Newsletter
International Input-Output Association (IIOA)
Number 8; November, 2009

Editorial
Carbon footprint and input-output analysis

Dear IIOA member,

This year's Special Issue of Economic Systems Research is devoted to the application of input-output analysis to carbon foot-printing. It aims to bring together the academic world of rigorous economic modelling and the practice, sometimes even the politics, of greenhouse gas accounting at various levels. It comes at a time when the world is anticipating a global agreement on climate change, when the awareness of the threats of global warming and the complexity and difficulty of tackling it is strong and when there is an increased demand for meaningful and robust quantification models and indicators.

Authors for this special issue have been asked to present their methods and findings in a way that is comprehensible and meaningful to non-input-output specialists, carbon footprint practitioners, or readers generally interested in methods and applications of carbon accounting. The main text of the articles has therefore been kept less technical although the methodological foundations can still be found in either the appendices or in referenced, peer-reviewed publications.

Carbon foot-printing – an attempt to capture the full amount of greenhouse gas emissions that is directly and indirectly caused by an activity or is accumulated over the life stages of a product – needs economic input-output analysis. Many would question such a statement and, indeed, carbon footprint analysis has been predominantly based on non-input-output methods and applied on a large scale. The articles in this special issue, however, show that input-output analysis can contribute substantially, if not decisively, to the practice of carbon foot-printing at all levels.

This is not new. Countless scientific publications have impressively demonstrated the ability of input-output analysis to support the quantification of environmental impacts of economic activities. Over the last decade there has been a tremendous increase in applications of analytical models based on environmentally extended input-output techniques. Besides being scientifically well described and established, the crucial advantage of input-output based analysis is that it is possible to provide a quantitative consumption perspective of virtually any economic activity.

The fact that the linear input-output model is inherently scalable serves carbon foot-printing well as it can be applied to many different levels of consumption and production, from individuals and lifestyle types to regions and nations, from products to sectors and multinational consortia. There are clear limitations on the micro-level – input-output analysis on its own cannot replace process analysis – but there are clear advantages too. The consistent combination of standardised environmental and economic accounts, the unambiguous link between production and consumption and its economy-wide character leading to system completeness are the strengths of input-output analysis. It is the particular focus on input-output assisted carbon foot-printing as a subject that is politically and economically relevant, from national greenhouse gas footprints down to product carbon labelling, that makes this issue of Economic Systems Research special.

Thomas Wiedmann,
Stockholm Environment Institute
University of York, UK

Manfred Lenzen
Centre for Integrated Sustainability Analysis
University of Sydney, Australia

In this issue

New documents have been published in the **Working Papers Series in Input-Output Economics** of the IIOA at: WPIOX (see p. 11)

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The basic concepts set forth by Wassily Leontief in the 1940s (especially The Structure of American Economy, 1941) have become key components of many types of contemporary economic analysis and, as the founding of the IIOA in 1988 perhaps illustrates, input-output analysis itself remains one of the most widely applied methods in economics. It is certainly not news to readers of this newsletter that Leontief's legacy is rich and vast, as illustrated by the scale and scope of the topics that have followed from his original work, and it is impossible to fully capture that legacy in a single volume.

Our initial plans for what became the first edition of Input-Output Analysis: Foundations and Extensions (1985) were developed in the late 1970s, roughly 25 years after the subject first appeared in undergraduate academic curricula (Harvard, 1952). The first edition was designed as an introductory textbook covering the basics ("foundations") and many additional topics ("extensions") that reflected our research interests in the late 1970s and early 1980s, such as interregional feedbacks, energy and environmental applications, spatial aggregation in many-region models, and a number of others. Over the past decade or so in the wake of a veritable explosion of methodological extensions and empirical applications of input-output it became increasingly and abundantly clear that an update and revision of the 1985 text was overdue. We began to take this notion seriously around 2000-2001—almost an additional 25 years further into the input-output timeline, so the field was essentially twice as old as when we wrote the first edition.

This new second edition reflects, we believe, a more extensive but certainly not comprehensive treatment of the basic framework set forth by Leontief as well as the many extensions that have been developed since the early 1940s. In order to gauge what should be included in the second edition, late in 2000 we communicated with about 30 of our input-output colleagues throughout the world, asking for help in sorting through the maze of material that had developed since the first edition appeared.

Input Output Analysis: Foundations and Extensions, Second Edition, Ronald E. Miller and Peter D. Blair, Cambridge, U.K.: Cambridge University Press, 2009.

A reflective synopsis by the authors

Ronald E. Miller

Peter D. Blair

With our request we listed some new topics that we thought should be included (e.g., social accounting matrices or SAMs), some that we might emphasize more (e.g., commodity-by-industry models), some less (e.g., detailed numerical interregional or multiregional examples), and we asked for reactions and suggestions. Additionally, we took into account what we knew of the uses to which the first edition had been put, e.g., as a text for teaching purposes (both graduate and undergraduate) and as a desk reference for practitioners and researchers.

