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1. Introduction

This chapter addresses regional issues in environment management. Economic integration beyond national boundaries has recently made great progress in regional levels as well as in global levels, with the formulations of Free Trade Agreement (FTA) and Economic Partnership Agreement (EPA) as typical examples. This trend in regional economic integration also refocuses attention on regional environmental issues including trans-boundary pollutions, and makes us rethink of what regional cooperation should be in environment management. Based on this context, we herein discuss regional environment issues, with a focus on East Asian region, from the following two perspectives.

The first one is about which effects, i.e. technological spillovers or pollution haven damages, the regional latecomers have dominantly received in environment management under a growing trend in economic integration within East Asia. If the dominance of technological spillovers effect is identified for latecomer's economies, we may have rather optimistic views on the future of environment quality as a whole region, because it implies that latecomers are absorbing the skills and technologies enough to leapfrog the mistakes made by developed economies in the past times. On the other hand, the dominance of pollution haven damages implies the mere relocation of polluters from developed economies towards latecomer's economies, i.e. no decline in pollution as a whole region, thereby making us feel uneasy on regional prospect of environment. Thus, knowing the effects for latecomers seems to be linked with knowing the degree of demand for policy actions as a region. East Asia, in recent decades, has strengthened intra-economic integration in terms of trade and investment flows.[2] At the same time, East Asian economies are still composed of a variety of countries with different stages of development: high-income countries like Japan and Korea, middle-income ones like Malaysia and Thailand, low-income ones such as Cambodia and Myanmar.[3] Since the integration and diversification characterized by East Asian economies make East Asia a typical area with provability of technology spillovers or pollution haven damages, targeting East Asia seems to be meaningful in our analysis.

The second perspective is about what the regional framework of environmental cooperation should be in East Asia. There have been intensive debates on the regional frameworks from

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[1] The views expressed in this paper are those of the author and not those of the Ministry of Finance or the Policy Research Institute.

[2] Kawai (2009) indicates, for example, that the ratio of intra-regional trade relative to world trade in East Asia has gone up from 35 percent in 1980 towards 54 percent in 2007, which is a little under 57 percent in EU and exceeding 43 percent in NAFTA.

[3] The classification of income classes depends on World Development Indicators of World Bank.

the viewpoints of commitment and compliance, especially in the cases of such trans-boundary issues as long-range air and water pollutions, freshwater resources in international rivers, migratory birds. The frameworks differ in the modality of cooperation: policy dialogue, cooperative environmental monitoring and assessment, implementation of project-based activities, and legal treaties and protocols. There seem to be some contrasts in the approaches towards regional cooperation between East Asia and Europe: Non-binding approaches in East Asia versus binding ones in Europe. The typical example is seen in the framework of the long-ranged trans-boundary air pollution control: East Asia is promoting non-binding agreements on pollution monitoring and other project-based activities, whereas Europe is controlling pollution based on binding agreement in terms of the Convention for the Long-Range Transmission of Air Pollutant in Europe (the LRTAP). Each approach appears to have advantages and disadvantages, and the choice of the approach seems to be linked with the region-specific properties in economical, political, and historical terms. The purpose of this section is, thus, to investigate the reason why East Asia has taken the non-binding approach, and to examine the justification of its choice considering the region-specific properties.

The rest of the paper is structured as follows. Section 2 examines the effects for latecomers in East Asia: technological spillovers versus pollution haven, corresponding to the first perspective above. Section 3 discusses the regional frameworks of environmental cooperation in East Asia, corresponding to the second perspective above.

2. Effects for latecomers: technological spillovers versus pollution haven

The purpose of this section is to examine whether the latecomer's economies in East Asia enjoy technological spillover effects or suffer pollution haven damages in their environment management: in other words, which of latecomer's advantage or latecomer's disadvantage dominates for pollution control in East Asian economies. We focus on environmental indices with data availability: carbon dioxide emissions, consumption of ozone-depleting substances and industrial organic water pollutant (BOD) emissions. The analytical framework of the Environmental Kuznets curve (EK curve) is used to arrive at a conclusion.

In the following subsections, we first review previous studies on the EK curve in brief and clarify this article's contribution (Subsection 2.1), present our own empirical study of the effects for latecomers (Subsection 2.2), and end with brief summary (Subsection 2.3).

2.1 Previous studies and our contribution

The environmental Kuznets curve (EK curve) provides an analytical framework to examine how economies deal with environmental issues. The EK curve postulates an inverted-U relationship between pollution and economic development; at early stages of development, environmental quality deteriorates with increases in per capita income, while at higher levels of development, environmental degradation is seen to decrease with further increases in per capita income. Kuznets's name was apparently attached to the curve by Grossman & Krueger (1993), who noted its resemblance to Kuznets inverted-U relationship between income inequality and development. Since the issue of the EK curve was first discussed in the World Bank's 1992 World Development Report, there have been numerous empirical tests and theoretical debates on the EK curve. Until the mid of the 1990s, most of the empirical studies concentrated on validating the EK curve hypothesis and its requirements, using cross-sectional data. Some of evidences on specific pollutants supported the validity of the EK curve (e.g. Grossman & Krueger; 1995, Selden & Song; 1994), while some argue that the EK curve does not hold at all times and for all pollutants (e.g. Shafik; 1994).

