a single country as well as across countries. These differences are likely, of course, smaller across regions in a country (particularly in a small country like Korea) than those regions in a large country (like China and USA) or those across countries.

In the dynamic world, both"β-convergence" (the poor states tending to grow faster than the rich ones) and "σ-convergence" (reduced dispersion of per capita income or product) continue across regions in a single country as well as across borders of countries. Nevertheless, the growth and productivity dispersion persistently hinges everywhere due to leadership gap, ideas gap, and cultural gaps among economic actors, not to speak of many factors associated with both differential natural resources and location-related traits.

This paper attempts to look into the role of cultural diversity on urban growth in Korea. There are numerous factors attributing to the growth of a particular city or region. To list a few, major policy targets of both central and local government as well as locality traits would significantly influence the pace and speed of any region's development. Accessibility to both factors and demand markets would also add to the growth potentials of the locality. Leadership factor is no exception as well.

In this paper, however, we do only focus in analyzing the urban growth sources with limited focus on traditional production factors along with cultural diversity factor. For a large country like China whose population consists of many different ethnic, language, and religious groups, the expected result of such study on the effects of cultural diversity on economic growth would be much more meaningful. In spite of the possibility of extreme limitation in terms of scope and degree of freedom dealing with cultural factors in Korea where diversity does not vividly exist among regions, we start first to wonder if cultural factors do matter to urban growth. It might be a quality of spirit that engineers the wings of the morning for a vital community, city and country at large. If we have to name this social revolutionary ingredient that brings livability to human society, we may call it “culture”. Of course, the entity named culture has many fold faces and multi-functions. Many diverse cultures have been in places and evicted or evolved into hybrid forms. Very often culture is embedded and revealed in the ways of food, language, religion, dialect, life pattern even across communities within the border of a single modern country.

The values, emotions and customs of one could not be completely combined with those of another, and the kinds of virtues, arts, heroism, literature, language and slang that have formed in one community over time are not easily eradicable or replicable in another society. So is the culture, a unique factor of a society that is historically embedded in any particular living mode. Culture of many diverse forms reflects itself an inner social structure that may cause the evolutionary development of the society. Culture similarity or diversity as well may affect the creativity and productivity of human works, positively or negatively. For illustration, cultural diversity is considered to affect the economy positively by enhancing creativity via hybrid new ideas, if not working as any conflicting elements with one another.

Cultural factors exist spatially and temporally across regions within a single country as well as across borders of nations. If cultural ingredients excrete political and interpersonal conflicts and mistrusts inherent in the different cultural backgrounds (like the antagonistic relations between Islamic and Judaic religions in middle East), cultural diversity will function negatively. On the other hand, many cultural activities and diversities would contribute positively to the economy if they are well orchestrated to enhance clusters of economic availability, opportunity, competition, and complement.

In an interesting paper by Ottaviano and Peri (November, 2004), they showed that cultural diversity as measured by diversity of countries of birth of US city residents does affect positively both production and consumption. They proved the positive amenity effect of cultural diversity by estimating the effects of foreign born workers on the wage and land rents in the US cities. This is a study across cities within a country.

Hwang and Guo (2002) investigated if empirical relationships exist among economic growth, income inequality, and cultural diversity using panel data of nations. They run panel regressions for growth rates with cultural diversity (defined as linguistic and religious diversity) along with income inequality across countries jointly and separately for both cold war periods (1980-99) and post-cold war periods (1990-99). The empirical study shows high inequality tends to retard growth in the 1980s and to encourage growth in the 1990s. For the 1990s, there were indications that religious diversity tends to drag down growth in high inequality nations while encouraging growth in low inequality countries. The regressions showed also some evidence that supports the views that inequality tends to encourage growth in low religious diversity nations, but not in high religious diversity places.

Since culture can be defined in many different angles, what kind of culture does matter to economic growth is another subject for us to make it clear. In particular, in a geographically small country like Korea where common Confucius cultural background dominates and where internet networks are widely diffused, cultural diversity does not in fact prevail recognizably across cities. Number of music concerts, artists, painting exhibitions, plays, movies, dancing shows and sports, and even irregular antic and flea market openings in the city center square belong to the categories of cultural activities which create social environments, attributing indirectly to the rise of productivity and creativity. But such micro data are not available or if any, the degree of freedom is too short to use for empirical testing in case of Korea. Indeed, the role of cultures can be analyzed by using either the micro aspect of cultural factors (i.e., art, music, dancing, etc.) or the aggregate cultural index such as cultural diversity or similarity scores. Both tasks of measurement must be extremely exhaustive unless the relevant qualitative cultural factors can be quantifiable. Thus, testing the hypothesis relating to the contribution of cultural factors to growth would not be such simple as those notional writings available in descriptive literatures on cultural effects.

This paper is an analysis of the determinants of Korean major city's growth factors with traditional production function taking account of cultural diversity (cf. Hwang and Guo 2002) and other technological, institutional factors (cf. Porter 1990). The paper also attempts to look into the major city's growth accounting via an eye on growth sources decomposition.

2. Analytical Framework

2.1 Production Function and its Variaties Estimation Models

Understanding all characteristics of cultural factors cited above, we may now formulate a simple set of theoretical models to look into attributing factors of urban growth. As demonstrated in the most traditional growth models, the process of economic growth depends on the shape of the production function.

We start from the simple conventional production function in which inputs are physical capital K and human capital H. The H can be alternatively replaced by hL as it is knowledge-augmented labor where L is total workers employed and h is an index for human capital quality. We may call h average human capital "stock and quality" index. Following Arrow'(1962) and Romer(1986), the tendency for diminishing returns to capital accumulation can be rejected by assuming that human capital productivity creation is a side product of investment. A city that increases its physical capital learns simultaneously how to enhance its productivity or creativity. This positive effect on productivity is called learning by doing or in our case, learning by investing.