As a result, in the second edition we have added discussions of SAMs (and extended input-output models) and their connection to input-output data; structural decomposition analysis; multiplier decompositions; identifying important coefficients; and international input-output models. In addition, we have expanded discussions of the historical background and context for Leontief's work; the connection of input-output accounts and national income and product accounts; commodity-by-industry accounting and the models built on those accounts; multipliers, including Miyazawa multipliers, net multipliers, elasticity measures and output-to-output multipliers; location quotients and related techniques for estimating regional technology, including numerical examples and real-world illustrations; energy input-output analysis, including references to econometric extensions; environmental applications, including linear programming and multi-objective programming extensions; the hypothetical extraction approach (and its variants) to linkage analysis; the Ghosh (supply-side) model; the Leontief price model; estimating interregional flows; hybrid methods; and mixed exogenous/endogenous models.

In order to keep the new edition to manageable length, there are topics that had to be excluded or treated only very briefly. These include: econometric/input-output model connections; qualitative input-output analysis; recent developments in dynamic input-output modeling; discussions and comparisons of alternative working models; and the role and interpretation of eigenvectors and eigenvalues in input-output models. Throughout the text we illustrate many of the applications of input output and its usefulness for practical policy questions as well as noting many current research frontiers.

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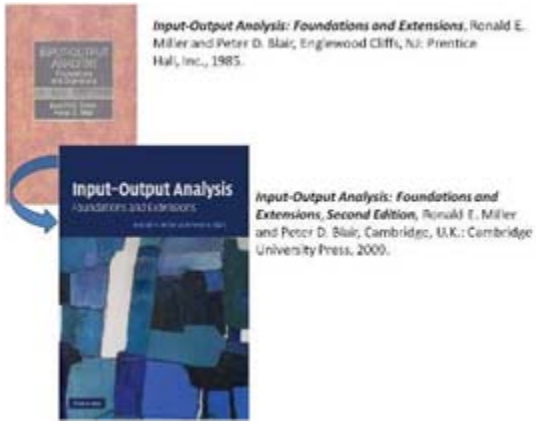
The historical U.S. input-output tables as well as other regional and national "real-world" tables have been reworked, expanded and updated, especially to reflect the international movement toward commodity-by-industry formulations. With the ready accessibility of computing capabilities, we have greatly expanded the end-of-chapter problems to include many more realistic examples as well as some real-world examples and applications. Because of the higher level of mathematical competence that we see in our potential readers as compared with 25 years ago, we have tried to use more compact matrix representations more extensively and whenever possible without compromising the readability of the text that so many readers of the first edition valued highly.



Finally, an internet website associated with this text, www.cambridge.org/millerandblair, includes supplementary information in three general areas: (1) additional material (appendices) in selected areas that were not possible to include in the printed text for a variety of reasons, (2) solutions to all end-of-chapter problems and (3) downloadable datasets of many of the examples and problems printed in the text. The web site will continue to evolve as we accumulate additional information and data that might be helpful to readers.

Needless to say a key audience for our text is the readership of this newsletter, and we hope this volume can serve as a desk reference for our colleagues that are researchers, educators and practitioners in the many-dimensioned field that input-output analysis has become as well as a useful text both for newcomers to the field and seasoned veterans.

Call for nominations for IIOA Fellows

The nomination and election of "Fellows of the IIOA" are regulated by the **bylaws** as revised and accepted at the Sao Paulo July 2009 Council meeting of the IIOA. These are:

1. Aim. The aim of electing Fellows of the IIOA is to honor appropriate members of the IIOA for their scientific contributions to the field of input-output analysis, broadly defined.

2. Number. During each International Input-Output Conference the maximum number of members to be elected as new Fellows of the IIOA is equal to two. The overall maximum number of Fellows is twenty.

3. Secretary. After each election round, one of the Fellows will be chosen by the Fellows as Secretary and will be responsible for the organization of the next election.

4. Nomination. In the calendar year preceding the next International Input-Output Conference members of the IIOA, not being a Fellow, will be invited by the Secretary to nominate other members for election before December 31. Each nomination must be supported by two other members, excluding the nominee and the Fellows. Each nominee must have been a member of the IIOA for at least six years. Each nomination will include: name, current address, current email, current institution, brief curriculum vitae, list of maximally ten key-publications, and a description of the candidate's contribution to input-output analysis of 100-200 words.

5. Election. All Fellows will be invited to deliver their votes on the election of the new Fellows. The Secretary will inform the newly elected Fellows, the President of the IIOA, the Chair of the scientific program committee and the Chair of the local organizing committee of the next International Input-Output Conference of their election, at least four months before the next conference.

6. Installation. The new Fellows of the IIOA will be installed as such during one of the plenary events of this next conference. If a new Fellow is unable to attend the event in person, a representative will receive the decorations that go with the Fellowship Award on her/his behalf at the next conference.

7. Rights. The Fellows have the right to call themselves "Fellow of the IIOA" and have the right to free memberships in the IIOA.

8. Obligations. The Fellows have the obligation to further promote the development and to advocate the proper application of input-output analysis, broadly defined.

