

Testing the Convergence Hypothesis of Health Care Expenditure: Empirical Evidence from Korea

Hyun-Jae Rhee

Department of Economics
Cheongju University, Cheongju 360-764, Republic of Korea

ABSTRACT

This research explores the convergence of health care expenditure in Korea with different income groups and the world level by applying different concepts of convergence, including growth rates, trends, differences as well as rationality and statistical variation of health care expenditure. The empirical evidence shows that, in general, the health care expenditure in Korea seems to be on the right track in terms of both level and difference, given the fact that convergence exists with the expenditures of the high income group and the world level. It is also worth mentioning that the Korean public health care system has been performing much better than its private health care counterpart. Such a result suggests that the private health care system has to be more elaborately and systematically managed through the establishment of an operational policy to stimulate an increase in private health care expenditure.

Key words: Health Care Expenditure, Convergence Hypothesis and Rationality.

1. INTRODUCTION

Given the increasing emphasis on social welfare within the last two decades, health care expenditure has tended to grow more rapidly than national income in most developed as well as developing economies. Korea is not an exception in this regard. Korea successfully legislated the national health insurance law in 1999, which paved the way towards setting up a lifetime health care structure. The management system for health related policies in Korea are mainly concerned with how to raise the quality of life of its citizens through improved public health and social security.

In general, the scale of health care expenditure can be classified as that for high, middle, and low income groups and that for the world. This is mainly because the public spending priority is not the same for different income groups. Therefore, it is important to identify trends in the health care expenditure to verify whether the scale of this expenditure is commensurate with the level of national income. Such an analysis would also help toward planning more effective health related policies in response to rising health care costs. Recently, the effectiveness of health care expenditure has received more attention, particularly in light of cost containment and budgetary control.

The central objective of this study is to empirically examine the convergence in the health care expenditure in Korea, by

comparing it across different income groups and with the level of the health care expenditure at the world level. Such an approach is interesting in that it helps us to analyze health care expenditure from a macroeconomic perspective, and it would also help pinpoint alternative policy directions pertaining to health care expenditure. The paper is organized as follows. Section 2 presents a literature review. Section 3 is discusses convergence formulation and empirical work. It includes the definition of convergence and a description of the econometric methods used in the empirical analysis, which test the convergence of health care expenditure in Korea across income groups as well as the world. Section 4 summarizes the results of the investigation.

2. LITERATURE REVIEW

Previous research has primarily focused on the outcome or economic growth resulting from an increase in health care expenditure and has attempted to uncover the determinants of health care expenditure. For instance, the health care expenditure was analyzed by inducing infant mortality and life expectancy [1][2]. These studies examined life expectancy and infant mortality as an output of health care expenditure. Notably, it was found that while increases in health care expenditure are significantly associated with large improvements in infant mortality, they are only marginally associated with improvements in life expectancy[1].

Many of the previous studies in this field, such as

* Corresponding author, Email : hyunrhee@cju.ac.kr
Manuscript received Jan. 16, 2013; revised Mar 11, 2013;
accepted Mar 21, 2013

references [3]-[9], have been conducted to verify the impact of the health care expenditure on economic growth or the welfare effect arising from the increase in the health care expenditure, by employing the Granger causality, quantile-based panel, and dynamic analysis. References [10]-[13] also evaluated the determinants for the health care expenditure.

Recent studies have suggested that convergence is quite important in identifying the pattern of health care expenditure. Reference [14] analyzed the convergence of per capita health care expenditures in member countries of the Organization for Economic Cooperation and Development (OECD) during 1970-2005 and concluded that a very strong form of persistence for OECD expenditures inequality. Reference [15] revealed that health care expenditure is converging in OECD countries, and this conclusion also holds when applied to smaller subgroups of countries and shorter time periods. However, it has been shown that countries do not move towards a common mean and that the rate of the convergence decreases over time. Reference [16] also investigated the existence of the convergence of health care expenditure in European Union (EU) countries and revealed that their health care expenditures exhibit β -convergence. Reference [17] analyzed the convergence of health care expenditure in the United States. The major findings point to moderate evidence of convergence in total health care expenditure and the diverse performance of expenditure components pertaining to convergence.