Since the late 1990s, the EK curve studies have shifted from cross-sectional analyses to time-series analyses, especially towards the analyses for comparing the EK curves of individual economies in terms of the height and the timing of their peaks, their shapes, etc (e.g. Panayotou; 1997, De Bruyn et al.; 1998).[4] One of the frontiers in this direction of the EK curve studies is to put into empirical tests the two contrasting hypotheses presented by Dasgupta et al. (2002). One is the technological spillover hypothesis that developing societies, by utilizing progressive environmental management and the technologies of more advanced countries, might be able to experience an EK curve that is lower and flatter than what conventional wisdom would suggest. The other is the pollution haven hypothesis that the relatively high environmental standards in high-income economies impose high costs on polluters, and shareholders pressure firms to relocate to low-income countries. This pollution haven scenario may not shift the latecomer's EK curves downward; on the contrary, it may even lift them up. Taguchi & Murofushi (2009), by using the EK curve framework, examined whether developing countries enjoy the latecomer's advantage or suffer the latecomer's disadvantage in the environment management, focusing on sulfur emissions as local air pollutants and carbon emissions as global air pollutants, by using the world-wide samples for the 188 economies from 1960 to 1990 in sulfur emissions and from 1970 to 2003 in carbon emissions. It found contrasting result between sulfur and carbon emissions on the latecomer's effects; sulfur emissions represent the dominance of the latecomer's advantage (the downward shift of latecomer's EK curve), while carbon emissions reveal that of the latecomer's disadvantage (the upward shift of latecomer's EK curve). It interpreted this contrast as the difference of maturity level in the know-how and technology to abate emissions: prevailing desulfurization technology and unrestricted "carbon leakage" (a kind of pollution haven in carbon emissions).

This study aims at testing the two contrasting hypothesis above in East Asia, – the dominance of the latecomer's advantage (technological spillovers) or of the latecomer's disadvantage (pollution haven). The main contribution is to extend the existing literature, mainly of Taguchi (2009), to the following directions. First, our study concentrates on East Asian economies (18 economies). The intra-area of East Asia with the characteristic of economic integration and diversification, as stated in Introduction, can be an experimental area suitable enough to put the hypotheses of technological spillovers and pollution haven into empirical tests. In addition, the evidence on the latecomer's effects in East Asia has been extremely limited in the existing literature. Second, our analysis uses the latest data of the period for 1990-2007 on carbon dioxide emissions, consumption of ozone-depleting substances and industrial organic water pollutant (BOD) emissions. The usage of the latest data enables us to make the EK curve estimation reflect the recent trends of technological progress and policy responses to address environmental issues as well as growing economic interaction of East Asia. Third, our estimation for the EK curve adopts a dynamic panel model by a system of Generalized Method of Moments (GMM). It appears to take some periods for the current level of emissions to adjust toward their equilibrium level – a kind of inertia in the emission level. Most of previous studies for the EK curve have adopted a static

[4] Borghesi (1999) criticized the cross-sectional approach by arguing that since environmental degradation is generally increasing in developing countries and decreasing in industrialized ones, the EK curve within the cross-sectional framework might reflect the mere juxtaposition of two opposite trends rather than describe the evolution of a single economy over time.

panel model in terms of ordinary fixed or random estimations. When there is evidence of dynamics in the data, however, the validity of applying a static model might be questioned as being dynamically miss-specified. To our knowledge, it is only Halkos (2003) that constructed a dynamic panel model for the EK curve estimation. This paper adopts the method of Halkos (2003), which allows dynamic adjustments in the level of emissions.

2.2 Empirics

We now turn to the empirical studies using the analytical framework of the EK curve. Our analysis consists of two steps. First, we simply overview the relationships between per capita real income and environmental indices. We then move to a dynamic panel analysis using cross-country panel data to examine the EK curve pattern and to see whether the latecomer's advantage or its disadvantage dominates in the environmental management in East Asian economies.

2.2.1 Data

We collect the data for three environmental indices per capita –carbon dioxide emissions, consumption of ozone-depleting substances and industrial organic water pollutant emissions– and real GDP per capita. All the data come from the Annual Core indicators online database developed by the Statistics Division of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP).[5] The database covers data from 1990 to 2007, all of which we use as sample periods. The sample economies are the following 18 ones in East Asia: Brunei Darussalam, Cambodia, China, DPR Korea, Hong Kong, Indonesia, Japan, Lao PDR, Macao, Malaysia, Mongolia, Myanmar, Republic of Korea, Singapore, Thailand, the Philippines, Timor-Leste and Viet Nam.

The indicator of "carbon dioxide emissions per capita" that we can obtain from the online database is defined as the quantity of estimated carbon dioxide emissions (tons of carbon dioxide) divided by total population, whose data sources are the United Nations Millennium Development Goals Indicators and the World Population Prospects: the 2006 Revision Population Database. The indicator of "consumption of ozone-depleting substances per capita" is defined as the sum of the national annual consumption in weighted tons of individual substances in the group of ozone-depleting substances multiplied by their ozone-depleting potential (Ozone-depleting substances are any substance containing chlorine or bromine that destroys the stratospheric ozone layer), expressed as ODP kilograms per 1,000 population. Its data sources are the same as those of carbon dioxide emissions per capita. The indicator of "industrial organic water pollutant emissions" is defined as the biochemical oxygen demand, which refers to the amount of oxygen that bacteria in water will consume in breaking down waste, expressed as kilograms per day. Its data source is the United Nations Environment Program, Emission Database for Global Atmospheric Research (EDGAR 3.2). This indicator shows total amount, thereby being divided by population. We can find the other emissions indicators in the online database: nitrous oxide emissions, sulfur dioxide emissions and PM10 concentration in urban area, but do not adopt them for the dynamic estimation later since their data cover only every five years. For the real GDP per capita, the indicator of "GDP per capita on 1990 US dollars base" is obtained from the online database.

[5] See the website of http://www.unescap.org/stat/data/syb2008/syb2008_web/index.asp

To sum up, for conducting the dynamic panel estimation later on, we constructed a panel table of the annual data of the 18 economies from 1990 to 2007 on each of per capita environmental indices of carbon dioxide emissions, consumption of ozone-depleting substances and industrial organic water pollutant emissions, and on real GDP per capita.