In Istanbul, 2007, the following life-time Fellows were announced: Andrew Bródy, Anne P. Carter and Karen R. Polenske. In Sao Paulo, 2009, the following additional life-time Fellows were announced: Clopper Almon, Ronald E. Miller and Graham Pyatt.

We now call for nominations for up to two additional Fellows. Any current members may nominate any members of the association according to the guidelines outlined in paragraphs 1 and 4, above. For consideration during the current nomination process, all nomination materials must be received by me (remiller@sas.upenn.edu) no later than **Thursday, December 31, 2009**.

I will confer with the five other Fellows after receiving the nominations, and we will then select up to two new Fellows who will join our group of six. An announcement will be made at the 18th International Input-Output Conference in Sydney, Australia, June 20-25, 2010.

Ronald E. Miller
Secretary of the Nominations Committee
IIOA Fellows

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Tales from the Input-Output world

Joy Murray

Manfred Lenzen

The World Resources Institute (WRI) and the World Business Council for Sustainable Development, who together are responsible for the Greenhouse Gas Protocol Initiative, are developing new standards for product and supply chain (Scope 3) GHG accounting. To do this they have engaged the expertise of around 300 people world-wide, including representatives of business, policymakers, NGOs, and academia. It is hoped that the new Protocol will provide a standardized method to inventory emissions associated with the full corporate value chain, taking into account upstream and downstream impacts. The idea is that a comprehensive approach to GHG measurement and management will identify the greatest opportunities to reduce emissions.

A number of academics representing input-output analysis groups world-wide were invited to participate in this process. For maximum impact they judiciously spread themselves around the seven technical working groups (TWG) that were formed to address product and supply chain standards. The Integrated Sustainability Analysis (ISA) team at the University of Sydney volunteered for the Scope 3 Guidelines TWG which itself split into the WHAT group addressing boundary setting and value chain mapping and the HOW group addressing data collection, quantification and verification.

It will come as no surprise to Newsletter readers that among the first questions raised were: What constitutes a full list of Scope 3 activities; and how do we determine which items from such a list are significant. To address significance what I own, buy, sell, or influence was suggested by some members of the group as a useful framework. To illustrate part of this framework the group agreed to look at sectoral value chain mapping of emissions by purchased categories for four industries. The ensuing debate, with some lobbying from ISA, culminated in a request for an example of the usefulness of input- output analysis to address the issues around screening, significance and Scope 3 completeness.

ISA's contribution was a discussion paper Pain-free scope 3 (http://www.isa.org.usyd.edu.au/index.html). In it we analysed 12 sectors representing the four nominated industry groups. Our analysis threw up some interesting findings and helped to address some of the common assumptions that had been made by some members of the group regarding significance. While it was obvious that electricity was a significant item contributing to emissions, it was not always Scope 2 electricity that was high on the list. In six of the 12 examples electricity supplied to a supplier of the sector rather than that supplied directly to the sector was a more significant contributor to total emissions.

In the case of sector specific items a comparison of: recorded and media publishing; printing and stationery; books, maps, magazines; and newspapers, showed that in Australia, softwoods and hardwoods are common as the most significant items. However these only accounted for around 60% of emissions so unless broad screening takes place to reveal the remaining 40% the many differences lower down the ranking will be missed, reducing the opportunities for abatement.

From another perspective the technical services and natural gas sectors showed clearly the between-sector differences of carbon footprints. While 93% of emissions were accounted for in just two items in the natural gas footprint, the top two items of the technical services sector accounted for only 23% and even the top twenty items only accounted for 43%.

This neatly illustrated the need for a screening tool – one that as well as capturing the top one or two items is able to capture a long list of smaller items that could account for as much as 60% of total emissions. If showed that if you were to impose a significance threshold you could miss out on the majority of contributions. For example the top 20 items contributing to the footprint of the data processing services sector made up only 44% of the total emissions. Not only that, but after the 12th item every category contributes less than 1% of the total.

University of Sydney

The debate continues as the group seeks consensus on the best way forward. Questions of completeness, relevance and consistency are still being discussed. Our contribution is being considered along with those of other group members. We are hopeful that input-output analysis will find its place as part of some future GHG Protocol. Whatever eventuates will be as a result of an inclusive consultative process, well managed by the WRI and WBSC and representative of the views of probably the most committed group of people that you could assemble world-wide.

Centre for Integrated Sustainability Analysis

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Upcoming conferences

Input-Output 2010
18th International Input-Output Conference
20-25 June 2010 • Sydney Australia