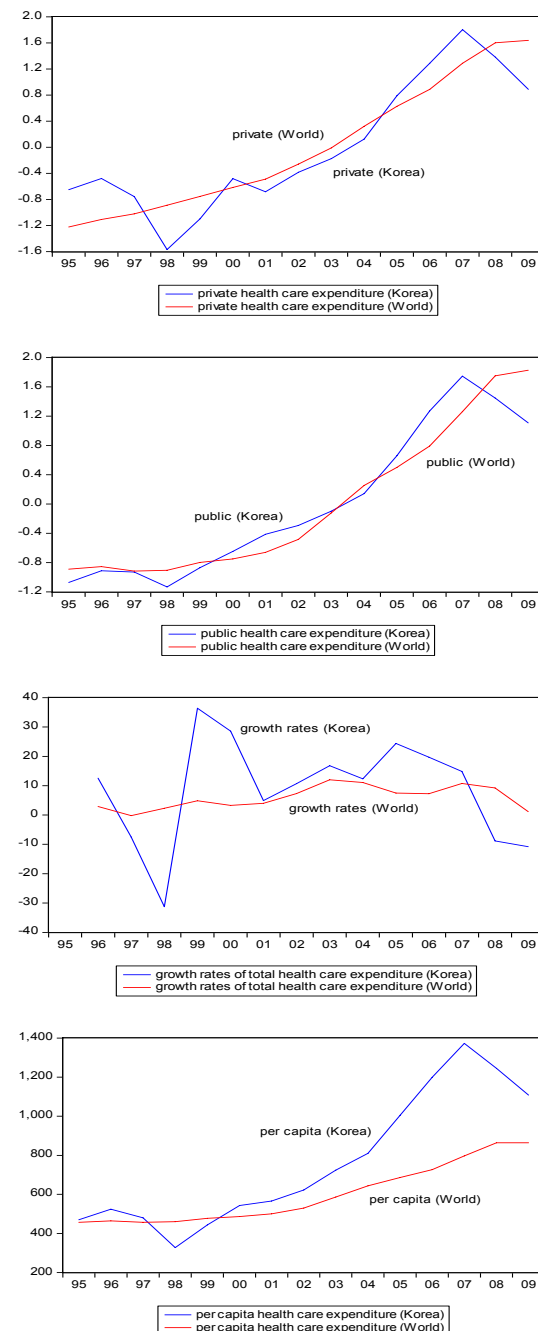
However, none of the previous studies in this field have dealt with convergence among different income groups and the world level of health care expenditure, particularly in the case of Korea. The basic argument in favor of examining this relationship is that as national incomes in Korea tend to convergence in different income groups, income-related health care expenditure should also follow an analogous pattern. Another important factor is that convergence in health care expenditure also influences integration in health care markets and common policies to promote health and living standards under the global economic system.

3. CONVERGENCE FORMULATION AND EMPIRICAL ANALYSIS

3.1 The Trend of Underlying Health Care Expenditure

First, the trend of the health care expenditures in Korea and the world are depicted by figures to perform an empirical analysis of the convergence hypothesis. As seen in Figure 1, private health care expenditure in Korea altered in general between the 1990s and the 2000s. It was lower than the world trend in most cases, except during the mid-2000s. Since then, it declined sharply at the end of the 2000s. However, the trends of public health care expenditure, growth rates of total health care expenditure, and per capita health care expenditure in Korea surpassed their respective values for the world throughout these periods. However, the private health care expenditure also fell drastically at the end of the 2000s. In general, the health care expenditures in Korea increased continuously during all the periods under

study, except at the end of the 2000s, in favor of the public sector.



Note: A normalized trend depicts a trend of private and public health care expenditures. That is, the Y-axis scaling is a linear scale using the data standardized to have mean 0 and variance 1. It implies that if $Y=0$, statistical distribution of the data approaches to the mean value.

