Inter-regional input-output environmental models: applications in the Asia-Pacific and Brazil

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Session Abstract:

The perception that large metropolitan areas are increasingly responsible for the ramp up of CO_2 emissions has supported the development of new analytical tools focused on the local level. Although cities are not considered important production sites their importance is seminal because consumption takes place there. Moreover, the reduction of the carbon footprint, and the evaluation of concurrent alternatives to mitigate global climate change contribute to the alleviation of other environmental pressures, such as health problems caused by local air pollution, which are enhanced in the urban setting. Because climate change is a global problem, researchers all around the world have developed analytical tools with the same objective: to promote welfare within a low carbon society.

This panel attempts to discuss an analytical method that has evolved in order to respond to the anxieties of citizens living in large metropolitan areas around the world. It consists of designing of local environmentally extended input-output models at the city level and state level. Applications for megacities in the Asia Pacific and provinces in Brazil are provided for comparative and methodological development discussion.

The panel consists of several short presentations and a discussion with the participation of the audience moderated by a facilitator. Applied papers developed according to these methods approach are expected to enrich the discussion between participants.

"Change in carbon responsibility for Tokyo from 1990 to 2005: evidence from carbon accounting using inter-regional input-output environmental model"

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Abstract:

Cities are the engines of economic growth of a nation and this is particularly true for the mega-cities of Asia where rapid economic growth has been taking place. To maintain the momentum of sustained economic growth, cities are transforming its structure of economic activities, the efficiency of production and the patterns of consumption. As a consequence of this economic transformation, the structure of energy and material supply and demand has been changing over time with dramatic increase in the external dependency of supply.

In this context, emission of GHGs within territorial boundary and mitigation responsibilities are two different aspects. The former is physical but the latter is an attribution or allocation. City governments account mitigation responsibilities for out-of-boundary GHG emissions associated with electricity consumption in cities but do not do the same with other goods and services. How much mitigation responsibility a city takes, defined by how much emission a city attributes to itself for mitigation, is subject to the definition of its chosen system boundary?

Delineating this system boundary for carbon responsibility is not an easy task. These complexities needs better understanding but also it has important but differential policy implications for commercial and industrial cities from production and consumption perspectives.

This paper analyses the case of Tokyo whose relatively rich data availability enables us to perform complete carbon accounting over the last fifteen years from 1990 to 2005. This would be novel application of inter-regional environmental input-output model to carbon accounting at the city. We first present the territorial emissions (direct emission, SCOPE I) and compare with those with electricity consumption supplied from outside of the city (SCOPE II). We also show how embedded emissions in goods and services other than electricity that Tokyo import and exports affect responsible emissions (SCOPE III). Lastly, we discuss the determinants and factors that influence on carbon emissions with different scopes which represents different climate liabilities of Tokyo.

"Economy-wide impacts of consumer responses to environmental information disclosure in Tokyo and the other parts of Japan"

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Abstract:

Environmental problems such as global warming due to GHG emissions have necessitated some constraint in our economic activities, as many countries and many people around the world are concerned about these issues. Environmental and economic policies such as carbon tax are one such constraint.
A tax policy can be interpreted as a desirable method that can lead the economy, which has to pay the social cost of false economic activity or market failure, to a more optimal path. However, this policy will surely raise prices of goods. On the one hand, this price rise will benefit the public sector, but on the other hand, consumers demand will decline. The magnitude of the reduction usually depends on the price elasticity of demand, and the increase in government gain depends on the necessity of the goods for the people. Therefore, it is not necessarily trivial to ask whether the total effect of rising energy prices will be negative. In addition, nowadays, many people are concerned about environmental problems, and there are indications that consumers tend to change their purchasing behavior regarding certain goods to take environmental concerns into account even if this necessitates paying a higher price.
This paper will empirically prove how the rise in oil and gas prices due to environmental policies like carbon tax affects the total production/consumption when we take into account the change in consumer behavior reflecting their attitudes toward preventing global warming. The main result of the analysis using an input-output model and price elasticity of demand in several sectors will show that most of sectors do not experience a decline in production after a price rise except the biggest sector, real estate. In Japan, real estate might be the main target to support for consumers' purchasing from the viewpoint of economic policy.