2.2.2 Overview of the EK curves in sample economies in East Asia

Fiure 1 indicates the time-series relationships between per capita real GDP and three kinds of environmental indices per capita in selected samples of East Asian economies. The rough

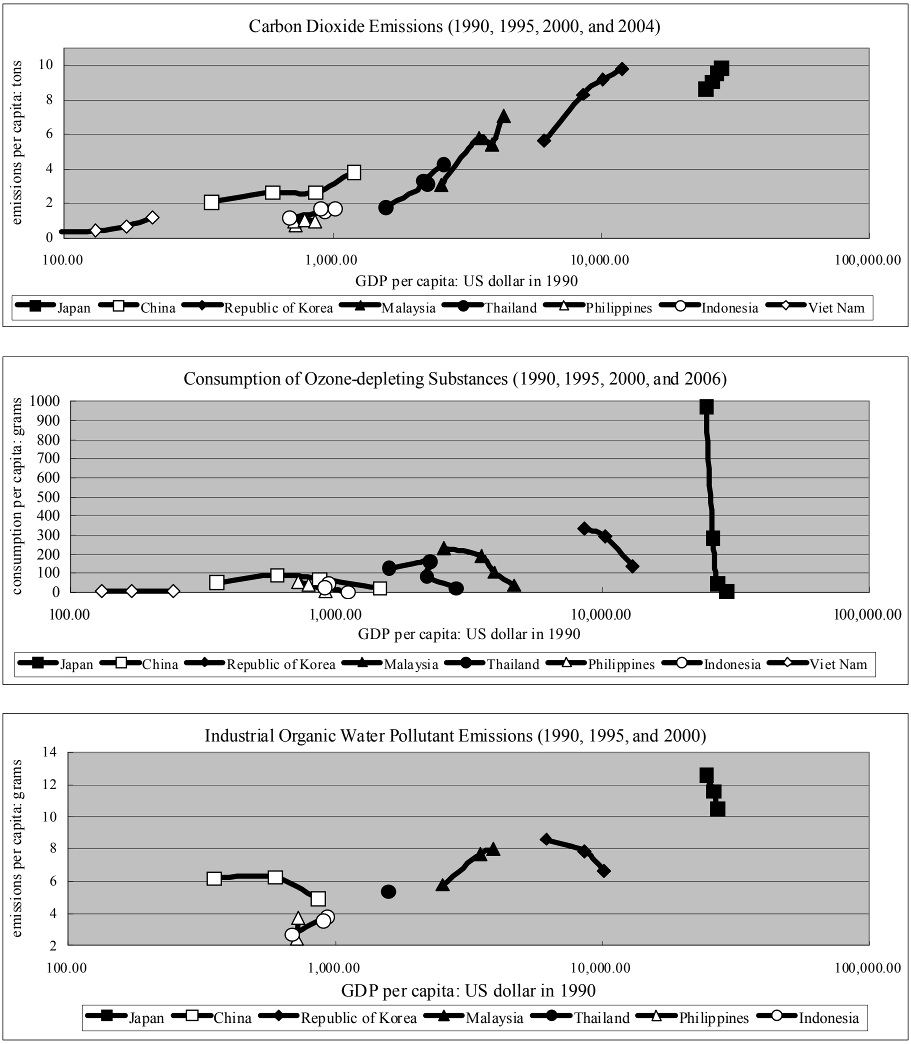

Fig. 1. Overview of the EK curves in selected sample economies

findings are as follows. First, there appears to be no cases where the assembly of the economy's trajectories clearly produces inverted-U shape patterns. The trajectories of carbon dioxide emissions represent an increasing trend whereas their slope seems to be flattened with higher real GDP per capita. The lines of consumption of ozone-depleting substances roughly represent declining slope. The cases of industrial organic water pollutant emissions have no clear trend of trajectories. We might speculate that the carbon dioxide emissions stay at the positively-sloping part of the EK curve, while the consumption of ozone-depleting substances stays at its negatively-sloping part. Second, the locations of the economy's trajectories represent a clear contrast; the upward shifts of trajectories for latecomer's economies are observed in the case of carbon dioxide emissions, while downward shifts are seen in the cases of consumption of ozone-depleting substances. The cases of industrial organic water pollutant emissions have no clear shift of trajectories. The GDP-emissions relationships described above may produce different implications among environmental indices. This point will be statistically tested through dynamic panel estimations in the following section.

2.2.3 Dynamic panel analysis

We'll now move to a dynamic panel analysis using cross-country panel data to examine the EK curve pattern and to see whether the latecomer's advantage or its disadvantage dominates in the environmental management in East Asian economies.

2.2.3.1 Methodology

We first clarify some methodological points related to our analysis. To study the relationship between pollution and growth, there are two possible approaches to model construction. One is to estimate a reduced-form equation that relates the level of pollution to the level of income. The other is to model the structural equations relating environmental regulations, technology, and industrial composition to GDP, and then to link the level of pollution to the regulations, technology, and industrial composition. We here take the reduced-form approach for the following reasons. First, the reduced-form estimates give us the net effect of a nation's income on pollution. If the structural equations were to be estimated first, one would need to solve backward to find the net effect. Moreover, confidence in the implied estimates would depend on the precision and potential biases of the estimates at every stage. Second, the reduced-form approach spares us from having to collect data on pollution regulations and the state of the existent technology, which are not always available. Thus, we think that the reduced-form relationship between pollution and income is an important first step.