Source: World Bank Database (www.worldbankgroup.org)[26]

Fig. 1. Underlying Trend of Health Care Expenditures by Year: Korea and the world

3.2 Result of Empirical Analysis

3.2.1 β -convergence

The convergence is broadly understood as the tendency of differences between the designated variables to disappear

over time. According to recent empirical studies, the convergence has been widening. This is mainly due to the fact that the convergence usually refers distinctly to issues related to the persistence of differences in the designated variables.

The theoretical background for the convergence hypothesis is provided in references [18]-[20]. Reference [18] used an almost everywhere convergence theorem for seminormed fuzzy co-integrals to show that the fuzzy measure is null-additive. Reference [19] revealed the equivalence between the tail series weak law of large numbers and a limit law established for a quasi-monotone decreasing sequence, thereby extending the result of a previous work to the wider class of norming constants. Reference [20] studied the duality between the limiting behavior of the tail series of random variables and that of Banach space valued random elements and revealed an alternative way of arriving at a result of a previous work that established equivalence between the tail series weak law of large numbers and a limit law provided in a Banach space setting.

The concept of convergence is defined in the literature as the implication that an optimal level of health care expenditure exists, and it enables a steady state condition at the top level of equilibrium. To apply such a procedure (based on the theoretical background) to health care expenditure, the formulations suggested by references [21]-[25] could be utilized tentatively. According to these, β -convergence occurs when health care expenditure in Korea grows faster than that for different income groups and the world level, thus indicating a negative relationship between health care expenditure in Korea, not only in the case of the other income groups, but also on the world level. β -convergence can be broadly classified into relative (conditional) or absolute (unconditional) convergence, and relative (conditional) convergence could be applied in this research, since the analysis basically compares the level of health care expenditures among Korea, the various income groups, and the world level.

To examine the convergence hypothesis in this research, the classification of health care expenditures used are as follows: private, public, total and per capita. Income groups are categorized as high, middle and low, and at the world level. The convergence hypothesis is tested using a set of data from 1995-2009. Secondary data are obtained from the World Bank database [26].

β -convergence indicated by growth rates captures whether the health care expenditure in Korea converged to the growth rate of the health care expenditure in different income groups and at the world level. On the other hand, β -convergence calculated by a trend tests the convergence throughout a time path. Moreover, β -convergence implemented by the differences checks if health care expenditure in Korea converged to the differences between the country's health care expenditure and that of different income groups, including the world level.

The formulations of β -convergence are as follows. In the

following structural equations, y_{it} is the health care expenditure in Korea, and y_{Wt} denotes the health care expenditures in different income groups and at the world level. The growth rate of health care expenditure in different income groups and at the world level is given by g_{Wt} , and (t) is a time trend variable. Should the β -convergences exist in the following structural equations, the estimated coefficients of $\hat{\beta}_1$, $\hat{\beta}_2$, and $\hat{\beta}_3$ should be negative.

β -convergence by growth rates (Model I):

$$g_{Wt} = \alpha_1 + \beta_1 \log y_{it} + \varepsilon_{it}$$

β -convergence by trend (Model II):

$$\frac{\partial \log y_{it}}{\partial t} = \alpha_2 + \beta_2 (\log y_{Wt} - \log y_{it}) + \varepsilon_{it}$$

β -convergence by differences (Model III):

$$(\log y_{Wt} - \log y_{it}) = \alpha_3 + \beta_3 \log y_{it} + \varepsilon_{it}$$

The result of β -convergence is shown in Tables 1 to 3. Table 1 shows the result of β -convergence by growth rates (Model I). As the signs of the β -coefficients in Table 1 are positive, except for the private health care expenditure in the high income group, the health care expenditure in Korea, in general, differs from the expenditures of different income groups and that of the world level. This is because the positive sign implies that the expenditure has diversified from the growth rate, based on the health care expenditures of different income groups and the world level.

