Editorial : External costs in transportation and logistics

Young-Tae Chang*

Graduate School of Logistics,
Inha University,
100 Inha-ro, Nam-gu, Incheon, 22212, Korea
Email: ytchang@inha.ac.kr
*Corresponding author

Paul Tae-Woo Lee

School of Business IT and Logistics,
RMIT University,
445 Swanston Street, Melbourne VIC 3000, Australia
Email: paultwlee2030@gmail.com

Kamonchanok Suthiwartnarueput

Chulalongkorn Business School,
Chulalongkorn University, 254 Phayathai rd.,
Pathumwan, Bangkok, 10330, Thailand
Email: Kamonchanok.s@chula.ac.th

Biographical notes: Young-Tae Chang is a Professor at the Graduate School of Logistics, Inha University in Incheon, Korea. He has published numerous papers in refereed international journals including *Transportation Research Record*, *Transportation Research Part A, D and E*, *Transport Reviews*, *Transportation Journal*, *Transport Policy*, *Marine Policy*, *Maritime Economics and Logistics*, *Maritime Policy and Management*, *International Journal of Shipping and Transport Logistics*, *Marine Resource Economics*, *International Journal of Coastal and Marine Law*, *International Journal of Production Economics*, *Energy Policy* and *Korea Observer*. He is the President of a newly established research network, Green Research and Education Network (GREEN).

Paul Tae-Woo Lee is Professor of School of Business IT and Logistics at RMIT University in Melbourne, Australia. He obtained his PhD degree from Cardiff University, UK and is a well-recognised scholar in the field of maritime studies and transportation, featuring widely in international publications, organisations and conferences. He is currently an Associate Editor of *Transportation Research Part E* and *Journal of Shipping and Trade*, and Editor of the series book of *Anthem Studies in Maritime Logistics and Supply Chain Management*. He has also been an adviser to several governments and maritime industries over the world.

Kamonchanok Suthiwartnarueput is a Professor at Chulalongkorn Buisness School, Chulalongkorn University, Bangkok, Thailand. She is currently the Director of the Master and Doctoral programs of Logistics and Supply Chain Management. She obtained her PhD degree from Cardiff University, UK and is

a well-recognised scholar in the field of maritime studies and maritime logistics, featuring widely in Thai publications and organisations. She is also the committees/advisers in many government agencies and logistics and supply chain industries.

1 Context of the external costs in transportation and logistics

External costs (EC) can be defined as the costs imposed by individuals or firms on others by their consumption or production activities. Individuals and firms in a society often suffer from noise, pollution, congestion, accidents, and infrastructure damage caused by other individuals and firms performing their consumption or production activities. This is clearly a cost to society because of the member entities' diminished utilities and reduced production activities. They are, however, not reflected at all or not properly reflected in the cost estimates of the sector activities because existing markets are incomplete in pricing them due to the unavailability of a transaction mechanism. For example, the total cost of traffic accidents can consist of the insurance cost and EC. The first part is transacted in the markets by pricing the damage of the accident with the likelihood of such accidents, but people, property and society can suffer much more than the coverage by the insurance policy. Therefore, the externalities exist and should be reflected in the cost functions of the individuals and firms' activities in the sectors. The EC are distinctive from social costs in that the latter covers both direct costs and indirect costs, whereas the former usually corresponds to indirect costs (Petruccelli, 2015).

Moreover, the growing awareness of the importance of global warming and climate change requires the firms to reflect the EC in their activities. Despite the importance of the EC, the transportation and logistics literature shows that the current level of knowledge is insufficient for theorising, modelling and estimating the EC. Therefore, there is a great need to address this issue. To do so, several issues arise, including the scope of the costs, methods/methodologies on capturing them, institutional problems, such as laws, regulations and governances, and the question of who pays for them. Traditionally, a neoclassical approach in economics has been used to capture the welfare changes either by maximising the social welfare or minimising social cost. This approach usually measures the social marginal costs, but often underestimates the real impact. In contrast, environmental economics has developed to address the more important and existential risks of natural resources, such as rare species, biodiversity and climate change. A target driven approach for reducing the externalities by the environmental economics is likely to lead to higher costs than the social marginal cost in the literature (Musso and Rothengatter, 2013). Because the climate change issue has become more important for the world than ever before, the solution by the neoclassical approach based on carbon price is not effective because of low carbon prices. Numerous studies have pointed out that carbon prices should be set very high, at the level of at least hundreds of dollars, to be effective, whereas the prevailing ones are only tens of dollars (see Kim and Chang, 2014; Musso and Rothengatter, 2013).