For illustration, a basic production function for a city i is as follows:

$$Y_i = F\ (K,\ H_i) = F(K_i,\ h_i L_i) \qquad (1)$$

The function F(·) satisfies the neoclassical properties: positive and diminishing marginal products of each input, homogenous of degree one in K and L (and also in h for given L), and the Inada conditions. Human capital productivity is assumed to be labor augmenting so that a steady state exists when h_i grows exogenously at the rate x.

Following Arrow (19620, Sheshinski (1967), and Romer (1986), two assumptions about productivity growth are made. First, learning by doing works through each city's net investment. Specifically, an increase in a city's total capital stock leads to a parallel rise in its stock of human capital quality, h_i. This presupposes that worker's productivity gains come along from investment and production. The second assumption is that any change in human capital quality, $\hat{h}_{i,}$ corresponds to the economy's overall learning and is therefore proportional to the change in aggregate capital stock, $\acute{K}$. If h_i and L_i are constants, each city faces diminishing returns to K_i as in the neoclassical model. However, if h_i rises as each city expands its capital stock (K_i), then city does not face diminishing returns to capital. ˙This reflects a spillover effect of average human capital stock on the city's overall productivity via the increase in investment. Here, the aggregate or possibly average level of human capital (h) in a city is considered as a capital that produces economy-wide knowledge spillovers (cf. Griliches 1979, Romer 1986, and Lucas 1988). The equation (1) is homogenous of degree one in K_i and h_i at the given L_i; that is, there are constant returns to capital at the social level when K_i and h_i expands together for fixed L. This constancy of the social returns to capital will yield endogenous growth.

Final output of a city at time t can be expressed as a function of physical capital K, human capital devoted to final output hL and other qualitatively influential variables (Zi's) as follows:

$$Y_t = A\ K_t^{\alpha}\ (h_t L_t)^{\beta}\ \Sigma_i Z_{it}^{\delta i} \qquad (2)$$

Since the equation (2) is assumed to be homogeneous of degree one in K and L, we can rewrite it in terms of per capita equation as follows;

$$y_t = A\ k_t^{\alpha} h_t^{1-\alpha} \Sigma Z_{it}^{\delta i} \qquad (3)$$

Among these malleable variables ($Z_{i's}$) which are assumed to influence total factor productivity directly or indirectly via their spillover effects on technology or innovation advances, we arbitrary decided to include selectively those variables representing government intervention, technology, external competitiveness (or proxy for openness), special demand conditions, and cultural diversity, in addition to k and h. (See the variables explanation in next section). If $\delta_i > 0$, either the direct or spillover effect of any Z_i is present and positive. Otherwise, the opposite would result.

Taking natural logarithm to equation (3), we have:

$$\ln y_t = \ln A_t + \alpha \ln k_t + (1-\alpha) \ln h_t + \delta_1 \ln Z_1 + \delta_2 \ln Z_2 + \delta_3 \ln Z_3 + \delta_4 \ln Z_4 + \delta_5 \ln Z_5 + \delta_6 \ln Z_6 \quad (4)$$

where y : per capita output

A : technological efficiency parameter

k : physical capital per worker

h ; stock of human capital

Z_1 : government intervention

Z_2 :external competitiveness (proxy for openness)

Z_3 : technology level

$Z_{4:}$: consumption rate

Z_5 : special demand condition

Z_6 : cultural diversity score

This is the baseline regression equation with a variety of tangible and intangible inputs to analyze the marginal effect of each chosen variable on production. The functional form as well as definition of some variables will be modified, if necessity of, in the simulation of each experimental estimation. Malleability exists in the definitional concepts of some Z_i variables, as seen in the explanation of variables in the next section. This problem mainly arises due to proper raw data unavailability.

In the above equation, note that all Z_i's variables are endogenously determined products. For illustration, Z_6 (cultural diversity score) is a composite one which encompasses ethnic, language, religious, organizational, political and institutional factors, of which some in turn may depend on Y, K, and L and others. Suppose, for example, political culture may be determined positively or negatively by people's literacy rate. In that case, a composite-function rule needs to apply. If we denote one or many influential factors as a vector $S = \Sigma S_{i\,,}$, then Z_i is a function of S and the coefficients δ_i must be equal to $dY/dS_i = (\partial Y/\partial Z_i)(\partial Z_i/\partial S_i)$. But in our empirical analysis, we simply rule out this complication, for simplicity. But it must be emphasized here that our neo-classical type production function can avoid the diminishing returns to inputs (K and L), by accommodating the endogeneity of those intermediate products in the production function. (Note, however, that all explanatory variables are considered to be determined outside the context of the regression equation in question, such that the classical regression assumptions hold.)