We then specify the reduced-form equation by basically following the traditions of the literatures like Grossman and Krueger (1995) and Selden and Son (1994), and adding appropriate variables in accordance with our analytical interests. Our specific concern regarding the EK curve for the sample economies in East Asia is to see whether the EK-curve trajectories for the latecomer's economies have shifted downward or upward, depending on the dominance of either the latecomer's advantage or its disadvantage[6]; in

[6] As Dasgupta et al. (2002) showed the revised EK curve that is actually dropping and shifting to the left as growth generates less pollution in the early stages of industrialization and pollution begins falling at lower income levels, the latecomer's effects may not always be tantamount to a simple up- and downward shifts of the EK curve. However, we here simplify the analysis by focusing on up- and downward shift of the EK curve.

other words, the levels of environmental pollution per capita have been affected not only by the level of per capita income following the EK curve, but also by the later degree of development among the economies. If a sample economy with later degree of development among the samples enjoys the lower level of environmental pollution (traces the downward course of the EK curve), we speculate that the economy, not repeating the EK-curve trajectories already experienced by the developed economies, should enjoy the latecomer's advantage by absorbing the progress in environmental know-how, skills, and technology i.e. technological spillover. On the contrary, if the later development in a sample economy is linked with higher pollution, the economy may suffer from the latecomer's disadvantage caused by the "pollution haven" scenario (see Figure 2). Therefore, we will include a term representing the later degree of development among the economies into the equation for the EK curve. The later degree of development of a sample economy in a certain year is specified as the ratio of the GDP per capita of that economy relative to the maximum GDP per capita among sample economies (equivalent to the GDP per capita of Japan) in that year. Another methodological innovation in this study is to adopt a dynamic panel model. Halkos (2003), pointing out that a static model is justified either if adjustment processes are really very fast or if the static equation represents an equilibrium relationship, argued that since the assumption that the data are stationary is incorrect, and we are not expecting a very fast adjustment for estimating the EK curve, a statistically sound approach requires estimating a dynamic model. Following the argument of Halkos (2003), we construct a dynamic panel model by inserting a lagged dependent variable as a regressor into the EK curve equation for materializing a partial adjustment toward equilibrium emissions level.

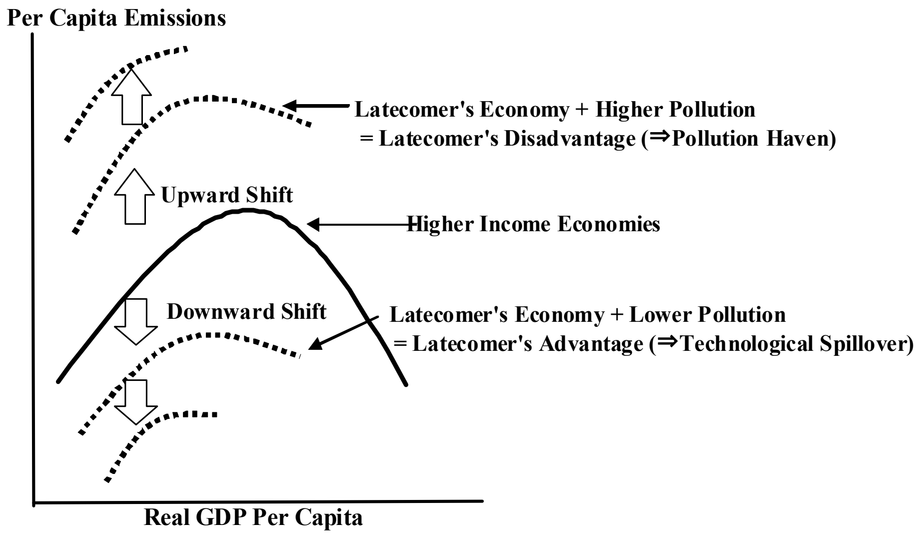

Fig. 2. Latecomer's advantage and disadvantage in the EK curves

Based on analytical interests mentioned above, we specify the modified EK curve model as follows:

$$EMS_{it} = \alpha_0 + \alpha_1 GDP_{it} + \alpha_2 GDP_{it}^2 + \alpha_3 LAC_{it} + \alpha_4 EMS_{it-1} + \alpha_5 f_i + e_{it} \quad (1)$$

where i is the economy's index (country), t is the time index, and e is the error term. The dependent variables EMS is measure of the per capita emissions: carbon dioxide emissions (CDE), consumption of ozone-depleting substances (ODS) and industrial organic water pollutant emissions (BOD). As for the independent variables, GDP is the real GDP per capita. LAC represents the later degree of development, specifically the ratio of the real GDP per capita of a certain economy relative to the maximum real GDP per capita among economies in a certain year (i.e. real GDP per capita of Japan) – the lower LAC means the later development of the economy. The f_i denotes exogenously economy-specific factors that affect emissions; climate, geography, energy resources, etc. The equation does not include period dummy, because its inclusion was rejected significantly by statistical tests in the equation estimate.

To verify the inverted-U shapes of the EK curves, the signs and magnitudes of α_1 and α_2 should be examined. Environmental emissions per capita can be said to exhibit a meaningful EK curve with the real GDP per capita, if $\alpha_1>0$ and $\alpha_2<0$, and if the turning point, $-\alpha_1/2\alpha_2$ is a reasonabe number. Of particular importance is the coefficient of LAC, α_3, which is useful for identifying the dominance of the latecomer's advantage or its disadvantage. The positive sign of α_3, the lower pollution with the later development of the economy that creates the downward shift of the latecomers' trajectories, indicates that the latecomer's advantage surpasses its disadvantage. On the other hand, the negative sign of α_3, the higher pollution with the later development of the economy equivalent to the upward shift of the latecomers' curve, reveals the dominance of the latecomer's disadvantage.

Equation (1) contains the lagged dependent variable among the explanatory variables, thereby the ordinary OLS estimator being inconsistent. Obtaining consistent estimates requires the application of an instrumental variables estimator or Generalized Method of Moments (GMM). We here adopt the system GMM estimator developed by Arellano and Bond (1991) who argues that additional instruments can be obtained in a dynamic model from panel data if we utilize the orthogonality conditions between lagged values of the dependent and the disturbances. The GMM estimator eliminates country effects by first-differencing as well as controls for possible endogeneity of explanatory variables. The first-differenced endogenous variables of EMS with two lagged periods can be valid instruments provided there is no second-order autocorrelation in the idiosyncratic error terms. We also use the first differenced explanatory variables of GDP with one lagged period as an instrumental variable since GDP can possibly be correlated with the error term in case that environmental pollution might aggravates economic growth. We then conduct two step GMM iterations with updating weights once, and adopt White period as GMM weighting matrix. We present the tests for autocorrelations and the Sargan test of over-identifying restrictions in the table that follow.