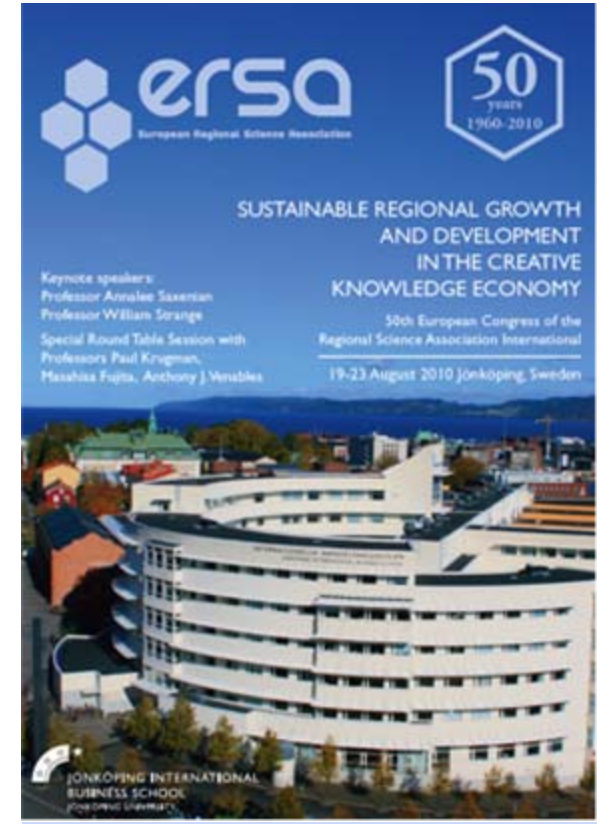
Re-thinking economic growth towards sustainability and well-being: after the financial crisis, what comes next?

The goal of the conference is to promote and stimulate the worldwide exchange of ideas among economists between them and government officials, policy makers, engineers, national accountants and managers with interests in input-output analysis and related methods.

This conference's main theme is about the repercussions of the current worldwide economic crisis on economic growth towards sustainability and well-being; along with the role that input-output analysis and/or input-output based models may play in their quantification. Top experts from this field will participate as plenary speakers to discuss this important topic along with other representatives from national and/or international statistical offices.

Over the past years at the International Input-Output Conferences, convened sessions have been very successful in terms of the number of attendees and discussion. Thus, we strongly encourage potential conveners to make proposals for sets of sessions around specific themes with the Chair of the Scientific Programme Committee (SPC). Please provide the Chair of the SPC by e-mail with a description of the theme and objectives for the session(s), the organiser, the session chair(s), and the speakers/papers by: name of the authors, title of the paper, affiliation of the authors and one selected topic from the list of themes (discussants can be assigned and confirmed at a later stage). The abstracts and full papers should be submitted individually by the authors for evaluation (not by the organizer) before the corresponding submission deadlines. For more information on the call for papers, visit the website of the conference: 18th International I-O Conference.

Abstracts for individual paper submissions are also welcome. In this case, please select an appropriate topic in order to allow allocation your submission to the appropriate thematic session. Please submit abstracts for papers before **December 31, 2009** through the new online abstract submission system COPASS: http://copass.iioa.org. Please, fill in the necessary data (title, abstract, names of all authors, e-mail address, etc.) and select an appropriate topic for the abstract. The length of the abstract should not exceed the maximum allowed by the system.



Abstract submission deadline
January 20, 2010

For more information:
http://www.ersa.org/ersa-congress/

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EUROPEAN SOCIETY FOR ECOLOGICAL ECONOMICS

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ISEE CONFERENCE 2010
Oldenburg - Bremen
Advancing Sustainability in a Time of Crisis

11th Biennial Conference "Advancing sustainability in times of crisis"

Oldenburg-Bremen, Germany, August 22-25, 2010

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- Climate Change
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- Land Use
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- Dematerialization and De-Growth
- Sustainable Development
- Environmental Ethics and Values
- Governance and Public Policy
- Knowledge and social learning
- Green Business
- Heterodox Economics
- Trans-disciplinarity
- Teaching Ecological Economics

Abstract submission deadline
November 30, 2009

For more information:
http://www.isee2010.org/

Highlights in journals

A. Collins. C. Jones & M. Munday, "Assessing the environmental impacts of mega sporting events: Two options?", *Tourism Management*, vol. 30 issue 6, 2009, pp. 828-837.

At a time when public and private agencies recognise the importance of sustainable development, the environmental impacts of mega sporting events are commanding increasing attention. However, despite event sponsors often flagging the importance of environmental as well as socio-economic legacy components, the environmental impacts of events are difficult to assess quantitatively, being complex and often occurring over extended periods. The general assessment issue is particularly acute with regard to mega events such as the Olympic Games and FIFA World Cup. The practical issues mean that any quantitative techniques seeking to assess environmental impacts are likely to be partial in scope. This paper examines two such approaches for quantitative impact assessment of selected environmental externalities connected with visitation at sporting events. The paper considers the use of Ecological Footprint analysis and Environmental Input–Output modelling. It provides examples of the applications of these techniques to discrete sporting events in a UK region, and discusses whether these techniques are appropriate for exploring the environmental impacts of mega events.

S. Hioki. G. J. D. Hewings & N. Okamoto, "Identifying the structural changes of China's spatial production linkages using a qualitative input-output analysis", *Journal of Econometric Studies of Northeast Asia*, vol. 6 issue 2, 2009, pp. 25-48.