Under this circumstance, more countries have attempted to internalise the EC in their transport pricing. This is particularly true with the European Union countries, which was

promoted by the European Commission (2001, 2006). The commission emphasises to introduce a 'fair' and 'efficient' pricing system in the region (Piecyk et al., 2010). Recognising the importance of the EC and reflecting them in a costing and pricing system in transportation sector are deemed to have been agreed by consensus in the region. Implementing it in practice, however, is problematic due to the varying assessment methods and guidelines among countries. Petruccelli (2015) showed how countries differ in practice in internalising them by comparing the cases among Germany, the UK and Italy.

The controversy over implementing to internalise the EC lies, largely, in the validity of the monetary valuation of the externalities. Various methods for the valuation have been developed over time. Among these, two approaches are noteworthy: the damage function approach and impact pathway approach. The former estimates the cost of avoiding the damage and the latter traces the pathway on how the source of externalities occur, diffuse, impact on human beings and property, and the impacts are then monetised. The paper by Vallamsundar, Lin and Chang of this special issue (SI) is an exemplar case using the impact pathway approach. The most critical part in quantifying the EC is monetising the costs. Traditionally, monetising the EC and benefits has been considered infeasible as a typical example of market failure; there was no clear and agreeable way to measure them between polluters and victims. This has changed remarkably in recent decades due to the new theories and methodologies developed by environmental economics. Unquantifiable EC in the past can be valued now using the stated preference (SP) or revealed preference (RP) approaches. The SP is used to capture the victims' or polluters' willingness-to-pay (WTP) or willing-to-accept (WTA) by surveying them in a given scenario. For example, when a new highway is constructed and so a high level of noise is expected, the residents in the affected areas are asked to *state* how much they are willing to pay for a project of building a noise wall (WTP) or how much they are willing to accept (WTA) as the compensation for enduring the noise. As the monetisation process is contingent upon given scenarios, it is called the contingent valuation method (CVM). In contrast, the RP captures the environmental benefits and costs *revealed* in the actual transactions of the properties involved. For example, a statistical analysis of housing prices can reveal how the environmental factor, e.g., noise, affects the housing price and so this approach is also called a hedonic pricing model.

To facilitate intellectual exchange and contribute to the advances of knowledge in the theme of EC in the logistics and transportation sectors, a call for papers for this SI was announced by the joint-conference of the GREEN Round Table 2014 and Asia Logistics Round Table (ALRT) 2014, held at Chulalongkorn University in Bangkok, Thailand on 2–3 April 2014. Furthermore, the call-for-papers for SI was announced at the website of this journal http://www.inderscience.com/info/ingeneral/cfp.php?id=2216) and also circulated to the relevant academic societies of transportation and logistics. Numerous papers were presented at the conference, and others were submitted to the website of the journal for publication in the SI. Multiple rounds of rigorous blind-review processes were undertaken to select the best papers both from the conference and submitted manuscripts from the journal. Consequently, only five papers have passed through the appraising lenses of the reviewers in the aspects of academic contribution and the suitability of the topic to the SI theme after two years inexorable works by the authors, reviewers and the guest-editors as well as the Editor-in-Chief.

2 Summary of the special issue papers

Of the five papers in the SI, one paper surveys the literature on how environmental issues have affected recent research in the transportation area. Two papers assess the EC in intermodal transportation with particular reference to short sea shipping (SSS). One paper investigates the EC in highway transportation using the impact pathway approach. The final paper estimates an emission tax for ships at berth based on the EC. All these papers except for the first one (literature survey) address the EC empirically in the respective setting of intermodal, land, and maritime transportation.