Although ordinary least squares (OLS) are a useful econometric method, autocorrelation is frequently presented in the error term. Such a difficulty might be overcome by virtue of the Cochrane-Orcutt AR(1) procedures. The process can easily capture and adjust auto-correlated components in the Gaussian error term ($\hat{\varepsilon}_t$) in structural equations. The procedure could be identified by an innovative equation, such that $\hat{\varepsilon}_t = \rho \hat{\varepsilon}_{t-1} + v_t$. The procedure involves a series of iterations, each of which produces a better estimate of ρ than the previous one. Here, $\hat{\varepsilon}_{t-1}$ is a lagged estimated error term, and ρ is a correlation coefficient associated with errors of adjacent time periods [27]. Because estimated correlation coefficients ($\hat{\rho}$) in most cases are less than 1 (unity) in absolute value, any possible auto-correlated components can be captured by $\hat{\rho}$. Thus, the stability of the estimated coefficients could be improved accordingly.

Table 1. Result of β -Convergence by Growth Rates

	Income groups	α_1	β_1	R^2	DW	AR(1)
private	high	27.97 (0.39)	-0.962 (-0.31)	0.05	1.63	0.26 (0.55)
	middle	-327.2 (-2.40)*	14.32 (2.47)*	0.35	1.68	0.20 (0.50)

	low	-354.6 (-5.15)*	15.47 (5.28)*	0.50	1.50	-0.51 (-1.75)
	world	-22.82 (-0.26)	1.219 (0.33)	0.14	1.36	0.41 (0.69)
public	high	-84.54 (-0.90)	3.816 (0.96)	0.24	1.38	0.38 (0.99)
	middle	-335.5 (-2.40)*	14.68 (2.48)*	0.44	1.40	0.28 (0.69)
	low	-233.3 (-4.48)*	10.36 (4.68)*	0.58	1.80	-0.09 (-0.29)
	world	-114.6 (-1.35)	5.114 (1.42)	0.33	1.34	0.33 (0.79)
total	high	-32.02 (-0.27)	1.544 (0.32)	0.15	1.35	0.48 (1.13)
	middle	-336.4 (-2.54)*	14.27 (2.62)*	0.45	1.50	0.27 (0.65)
	low	-278.1 (-5.89)*	11.86 (6.09)*	0.60	1.35	-0.40 (-1.34)
	world	-75.39 (-0.71)	3.350 (0.76)	0.25	1.26	0.44 (0.96)
per capita	high	-6.411 (-0.19)	1.697 (5.04)*	0.12	1.38	0.46 (1.09)
	middle	-94.20 (-2.54)*	15.57 (2.80)*	0.45	1.63	0.23 (0.61)
	low	-77.98 (-4.18)*	12.87 (4.55)*	0.51	1.63	-0.21 (-0.66)
	world	-21.14 (-0.72)	3.917 (0.88)	0.26	1.30	0.41 (0.89)

Note: Figures in parentheses denote t-statistics, and (*) denotes that the null hypothesis is rejected at the 5% significance level.

β -convergence by trend (Model II) is also identified for different income groups and the world level of health care expenditure. The result of β -convergence by trend is shown in Table 2. The β -coefficients for the high and middle income groups and for the world level of health care expenditure are negative in all cases. This implies that the health care expenditure in Korea converged to high and middle income groups and the world trend. However, the β -coefficients for the low income group diverged, since these β -coefficients are positive.

Table 2. Result of β -Convergence by Trend

	income groups	α_2	β_2	R^2	DW	AR(1)
private	high	3.664 (2.25)*	-0.826 (-2.24)*	0.16	1.80	0.39 (1.23)
	middle	2.849 (3.98)*	-1.043 (-3.94)*	0.45	1.78	0.50 (1.94)
	low	-4.896 (-1.13)	0.210 (1.14)	0.11	1.80	0.11 (0.33)
	world	4.261 (2.46)*	-0.925 (-2.44)*	0.26	1.81	0.36 (1.12)
public	high	3.743 (2.46)*	-0.802 (-2.51)*	0.02	1.99	0.76 (3.96)*
	middle	1.427 (3.36)*	-0.539 (-3.18)*	0.41	1.95	0.22 (0.77)
	low	-1.221 (-0.46)	0.055 (0.49)	0.04	1.69	0.16 (0.49)
	world	3.961 (2.63)*	-0.825 (-2.66)*	0.07	1.99	0.75 (3.88)*
total	high	2.845	-0.612	0.06	1.79	0.49

