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A NEW DIRECTION IN ENVIRONMENTAL ECONOMICS

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1. Introduction

The global economy has evolved into a borderless age of climate change. Numerous studies such as those of Stern (2007) and Jones *et al.* (2013) have pointed out that the nature of climate change is an international and intergenerational externality problem. This human-induced change in the rising global mean temperature is mainly due to the enormous emission of carbon dioxide arising from the combustion of fossil fuels. To date, more than 100 countries have adopted a global warming limit of 2 °C or below (relative to preindustrial times) as a general guideline (IPCC, 2007). That is, the concentration of carbon dioxide should be maintained at a range of 400–450 parts per million (ppm). The United States and China, the two largest national economies in the world, have recently unveiled a negotiated deal to reduce their greenhouse gas (GHG) output, with China agreeing to cap its emissions by 2030 or earlier and the United States pledging to cut its emissions to 26–28% below the 2005 levels by 2025.

The issues of climate change include not only the key investigation of global warming but also the concerns about rising sea levels, melting glaciers, changes in precipitation and storminess, and so on. Thus, climate change has become a complicated problem of uncertainty to a greater extent than any other environmental externality. Over the past two decades, academics and researchers have employed various methods to provide estimates of the economic effects of climate change. An early study conducted by Nordhaus (1994) indicates that the effect of 3 °C global warming is equivalent to a 1.3% decline in GDP. Later studies have estimated net gains and losses associated with climate change for various regions at different times (see, for example, Mendelsohn *et al.*, 2000; Tol, 2002; and Hope, 2006). According to Dell *et al.* (2014), estimates across labor productivity, industrial output, and economic growth approximately converge to a 1–2% decline per 1 °C in poor countries.

Not surprisingly, sustainability has emerged as one of the most pressing issues in the 21st century since it was recognized that everyone has a stake in Our Common Future. Reacting to this phenomenon, governments all over the world have begun to implement energy preservation and carbon emission reduction policies, as well as spearheading other related initiatives. These governments have recognized that, to address such hazards, economic planning is necessary. Governments are obligated to initiate various cooperative and institutional mechanisms to internalize individual choices. They also have to coordinate various needs and interests, and to ensure an equal chance of participation for people at all levels of society.

2. Overview of Scholarly Findings

2.1 *Econometric Modeling of Climate Change*

This special issue seeks to offer a timely collection of papers that critically address the aforementioned challenges. Climate change, via a change in Mother Nature, may trigger unexpected consequences of economic evolution in the long run. The lead paper in this special issue by Pretis, Schneider, Smerdon, and Hendry presents an econometric methodology for detecting breaks at any point in time-series regression models, particularly applied to modeling climate change. Econometric modeling in this paper is statistically formulated without prior knowledge about stochastic breaks of climate time series and their occurrence or magnitude. The detection of structural breaks is focused on breaks in the mean through the general-to-specific approach of step-indicator saturation (SIS) and impulse-indicator saturation (IIS). The results indicate that 74% of all larger Northern Hemisphere volcanic eruptions over 20 Tg can be detected on average within an interval of ± 1 year in the model temperature series spanning from years 850–2005. The break detection procedure demonstrated in this paper, according to the authors, is also instrumental for detecting previously unknown events as well as forecasting economic recessions.

2.2 *Air Pollutants and CO₂ emissions*

The second paper by Giovanis and Ozdamar provides a new way to qualify people's marginal willingness-to-pay (MWTP) for reducing air pollutants. Air pollution generates significant negative impact on well-being, as observed in health, mood, and life satisfaction. It is crucial to have reliable estimates of the public willingness-to-pay for air pollution reduction, and they will be the key parameters in the benefit-cost analysis of public investment with the purpose of mitigating pollution. The merit of their data set is that the detailed micro-level data (from the Swiss Household Panel survey) with respondents' zip municipality codes allow the authors to map air pollution to individuals far more accurately. The authors also limit their sample to nonmovers, so as to address the possible endogeneity problem from the sorting of individuals across places with different pollution levels. A unique methodology contribution of this paper is estimating the panel structural equation model (SEM), along with a simple fixed effects regression analysis, in order to examine the causal effects of permanent income on life satisfaction, and then to calculate the MWTP values. Overall, the results show that the MWTPs are relatively low for NO₂, CO, and PM₁₀, while the highest values are observed for O₃ and SO₂. Additionally, it is also found that there is evidence of a substantial trade-off between income and air quality. The third paper by Auffhammer, Sun, Wu, and Zheng is a city-level analysis. They first provide the estimates of city-level industrial CO₂ emissions and their growth rates

for all 287 Chinese prefecture-level cities during the years of 1998–2009. Then, they decompose the CO₂ emission changes into scale, composition, and technique effects. An interesting finding is that the three effects differ significantly across the three tiers of cities. The scale effect contributes to rising CO₂ emissions, while the technique effect leads to declining CO₂ emissions in all cities. The composition effect leads to increasing CO₂ emissions in the third-tier cities, while it reduces CO₂ emissions in the first- and second-tier cities, perhaps due to the relocation of energy-intensive industries from the latter to the former type of city. Based on the decomposition results, they also find that the inflow of foreign direct investment (FDI) pulls down energy intensity and thus CO₂ emissions by generating a significant technique effect (with the other two effects found to be insignificant), while the environmental regulations help cities to reduce their industrial CO₂ emissions through all three channels.