The first paper by Lee, Chung and Lam investigates major environmental research topics and research methods in the transportation field by selecting a total of 1,291 papers from 51 journals based on the keywords of both transport and environment. The science and social science citation indices (SCI and SSCI) maintained by the Thomson Reuters are incorporated to choose the journals. Since 2007, environmental issue papers have increased sharply, reaching 190 papers in 2011. This indicates the growing interest of environmental issues over the recent five years. Among the journals, *Transportation Research Part D: Transport and Environment* contributes the most articles, comprising 55% of the total articles. The *Journal of Transport Geography* published 115 articles related to environmental issues, particularly in the last three years (i.e., 2010–2012), indicating growing interest in environmental issues from a geographical or spatial perspective. *Transport Policy and Transportation Research Part A: Policy and Practice* has published approximately 70 papers since 2002. The *Journal of Air Transport Management*, a journal specific to air transportation, shows a stable number of articles, whereas other journals show an increasing rate. *Transportation Research Part E: Logistics and Transportation Review*, which is specific to logistics published the lowest number of environmental issue papers among the top ten journals, but showed a growing interest in recent years, particularly in 2011 and 2012.

Greenhouse gas emissions are one of the hottest topics in the environmental literature. EC, however, does not appear in the keyword search. The top three methodologies are emission analysis, survey, and simulation. The survey method is combined frequently with others, such as discrete choice models, environmental impact analysis, or emission measurement development. Behavioural models, such as mode or attitude changes, are usually developed with choice models or with SP surveys. CVM with the WTP approach is popular when developing behavioural models. Environmental issues in maritime transport are under-researched, compared to the passenger, land, and aviation sectors. One third of the papers in maritime journals are review papers or use qualitative analysis as their primary methodology. In contrast, other transportation journals mainly use quantitative methodologies, such as simulation, optimisation, and econometric analysis. Therefore, there is plenty of room to conduct future transportation research on environmental topics, particularly in the maritime field.

The second paper by Vallamsundar, Lin and Chang presents a methodology to develop finely resolved health exposure metrics from vehicular emissions and estimate their corresponding monetary values. The US Environmental Protection Agency's regulatory models, namely the MOVES and AERMOD models are employed to estimate the traffic related particulate matter ($PM_{2.5}$) emissions and near-road pollutant concentrations, respectively. Health exposure is assessed using an exposure metric of the intake fraction (iF) that measures the fraction of pollutants inhaled by an exposed population over a defined period of time. The methodology is carried out on a real case

study of the Gold Coast region in the City of Chicago. The average $PM_{2.5}$ concentration ranges from 0.31 to 4.53 μg/m^3 and is higher near the roadway links. The iF ranges from 0.0015 to 3.65 per million with seniors, adults and children accounting for 28%, 68% and 3%, respectively, of the total intake. The results show a significant portion of the concentration and health exposure levels to occur within a distance of 300 m from roadway links; 75% of concentrations occur within 300 m, which translates to 78% of the health exposure. In contrast, their physical impacts and economic losses are incurred over a much wider area, reaching out to a distance of 800 m and capturing 93% of the total impact. When environmental mitigation measures related to air pollution by traffic sources are discussed and adopted, attention should be paid to the human impacts as equally importantly as the concentration level. This study shows that the human population is impacted in much wider areas by the pollution, whereas the chemical concentration of the pollution dissipates rapidly with distance. In addition, the suffering of people should be analysed based on the long-term impacts more importantly due to their dominant magnitude. Furthermore, the circulatory impact is more than respiratory one unlike these expectations that air quality problem may cause more respiratory mortality and morbidity. Therefore, more comprehensive coverage of the human impacts should be considered in practical investigations and policy-formulation.

The third paper by Martínez-López, Sobrino and González builds a mixed integer program to search for the most suitable container fleet for operation under the SSS context. Although the SSS is deemed to be more environmental friendly than other transport modes, empirical evidence has often shown the opposite results to expectation, in particular when smaller and fast container vessels, the most suitable ones for SSS, are analysed. Their model incorporates the cost, time and EC (gas emissions) in the objective function and compares the results with the uni-modal road haulage. The optimisation model is applied to a case study in SSS between France and Spain. Owing to the nonlinearity of the objective function and numerous constraints, a heuristic method, evolutionary algorithms are used. The EC of the unimodal transport in the case study comprise 7.79% of the total costs, whereas the portion in intermodal transport with the optimised fleet is 10.28%, with the land stretches and maritime leg being 5.48% and 4.80%, respectively. The initial competitive advantage of the costs in the multimodal chains through the optimised container vessel fleet is widened when the EC are evaluated. The results are, however, sensitive to the technical and operative features of the optimised vessels, which are substantially different from reality. Optimised fleets with extremely small and fast container vessels make the multimodal transport inefficient from the environmental perspective. On the other hand, multimodal chains operated by fleets with vessels of wide dimensions and reduced speeds maximise their environmental sustainability, but their slowness may be unacceptable to the industry, compared to the road alternative. The authors argue that the optimised vessels can provide for more viable greener multimodal chains than the road, despite the EC in the sea leg being significant, even surpassing the staff cost.