In this paper, we attempt to identify the structural changes in China's interregional input-output linkages over the period 1987-1997 using the Minimal Flow Analysis (MFA) introduced by Schnable(1994,2001). MFA clearly reveals that some major changes in the structure of China's interregional linkages took place along with the increasing

self-sufficiency of many regions. Although many interregional linkages between manufacturing industries within coastal areas have decreased in their relative importance, some new linkages with other industries and with other regions have gradually become more important over the same time period, leading us to conclude that in China the structure of the economic interdependencies between its spatial units is now being reorganized.

M. Ciaschini, R. Pretaroli & C. Socci, "A Convenient Multisectoral Policy Control for ICT in the US Economy", *Metroeconomica,* 60(4), 2009, pp. 660-685.

Through the application of the Macro Multiplier (MM) approach on an input–output matrix for the US economy in 2005, the paper identifies the 'convenient' structure of a policy control on final demand that is oriented to a particular policy objective. The approach quantifies a set of aggregated scale effects, called MM, and the associated structures of both policy and objective variables. In this way the policy maker can both get a complete picture of the patterns of the objective that can be attained and determine a 'convenient' structure of the policy variable that compels the model towards those patterns.

I. Mongelli, G. Tassielli & B. Notarnicola, "Carbon Tax and its Short-Term Effects in Italy: An Evaluation Through the Input-Output Model", in: S. Suh (ed) *Handbook of Input-Output Economics and Industrial Ecology,* SpringerLink, 2009, pp. 357-377.

Economists and policy makers refer to carbon tax as an efficient instrument to control CO_2 emissions, but concerns about possible negative effects of its implementation, as for instance the loss of competitiveness on the international market, have been expressed. In the present chapter the I-O model is used to estimate the short-term effects of a carbon tax in Italy (the results can be easily extended to the case of a permission trading scheme), which include the percentage increase in prices and the increase in the imports of commodities to substitute domestically produced ones as intermediate input. The present study is not "behavioural", in the sense that the change in the consumers' behaviour and choice, induced by higher prices, is not taken into account.

J. Oosterhaven & K. P. Polenske, "Modern regional input-output and impact analyses", in: R. Capello & P. Nijkamp (eds) *Handbook of Regional Growth and Development Theories*, Edward Elgar, Cheltenham, 2009, pp. 423-39.

The authors first overview theory of demand-driven I-O and SAM impact analysis, and the theory of price and supply-side impact analysis. Then, they review developments in I-O data construction and model applications, and give an overview of modern impact analyses, with special attention to the quality of the various current software packages available.

T. O. Wiedmann, M. Lenzen & J. R. Barrett, "Companies on the Scale. Comparing and Benchmarking the Sustainability Performance of Businesses", *Journal of Industrial Ecology*, 13(3) pp. 361-383.

A determination of the sustainability performance of a company ought to fulfil certain requirements. It has to take into account the direct impacts from on-site processes as well as indirect impacts embodied in the supply chains of a company. This life cycle thinking is the common theme of popular footprint analyses, such as carbon, ecological, or water foot-printing. All these indicators can be incorporated into one common and consistent accounting and reporting scheme based on economic input–output analysis, extended with data from all three dimensions of sustainability. We introduce such a triple-bottom-line accounting framework and software tool and apply it in a case study of a small company in the United Kingdom. Results include absolute impacts and relative intensities of indicators and are put into perspective by a benchmark comparison with the economic sector to which the company belongs. Production layer decomposition and structural path analysis provide further valuable detail, identifying the amount and location of triple-bottom-line impacts in individual upstream supply chains. The concept of shared responsibility has been applied to avoid double-counting and non-comparability of results. Although in this work we employ a single-region model for the sake of illustration, we discuss how to extend our ideas to international supply chains. We discuss the limitations of the approach and the implications for corporate sustainability.

F. J. André & M. A. Cardenete, "Designing Efficient Subsidy Policies in a Regional Economy. A Multicriterion Decision Making and (MCDM) and Computable General Equilibrium (CGE) Approach", *Regional Studies,* 43(8), 2009, pp. 1035-1046.

Since policy makers usually pursue several conflicting objectives, policy making can be understood as a multi-criteria decision problem. Following the methodological proposal in André and Cardenete (2005), we use multi-objective programming in connection with a computable general equilibrium model to represent optimal policy making and to get so-called efficient policies in an application to a regional economy (Andalusia, Spain). We apply this approach to the design of subsidy policies under two different scenarios. In the first scenario, we assume that the government is concerned just about two objectives: ensuring the profitability of a key strategic sector and increasing overall output. Finally, we enlarge the scope of the exercise by solving a problem with seven policy objectives, including both general and sectoral objectives. We conclude that the observed policy could have been Pareto-improved in several directions.

L. de Mesnard, "Is the Ghosh Model Interesting?", *Journal of Regional Science,* 49(2), 2009, pp. 361-372.

The overall value of the Ghosh model is appraised. Its treatment of quantities and prices is scrutinized by examining the variant with data in quantities and prices, and the variant with data in value and price indexes. The methodology involves returning to the accounting equations and shows that: (i) the Ghosh model offers solutions of limited interest, being incapable of providing prices or price indexes separately from quantities; (ii) what is taken to be the equation of Ghosh's value model is actually that of Ghosh's physical model; (iii) the Ghosh model may serve for cost-push exercises, but the dual of the Leontief model performs the same task in a much simpler and more natural way; and (iv) Cronin's mixed models do not actually mix Leontief and Ghosh hypotheses.

