Examining the Effects of Local Economic Growth and Government Expenditures on Water Quality

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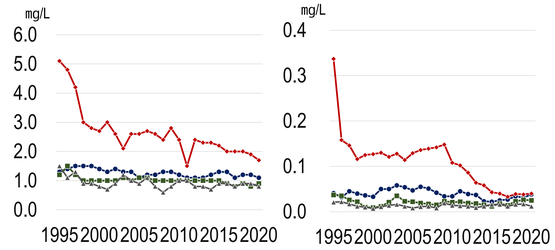
Background and Objective

- The water policies were accompanied with the increased environment-related budget for water quality. The water conservation budget increased by 39.7% over decades, reaching about 2.2 billion dollars per year, which accounted for 41.7% of the total environmental budget.
- According to the Korean Statistical Information Service, the biochemical oxygen demand (BOD) was improved from of 1.2-5.1 *mg/l* in 1995 to 0.8-1.7 *mg/l* in 2020, while total-phosphate (T-P) was improved from 0.02-0.34 in 1995 to 0.01-0.04 in 2020.



- Thus, this paper aims to determine whether local environmental expenditures for water quality are effective directly in improving local water quality and whether they improve water quality indirectly by stimulating local economic growth.

Data

- The data are obtained from the Water Environment Information System, the Local Finance Integrate Open System, and the National Statistical Office database for 173 cities from 2010 to 2018.

Variable	Unit	Mean	Std. dev.	Min	Max
BOD	mg / l	2.3	2.1	0.3	32.5
TP	mg / l	0.1	0.1	0.0	2.7
GRDP	million won	32.6	32.1	6.9	431.7
GOV	million won	0.5	0.4	0.0	2.6
PROD	million won	92.2	76.7	15.6	781.3
COMP	person	7,496	8,862	364	55,920
URB	%	71.2	24.4	5.1	100.0
GREEN	%	63.2	80.7	0.0	411.3
OLD	km2	27	22	3	132
POP	1000person	210	229	17	1,203

Method

- This paper employs the dynamic panel model with a two-step estimation procedure following the approach of Zhang et al. (2017).
- In the first step, we regress local environmental expenditures and other explanatory variables on the gross regional domestic product (GRDP) per capita.

$$lnGRDP_{it} = \gamma_i + \delta_t + \alpha_0 + \alpha_1 lnGRDP_{it-1} + \alpha_2 GOV_{it} + \alpha_3 lnPROD_{it} + \alpha_4\, lnCOMP_{it} + \alpha_5 URB_{it} + \alpha_6 lnGREEN_{it} + \alpha_7 lnOLD_{it} + u_{it}$$

- In the second step, we regress the predicted GRDP obtained from the first step, local environmental expenditures, and other explanatory variables on water quality indicators.

$$lnY_{it} = \mu_i + \xi_t + \beta_0 + \beta_1 lnY_{it-1} + \beta_2 GOV_{it} + \beta_3 ln\widehat{GRDP}_{it} + \beta_4 ln\widehat{GRDP}^2{}_{it} + \beta_5 PROD_{it} + \beta_6 lnCOMP_{it} + \beta_7 URB_{it} + \beta_8 lnGREEN_{it} + \beta_9 lnPOP_{it} + \epsilon_{it}$$

- The total effect of government spending on water pollutant is decomposed into the direct and indirect effects.

$$\frac{d(lnY)}{d(GOV)} = \underbrace{\frac{\partial(lnY)}{\partial(GOV)}}_{\text{Direct}} + \underbrace{\frac{\partial(lnY)}{\partial(ln\widehat{GRDP})} * \frac{\partial(lnGRDP)}{\partial(GOV)}}_{\text{Indirect}}$$

where the first term indicates the direct effect and the second term indicates the indirect effect

- The system GMM is used to address the endogeneity problem of using the lagged variables in the dynamic panel models (Blundell and Bond, 1998).

Reference

Blundell, R. and Bond, S. 1998. "Initial conditions and moment restrictions in dynamic panel data models." *Journal of Econometrics* 87(1), 115-143.

Zhang, Q., Zhang, S., Ding, Z., and Hao, Y. 2017. "Does government expenditure affect environmental quality? Empirical evidence using Chinese city-level data." Journal of Cleaner production 161: 43-152.

Results

	[GRDP]		[BOD]		[T P]	
	Pooled OLS	Sys-GMM	Pooled OLS	Sys-GMM	Pooled OLS	Sys-GMM
$GRDP_{t-1}$	0.954***	0.843***	0.913***	0.844***	0.881***	0.772***
	(0.006)	(0.036)	(0.010)	(0.037)	(0.012)	(0.050)
GOV	0.008	0.020**	-0.014	-0.146***	-0.039	-0.107
	(0.007)	(0.010)	(0.021)	(0.055)	(0.031)	(0.077)
PROD	0.022***	0.090***	0.143	0.620***	0.080	0.608**
	(0.005)	(0.019)	(0.101)	(0.216)	(0.150)	(0.306)
COMP	0.031***	0.096***	-0.018	-0.063***	-0.008	-0.059*
	(0.007)	(0.028)	(0.013)	(0.023)	(0.020)	(0.034)
URB	-0.001***	-0.001***	-0.004	-0.144**	0.018	-0.116
	(0.000)	(0.000)	(0.015)	(0.063)	(0.022)	(0.121)
GREEN	-0.004**	-0.012**	-0.004	-0.129**	-0.064	-0.191
	(0.002)	(0.006)	(0.030)	(0.061)	(0.044)	(0.129)
OLD	-0.032***	-0.111***	-0.001	-0.002*	-0.002***	-0.002*
	(0.008)	(0.035)	(0.000)	(0.001)	(0.001)	(0.001)
Constant	0.202***	0.606**	0.001	0.017**	0.004	0.010
	(0.052)	(0.238)	(0.006)	(0.008)	(0.009)	(0.013)
			0.019	0.157**	0.105**	0.291**
			(0.032)	(0.070)	(0.049)	(0.146)
			-0.356	-1.254**	-1.178***	-3.225***
			(0.242)	(0.571)	(0.375)	(1.014)
AR(1)/AR(2)		0.000 / 0.385		0.000/0.220		0.000/0.641
Hansen		0.429		0.273		0.113

Notes: ***, ** and * denote the level of significance at 1%, 5% and 10% respectively

Direct and Indirect Effect

		Direct effect		Indirect effect		Total effect	
[BOD]	Short run effect	-0.146***	(0.055)	0.004**	(0.002)	-0.142***	(0.048)
	Long run effect	-0.937**	(0.436)	0.174	(0.141)	-0.763**	(0.420)
[TP]	Short run effect	-0.107	(0.077)	0.004*	(0.003)	-0.102	(0.073)
	Long run effect	-0.468	(0.314)	0.124	(0.092)	-0.343	(0.394)

Conclusion

- This study supports the Environmental Kuznets Curve hypothesis due to an inverse U-shaped relationship between economic growth and water pollution.
- The impact of local government spending on water quality varies with the water pollutants. Local government spending was significant in both short-run and long-run direct and indirect effects on BOD, but only short-run indirect effect on TP.