2.2.3.2 Estimation results and interpretations

Table 1 lists the results of the GMM estimation per capita on carbon dioxide emissions (CDE), consumption of ozone-depleting substances (ODS) and industrial organic water pollutant emissions (BOD). All the cases indicate that the inclusion of the lagged dependent variable of the emissions per capita proved to be positively discernable, thus imply inertia in the level of the emissions and justify forming the dynamic panel model. The Sargan tests do not suggest rejection of the instrumental validity at conventional levels for any cases estimated. As for the test results for autocorrelations, all the AR(2) test statistics reveal absence of second-order serial correlation in the first-differenced errors and thus that the instruments are valid.

We first verify the shape of the EK curve of each emission index. There are no cases that reveal the meaningful EK curve with the inverted-U shape. The linear CDE estimation indicates upward sloping with real GDP per capita at significant level. The quadratic CDE estimation has the significant coefficients, α_1 and α_2 with correct signs of the inverted-U shape. Its turning point of 26,800 US dollars is, however, falling into the edge of the samples, i.e. only within the sample of Japan with the highest real GDP per capita. Almost all of the trajectories are within the monotonic increasing trend, i.e. the positively-sloping part of the EK curve. The ODS estimation indicates that the trajectories are in the monotonic decreasing trend regardless of the linear or quadratic equation forms. Although the quadratic estimation's coefficients, α_1 and α_2, suggest not inverted-U but U shape, the turning point of 116,000 US dollars is far higher from the range of the samples. The BOD represents only monotonic downward sloping in its estimation, since the coefficient of the square of GDP, α_2, is insignificant. We speculate that it is due to the shortage of sample data backward from 1990 that the ODS and BOD do not prove to form the inverted-U shape curve in their estimation.

We next see if the latecomer's EK trajectories show a downward shift or an upward shift, namely whether the latecomer's advantage or its disadvantage dominate in the environmental management of latecomer's economies. The CDE estimate has significantly negative α_3, coefficient of LAC, thereby representing the upward shift of the latecomer's trajectories and the dominance of the latecomer's disadvantage. On the other hand, the ODS and BOD estimates have significantly positive α_3, showing the downward shift of the latecomer's trajectories, the dominance of the latecomer's advantage.

	CDE		ODS		BOD	
GDP	$4.43*10^{-4}$ ***	$2.57*10^{-3}$ ***	$-2.33*10^{-2}$ ***	$-2.98*10^{-2}$ ***	$-1.38*10^{-4}$ ***	$-3.41*10^{-4}$ **
	(978.87)	(33.96)	(-68204.89)	(-6078.09)	(-6.97)	(-2.25)
GDP^2		$-4.78*10^{-8}$ ***		$1.28*10^{-7}$ ***		$3.53*10^{-9}$
		(-21.42)		(1150.38)		(1.25)
LAC	-2.21*10 ***	-5.18*10 ***	$1.56*10^{2}$ ***	$2.39*10^{2}$ ***	1.22 *	4.61 **
	(-2980.99)	(-291.37)	(14700.19)	(3125.34)	(1.72)	(2.12)
$(EMS)_{t-1}$	$4.96*10^{-1}$ ***	$4.53*10^{-1}$ ***	$5.66*10^{-1}$ ***	$5.65*10^{-1}$ ***	$6.11*10^{-1}$ ***	$5.76*10^{-1}$ ***
	(11958.02)	(106.46)	(517030.9)	(171680.4)	(19.48)	(10.00)
Tuning Point		$2.68*10^{4}$		$1.16*10^{5}$		$4.83*10^{4}$
Sargan test	0.60	0.85	0.71	0.75	0.88	0.91
AR(1)	0.00	0.01	0.07	0.07	0.01	0.01
AR(2)	0.21	0.24	0.74	0.75	0.86	0.81
No. of obs.	222	222	192	192	93	93

(Notes)
i) The t-value are in parentheses. ***, **, and * indicate rejection at the 1 percent, 5 percent, and 10 percent significance levels.
ii) "Sargan test" denotes the p-value of a Sargan-Hansen test of overidentifying restrictions.
iii) AR(k) is the p-value of a test that the average autocovariance in residuals of order k is zero.

Table 1. Results of dynamic panel estimation by GMM

There seem to be some contrasts of estimation results in terms of both the trajectory's shape and location between CDE and the other indices of ODS and BOD. These contrasts appear to be interpreted as follows. The first contrast is concerned with the shape of the EK trajectories. The ODS and BOD mainly come from manufacturing production activities, thereby being subject to regulation due to their localized impact. In fact, the pollution controls on the ODS and BOD have intensively been promoted by East Asian countries. The ozone-depleting substances have been strictly regulated since the 1987's signature of the Montreal Protocol, i.e. an international treaty designed to protect the ozone layer by phasing out the production of a number of substances believed to be responsible for ozone depletion. All of East Asian countries have had a commitment to the treaty or its amendments in terms of ratification, accession or acceptance. The issues of water pollution as well as air pollution have also been addressed with technological progress over a broad area of East Asia since the 1970-80s, when ASEAN countries formulated comprehensive environmental protection laws (the Philippines in 1977, Malaysia in 1974, Thailand in 1975, and Indonesia in 1982). These factual backgrounds seem to make the EK trajectories of ODS and BOD slope downward i.e. create downward sloping part of the inverted-U shaped EK curve. On the other hands, the CDE is producing an opposite pattern of its trajectories, a positively-sloping part of the EK curve. It seems to be because carbon dioxide emissions arise from not only production but also from consumption such as automobile use and the burning of fossil fuels for the generation of electricity, thereby being easily externalized and thus not subject to regulation. The reality is that it is only after the Kyoto Protocol was approved in 1997 that regulatory frameworks on Greenhouse Gas have come to be set about domestically and internationally. The contrasting outcomes on the shape of the EK trajectories in this study appear to be consistent with those of previous works, which Nahman & Antrobus (2005) summarize by stating that the levels of the pollutants with local impacts fall with per capita income whilst the levels of easily externalized pollutants continue to rise with per capita income.