To see this, let's write a vector $X = K + \Sigma Z_i$,where i = 1……n. Z represents all intermediate products except for physical capital K and human capital H (both are intermediate inputs). And following Romer (1990) we may rewrite the production function for a city as follows.

$$Y_t = A H_t^{1-\alpha} \cdot \Sigma (X_{t\ i,})^{\alpha} \text{ and i goes from 1 to N} \quad (5)$$

where $X_{t\ i}$ is the employment of ith type of specialized goods (whether tangible or intangible) and inputs, and thus X_i's include physical capital K and all Z_i's. Here N is the number (type) of varieties of intermediate factors, and note that technological progress takes the form of expansion of N, the number of specialized intermediate goods available, rather than increase in A, the productivity parameter. To see the effect from an increase in N, we may suppose that all elements in vector X (intermediate goods) can be measured in a common physical unit and that all employed in the same quantity, $X_{t,i} = X_{t,j}$ for brevity. The quantity of output is then given from equation (2) and (5) by,

$$Y_t = A (h_t L_t)^{1-\alpha} N X_{t,i}^{\alpha} = A (h_t L_t)^{1-\alpha} \cdot (N X_{t,i})^{\alpha} \cdot N^{1-\alpha} \quad (6)$$

For given N, equation (6) implies that production exhibits constant returns to scale in H_t (that is, $h_t L_t$) and $NX_{t,i}$ For fixed H, equation (6) implies that an expansion of the composite intermediates, $NX_{t,i}$, encounters diminishing returns if it occurs through an increase in X for given N. Diminishing returns do not arise, however, if the increase in $NX_{t,i}$ takes the form of a rise in N for given $X_{t,i}$. For given quantities of H_t and $NX_{t,i}$, Y_t increases with N in accordance with the term $N^{1-\alpha}$. Thus a kind of technological change in the form of continuing injection in N (that involves the type of both qualities and varieties of intermediate products, Z_i's+K) avoids the tendency of diminishing returns in the production process.

This suggests that as long as h and N (that is the type of varieties of intermediate goods) are continuous in the form of endogenous growth, Y_t will remain "dynamic".

With limited degrees of freedom of each city time-series data available now in Korea, however, the inclusion of all relevant variables in the estimation equation (5) for individual city regression will only produce biased and inconsistent estimates. So we consider to detour before attempting to switch to panel data

2.2. The Solow Residual and Z_i products including Cultural Diversity

Instead of directly estimating the form of $Y= T (hL)^{1-α} X^{α} Z^{1-α}$, where $Z = Z_1 + \cdots. + Z_6$, we take two steps. The first step is to estimate total factor production (TFP) growth from per-capita form of equation (1) by regressing log y on capital (log k) and human capital (log) h. Next step is to run the so-called Solow residual (TFP growth) on the remaining intermediate goods represented by Z_i variables. (See section 4 for the explanation of the results).

2.3 Pooling of Cross-section and Time-Series Data

Having estimated various functional forms on data of seven individual cities separately, the aggregated data of these cities dumping together is brought in a verdict of not guilty on insignificances of each relevant input actors. But this aggregation does not differ from the individual city data in terms of the degrees of freedom of time series since they are from the same statistical sources.

To avoid possible large effects of the stochastic or purely random component of the equation on inferences about the deterministic portion, we decide to enlarge the number of degrees of freedom by pooling cross-section data with time-series data. A panel data consisting of seven major cities (Seoul, Busan, Kwangju, Daegu, Inchon, Daejon, Jaeju, where Jaeju is province instead of city) and twenty-six time-series (1985-2005) provide us with a total of 147 observations which would make it possible to extend the number of variables to about 25 at most if necessary.

In general, the regression equation for this type data on N cross-section units over T periods of time can be written in matrix notation as

$$y = x\beta + \varepsilon,$$

where,

$$y=\begin{bmatrix} y_{11} \\ \vdots \\ y_{NT} \end{bmatrix},\ x=\begin{bmatrix} x_{11,1} & \cdots & x_{11,K} \\ \vdots & & \\ x_{NT,1} & \cdots & x_{NT,K} \end{bmatrix},\ \varepsilon=\begin{bmatrix} e_{11} \\ \vdots \\ e_{NT} \end{bmatrix},\ \text{and}\ \beta=\begin{Vmatrix} b_1 \\ \vdots \\ b_K \end{Vmatrix}.$$

In many circumstances, the most questionable assumption in using longitudinal data model is that the cross-sectional units are mutually independent. For instance, when the cross-sectional units are geographical regions (like Korean cities) with arbitrarily drawn boundaries, we would not expect this assumption to be well satisfied. Facing this possibility, we have to drop the assumption of mutual independence. Then we have what may be termed 'a cross-sectionally correlated and time-wise autoregression model" For illustration of the case, $E(\epsilon_{it}^2) = \sigma_{it}^2$ (heteroskedacity), $E(\epsilon_{it}\epsilon_{jt}) = \sigma_{ij}$ (mutual correlation), and $\epsilon_{it} = \rho_i\epsilon_{i,\,t-1} + \mu_{it}$ (autorregression).

The behavior of the disturbances over the cross-sectional units (cities in our study) is also likely to be different from the behavior of the disturbances of a given cross-sectional unit of time. In particular, the relationship between the disturbances of two cities (say, Seoul and Busan) at some specific time (say, 1995 or 2005) may differ from the relationship between the disturbances of a specific city (say, Seoul) at two different periods of time (say, 1995 and 2005). Clearly, various kinds of prior specifications with respect with the disturbances will lead to various kinds of restrictions on both variance $E(\epsilon_{it}^2)$ and covariance $E(\epsilon_{it,}\epsilon_{jt}) = \Omega$. The discussions on different specifications and handling of different estimation technicality are beyond the scope of this paper. Thanks to well-advanced econometric package programs such as EViews, various modified Aitken's estimation approaches are readily available to solve such cases automatically.

The base line equation (4) is also used for this panel data regression, using Eviews package program. (For the results, see section 4).

2.4 TFP Growth and Growth Source Decomposition by City.

An aggregate production function relates output of an economy or part of an economy (i.e., a city in our study) to the inputs attributed to produce the output. Thus, simply observing inputs over time shows the proximate contribution of each input to the growth of the economy. If we want to have more precise magnitude of factors affecting growth, more technical growth accounting decomposition is needed. The comparison of growth sources by cities can show factors responsible for differences in incomes between regions at a given point in time. The growth source analysis provides an organizing framework for making quantitative projections of future growth, taking account of causal interrelations between the growth sources.