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In the next ESR issue

Economic Systems Research - Journal of the IIOA

Special issue on Carbon Footprints and Input-Output Analysis

Volume 21 ***Number 4*** ***December 2009***

Manfred Lenzen and Bart Los. Editors

T. Wiedmann. *Carbon Footprint and Input-Output Analysis - An Introduction*

This editorial is the introduction to a special issue of Economic Systems Research on the topic of carbon footprint and input-output analysis. It provides a brief historical context of the involvement of input-output analysis with applications in environmental research and makes the link to carbon footprint theory and practice. The six papers in this issue are briefly introduced. The aim of the special issue is to bring together the academic world of rigorous economic modelling and the practice of greenhouse gas accounting at various levels.

J.C. Minx, T. Wiedmann, R. Wood, G.P. Peters, M. Lenzen, A. Owen, K. Scott, J. Barrett, K. Hubacek, G. Baiocchi, A. Paul, E. Dawkins, J. Briggs, D. Guan, S. Suh & F. Ackerman. *Input-Output Analysis and Carbon Foot-printing: An Overview of Applications*

This article provides an overview of how generalised multi-regional input-output models can be used for carbon footprint applications. We focus on the relevance and suitability of such evidence to inform decision making. Such an overview is currently missing. Drawing on UK results, we cover carbon footprint applications in seven areas: national emissions inventories and trade, emission drivers, economic sectors, supply chains, organisations, household consumption and lifestyles as well as sub-national emission inventories. The article highlights the multiple uses of generalised multi-regional input-output models for carbon foot-printing and concludes by highlighting important avenues for future research.

Y.A. Huang, M. Lenzen, C.L. Weber, J. Murray & H.S. Matthews. *The Role of Input-Output Analysis for the Screening of Corporate Carbon Footprints*

In developing a standardised approach for companies to inventory greenhouse gas (GHG) emissions along their value chains, key challenges identified by stakeholders and technical experts include: which emissions sources a company should include in their inventory and how to calculate them, what constitutes a full list of indirect supply chain activities, and how to determine which activities from such a list are significant by application of a cut-off threshold. Using GHG accounting based on input-output models from Australia and the United States, this work presents specific case-study examples and general results for broad industry sectors in both economies to address the development of a complete upstream carbon footprint for screening purposes. This is followed by an analysis of the issues surrounding application of cut-off thresholds and the relationship with system capture rate and efforts in carbon footprint analysis. This knowledge can inform decision makers about where to expend effort in gaining progressively greater accuracy for informed purchasing, investing, claiming carbon credits, and policy-making. The results from this work elucidate several findings: while it is probably true that some companies will know what sources contribute most significantly in the supply chain, this is not likely to be true for all. Contrary to common perception, scope 1&2 emissions are not always more significant than scope-3 sources, and for some sectors, the largest sources of emissions may be buried further upstream than many companies may have previously perceived. Compiling a list of core elements of significance across all sectors may be problematic because these elements are not necessarily significant for most sectors. Lastly, application of cut-off thresholds results in highly variable performance in footprint capture rate and is not a reliable criterion for including emission sources in GHG footprints. Input-output analysis is a powerful tool in informing supply-chain GHG accounting, and there is a need for plain language education, training, support materials and information to be made easily accessible to a global business community.

R. Wood & C.J. Dey. *Australia's Carbon Footprint*

This paper overviews construction techniques and methods used to assign greenhouse gas accounts to industry sectors and of the use of input-output analysis to subsequently calculate the carbon footprint of Australia. The work is motivated by the introduction of an emissions-trading scheme in Australia, and by the need for policy to be developed around the direct and indirect (life-cycle) greenhouse gas emissions of industries, especially with regards to the trade exposure of industries with large carbon footprints. Greenhouse gas multipliers, which show the carbon footprint intensity of consumption items, are calculated to gain insight into opportunities for 'greening' consumption. Key industries are identified in relation to both greenhouse gas emissions and economic importance. The effects of imports, exports and capital consumption are explored and a brief analysis of the change in greenhouse gas multipliers over time is given.

K. Nansai, S. Kagawa, Y. Kondo, S. Suh, R. Inaba & K. Nakajima. *Improving the Completeness of Product Carbon Footprints Using a Global Link Input-Output Model: The Case of Japan*

This paper is concerned with the main activities of Japan's "Disclosure of CO_2 emissions" programme, aimed at illustrating the CO_2 emissions associated with consumer products as a 'carbon footprint' (CF). Although the current, provisional guidelines for calculating product carbon footprints specify that only the bottom-up approach is to be used for this purpose, this paper presents useful applications of input–output analysis that can improve the reliability of the method considerably, by taking full advantage of the strengths of input–output analysis. To this end, we first estimated the global carbon footprint (GCF) of food and consumables in Japan, using a global link input-output (GLIO) model comprising 804 economic sectors in Japan and 230 foreign countries and

regions. By visualizing the GCF on a world map, the global distribution (including Middle East and African countries) of the induced CO_2 emissions of each of the Japanese sectors were identified. To investigate the scope for reducing the data collection burden for CF practitioners, GCFs were compared with CFs obtained using a single-region input-output model. This showed that there are certain commodity groups with a CF equating to 70% to over 90% of the corresponding GCF, even if the imported goods used for producing a Japanese domestic product are considered environmentally equivalent to their domestically produced counterparts. Furthermore, it was identified which data should preferably be collected by the bottom-up approach to secure CO2 emissions coverage greater than a certain predefined level and keep data and labour cost at a minimum.