2.3 *Environmental Sustainability, Waste Management and Recycling*

To date, more and more countries in the world have taken measures to promote environmental sustainability. For instance, the Netherlands Organisation for Applied Scientific Research (TNO) published a report in 2013 (TNO, 2013) analyzing the opportunities and challenges facing the Netherlands as the country moves toward a more circular economy. It focuses on recycling in the metal and electrical sectors and the use of waste streams from biomass. The study reports that, by 2013, the Netherlands was already recycling 78% of its waste, incinerating 19% and dumping only 3%. The fourth paper by Chen, Lin, and Anderson elaborates the notion of environmental sustainability and proposes that the government can initiate a spending scheme for the green public good provision. This paper focuses on the expenditure side of the budget and argues that implementation of green spending has the potential to not only give rise to benefits of the so-called double dividend but also generate additional benefits. Specifically, the environmental sustainability condition can be met as long as the total usage of environmentally polluted resources generated by households does not exceed the equivalent absorptive capacity provided via the provision of green public goods. In other words, the provision of green public goods contributes to the attainment of the macro-environmental equilibrium. This paper also presents a greened Samuelson rule, that is, a modified Samuelson rule associated with the environmental sustainability condition.

Clearly, household waste management and recycling raise a variety of questions and also require proper cooperation among local communities. In this regard, the fifth paper by Briguglio provides a review of the relevant literature and synthesizes it around two themes: initial conditions conducive to household cooperation and intervention that may stimulate cooperation. According to the author, household cooperation in waste management is primarily stimulated by the members' desire to satisfy their moral preferences. As long as such favorable preferences exist, higher cooperation among households can be expected. However, households have limited space and time constraints for cooperation. Policy makers could further check the demographic data on poverty, dwelling size, and household size, and do their best to help communities relieve their constraints. Generally speaking, waste management intervention for household cooperation involves three attributes, namely, convenience, charges, and communication. A review in the literature also confirms that intervention may incur unintended consequences. To advocate environmental intervention, further research on the design of incentives is essential.

In general, recycling behavior is not only an individual behavior but also a social behavior. To encourage recycling behavior, it is important to analyze other social factors that may

affect individual recycling. The sixth paper by Kirakozian initially reviews three major types of economic incentive instruments, namely, taxes, subsidies, and the deposit refund system for encouraging household waste recycling. Overall, people are not motivated solely by monetary compensation and these instruments appear to be complementary. The economic incentive instruments will be effective if they are coupled with other forms of state intervention. Also, sufficient provision of information to consumers is important for them to make a change in recycling behaviors. As for the impact of social factors on recycling, social norms or social pressure arising from self-image could lead individuals to adopt behaviors consistent with the public interest. To encourage more household recycling, the paper suggests a combination of economic incentive mechanisms and behavioral instruments that change the preferences of individuals toward more environmentally friendly behaviors.

2.4 Cultural Evolution, Globalization, and Environmental Innovation

In documented Chinese history, climate changes and geographic conditions are constraints of the economic evolution in ecologically fragile regions. Ecologically fragile regions in China are almost all located in western China, which cover 6.87 million km², accounting for 71.54% of China's total area. The seventh paper by Deng, Wang, and Zhao reviews the research records of several key factors closely associated with economic evolution in the history of ecologically fragile regions in China, including climate change, cultural transition, economic base, resource endowment, and transportation accessibility. This study focuses on five representative geographic units selected from ecologically fragile regions of western China, and examines the paths of economic evolution mixed with adaptive cultures response to climate change in each region. From the record counts in the most recent 200 years on Google Scholar, the authors search the combinations of key words to examine economic evolution in each selected part of ecologically fragile regions. The authors find that the economic evolution with regional climate changes interactively experience three stages of culture-hindered, culture-mixed, and culture-impelled adaptation diversely. Regions that have higher economic performance with less innovative records are highly likely to have a relatively large number of indigenous knowledge unpublished throughout cultural evolution.