Taking the ratio between periods of the variables in production function (3) gives per capita income ratios attributable to each factor:

$$y_t / y_{t-1} = A_t/A_{t-1}(k_t/k_{t-1})^{\alpha} \ (h_t/h_{t-1})^{1-\alpha}(\Sigma \ Z_{it}/Z_{it-1})^{\delta i} \qquad (7)$$

The equation (7) is also to be transformed into double log form for estimation. Note that for example, y_t/y_{t-1} in natural log is equal to $\triangle \ln y_{t.} = \ln y_t - \ln y_{t-1} \fallingdotseq (\triangle y/y)$ when $\triangle y/y$ is small, where "≒" means "approximately equal to."

(Explanation of the estimates is given in section 4.)

3. The Data

We use data on major cities from both 'gross regional domestic product and expenditure" and "Korea statistical yearbook" compiled by Korea National Statistical Office (www.nso.go.kr), data from "comparative statistics of major cities" compiled by Seoul Metropolitan Government. Also used is National Income Statistics (annual) compiled and published by the Bank of Korea (www.bok.or.kr). The lists of variables used and derived for the estimation are given in the table 1.

<Table 1> The Lists of Variables and Definition

Variables	Indicators	Definition of Variables
y_1	RGDP per capita	Real RGDP/ population
k_1	Capital per capita	Capital stock/population
h	Human capital	Ratio of workers of college plus education to total workers employed. Usually, human capital is defined elsewhere as average level of education of workers.
Z_1	Government power	Real government consumption spending/real RGDP
Z_2	External competitiveness	Net trade/real RGDP (if it is positive, competitive; if negative, incompetitive).
$Z_{3,1}$	Technology level	Real R&D spending per capita
$Z_{3,2}$	Technology level	Number of patents approved.
Z_4	Consumption-output ratio	Real final consumption/RGDP
$Z_{5,1}$	Demand condition	Ratio of real spending in recreation, cultural activities and education to private final consumption expenditure.
$Z_{5,2}$	Demand condition	Ratio of real spending in recreation, culture, religion, and education to final consumption expenditure of non-profit institutions serving to households(NPISHs).
$Z_{6,1}$	Shares of foreign-born	Ratio of foreign-born people to total population
$Z_{6,2}$	Shares of foreigners	Ratio of foreign-born people to workers employed

Z_7	Cultural diversity index	Diversity=1−$\Sigma(CB_i)^2$ where CB_i is the share of people born in country i among total people of a city at a given year t. If the index is 0, no diversity meaning all individuals born in the same country. If it reaches its maximum value 1, there are no individuals born in the same country. Note i goes from 1 to N (Nth country).(cf. Ottaviano and Peri,2004)

By passing, we need to explain some more about the nature of culture or cultural diversity. Indeed, culture has many-fold faces and multi-functions. Thanks to the varying geographical and historical circumstances and forms of self-understandings, different people and societies have been developing different capacities, needs, ideals, forms of cognition, modes of imagination and system of belief and life. There have come different forms of "culture" including ethnicity, language, religion, and artistic and literary activities, morality and ethics. Thus, every society has remained more or less a distinct cultural community, if not hybrid in the forms of mixed pluralism through interactions one another over age.

It is nearly impossible to quantify the qualitative characteristics of a society's culture—the untouchable values and ideals of a community- in a stick-yard measurement method. We cannot also take account of every aspects of cultural factors inherent in any community, but can only rely selectively on one or a few of measurable factors among many cultural traits, for brevity, in establishing any significance between economic growth and culture. In this study, we choose ethnic diversity as "the" cultural variable among others. Ethnicity index may be substituted for diversity score in either languages or religions of a society, of course, if data on them are available. The diversity score can be alternatively defined as: DIVERSITY= $N^{(1-r)}-1$, where N denotes number of cultural groups (i.e., different ethnic groups residing in the society either using different languages and dialects as their respective major communications means or having different religions. Note that in this formula, diversity is positively related to N but negatively related to r. Specifically, when either N=1 or r=1, diversity will be zero. (cf. Hwang and Guo, 2002). This is the exactly same but simple measure of the cultural diversity as the variation of Herfindahl index approach (cf. Ottaviano and Peri, 2004) suggested in our data. Recent efforts to construct different types of indicators of cultural characteristics are under ways. (see Hall and Patrinos 2005, MacIsaac 1994 and Trivelli 2005).

All data sets in our cities (Seoul, Busan, Daegu, Kwangju, Daejun, Inchon, Jaeju, and all cities) cover from 1985 to 2005. In case of Jaeju, it is Jaeju province instead of Jaeju city. Basicaclly, every variable is transformed into natural logarithm except for Z_2 (that is ratio of net trade, being both positive and negative numbers) and Z_7(that is cultural diversity having numbers between 0 and 1).

4. Results and Interpretation

In estimating the production functions as well as the growth accounting equations for both individual city and pooled cities, effort has been made to run a number of alternative specifications to determine as much robust (not statistical flukes) results as possible.

The results shown in all tables in the appendix are those selective ones obtained by the sensitivity analysis among a variety of alternative specifications, functional forms, variable definitions and subsets of the data. In our sensitivity analysis the formal specification criteria for choosing the explanatory variables is used for each equation estimation. To augment the conventional basic specification criteria for the additional inclusion of a variable in an equation, Akaike's Information Criterion (AIC) and the Schwarz Criterion(SC) are also employed[1]. The later two criterions are trying both to detect the specification error and to decide if the improved fit caused by an additional variable is worth the decreased degree of freedom and increased complexity caused by the addition.