H.C. Wilting & K. Vringer. *Carbon and Land Use Accounting from a Producer's and a Consumer's Perspective - An Empirical Examination Covering the World*

National policies for reducing environmental pressures stemming from emissions and the use of natural resources usually adopt a producer approach, i.e. the legislation refers to pressures occurring within the territorial boundaries of a country. An alternative approach to environmental accounting is the consumer approach, which includes environmental pressures associated with imports for domestic consumption, wherever these pressures occur. The carbon footprint, for example, is such an approach, in which CO_2 or greenhouse gas (GHG) emissions are considered from a consumer's perspective. The consumer approach may offer new ways for policies to reduce pressures, and therefore it would be interesting to adopt this perspective in national environmental policy-making and international negotiations. To gain insight into the differences between the approaches, this paper discusses the concepts of both, showing the results of an empirical analysis and going into the application of the two different perspectives in (international) environmental policies.

Due to international trade, the environmental pressures accounted for in a producer's and a consumer's perspective are usually not the same for a country. This paper presents a worldwide overview, comparing the outcomes for the two approaches with regard to GHG emissions and land use, for 12 world regions. Furthermore, for GHG emissions, a quantitative comparison was made between 87 countries and regions covering the world. Consumption-related GHG emissions and land use per capita were calculated with a full multi-regional input-output (MRIO) model. MRIO analysis is an attractive method for footprint analyses in an international context. The research shows that, for most developed countries, GHG emissions and land use are higher in the consumer approach than in the producer approach. For most developing countries, the opposite is true. Before applying national targets to the consumer approach, for instance, in climate policies, further improvements and standardisation of methodology and data will be necessary.

R. Andrew, G.P. Peters & J. Lennox. *Approximation and Regional Aggregation in Multi-Regional Input-Output Analysis for National Carbon Footprint Accounting*

Multi-regional input-output (MRIO) analysis has been used widely to quantify the global environmental impacts (e.g., energy use, greenhouse gas emissions, water use) embodied in consumption and international trade. Often, analysts have used approximations to a full global MRIO model; however, without access to a full MRIO model the approximation errors are unknown. In this paper we use an MRIO model based on the dataset provided by the Global Trade Analysis Project (GTAP) to quantify the errors introduced by various approximations of the full MRIO model. We find that emissions embodied in imports contribute an average 40% of the total emissions embodied in countries' final demands. For the emissions embodied in imports, we find: a) that the unidirectional trade model gives a good approximation to the full MRIO model when the number of regions in the model is small; b) that including only the most important trade partner in terms of emissions embodied in imports can substantially improve the accuracy of estimates; and c) that a world-average input-output table often provides a good representation of the aggregate 'rest of world' economy.

Finally, assuming that imports are produced with domestic technology (Domestic Technology Assumption, DTA) in an MRIO model can introduce significant errors and requires careful validation before results are used. However, the DTA generally produces better estimates than ignoring imports altogether.

Teaching I-O: First Human I-O Table

Forty second-year Chemical Engineering students formed the world's first ever human input-output table during a recent lecture at the University of Sydney (Australia). The total Australian economy was compressed into five sectors: Agriculture (Green hats), Mining (Black hats), Manufacturing (Blue hats), Utilities (Red hats) and Services (White hats). The Brown, Pink and Yellow hats represented the satellite accounts for Land disturbance, water and greenhouse gas emissions. Other students were enlisted to 'spend' $1000 in any one of the sectors. Students in the input-output table identified and built a single structural path precipitated by the spend. They calculated the emissions generated, or water or land needed, five layers up the supply chain from that one single path.

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International Input-Output Association (IIOA)
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Teaching IO: Related courses

SOCIO-ECONOMIC APPLICATIONS is an optional course unit for the 3rd year of the graduate courses offered in the School of Economics and Management of the Technical University of Lisbon, in Portugal. It is taught by Susana Santos, who researches the measurement and modelling of economic activity using Social Accounting Matrices (SAMs).

The course unit attempts to study the relationship between economic activity and social life. It specifically centers on how economic activity effects change in socio-economic levels.

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The course examines a myriad of concepts through the lens of the interrelatedness of industries and the circular flow of transactions as depicted in national accounts. SAMs thereby contribute to a more thorough understanding and awareness of the importance of the strength and breadth of general equilibrium effects in an economy.

In the course, the construction of SAMs (and input-output matrices) and specific statistical sources required for them are taught. A top-down method is used with national accounts as the main information source.