The second contrast – downward shift of the latecomer's trajectories on the ODS and BOD versus upward shift on the CDE – can be explained by the degree of maturity in the know-how and technology to abate those emissions in East Asia. More or less, the concentration of manufacturing industrial activities have tended to shift from advanced economies to developing economies since wealthy consumers in advanced economies demand a cleaner environment and stringent environmental regulations. Thus, the pollution haven effects can not help being avoided for latecomer's economies. The question is, then, whether the technological spillover effects overcome the pollution haven effects for latecomer's economies i.e. the dominance of latecomer's advantage or disadvantage. The cases with downward shift of the latecomer's trajectories on ODS and BOD can be interpreted in such a way that the policy efforts, know-how and technology to abate those emissions are mature and feasible enough to be transferred to latecomer's economies and to exceed their suffering pollution haven effects in the area of East Asia. Especially, as Kofi Annan, the Former Secretary General of the United Nations, stated "perhaps the single most successful international agreement to date has been the Montreal Protocol",[7] the widespread adoption and implementation of the international framework to protect the ozone layer seems to be effective enough for developing economies in East Asia to enjoy the latecomer's advantage. On the contrary, the case with upward shift of the latecomer's trajectories on CDE may be

[7] See the website: http://www.theozonehole.com/montreal.htm

explained in such a way that the regulatory framework and technology to mitigate the emissions coming from both production and consumption are too immature to be transferred and disseminated to latecomer's economies (Yaguchi et al. 2007). Thus, only the pollution haven effect seems to remain for latecomer's economies. This phenomenon on carbon dioxide emissions might be regarded as what we call "carbon leakage" in the context of the Greenhouse Gas reduction at global level: the effect that there is an increase in carbon emissions in one country as a result of an emission reduction by a second country with a strict climate policy.

2.3 Summary

In this section, we set out to examine, using the analytical framework of the environmental Kuznets curve, whether the latecomer's economies in East Asia enjoy technological spillover effects or suffer pollution haven damages in their environmental pollution management, in other words, which of latecomer's advantage or latecomer's disadvantage for pollution control dominates in East Asian economies. For this purpose, we carried out dynamic panel estimation by a system of Generalized Method of Moments (GMM), using the panel data with 18 economies for the period from 1990 to 2007 on environmental indices of carbon dioxide emissions, consumption of ozone-depleting substances and industrial organic water pollutant emissions.

Through this analysis, we found two contrasting results among the environmental indices: 1) per capita consumption of ozone-depleting substances and industrial organic water pollutant emissions indicate monotonic decreasing trends with per capita real GDP while per capita carbon dioxide emissions show monotonic increasing trend, and 2) consumption of ozone-depleting substances and industrial organic water pollutant emissions represent the dominance of the latecomer's advantage while carbon dioxide emissions reveal that of the latecomer's disadvantage. We speculate that the contrast in the trends comes from the difference in the origin of emissions: consumption of ozone-depleting substances and industrial organic water pollutant emissions come mainly from production (easily regulated on the local level), and carbon dioxide emissions come from both production and consumption (easily externalized and not easily subject to regulation). We also presume that the contrast in the latecomer's effects lies in the degree of maturity in regulatory framework and technology that offset pollution haven effect: good governance for controlling ozone-depleting substances and water pollutants, versus unrestricted "carbon leakage" for latecomer's economies.

The result implying "carbon leakage", suggests the urgent necessity to facilitate the technological progress such as the development of technology on carbon dioxide capture and storage, and the internalization of external diseconomy through such methods as emissions charge and greenhouse taxes. For latecomer's economies in East Asia, which appear to face a trade-off between environmental quality and productive activities and to strengthen regional economic integration, it can be expected that the spillover effects from technological progress and the consolidated regulatory framework should overcome "carbon leakage".

3. Regional framework of environmental cooperation

In the previous section, we argued that the technological spillovers, offsetting the pollution haven damages, take an important role in environment management, especially in East Asia with the characteristic of economic integration and diversification. The significance of the technological spillovers reminds us of the necessities of international cooperation in environment management in terms of regional framework as well as global and bilateral ones. The regional framework of environmental cooperation is, at the same time, crucial in addressing trans-boundary pollutions in specific region's air and water. This section discusses the regional framework of environment cooperation, with a focus on the non-binding approach taken by East Asia. In the following subsections, we first review major trans-boundary environmental issues in East Asia (Subsection 3.1), represent the regional frameworks to address the trans-boundary issues (Subsection 3.2), and finally discuss the background and justification of the non-binding approach characterized by East Asia.

3.1 Trans-boundary issues in East Asia

We herein pick up major trans-boundary environmental issues in East Asia: acid deposition, marine pollution, haze pollution, and sand and dust storms.

3.1.1 Acid deposition[8]

Acid deposition originates from such pollutants as sulfur oxides (SOx) and nitrogen oxides (NOx), generated mainly by combustion of fossil fuels. Acid deposition appears in various forms of precipitation, such as rain, fog, mist, snow, etc. Its impacts are: affecting fishes due to the acidification of inland waters, threatening forests due to soil acidification, accelerating the decay of cultural monuments, and so forth. Since the substances causing acid deposition are transported over long distance, its influence diffuses to not only inside of the country but also to outside of the country. In East Asia, the rapid growth, accompanying the increasing energy consumption, has threatened to aggravate acid deposition since the 1990s. Some researches show that the trans-boundary acid rain in Northeast Asia is linked primarily to China's coal consumption which accounts for two thirds of the country's primary energy source (Yoon; 2007).