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[1] $AIC = \log(RSS/N) + 2(K + 1)/N$

$SC = \log(RSS/N) + \log(N)(K + 1)/N$, where RSS stands for the summed squared residuals; N is the sample size; and K is the number of independent variables. (see H.Akaike, 1981 and C.Schwarz, 1978).

In most of our estimations of production functions and growth source equations (but for the Solow residual estimation), we find that adjusted R^2 tends to stay almost intact even with additional regressors (implying that the sum of squared residual reduction fully offsets the effects of the loss of the degrees of freedom), while AIC and SC values are surprisingly lowered. These exceptional results confirm us that our base-line specification (equation 4) is basically very correct and robust for our data sets.

4.1 Estimation Results of Production Function by City

Table 2 shows the results of production function estimation for each city for the time series (1985-2005) data. In general, the estimates conform to our theory in terms of the direction and strengths of the quantitative relationships involved, although the kinds and relative importance and significance of influential factors are much varied across cities. Initially, we have some suspicion about imperfect multicollinearity to exist among $Z_{1,}$,$Z_{3,1}$, Z_4, and $Z_{5,1}$ or $Z_{5,2}$. Because these variables come from the same sample of each city's expenditure on GRDP (gross regional domestic product), given the size of our sample (time series = 1985-2005) being also not long enough. Multicollinearity increases the variance of the estimated coefficients and therefore decrease the t-scores of those coefficients, while it has little effect on the overall significance of the regression or on the estimates of any nonmulticollinear explanatory variables. So for individual city regression, we conduct sensitivity analysis by dropping seemingly redundant variable which appears to have correlation with other regressors. However, no significant improvement is evidenced in the fit of an estimated equation (adjusted R-squared), the estimated coefficients, and our prior expectations (the directions and strength of the statistical relationships). So, we think it is better to retain all relevant variables to avoid any possible omitted variable bias. (see table 2).

As shown in table 2, estimates for both physical and human capital are generally very good and significant across all seven cities as well as nation as a whole. In both Inchon and Jaeju, the coefficients of human capital turn out to be negative, mostly because these two cities have exported their highly educated people to other regions during the sample period. Except Busan and Daegu, other cities (and nation as a whole) demonstrate that government intervention or role in economic growth has been positive, contrary to our promulgation for the advantage of free market economy (small government). But it would be naturally so as long as government spending attributes to economic growth in real world. External competitiveness and technology affect positively to city growth, while consumption-output ratio and other demand condition do also influence positively and statistically significant in most of cities (except Daegu) under our study. It must be noted that the variable Z_5 implies citizen's utility gain from spending in their culturally related activities. Except for Daegu city, this variable is very statistically significant and positive effect on growth. However, the effects of either the shares of foreigners (Z_6) or cultural diversity index (Z_7) are interestingly promiscuous. In Seoul, Busan, Daegu, Inchon and whole nation, the shares of foreigners (Z_h) have positive effects on growth, but negative effects in Kwangju, Daejun and Jaeju (though significance levels vary across cities). On the other hand if we use diversity score variable (Z_7) instead of Z_6, whole nation, Seoul, Busan, and Inchon show negative signs while Daegu, Kwangju, Daejun, and Jaeju have positive sign on this variable.

If the estiamted coefficient of Z_6 reveals "negative sign", it means that the share of foreigners to total residents of the city has decreased over the sample period. If the estimate of Z_7 is negative (while Z_6 is positive), it implies that the diversity (number of different ethnic groups) is reduced while the share of aggregated number of foreigners increase in that city. So, only based on the estimated signs of the coefficient, we must not conclude that diversity has no or opposite effect on growth. In order to have "good' results that conform to our hypothesis and expectation, we need an extensively large data set which involves a heterogeneous society in terms of race composition and other cultural characteristics. Otherwise, as in case of our Korean cities which are almost homogeneous in cultural factors, and the sample is limited in numbers of cross section and also in time series, we face the unexpected sign of the coefficient. Indeed, in our experiment, we end up with a variant of Calton's fallacy[2]. Since the change of diversity score was fairly low or negative (in some city cases)

[2] Calton's fallacy shows the classical example of the danger of attempting to draw inferences about "dynamic" behavior over time from "steady" cross-sectional data. (cf. Sir Francis Calton of the 19th century)

compared with the growth of other explanatory and dependent variable during the sample years, it was possible that the output (city growth) was "fairly inelastic" or "negatively related" with respect to "diversity score" in Korean city's sample. But our estimates of diversity index show that cultural diversity does indeed matter for economic and city growth.

4.2 Estimation Using Solow Residuals

Table 3 shows the results of the regression of Solow residuals on Z_i's variables have strong negative constants implying that too much attributes are absorbed by the growth rates of the quantities of inputs (k and h) employed in estimating total factor productivity. The indicators of the overall quality of the regression are not improved as compared to the production function estimation approach. As expected, Solow residual approach produces lower R-bar-squared (even negative one for Daegu). In general, this happens when the regressors, taken together, reduce (increase) the sum of squared residuals (SSR) by such a small (large) amount that the reduction (increase) fails to offset the factor (N-1)/(N-K-1). Here N is number of sample size, K is number of regressors. In our Solow residual estimation, the number of regressors are reduced by two factor inputs (k and h), which increases the sum of squared residuals which in turn offset the effect of the increase of degree of freedom, that is, the overall effect of the drop of factor (N-1)/(N-K-1). Total factor productivity growth (Solow residual) approach has resulted in some changes in both signs and t-values of estimated coefficients, possibly because of partial multicollinearity among those Z_i's variables. To remedy this problem, we may need to increase further the sample size if we do not want to make the error of omitting relevant variables in the equation. But since the available data sets do not permit this, we tried the typical sensitivity analysis by either removing one or two related variables or redefining some relevant variables in the equation, which surely increased the significance and confidence levels of the remaining estimates at the cost of omitting the relevant variable(s). (Results are not reported here by cities, but see table 4 for a few of results from sensitivity analysis for the pooled regression).