Another paper by Kotowska, who assessed the EC generated in land-sea transport chains and in alternative road transport, compares the multimodal chains with uni-modal road transportation. She argues that the previous methods to assess the EC for EU SSS known as the Marco Polo Program either ignored, or considered only a limited range of the vessel type and load capacity. As opposed to the methods adopted in the Marco Polo program, her model assesses the external benefits of a modal shift from road

to sea. The EC encompass the emissions of harmful pollutants (sulphur and nitric oxides, particulate matters, non-methane volatile organic compounds), greenhouse gases emissions, traffic accidents, congestion, and noise. The model is applied to three land-sea transport chains: Ro-Pax, Ro-Ro and a container vessel. The results show that not all means of maritime transport generate a lower EC, compared to road transport. The Ro-Ro and Ro-Pax vessels produce much higher sulphur oxides and particulate matter as well as similar amounts of carbon dioxide and non-methane volatile organic compounds, compared to the Euro V emission standard road vehicles per one cargo unit and one kilometre. The total EC generated in land-sea transport chains depend on the route length, the pre-haulage distance and mainly the ratio of the land-sea transport chain length to the alternative land route. The EC are affected significantly by fuel consumption, which depends on the vessel's load capacity, age, speed, voyage duration and the number of calling ports in the route. The EC also decreases with the economies of scale. Container vessels operating along the coastline of a continent generate a significantly lower unit EC than road transport. Ferries and Ro-Ro vessels generate a similar unit EC to road transport, but usually run a short distance. In both cases, the total EC generated in land-sea transport chains are lower than road transport. This lower EC corroborates that the European SSS contributes to the sustainable transport development.

The final paper by Tseng and Pilcher estimates the external air pollution costs based on ships at berth during 2012 in the three largest Taiwanese container ports: Kaohsiung, Keelung and Taichung using a bottom-up activity-based model. Based on the categories of the ship types, they calculate the monetary value per emission unit (per ship-hour at berth) and set it as the calculation basis of the emission tax. To this end, two computation processes are undertaken. First, they estimate annual EC for various ships through multiplying monetary value and the annual volume for various pollutions emitted from ships. Second, through a process of dividing these annual EC for various ships by the annual number of ships and hours in one year, the EC of each type of ship per ship-hour are obtained. The data is then contextualised within the perspectives of government officials and port operators regarding the practicality of such a tax gathered through in-depth qualitative semi-structured interviews with 15 experts: port operators and government officials. The results show that pollutants are both measurable and serious in scale, i.e., that such a tax is theoretically valuable and viable. The cost impact of such emissions and their social impacts are significant (US$3.24 per ship hour for passenger ships). They argue that an emissions tax is both viable and desirable in an empirical respect. From a practical policy perspective, however, the qualitative data from in-depth interviews with government officials and port operators reveal numerous tension. Regarding the perceptions related to the introduction of such a tax, there are tensions between profit and the environment, between the need to remain competitive by not introducing something punitive that other ports do not have, and between using an emissions tax and drawing on other policies and approaches to control emissions.

3 Conclusions

As environmental issues become increasingly important and prevalent in recent years, more journals in transportation and logistics areas have shown increasing interest in terms of both the number of published papers and topicality. Maritime transportation, however, is the most under-researched area, compared to other sectors in all aspects of the number

of papers, scope of issues and using advanced methodologies. The increasing publications on the environmental issues can be ascribed, in part, to the available new theories and methodologies developed by environmental economics.

Estimating the EC in transportation and logistics arena is still at the primitive stage. This is true particularly with the maritime transportation area. The selected papers in the SI, however, show encouraging new evidence, with half the SI papers focusing on the maritime field. As one of the top three representing maritime journals, it is hoped that this journal can facilitate more research in this area in the future. A good future topic will be to address the issues of 'benefit transfer'. All the empirical studies in the SI used this approach to estimate the monetary value of the externalities. The approach is used when the necessary data is unavailable for the estimation or the situation under study is similar to those of previous works, therefore, borrowing the results of others to apply for their own cases (Ready and Navrud, 2006). An important question, however, arises as to whether our case is really comparable to the cited one.

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