Addressing the trans-boundary acid deposition in East Asia, was motivated by the Agenda 21 adopted by the United Nations Conference on Environment and Development in 1992, "the programs (in Europe and North America) need to be continued and enhanced, and their experience needs to be shared with other regions of the world". Since 2001, the Acid Deposition Monitoring Network in East Asia (EANET) under 13 countries participation has been running as a regional cooperative initiative for monitoring acid deposition. As a related cooperative framework, the Northeast Asian Sub-regional Programme of Environmental Cooperation (NEASPEC) is promoting the several projects for mitigation of trans-boundary air pollution from coal-fired power plants in North-east Asia.

3.1.2 Marine pollution[9]

The Northwest Pacific sea region is specifically composed of the Yellow Sea, surrounded by China and the two Koreas, and the Sea of Japan/the East Sea, encircled by Japan, the two Koreas, and Russia. The region features coastal and island ecosystems with spectacular marine life and commercially important fishing resources. The region has, however, been getting enormous pressures and demands on its environment through coastal area

[8] Most of the description is based on http://www.env.go.jp/en/earth, http://www.eanet.cc/index.html, and http://www.neaspec.org.

[9] Most of the description is based on http://www.nowpap.org/index.php.

development, river pollution flowing into the seas, and marine dumping. Marine contamination occurs also by such accidents as heavy oil spills from troubled tankers, e.g. the "Oil disaster of Nakhodka Accidents" in Japanese coastal sea by the Sea of Japan (the East Sea) in 1997.

As a regional framework for monitoring and assessing marine pollution, the Action Plan for the Protection, Management and Development of the Marine and Coastal Environment of the Northwest Pacific Region (NOWPAP) was adopted in September 1994 as a part of the Regional Seas Programme of the United Nations Environment Programme (UNEP). The participants of this plan are the countries bordering the sea region: China, Japan, Korea, and Russia (North Korea still reserves the option to become a regular member).

3.1.3 Haze pollution[10]

Haze is an atmospheric phenomenon where dust, smoke and other dry particles obscure the clarity of the sky. In the 1990s, haze pollution spreading across national boundaries was getting obvious in Southeast Asia. It originated from widespread land clearance through open forest burning, with the most well-known hotspots being in Sumatra, Borneo and the Malay Peninsula. Most of the smoke came from oil palm plantations which used burning instead of heavy equipment to clear land. The year 1997 was particularly noted for the raging forest fires in Indonesia which produced a pall of small particle pollution over the region for several weeks. Due to the prevalent monsoon winds, Malaysia, Singapore, Thailand and Brunei were seriously suffering from haze pollution.

In light of the haze disaster, environmental ministers of the Association of Southeast Asian Nations (ASEAN) agreed on the Regional Haze Action Plan (RHAP) in 1997. As a further step, the ASEAN reached a legal agreement in 2002, which entered into force for the ratifying countries in 2003. The agreement contains provisions for monitoring, assessment and prevention, technical cooperation, scientific research, mechanisms for coordination and lines of communication, etc. for addressing trans-boundary haze pollution. Due to Indonesia's current decision not to ratify and implement the agreement, however, the provisions of the agreement are not legally binding for the country which is perceived as being by far the greatest contributor to haze in Southeast Asia.

3.1.4 Sand and dust storms[11]

The dust and sand storms (DSS) is a phenomenon of wind carrying dust, which originate in the arid and semi-arid regions of northern China and Mongolia, and arrive at Japan and Korea across national boundaries in the spring due to the region's prevailing seasonal winds. DSS has recently been worsening in terms of their frequency and intensity because of China's rapid desertification, soil degradation, and forest reduction. It causes problems in human health (e.g., sore eyes and respiratory infections), agricultural products, dust-sensitive industries (such as semi-conductor manufacturing), and transportation.

The Tripartite Environmental Ministers Meeting (TEMM) among China, Japan, and Korea, in its forth meeting in 2002, sharing their concern about the DSS problem, agreed to strengthen monitoring capacity to combat sandstorms, and stressed the importance of

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[10] Most of the description is based on UNEP (2010).

[11] Most of the description is based on http://www.env.go.jp/en/earth/dss/pamph/02.html, http://www.env.go.jp/earth/coop/temm/introduction_j.html, and http://www.neaspec.org.

extensive engagement of national environmental administrations in the region and international organizations in the efforts to cope with the DSS challenges. In 2003, the Global Environment Facility (GEF) launched the joint projects including those of improving monitoring and developing early warning network systems for DSS, in collaboration with the UNEP, the ADB, the UNESCAP, the United Nation Convention to Combat Desertification (UNCCD), and four countries (China, Japan, Korea and Mongolia). The NEASPEC is also promoting a demonstration project focusing on the prevention of dust and sandstorms at source areas in China and Mongolia.

3.2 Modalities of regional frameworks in East Asia

The fore-mentioned trans-boundary environmental issues in East Asia have urged the countries in the region to make efforts to promote regional cooperation to address these issues. In this subsection, we pick up regional frameworks focusing on those for coping with trans-boundary environmental issues in East Asia, and examine their modalities in comparison with that in Europe.

When we see the ongoing cases of regional frameworks for environmental cooperation in the world, we can find a variety of their modalities (e.g. IGES; 2001, Takahashi; 2003). We herein attempt to classify the modalities from the viewpoint of the consolidation of regional governance for cooperation as follows: a) Policy dialogue for sharing views and information on common environmental issues, b) Monitoring and assessment on trans-boundary environmental pollution by common methodologies, c) Project-based joint activities for mitigating pollution by utilizing permanent financial resources, d) Treaty and protocol for imposing common regulations on trans-boundary environmental pollution.

Table 2 reports the existing regional frameworks for environmental cooperation to address trans-boundary environmental issues. If we simply follow the modality classification above, the TEMM is classified into a)-type (policy dialogue); the EANET and the NOWPAP into b)-type (monitoring and assessment); the NEASPEC into c)-type (project-based joint activities); the ASEAN Agreement on Trans-boundary Haze Pollution into d)-type (treaty and protocol). It should be noted that the ASEAN Agreement on Trans-boundary Haze Pollution has problem in its implementation because of the lack of enforcement and liability clauses in the agreement in addition to Indonesia's current decision not to ratify and implement the agreement as mentioned above (UNEP; 2010).