4.3. Panel Data Estimates

Pooling of cross-section and time-series data gives much improved estimates for both production functions and residuals equations as shown in table 4. In all estimations, the coefficient of Z_4 (final consumption-output coefficient) turns out to be significantly negative, implying that the leakage of income is detrimental to growth contrary to the saving rate in the city. This does also well conform to the negative multiplier effect of marginal consumption on income change. On the other hand, cultural factor or cultural diversity variable produces expected signs but not statistically significant except for the specification VI, possibly due to very limited heterogeneity of Korean society as well as insufficient data information on this.

4.4. Growth Source Decomposition

Growth source estimation reveals that the average of all sample cities together have relatively larger technology shift effect than Korean national average (that is 64.633 percent as compared to the pooled cities' 79.799 percent). The "A" factor (factor productivity) appears to wag the entire dog according to the estimates shown in table 5. Indeed, most of the growth over time in this analysis is due to technology-quality shift factor, followed by special demand condition (spending on cultural products) and physical capital and human capital and government intervention in order. The "A factor" determines the profitability of using capital. Therefore, in addition to its direct contribution, "A" makes the use of capital and also affects some Z_i's, thus making them endogenous result of the increase in "A". Next, the relative large contribution by special demand condition (Z_5) explains that Korean cities have been transforming into the stage of maturity in which citizens value highly their recreation, cultural activities and education selectively in their welfare. This fact is very interesting in light of the increasing importance of this service sector in Korean economy, at large. Another notable thing is that here again shows the negative contribution of the aggregate final consumption rate (Z_4) to city growth as in cases of production function analysis. Cultural factors reveal some insignificant positive contribution to growth probably due to the same reasons cited before.

The growth source analysis will provide a framework for making effective policies and projections of future growth to each city planners and administrators. Such an analysis helps choose the efficient resource allocation under budget constraints. Promoting regional or urban growth requires promoting conditions of many different kinds to increase the productivity of employing physical and human capital (inputs) and other products (i.e, Z_i's) which are partially endogenous to policy options and their employment. Any city administrator whose city is lagging behind others must study how to catch up the ahead guys based on this kind of growth source analysis. For economists, efforts must be made to estimate aggregate amounts of inputs in a city or economy that will accompany a given degree of growth. No question about the importance of securing accurate and sufficient data sets needs addressing.

5. Conclusion

In this paper we analyze the effect that cultural factors, together with other factors and products, may have on economic growth of some big growing cities in Korea. We attempt to improve previous literature on national growth by introducing cultural factors in particular terms of culturally related activities (Z_5) and cultural diversity score derived in a context in which various races have coexisted and mixed in each city.

We construct two types of indicators of racial intensities using diversity score procedure on one hand and simply calculating on the other hand the shares of foreigners to total residents in each city. Since Korea is exceptionally homogeneous in terms of racial intensities,

the simple share indicator excels the calculated (but very restrictive) cultural diversity score indicator in terms of the performance of our overall estimators. Since available data history on city level is very short, we employ both the Solow residual approach and longitude data approach from which some relative efficiency and consistency of the estimators are made. But ultimate objective of this study targets to provide the growth analysis that takes account of causal interrelations between urban growth sources including cultural variables. Relative importance of inputs (and factor products) in a city that accompany a given degree of growth is estimated and may be useful in planning for the future. One remaining pitfall in this paper is, however, related with the reality that we do not have much basic data that can be reliably used for quantifying the cultural traits that will attribute to economic growth. Our data set for Korean cities does not allow us to test satisfactorily for our hypothesis on various cultural factors which are important for economic growth. To analyze if culture matters to economic growth and development particularly in East Asian countries, a comparative study based on both individual country analysis and panel data analysis including China, and Japan, and Korea may worth be attempted in addition to this paper. The cross-section income decomposition normalized to any standard city (and country) across cities within a country (or across countries) over two or multiple time dimension will provide important information on both β-convergence and σ-convergence among those cities and countries. This is our task to keep on continuing path to explore in the future.

Since no man knows the future, who can tell him what is to come?
Ecclesiastes 8:7

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<Table 2> Production Function for Individual City

(Dependent Variable: y_1)