The eighth paper by Bu, Lin, and Zhang asks an important question "Whether globalization is good or bad for the environment?" In the literature, nearly all related studies use trade or FDI to measure globalization, and dimensions of globalization other than economic globalization have largely been ignored (Frankel, 2003). In fact, pollution issues cannot be assessed from a single perspective. Globalization has been associated with a remarkable growth in the level of popular concerns for political, economic, and sociocultural issues – including pollution – on a global basis due to accelerated economic growth, intimate regional cooperation, and widespread cultural broadcasting. This paper takes advantage of the Konjunkturforschungsstelle (KOF) globalization index (overall index and sub-indices for economic, social, and political globalization) to examine the effects of the whole globalization and its three sub-dimensions on a country's pollution (the three pollution indicators are as follows: GHG, CO₂, and CO₂ from the manufacturing and construction sector), with a panel data sample of 166 countries from 1990 to 2009. They also use the instrumental variable method to address the potential endogeneity problem. On average, increased carbon emissions move in tandem with higher levels of economic, social, and political globalization. Such effects are larger and more significant for non-OECD countries than OECD-countries. To understand the underlying mechanisms, the authors further examine such effects in the CO₂ from the

manufacturing and construction sector. The results support that pollution haven effects do exist for this energy-intensive sector, and all globalization indices lead to a cleaner environment in OECD countries and to almost continuous environmental degradation in non-OECD countries. This also means that not only economic globalization, but also political and social globalization will enable OECD countries to shift those high-carbon industries to developing countries.

The achievement of strong decoupling between economic growth and environmental degradation crucially depends on technological improvements that reduce environmental pressure from production and consumption. Therefore, environmental technological innovation may potentially lead to win-win situations in which improvements in environmental quality and economic growth coexist. The ninth paper by Barbieri, Ghisetti, Gilli, Marin, and Nicolli reviews the literature on environmental innovation (EI) using the main path analysis tool. They summarize that this literature revolves around the following four topics: determinants of EI; economic effects of EI; environmental effects of EI; and policy inducement in EI. The main path analysis results show that the “determinants of EI” and “inducement mechanism” subfields have a long tradition in academic research, while the “environmental effects” field is still in the early stages of development, and the literature on “economic effects” can be expanded in numerous ways. The authors highlight the directions of potential future research.

2.5 *International Environmental Agreements*

There is little doubt that international cooperation across countries is instrumental for resolving environmental issues such as climate change in the global community. To further environmental cooperation in the global community, international environmental agreements (IEAs) have gradually become an important instrument and have drawn considerable attention in the literature (see, for example, McGinty, 2007; Ferrara *et al.*, 2009; Pavlova and de Zeeuw, 2013). The 10th paper by İriş develops a dynamic game in which countries attempt to maintain cooperation on agreed-upon emission policies with the presence of a free-riding public goods problem. The paper assumes that IEAs are self-enforcing since there is no supranational authority to enforce cooperative mechanisms. Building on the work of Mendez and Trelles (2000) and taking the countries’ economic target into account, this paper has derived some results consistent with those of Mendez and Trelles (2000). The first proposition in the paper states that if a country is more concerned with its economic target, then it is more difficult for this country to sustain cooperation at the agreed emission. Concurrently, it is easier for other countries to sustain cooperation. The second proposition states that if all countries have stronger economic target concerns, then it is easier for some sufficiently developed countries to sustain an agreed-upon cooperative emission level. The final paper by Rogna claims to offer some solution concepts in cooperative game theory for analyzing IEAs. The author emphasizes the Chander and Tulkens (1995) solution and proposes two alternative concepts: the Rawlsian Nucleolus and a ‘revisited’ Nash Bargaining solution. Based upon a numerical comparison of the aforementioned solution concepts, the author concludes that the Rawlsian Nucleolus is the core solution with the highest redistributive properties. That is, the Rawlsian Nucleolus is the most beneficial solution for poor countries that are suffering from climate change.

3. Final Remark

Overall, the aforementioned papers provide theoretical analyses, empirical advances, methodological discussions, or further reflections on environmental economics with endeavors for

enhancing sustainability. Six out of the 11 papers collected in this special issue were originally presented at a conference held in Taipei on August 24, 25, and 26, 2015. The conference took place at National Chengchi University (NCCU) and was jointly organized by the authors of the present introduction on behalf of their respective affiliated institutions, the Department of Public Finance at National Chengchi University and the Department of Construction Management at Tsinghua University. The conference was entitled “The Economics of Climate Change” and gathered presentations of 12 papers together with two keynote addresses by Professors Leslie T. Oxley and Alexey A. Voinov. In the first day of the conference, Professor Yuan-Tseh Lee, 1986 Nobel Prize laureate in Chemistry, delivered a distinguished guest lecture entitled “Climate Change and Survival of Humanity on Earth” following a welcome address delivered by the NCCU President, Professor Edward H. Chow.

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