Europe, though having various modalities in regional frameworks for environmental cooperation, appears to depend more on legal frameworks backed by the EU organization than East Asia does. Some clear contrasts can be seen in the framework to address trans-boundary acid deposition and marine pollution. The acid deposition problem first came to trans-boundary attention in Europe in the 1970s. In the first place, the OECD responded to a request from Scandinavian countries to inaugurate a multilateral monitoring program of acid rain in 1972. And it was taken over by the United Nations Economic Commission for Europe in 1977. Subsequently, the Convention for the Long-Range Transmission of Air Pollutant in Europe (the LRTAP) was agreed upon in 1979, and the protocols on 30% reduction of sulfur emission and on NOx emission control were adopted in the 1980s. For trans-boundary marine pollution, for instance, the Convention for the Protection of the Mediterranean Sea Against Pollution (the Barcelona Convention) was concluded in 1975, followed by the protocols on marine dumping, emergency oil pollution, land based pollution source, and so forth in 1975 and 1980. These conventions and protocols are definitely classified into d)-type in the classification above, whereas East Asian frameworks for trans-boundary acid deposition and marine pollution mainly fall into a), b), or c)-type of modalities.

Acid Deposition Monitoring Network in East Asia (EANET)	
Staring year:	2001
Area:	East Asia: 13 countries
Issues:	Acid Deposition
Secretariat:	UNEP
Modality:	Joint monitoring and assessment
Northwest Pacific Action Plan (NOWPAP)	
Staring year:	1994
Area:	Northeast Asia: China, Japan, Korea (South), and Russia
Issues:	Marine Pollution
Secretariat:	UNEP
Modality:	Joint monitoring and assessment
ASEAN Agreement on Transboundary Haze Pollution	
Staring year:	2002
Area:	ASEAN
Issues:	Haze Pollution
Secretariat:	ASEAN
Modality:	Legal agreement
Tripartite Environmental Ministers Meeting (TEMM)	
Staring year:	1999
Area:	China, Japan, and South Korea
Issues:	Comprehensive
Secretariat:	Rotation
Modality:	Policy dialogue
North-east Asian Subregional Programme of Environmental Cooperation (NEASPEC)	
Staring year:	1993
Area:	Northeast Asia: China, Japan, Korea (North), Korea (South), Mongolia, and Russia
Issues:	Comprehensive
Secretariat:	UN/ESCAP (Interim)
Modality:	Project-based activities

Table 2. Regional frameworks for environmental cooperation

3.3 Discussion on non-binding approach in East Asia

The modality of regional frameworks for environmental cooperation has recently been discussed in terms of binding and non-binding approaches (e.g. Yoon; 2007, Köppel; 2009). Yoon (2007) argued that the environmental cooperation in Northeast Asia has evolved through non-binding agreements which do not contain official commitments on compliance or legal restrictions for non-compliance, whereas that in Europe has followed binding agreements by concluding with conventions and working through a series of protocols for solid compliance. This view is consistent with our comparative analysis on the modalities for environmental cooperation between in East Asia and Europe in the previous section. Then, why East Asia has taken the non-binding approach for environmental cooperation is the question in this section.

Köppel (2009) explained theoretically the advantages of both binding and nonbinding agreements as follows. A nonbinding agreement is easier and faster to achieve, allows states to tackle a problem collectively at a time they otherwise might not due to economic or political reasons, and enables governments to formulate their commitments in a more precise and ambitious form than they would be possible in a binding treaty. Seeking deeper cooperation like a smaller club of "like-minded enthusiasts", and facilitating learning processes or learning by doing, can be further benefits of nonbinding agreements. On the other hand, binding agreements strengthen the credibility of a commitment, increase compliance with the commitment, and reduce intergovernmental transaction costs.

Considering this theoretical viewpoint, we can interpret East Asian choice of non-binding approach in such a way that East Asia is getting or trying to get the non-binding advantages whereas facing the difficulties for getting the binding advantages. In fact, the progress in the trans-boundary on-going projects under the frameworks of EANET, NOWPAP, NEASPEC, etc., appears to be reflecting East Asian stances to pursue the "easier", "faster" and "deeper" advantages of non-binding approach. On the other hand, the difficulties for binding approach in East Asia seem to come from the following economical, political and historical backgrounds. First, a lack of economic and political homogeneity is making it difficult for East Asia to reach binding agreements. As mentioned in Introduction, East Asian countries are composed of a variety of countries with different stages of development and with different political system. In addition, there is no regional organizations equivalent to the EU in East Asia except for ASEAN. The typical contrast can be shown in the LRTAP Convention, which was created by homogenous advanced European nations and has well been maintained by strong links to EU policies and aid programs. Second, the environmental cooperation in East Asian region is too immature to lead to legal agreements. It was only after the Rio Earth Summit in 1992 that East Asian countries initiated environmental cooperation as an official diplomatic issue as shown in Table 2. We can also see a contrast in monitoring trans-boundary acid deposition: East Asian started its system in 2001 as the EANET, while Europe inaugurated it about thirty years earlier, in 1972. Finally, more importantly, political sentiments among East Asian nations are placing obstacles on the road toward binding agreements (see Yoon; 2007). The historical experiences of World War Two are making East Asian nations suspicious of Japanese initiatives on regional affairs. And China tends to prefer bilateral cooperation to supranational institutions, because bilateral negotiations do not place the country in the diplomatically unfavourable situation of being the main source of regional, trans-boundary pollution. The bilateral environmental cooperation promoted by Japan through official development assistant (ODA) may also have attenuated the need for binding agreements at multilateral level.

To sum up, considering the region-specific properties in economical, political, and historical terms, non-binding approach as regional framework of environmental cooperation may be an optimal choice for East Asia, in the sense that it provides the "easier", "faster" and "deeper" framework regardless of economical, political, and historical constraints.

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