"Carbon accounting of mega-cities in Asian developing countries: cases of Beijing, Shanghai and Jakarta"

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Cities featured with rapid economic development and urbanization often need to overcome a number of energy related challenges in aspects of, first, increasing economic activities induce more energy consumption; and increasing demand for energy leads to structural changes in energy consumption; second, growing consumption escalates both direct and indirect energy demand for producing goods. Hence, it is necessary to address the effects of these factors on carbon inventories to provide reliable references for promoting low-carbon city development.

In inventorying carbon emissions at city level, system boundary definition is the key that influences the results of the accounting. According to the international standard for determining greenhouse gas (GHG) emissions for cities issued by the IPCC in June 2010, it is advised that the city GHG inventories should not only be complete and accurate, but they also should include the out-of-boundary emissions from the generation of electricity and heat, as well as emissions from out-bound aviation and marine vessels and wastes. Thus, when it comes to account for the carbon inventories within a set city boundary, the abovementioned out-of-boundary emissions that are driven by the city economic activities should be carefully traced and mitigation responsibility allocation method should be identified.

On the other hand, apart from tracing the mitigation responsibilities of the out-of-boundary emissions that associate with abovementioned sources, emissions embedded in the imports and exports flowing in and out of the boundary should also be considered as part of the city's carbon emission dependence and responsibilities. Without accounting for these embedded emissions, the carbon inventories of the city could be underestimated and the carbon dependence and mitigation responsibilities might not be fully understood.

However, accounting for the carbon emissions and mitigation responsibilities at city level is not an easy task. It becomes more challenging when it comes to measure the carbon inventories and allocate the mitigation responsibilities of cities in developing countries for various reasons including data availability and data consistency. By taking this challenge, this study features on three Asian mega cities namely Beijing, Shanghai, and Jakarta, all of which are highly urbanized, and have rapid economic growth and with similar economic structure. The aims of this study are to reveal the trends of energy use, and the carbon emissions of these cities. The study also measures and identifies the carbon dependence and their mitigation responsibilities under a consistent system boundary definition applied for all three cities.

To accomplish the abovementioned objectives, this study applies environmental input-output analysis as a typical top-down approach to calculate the carbon emissions at sectoral levels. In the analysis, the carbon emissions embodied in goods and services, either locally produced or being imported and exported, are accounted for. Finally, based on the results we expect to provide discussions on the policy implications under the specific carbon responsibility framework defined for the three case cities.

"Assessing emission reduction targets of São Paulo state climate change policy by means of input-output multipliers"

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Abstract:

The Sao Paulo State Climate Change Policy (CCP) was launched in 2010. This voluntary policy, which is independent of any domestic and international accord, was established to reduce greenhouse gas emissions in 2020 by 20%, according to 2005's emission levels. Energy efficiency improvements are among the carbon mitigation actions considered by decision makers, and the commercial sector is always targeted by such type of projects. The present work aims to evaluate direct and indirect carbon dioxide equivalent emissions (CO2e) and energy consumption of production chains of each sector in Sao Paulo State's economy. Consequently, this study combines data from Sao Paulo Input-output Matrix developed by GUILHOTO (2011) with the First Inventory of Greenhouse Gases of the State of Sao Paulo, published by the Sao Paulo State Environmental Company, and the Energy Balance of the State of Sao Paulo (2010), published by the Sanitation and Energy State Secretary. Hence, the work integrates data related to each economic sector considering environmental aspects such as climate change and energy intensity. All data used are based on 2004 values. The work compares direct reductions of each sector to direct plus indirect reductions, and evaluates the adoption of fixed percentage based targets for each sector that are based solely on their direct emissions. In addition, the work presents a comparison between all sectors in terms of their direct and indirect emissions, which is conveyed by emission multipliers. The multipliers represent the amount of direct and indirect emissions generated for each direct emission emitted by sector. They resume the total emissions, direct and indirect, per unit of production by the carbon intensity. Finally, this study identifies key sectors and facilitates the accomplishment of reduction targets that comply with the recent CCP. Sectors presenting the highest emissions multipliers were: commerce, public health, public administration and education, food and beverages, and textile products. For each CO2e tonne of direct emission in the commercial sector, other 36.6 CO2e tonnes are emitted along its supply chain. The multipliers of the other cited sectors are respectively 11.8, 6.6, 6.1 and 4.6 tonnes of total emissions for each tonne of direct emission. This demonstrates that although direct emission releases are small the sector's responsibility is greater if indirect emissions are considered. Therefore, it is possible to argue that its mitigation burden, on a percentage basis, should be greater than for other sectors which traditionally are targeted because of their greater direct emission intensity.