	middle	(2.06)*	(-2.04)*			(1.62)
	low	1.953 (3.85)*	-0.743 (-3.74)*	0.51	1.85	0.14 (0.45)
public	high	-2.624 (-0.78)	0.111 (0.80)	0.07	1.73	0.16 (0.48)
	world	3.346 (2.34)*	-0.702 (-2.32)*	0.13	1.81	0.51 (1.74)
per capita	high	0.880 (1.98)*	-0.572 (-1.93)	0.06	1.80	0.43 (1.36)
	middle	-1.453 (-3.57)*	-0.748 (-3.72)*	0.50	1.87	0.18 (0.57)
	low	-0.764 (-0.81)	0.124 (0.87)	0.08	1.75	0.15 (0.44)
	world	-0.117 (-0.89)	-0.737 (-2.40)*	0.11	1.86	0.56 (1.98)*

Note: Figures in parentheses denote t-statistics, and (*) denotes that the null hypothesis is rejected at the 5% significance level.

Table 3 depicts the result of β -convergence by differences (Model III). It shows that the β -coefficients are negative in all cases. This signifies that the health care expenditures in Korea are quite sensitive to the differences, regardless of the levels of income. A subordinate issue in the literature about the convergence is the assessment of the speed of convergence among the variables. Therefore, any additional formal testing strategies for the persistence of health care expenditure inequality might constitute a relevant endeavor. The speed of adjustment is highly evaluated in these cases.

Table 3. Result of β -Convergence by Differences

	income groups	α_3	β_3	R^2	DW	AR(1)
private	high	-183.0 (-0.01)	-0.967 (-31.4)*	0.99	1.52	1.00 (38.6)*
	middle	363.7 (0.01)	-0.903 (-8.91)*	0.87	1.20	0.99 (18.4)*
	low	499.0 (0.01)	-0.948 (-9.15)*	0.85	1.44	0.99 (16.8)*
	world	242.8 (0.01)	-0.959 (-30.4)*	0.98	1.33	0.99 (40.8)*
public	high	376.3 (0.01)	-0.925 (-11.3)*	0.98	0.87	0.99 (16.0)*
	middle	723.2 (0.01)	-0.918 (-4.88)*	0.83	0.82	0.99 (12.7)*
	low	748.9 (0.01)	-1.039 (-8.85)*	0.90	0.64	0.99 (23.0)*
	world	467.8 (0.01)	-0.926 (-10.8)*	0.97	0.77	0.99 (16.5)*
total	high	377.4 (0.01)	-0.924 (-16.9)*	0.98	1.13	0.99 (22.3)*
	middle	634.9 (0.01)	-0.882 (-6.59)*	0.82	0.95	0.99 (15.0)*
	low	21.31 (10.8)*	-0.975 (-11.0)*	0.90	1.60	1.09 (23.8)*
	world	26.14 (22.0)*	-0.920 (-18.4)*	0.98	1.32	1.06 (26.6)*
per capita	high	328.4 (0.01)	-0.917 (-16.1)*	0.97	1.20	0.99 (19.2)*
	middle	470.7 (0.01)	-0.872 (-6.25)*	0.81	1.03	0.99 (12.4)*
	low	1.842 (3.19)*	-0.965 (-9.53)*	0.92	1.51	1.12 (14.6)*
	world	5.247	-0.913	0.98	1.37	1.08

	(12.1)*	(-17.5)*	(20.9)*
--	---------	----------	---------

Note: Figures in parentheses denote t-statistics, and (*) denotes that the null hypothesis is rejected at the 5% significance level.