Coefficient	Nation	Seoul	Busan	Daegu	Kwangju	Daejun	Inchon	Jaeju
C	2.811851	0.842902	2.597373	3.887267	3.506300	−16.56626	6.996066	6.733923
	(2.878984)	(0.390459)	(0.915007)	(1.936758)	(2.781280)	(−1.352206)	(13.03697)	(7.233977)
k_1	0.318715	0.306871	0.317724	0.349696	0.29863	0.310392	0.102875	0.191881
	(8.002075)	(2.656777)	(3.254147)	(2.684932)	(5.382778)	(3.572822)	(3.218593)	(3.004441)
h	0.177405	0.067997	0.134071	0.243807	0.137906	0.237366	−0.107975	−0.032958
	(5.089814)	(.625571)	(1.267674)	(1.155267)	(1.126580)	(2.890560)	(−2.344439)	(−0.293307)
Z_1	0.126136	0.169117	−0.086749	−0.220290	0.109137	0.088159	0.494454	1.021716
	(0.782601)	(0.745805)	(−0.477378)	(−0.476969)	(0.262847)	(0.344355)	(5.154354)	(2.948324)
Z_2	0.715498	1.261801	0.659239	3.549832	1.349215	0.730149	0.195762	0.125412
	(2.472275)	(2.876575)	(1.424415)	(3.007017)	(3.716740)	(2.127027)	(1.933516)	(0.487854)
$Z_{3,1}$	0.012867	0.019250	0.018962	0.073951	0.000100	0.006414	0.034346	0.00831
	(1.225270)	(1.267124)	(1.531453)	(1.559911)	(0.023403)	(0.336660)	(5.405904)	(0.515983)
Z_4	0.042205	0.771081	0.300248	3.74004	−0.655774	−0.263560	−0.360141	−1.125669
	(0.162767)	(2.497102)	(0.5942777)	(3.044206)	(−2.852092)	(−1.014734)	(−2.246439)	(−1.939698)
$Z_{5,1}$	0.239001	0.216371	0.215225	−0.280814	0.613125	0.397454	0.449717	0.483327
	(4.163334)	(2.234414)	(3.056794)	(−1.253396)	(12.62406)	(4.763809)	(10.07497)	(3.450024)
$^*Z_{6,1}$	1.999379	1.945260	22.63112	6.262087	−12.76528	−26.50210	8.861451	−49.13617
	(0.544732)	(0.279875)	(2.108668)	(0.396342)	(−0.59460)	(−1.64398)	(3.764923)	(−1.357592)
$^*Z_7$	−1.449153	−1.427916	−16.37283	10.89241	9.230956	19.17252	−6.427516	35.49274
	(−0.545217)	(−0.282802)	(−2.110794)	(1.052865)	(1.594752)	(1.642694)	(−3.764678)	(1.357127)
$\overline{R}^2$	0.999460	0.998783	0.996613	0.983607	0.998353	0.9976270	0.997133	0.997181
D-W	1.463763	1.296430	1.033298	2.220850	2.446081	1.909564	1.588229	2.027144
AIC	−6.613157	−5.830895	−5.029240	−3.590150	−4.986901	−4.653571	−6.264388	−5.021649
SC	−6.165077	−5.383242	−4.581587	−3.142498	−4.539249	−4.205918	−5.816736	−4.573996
F-statistic	4395.672	2053.265	736.5609	90.00187	1516.103	1051.814	870.4989	885.4438
Prob (P)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SSR	0.000639	0.001532	0.003414	0.0014392	0.003562	0.004972	0.000993	0.003440

( ) indicates "t-statistics"

* Alternative variable included in the estimation.
For example, when $Z_{6,1}$ is included, then Z_7 is omitted, and vice-versa.

<Table 3> Estimation using the Solow Residuals

Dependent Variable: lnR=lny-alnk-(1-a)lnh

Coefficient	Nation	Seoul	Busan	Daegu	Kwangju	Daejun	Inchon	Jaeju
C	−3.945178 (−2.482445)	−5.347046 (−5.719300)	−3.190101 (−1.934009)	−10.39610 (−1.938959)	−5.320383 (−2.855027)	−0.814863 (−0.544754)	−5.160894 (−3.351163)	−0.946812 (−0.889209)
Z_1	−0.294968 (−1.066053)	0.132201 (0.552407)	−0.108891 (−0.689503)	0.103375 (0.304346)	2.279180 (3.476676)	−0.057370 (−0.191908)	−0.077342 (−0.248617)	0.718136 (1.748264)
Z_2	1.235845 (3.058607)	1.436718 (5.748963)	0.636296 (3.915984)	1.313301 (1.756341)	0.152595 (0.190658)	0.942985 (2.327648)	0.619236 (4.359985)	0.367617 (1.305163)
$Z_{3,1}$	0.048318 (2.904738)	0.036277 (4.304345)	0.019774 (2.143298)	0.081390 (2.170709)	−0.000761 (−0.075828)	−0.017980 (−0.808199)	0.048942 (2.156330)	0.004042 (0.211426)
Z_4	0.755605 (1.728770)	0.742914 (2.356525)	0.317937 (0.965112)	2.237246 (1.831875)	−0.639505 (−1.409013)	0.006352 (0.020286)	0.541670 (1.247469)	−0.810638 (−1.385436)
$Z_{5,1}$	0.121571 (1.220238)	0.174333 (3.249695)	0.226630 (4.250079)	−0.050617 (−0.242578)	0.253561 (5.189467)	0.157901 (7.033914)	0.297933 (2.763821)	0.286468 (2.033759)
$^{*}Z_{6,1}$	8.94661 (1.682928)	−5.727377 (−1.175538)	21.84720 (2.286507)	−4.834276 (−0.390343)	−120.3786 (−2.957911)	−33.99652 (−1.681477)	15.37184 (2.028978)	−42.72865 (−1.179936)
$^{*}Z_7$	−6.472415 (−1.681977)	4.152580 (1.174097)	−15.80671 (−2.288875)	3.475696 (0.388114)	87.04000 (2.959650)	24.62209 (1.684417)	−11.16389 (−2.032324)	30.87538 (1.179635)
$\bar{R}^2$	0.434390	0.683668	0.693410	−0.025549	0.654416	0.806205	0.718152	0.348387
D-W	1.474429	1.246526	1.112981	1.347903	2.073300	1.75057	1.254545	2.118088
AIC	−5.330563	−5.697325	−5.207702	−3.269287	−3.270095	−4.208278	−3.717165	−4.573102
SC	−4.982057	−5.349151	−4.859527	−2.921113	−2.921921	−3.860104	−3.368991	−4.224928
F-statistic	3.432007	8.204121	8.538962	0.916958	7.312173	14.86695	9.493368	2.782174
Prob (P)	0.029557	0.000611	0.000498	0.511283	0.001086	0.000024	0.000287	0.053769
SSR	0.002815	0.002118	0.003456	0.024009	0.023990	0.009388	0.015342	0.006518

( ) indicates "t-statistics"

* Alternative inclusion of variables between $Z_{6,1}$ and Z_7 into the equation.