“A carbon footprint calculator based on a Brazilian customized economic-environmental input-output model”

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Abstract:

It is of utmost importance for the Earth`s sustainability to know a measure of your footprint and its correlation with your own consumption. Besides, economic input-output models combined with environmental indicators are excellent methods to evaluate household consumption. One of the most common is EIOLCA - Economic Input-Output Life Cycle Assessment. It uses aggregate sector-level data to point environmental impact directly attributed to each sector of the Economy and how much each sector purchases from other sectors in producing its output.

Our Calculator was adaptaded from EIOLCA model to the Brazilian context. The construction of environmentally extended input-output tables can be quickly made in countries such as Brazil. However, the level of aggregation of these tables is greater than that of tables available in other countries. Some workaround was necessary to refine the analysis of specific consumer products or services. We have substituted emissions arising from the Brazilian electrical generation mix for that of the USA, and we have added some of the most significant land use change related emissions, particularly those due to cattle ranching expansion in the Amazon and cerrado regions. We have compiled official data from household consumption surveys in Brazil and have identified which economic sectors are responsible for supplying goods and services to meet this final demand.

The next step was to construct a web solution that, after the user answers a set of consumption questions, calculates CO2 emission in household perspective. The tool determines the carbon footprint based on average income levels. These standard values are taken from 3 basic questions: income bracket, localization (Brazilian state) and number of persons per household. Another way is to customize each one of values presented to the disaggregated goods and services and to provide, thus, a more precise footprint calculus. In addition to food, other consumer products, energy, and transport, the calculator suggests some behavioral options (“take action”) that could lead to individual household emission reductions. A summary of results - with graphics - completes the tool display.

After running several scenarios, we could see, in comparison with other countries, that energy efficiency measures are not as relevant in Brazil to achieving such reductions. Measures dealing with food choices and transportation are more effective. Results of this study show to consumers in Brazil the actual effects of their typical consumption patterns. Household consumption in Brazil is tied to the "common sense" perception that Brazil is one of the largest carbon emitters due to its land use, forest profile and cattle production in extensive areas.

The application was developed having as paradigm the CoolClimate Calculator of the University of California, Berkeley <http://coolclimate.berkeley.edu>. The project was financed and conducted on behalf of "Amigos da Terra-Amazonia Brasileira" <http://www.amazonia.org.br>. It was sponsored by "Forum SYD" (Sweden NGO). It was implemented and available to operate (experimental phase) at <http://carbonocal.org>.
One of these relevant technical features is to allow quick transformation of background model - questions and amount values internally used. The implementation followed, as guideline, a metadata model, structured in xml format.

In the future, we expect to upgrade this tool extending the model to some regional cases, such as RJ and SP and also implementing an effective comparative analysis between regions and Brazil, with some enhancements. Another good improvement is to integrate the tool inside <http://www.eiolca.net>, because in this way it can be viewed and tested by a large number of users - amplifying its reliability.