3.2.2 Pairwise Convergence with Rationality

Reference [28] suggested that pairwise convergence could be identified by generating a pair variable associated with an original one. According to reference [29], a pair variable could be extended by employing rationality. The convergence with rationality could be formulated as follows. A pair variable, y_{it}^F , can be generated using the conditional probability of an original variable, y_{it} . The information matrix, I_t , refers to the world level of the health care expenditure. If pairwise convergence exists, the estimated coefficient should equal unity. In other words, $\hat{\omega} = 1$ should be satisfied. The advantage of pairwise convergence using Model IV is that it helps identify level-based convergence.

$$y_{it}^F = E[y_{it} | I_t]$$

$$y_{it} = \gamma + \delta y_{it}^F + \varepsilon_{it}$$

Convergence with rationality (Model IV):
 $\log y_{it} = \eta + \omega \log(E[y_{it} | y_{it}^F]) + \varepsilon_{it}$

The result of the pairwise convergence with rationality is shown in Table 4. The signs of ω -coefficients for the level or magnitude of the private health care expenditure in Korea are shown to be 1 (unity) in all cases. The signs of the ω -coefficients for the high income group and the world level are also satisfied by the convergence condition. However, this is not so for the other cases (middle and low income groups).

Table 4. Result of Pairwise Convergence with Rationality

income groups		η	ω	R^2	DW
private	high	-1.223 (-0.36)	1.052 (7.37)*	0.80	1.50
	middle	-1.418 (-0.38)	1.061 (6.62)*	0.77	1.28
	low	-1.544 (-0.39)	1.066 (6.40)*	0.75	1.36
	world	-1.154 (-0.35)	1.049 (7.37)*	0.80	1.50
public	high	-1.629 (-0.81)	1.070 (12.5)*	0.92	1.13
	middle	-6.963 (-2.49)*	1.297 (0.12)	0.90	0.99
	low	-8.165 (-2.97)*	1.347 (11.5)*	0.91	1.19
	world	-2.222 (-1.04)	1.095 (12.0)*	0.92	1.06
total	high	-0.532 (-0.24)	1.022 (11.2)*	0.91	1.37
	middle	-4.404 (-1.18)	1.183 (7.65)*	0.82	0.82
	low	-3.471 (-1.03)	1.144 (8.25)*	0.84	1.06

	world	-0.811 (-0.34)	1.034 (10.6)*	0.90	1.25
per capita	high	-0.128 (-0.21)	1.020 (10.8)*	0.90	1.42
	middle	-1.474 (-1.26)	1.228 (6.91)*	0.78	0.79
	low	1.436 (6.93)*	1.436 (6.93)*	0.78	0.92
	world	-0.203 (-0.31)	1.032 (10.2)*	0.89	1.28

Note: Figures in parentheses denote t-statistics, and (*) denotes that the null hypothesis is rejected at the 5% significance level.

3.2.3 σ -Convergence

σ -convergence occurs when the variance or standard deviation of health care expenditure in Korea is smaller than the respective values for different income groups and the world level. The convergence identified by a variance or standard deviation is superior to those identified by other means, as statistical variation can be recognized in the former. Following reference [24], statistical variations in health care expenditures in Korea, for different income groups, and the world, can be measured by variance or standard deviation. In order to verify the σ -convergence hypothesis, the following condition should be identified.

$$\sigma_{\log(y_{it})} - \sigma_{\log(y_{it}^F)} < 0$$

The result of σ -convergence is summarized in Table 5. As far as σ -convergence is concerned, the variation of health care expenditures in Korea is strongly correlated with the high income group, in terms of statistical characteristics. σ -convergence also exists for the middle income group and the world level but not for per capita health care expenditure in Korea. Moreover, no σ -convergence is revealed for the low income group.