The course identifies associations between the SAMs and the National Accounting Matrix (NAM), which is constructed directly from the national accounts. Associations with main macroeconomic aggregates are also identified.

The importance of SAMs as working instruments is then emphasised using their algebraic and numerical versions. With the numerical version, the course demonstrates how to construct consistent databases that may be used to support the economic models that underlie the algebraic versions. The importance of a consistent database in modelling socio-economic activity is emphasized. The course is completed through a discussion of a set of case studies and applied analyses that use the methods and data detailed earlier in the course. (See more details in: Socio-economic applications- choose English in the right hand corner)

Susana Santos
Technical University of Lisbon

Job opportunities

THE UNIVERSITY of York

SEI STOCKHOLM ENVIRONMENT INSTITUTE

Research Associate at The Stockholm Environment Institute at the University of York For an informal discussion please contact Dr John Barrett jrb8@york.ac.uk. No direct applications. Please see the job description for details of how to apply. The post is available full time, however, reduced hours may be considered (salary reduced pro rata accordingly). The post is available for a period of two years. The detailed job advert can be found here: SEI-Y. Closing date is **Wednesday, 18 November 2009**. Interviews are scheduled for an anticipated date of Friday, 4 December 2009.

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Opening for Economics Faculty; Rensselaer Polytechnic Institute, the oldest technological institute in the English-speaking world, invites applications for a tenure track or tenured position in the Department of Economics. The specific field within Economics is open, but the ideal candidate will complement one or more of the strengths of the department in energy, environmental and ecological economics, the economics of technical change, and mathematical and quantitative methods.

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Please send CV and contact information for three references, either by mail or by email.

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Ms. JoAnn Drost
Off ice of the Dean of Humanities, Arts, and Social Sciences
Rensselaer Polytechnic Inst., 110 8th St., Troy, NY 12180 USA

For More Information, email:
Prof. Arturo Estrella, Head of Economics Department, estrea@rpi.edu

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Input-Output Database

Danish input-output tables and tables for air emissions and energy

Statistics Denmark has a very long tradition of compiling input-output tables based on the commodity flow system. Thus, the Danish National Accounts are based on supply and use tables and the compilation of input-output tables is a fully integrated part of compilation of the National Accounts in Denmark. Symmetric input-output tables have been compiled for the period 1966 to 2006 in current prices, constant prices and previous year's prices. The tables include 130 industries at the most detailed level.

The I-O tables are supplemented with satellite matrices for energy and air emissions for analytical purposes. The satellite matrices have the same 130 industry interface facilitating integrated input-output analyses of questions related to energy as well as environmental economics analyses. The energy matrices (available for 1966-2007) include 40 energy products and the air emissions matrices (available for 1990-2007) present 8 different types of emissions: CO_2, SO_2, NO_x, CO, NH_3, CH_4, N_2O, and NMVOC.

Download of Danish input-output tables from the internet

The Danish I-O tables are published every year in the fall at the same date as the final version of the National Accounts is published. The accounts and tables are published three years after the reference year. Users can download data in various formats either as full tables or as own-specified fragments of full tables.

All input-output tables as well as detailed Energy balances and Emission tables from 1966 to 2006 can be downloaded in four different formats: SAS, Excel, GAUSS and GAMS. The matrices can be downloaded free of charge from: www.dst.dk/inputoutput. Another possibility is to look up or download any input-output data from single cells to full tables from Statistics Danmarks databank.

Annual input-output publication

Every year in the spring the book "Danish Input-output Tables and Analyses YYYY" is published. The book includes a large variety of information compiled on the basis of the I-O tables and I-O models. It contains analyses of, among other things, employment, investment, import and emissions. Theses issues are described in terms of levels of the economic variables and physical amounts, respectively, as well as coefficients, multipliers and other information. The book also contains documentation of the I-O tables and the contents of the tables. The printed book can be ordered from the webpage of Statistics Denmark. If a PDF-file is sufficient it is available free of charge at Statistics Denmark PDF.

Uses of Danish input-output data

The detailed input-output information and the satellite accounts are used for analyses in relation to the Danish Environmental Accounts compiled by Statistics Denmark in the spring every year. One application of the data is for a detailed structural decomposition analysis revealing the factors behind the changes in e.g. CO_2 emissions and the extent to which a decoupling between growth and emissions can be observed for the Danish economy. The Danish Environmental accounts are available at NAMEA. Another main use of the I-O tables is as the core of the large scale macro-econometric model ADAM developed and maintained by Statistics Denmark.

STATISTICS DENMARK

Peter R. Jensen
Statistics Denmark

New Publications of the WPIOX Series in 2009

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WPIOX09-007 Frederik Neuwahl, Andreas Uihlein and Aurelien Genty
An Econometric Input-Output Model for EU Countries Based on Supply and use Tables: The Production Side: Abstract | PDF

WPIOX09-006 K. Kratena, I. Mongelli and M. Wueger
An Econometric Input-Output Model for EU Countries Based on Supply and use Tables: Private Consumption: Abstract | PDF

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