<Table 4> Sensitivity Analysis using Pooled Data

Coefficient \ Eq	I	II	III	IV	V	VI	VII
C	5.927597 (5.867629)	7.971342 (2.550252)	8.313859 (42.60606)	1.785869 (4.772718)	−4.373020 (−1.453116)	−10.69183 (−2.523354)	−4.17969 (−12.52425)
k_1	0.145542 (3.036652)	145496 (3.035765)	0.041688 (1.967907)	0.335135 (15.41483)	–	–	–
h	0.117959 (3.6105044)	0.117932 (3.614287)	0.151015 (5.016825)	0.055507 (1.779366)	–	–	–
Z_1	0.302339 (5.261645)	0.302510 (5.263549)	0.307712 (5.269220)	0.220387 (3.815949)	0.253531 (4.204880)	−0.065908 (−0.849446)	0.19778 (3.311988)
Z_2	0.538033 (2.405908)	0.538036 (2.406018)	–	1.445929 (16.34475)	1.210025 (12.16925)	–	1.395546 (16.60540)
$Z_{3,1}$	−0.008863 (−1.507338)	−0.008848 (−1.504526)	−0.018791 (−4.410411)	0.006334 (1.255865)	0.004225 (0.817555)	−0.029277 (−4.683091)	0.007673 (1.469072)
Z_4	−1.016518 (−4.373822)	−1.016559 (−4.374170)	−1.53531 (−17.45958)	–	−0.333168 (−3.246015)	−1.051512 (−8.761032)	–
$Z_{5,1}$	0.729207 (10.19143)	0.729169 (10.19134)	0.868692 (20.36857)	0.440990 (14.87723)	0.495390 (14.93858)	0.473945 (10.01265)	0.433128 (15.50670)
$*Z_{6,1}$	2.787710 (0.698840)	–	2.796333 (0.689231)	2.681003 (0.632140)	–	–	2.301891 (0.549881)
$*Z_7$	–	2.043099 (0.706847)	–	–	1.00155 (0.328415)	11.76396 (2.819826)	–
$\overline{R}^2$	0.944762	0.944767	0.942859	0.937557	0.800245	0.591861	0.786721
D-W	0.390400	0.390255	0.372363	0.536433	0.560686	0.523418	0.581188
AIC	−2.143484	−2.143565	−2.116000	−2.027268	−2.003746	−1.295918	−1.944746
SC	−1.960396	−1.960478	−1.953259	−1.864523	−1.861344	−1.173660	−1.822688
F-statistic	313.1393	313.1662	345.1564	314.1631	98.48234	43.34417	108.7127
Prob (P)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SSR	0.892814	0.892741	0.930263	1.016580	1.055033	2.171037	1.134482

( ) indicates "t-statistics"
Equations Ⅰ-Ⅳ are production fuctions
Equations Ⅴ-Ⅶ are solow residuals equations.

<Table 5> Growth Source Decomposition by City

(1985-2005 Average)

City	$\dot{y}$	$\dot{A}$	$\dot{k}$	$\dot{h}$	$\dot{Z}_1$	$\dot{Z}_2$	$\dot{Z}_3$	$\dot{Z}_4$	$\dot{Z}_5$	$\dot{Z}_6(\dot{Z}_n)$
Nation	4.698	64.6329	22.6062	11.4423	0.9562	0.0246	−0.5846	−12.8573	14.3777	−0.3938
Seoul	4.564	60.6363	12.6216	1.9908	3.1364	0.1097	−0.0129	−4.7208	26.1790	0.1125
Busan	4.514	69.3117	22.0239	8.7616	2.7832	−0.0150	0.6460	−32.2837	28.0134	0.7797
Daegu	3.385	60.0005	32.9451	21.3722	20.3873	0.0305	0.9100	−58.5359	21.9961	0.7561
Kwangju	8.516	27.4792	10.8418	7.7556	9.0794	−0.3072	0.8800	−3.3231	45.7715	1.6354
Daejun	8.223	69.3675	12.4314	7.7873	11.0542	0.0197	−1.1659	−41.7557	40.877	1.1880
Inchon	2.783	64.9420	6.1556	−3.8422	13.3971	−0.0338	3.4478	−25.1930	40.8797	0.2139
Jaeju[a]	4.548	79.3091	18.8711	−11.2046	16.4625	0.0335	0.3043	−53.8875	51.8656	−1.5069
Pooled citie	5.579	79.7998	2.0560	6.0568	2.4890	0.0117	−2.6989	−51.4485	62.6383	0.9873

Note: [a] Jaeju is whole Jaeju province instead of Jaeju city alone

[b] Pooled cities include Seoul, Busan, Daegu, Kwangju, Daejun, Inchon, and Jaeju province.

"Dot" on the head of each variable means "growth rate".

For example $\dot{y} = \triangle \ln y = \ln y_t - \ln y_{t-1}$

$$= \ln(y_t / y_{t-1})$$