Table 5. Result of σ -Convergence

	high income	middle income	low income	world
private	-1.06	-1.21	2.44	-1.88
public	-3.42	-1.50	9.70	-4.96
total	-8.69	-5.36	2.71	-1.34
per capita	-5.10	1.12	1.14	9.10

4. SUMMARY AND CONCLUSION

The magnitude of health care expenditure has been increasing sharply in most developed and developing economies since the last two decades. This is mainly because social welfare is a crucial issue in these economies, due to their elderly or aging population. Korea is not an exception in this regard. However, the trend of the health care expenditure has tended to diversify in general among high, middle and low income groups, because the public spending priority is not the same across the different income groups.

This research is basically designed to deal with the convergence of the health care expenditure in Korea with

different income groups and the world, by applying different concepts of convergence, such as growth rates, trends and differences as well as rationality and statistical variation in the health care expenditure. According to the empirical evidence, the health care expenditure in Korea seems to be on the right track, in general, in terms of the level and difference, given that the convergence exists with the health care expenditures of the high income group and the world level. It is also notable that the Korean public health care system has been performing exceptionally well compared to the country's private health care system. Such a result suggests that the private health care system needs to be more elaborately and systematically managed to stimulate an increase in the private health care expenditure through the establishment of an operational policy.

The number of elderly in Korea is bound to increase in the near future. Accordingly, the magnitude of the health care expenditure will be a fast-growing account in the government's budget. Therefore, the effectiveness of the health care expenditure will diminish over time. There will be a need for more effective health related policies to overcome the cost containment and budgetary control in response to rising health care costs. Hence, although health care expenditure in Korea appears to be on the right track for now, further research is crucial to ensure its continued efficiency from a microeconomic perspective.

