How does energy efficiency affect carbon emissions in Asian economies?

○本間聡[*], 牛房義明[**], ファルハード　タギザーデ ヘサーリ[***],
リル　ヴァンデルカム[****]

○Satoshi Honma, Yoshiaki Ushifusa, Farhad Taghizadeh-Hesary,
and Lilu Vandercamme

１．Introduction

In Asian countries, especially in fast-growing emerging economies such as China, India, and Southeast Asian countries, the deployment of renewable energy (RE) and the improvement of energy efficiency (EE) are important to reduce carbon emissions in line with the Paris Agreement and the sustainable development goals (SDGs) 7 and 13. In many previous studies, energy intensity or energy productivity are taken as an EE indicator (e.g., Akram et al., 2020). However, they are partial-factor productivity. Hence, in this study, we use data envelopment analysis (DEA) model to measure total-factor energy efficiency (TFEE), which has been widely applied in energy efficiency study (Hu et al., 2021). We examine how energy efficiency improvements affect carbon emissions compared to an increase in RE share in Asian economies, which are composed of heterogeneous countries.

２．Methodology

We measure TFEE using slacks-based measure (SBM) DEA model with undesirable outputs), in which capital, labour, energy are taken as the inputs and real GDP and CO_2 emission are taken as the desirable and undesirable outputs, respectively. Then we estimate the following equation:

$$LnC_{it} = \beta_0 + \beta_1 EE_{it} + \beta_2 RE_{it} + \beta_3 GDPPC_{it} + \beta_4 GDPG_{it} + \boldsymbol{\gamma Z} + \epsilon_{it}$$

where C_{it}, EF_{it}, $GDPPC_{it}$, and $\boldsymbol{Z}$ denote CO_2 emissions per GDP, EE, real GDP per capita, real GDP growth rate and control variables of country i in time t, respectively, while ϵ_{it} denotes the error term. To address the endogeneity problem in the energy efficiency measurement, we employ instrumental variable models, in which the lagged EE is used as the instrument. Our data are taken from the World Development Indicators and the Penn World Tables. Our sample consists of 30 Asian countries. The sample period is 2000-2019.

３．Empirical results

[*] Tokai University, E-mail: honmasatoshi@tokai.ac.jp
[**] The University of Kitakyushu, E-mail: ushifusa@kitakyu-u.ac.jp
[***] Tokai University, E-mail: farhad@tsc.u-tokai.ac.jp
[****] Keio University, E-mail: liluvandercamme119@gmail.com

Table 1 presents fixed effects (FE) and instrumental variable (IV) results. The dependent variable is natural logarithm of CO_2 emissions per GDP. In Column FE(1) and IV(1), the coefficients of TFEE are significant at 1% and negative, suggesting that a 1% improvement in TFEE will reduce CO_2 emissions per GDP by 0.272% and 0.268%, respectively. The coefficients of RE ratio are also significant at 5% and 1% and negative, whereas the absolute values of them, 0.153 and 0.162, are smaller than those of TFEE, respectively. In both FE(2) and IV(2), EP is taken as the main explanatory variable instead of TFEE. The negative and significant coefficients of EP show the same results. Note that the absolute values of the coefficient of TFEE is smaller than that of TFEE for each of FE and IV. These results imply that the improvement of EE is more effective in reducing CO_2 emissions than the expansion of the RE share. This is consistent of the results of Akram et al. (2020).

Table 1 The results of panel OLS and instrumental variable method

	FE(1)	FE(2)	IV(1)	IV(2)
Ln TFEE	-0.272**		-0.268***	
Ln EP		-0.967***		-0.759***
Ln renewable energy	-0.153**	-0.120**	-0.162***	-0.132***
Ln GDP per capita	-0.423***	-0.010	-0.449***	-0.098
Ln GDP growth	0.032*	0.029	0.032***	0.029***
Nuclear energy share	-0.002*	0.000	-0.001	0.000
Trade	0.001	0.002**	0.001*	0.002***
Constant	-4.551***	-9.817***	-4.218***	-8.655***
R^2	0.468	0.715	0.246	0.634

(Notes) The coefficients of year dummies are omitted. * p<0.1, ** p<0.05, *** p<0.01.

4. Conclusion

Our results show that improving energy efficiency is more effective in reducing carbon dioxide emissions in Asian economies than increasing the RE share. The policy implication of this result is the importance of improving EE.

References

Akram, R., Chen, F., Khalid, F., Ye, Z., and Majeed, M. T. (2020). Heterogeneous effects of energy efficiency and renewable energy on carbon emissions: Evidence from developing countries. Journal Of Cleaner Production, 247, 119122.

Hu, J. L., Honma, S., and Chen, Y. K. (2021). Total‐factor energy and emission efficiencies of ASEAN and other Asian economies. Asian Economic Policy Review, 16(1), 92-112.