REFERENCES

- [1] J. Nixon and P. Ulmann, "The Relationship between Health Care Expenditure and Health Outcomes: Evidence and Caveats for a Causal Link," *European Journal of Health Economics*, vol. 7, no. 1, Mar. 2006, pp. 7-18.
- [2] H.-J. Rhee, "Effects of Health Care Expenditure on the Infant Mortality Rate and Life Expectancy at Birth in Korea," *International Journal of Contents*, vol. 8, no. 3, Sep. 2012, pp. 52-56.
- [3] P.-R. Agenor and K. C. Neanidis, "The Allocation of Public Expenditure and Economic Growth," *Manchester School*, vol. 79, no. 4, Jul. 2011, pp. 899-931.
- [4] K.-M. Wang, "Health Care Expenditure and Economic Growth: Quantile Panel-Type Analysis," *Economic Modelling*, vol. 28, no. 4, Jul. 2011, pp. 1536-1549.
- [5] M. Mehrara and M. Musai, "Health Expenditure and Economic Growth: An ARDL Approach for the Case of Iran," *Journal of Economics and Behavioral Studies*, vol. 3, no. 4, Oct. 2011, pp. 249-256.
- [6] A. Amiri and B. Ventelou, "Granger Causality between Total Expenditure on Health and GDP in OECD: Evidence from the Toda-Yamamoto," *Economics Letters*, vol. 116, no. 3, Sep. 2012, pp. 541-544.
- [7] M. M. Rahman, "Causal Relationship among Education Expenditure, Health Expenditure and GDP: A Case Study for Bangladesh," *International Journal of Economics and Finance*, vol. 3, no. 3, Aug. 2011, pp. 149-159.
- [8] S. N. Sulku and A. Caner, "Health Care Expenditures and Gross Domestic Product: The Turkish Case," *European Journal of Health Economics*, vol. 12, no. 1, Feb. 2011, pp. 29-38.
- [9] E. Tobing and J.-L. Jeng, "Long-Run Growth and Welfare Effects of Rising US Public Health Expenditure," *Public Finance Review*, vol. 40, no. 4, Jul. 2012, pp. 470-496.
- [10] D. Cantarero and S. Lago-Penas, "The Determinants of Health Care Expenditure: A Reexamination," *Applied Economics Letters*, vol. 17, nos. 7-9, May-Jun. 2010, pp. 723-726.
- [11] I. Mosca, "Decentralization as a Determinant of Health Care Expenditure: Empirical Analysis for OECD Countries," *Applied Economics Letters*, vol. 14, nos. 7-9, Jun.-Jul. 2007, pp. 511-515.
- [12] J. M. Martin et al., "Review of the Literature on the Determinants of Healthcare Expenditure," *Applied Economics*, vol. 43, nos. 1-3, Feb. 2011, pp. 19-46.
- [13] J. B. Ang, "The Determinants of Health Care Expenditure in Australia," *Applied Economics Letters*, vol. 17, nos. 7-9, May-Jun. 2010, pp. 639-644.
- [14] D. Cantarero and S. Lago-Penas, "Decomposing the Determinants of Health Care Expenditure: The Case of Spain," *European Journal of Health Economics*, vol. 12, no. 1, Feb. 2012, pp. 19-27.
- [15] A. Aslan, "Convergence of Per Capita Health Care Expenditures in OECD Countries," *International Research Journal of Finance and Economics*, vol. 24, 2009, pp. 48-53.
- [16] A.M. Leiter and E. Theurl, "The Convergence of Health Care Financing Structures: Empirical Evidence from OECD-countries," *European Journal of Health Economics*, vol. 13, no. 1, Feb. 2012, pp. 7-18.
- [17] T. Hitiris and J. Nixon, "Convergence of Health Care Expenditure in the EU Countries," *Applied Economics Letters*, vol. 8, Feb. 2001, pp. 223-228.
- [18] Z. Wang, "The Convergence of Health Care Expenditure in the US States," *Health Economics*, vol. 18, 2009, pp. 55-70.
- [19] S.-M. Im and M.-H. Kim, "Almost Everywhere Convergence Theorem for Seminormed Fuzzy Co-integrals," *Journal of the Korea Contents Association*, vol. 5, no. 5, May 2005, pp. 140-144.
- [20] E. Nam and Y.-S. Jang, "Limiting Behavior of Tail Series of Independent Random Variable," *Journal of the Korea Contents Association*, vol. 6, no. 4, Jun. 2006, pp. 63-68.
- [21] E. Nam, "On the Tail Series Laws of Large Numbers for Independent Random Elements in Banach Spaces," *Journal of the Korea Contents Association*, vol. 6, no. 5, Jun. 2006, pp. 29-34.
- [22] T.-W. Ho, "Income Thresholds and Growth Convergence: A Panel Data Approach," *Manchester School*, vol. 74, no. 4, Mar. 2006, pp. 170-189.
- [23] J. Villaverde, "Provincial Convergence in Spain: A Spatial Econometric Approach," *Applied Economics Letters*, vol. 12, 2005, pp. 697-700.

- [24] B. Vojinovic, Z.J. Oplotnik, and M. Prochniak, "EU Enlargement and Real Economic Convergence," *Post-Communist Economies*, vol. 22, no. 3, Sep. 2010, pp. 303-322.
- [25] S.D. Durlauf and L.E. Blume, *New Palgrave Dictionary of Economics*, vol. 2, 2nd ed., Macmillan, 2008, pp. 216-220.
- [26] World Bank database (www.worldbankgroup.org).
- [27] R.S. Pindyck and D.L. Rubinfeld, *Econometric Models and Economic Forecast*, 4th ed., McGraw-Hill, 1998.
- [28] K. Chowdhury and G. Mallik, "Pairwise Output Convergence in Selected Countries of East Asia and the Pacific: An Application of Stochastic Unit Root Test," *ASEAN Economic Bulletin*, vol. 28, no. 1, 2011, pp. 1-15.
- [29] G.S. Maddala, *Introduction to Econometrics*, 3rd. ed., Wiley, 2001.

**Hyun-Jae Rhee**

He received an M.A. in Economics from Kyung Hee University, Korea in 1979 and an M.S. in Economics from Utah State University, USA in 1989. He also received a Ph.D. in Economics from the University of Wisconsin-Milwaukee, USA in 1994. Since then,

he has worked in the Department of Economics, Cheongju University, Korea. His main research interests include evaluating economic performance and econometrics.