Frontiers and Extensions

Capabilities accounting in the I-O/SAM framework

The doubts about GDP as a trustworthy indicator of economic advancement have greatly increased in recent times, to a so great extent that some economists even advocate its total demise. GDP — and by implication, national accounting in general —, it is contended, focus on an increasingly irrelevant and misleading valuation of economic activity, and leaves aside several crucial aspects of the functioning of the economic system. The total value of the tons of iron, coal and so on produced by a country, or the added incomes of persons living highly (and increasingly) heterogeneous circumstances, are less and less relevant as a synthetic assessment of the relative economic success of a society — and even less relevant as an assessment of the welfare or wellbeing of its members. A misleading GDP-mania, it is argued, forces the focus of the economic policy debate, and the economic policy actually implemented, away from the aspects of social and economic life that are really important for the fulfilment of the life aspirations of the members of society.

As we know, several different indicators have been proposed as solutions to the deficiencies of GDP, consisting basically in different types of GDP, consisting basically in different types of adjustments or corrections of the GDP figure, to take into account different economic, social or ecological criteria advocated by their proponents. Perhaps the most well known and widely used such indicator is the Human Development Index of the United Nations Development Programme — which is the geometric mean of three (normalized) indices, life expectancy, education, and income per capita—conceptually based in Amartya Sen's capability approach.

In a recent article in the online *Real World Economics Review*, "The ℵ capability matrix: some observations on GDP and the economics of human development," a proposal is made to completely free human development accounting from GDP accounting. Based on classical economic and philosophical perspectives, the idea is to give human development accounting an exclusive focus on human development, understood as the all-round development of the individuals' capabilities. The article is an attempt to give concrete empirical content to the general idea of human development as human capability growth, and to express capability development in the form of a metric of empirical, measurable dimensions, closely related with the workings of the economic system as a whole.

A preliminary inspection of the conceivable space of capabilities may start with the notion of need, or more specifically, with the capabilities of individuals to provide for particular needs. The basic needs approach of international organizations gives a first group of basic capabilities. More general theories of human need propound larger sets of needs, giving rise to additional groups of capabilities. Maslow's theory of the hierarchy of human needs, for instance, offers a large account of human needs, in which basic physical survival needs form the base of the pyramid of needs. Several needs/capabilities are also consecrated human rights according to United Nations' declarations and conventions. It is possible to conceive a pure index of human capability development on the basis of a relevant set of capability indices.

The idea of a hierarchy of needs and capabilities, along

with the possibility of obtaining objective measures for the different capabilities, allows also for the conceptual possibility of what one may call a society's capability matrix. The idea of a hierarchy of needs-capabilities in which some basic categories of needs/capabilities are the precondition for the fulfilment of other, less basic, categories, which in turn are the preconditions for the fulfilment of other less basic categories (and so on), suggests

the conception of (some) capabilities being the necessary "inputs" for the formation of (other) capabilities. That is, capabilities are produced by means of capabilities. Capability matrix ℵ (an $n \times n$ matrix) is the matrix of capability coefficients $ℵ_{ij}$ representing the proportion in which capability i contributes to the production of capability j.

The growth of capabilities can be investigated with the help of, and by analogy with, input-output theory. The eigenvalues associated with matrix ℵ are the potential rates of balanced, equiproportional capability growth inherent to ℵ; the eigenvectors corresponding to those characteristic roots indicate the respective capability proportions necessary for balanced growth. The causal plausibility of the model may increase incorporating a causal link between capability growth and capability investment, by analogy with the dynamic version of the input-output model. The growth of capabilities requires/implies the dedication of particular types of capability-increasing capabilities to the production of capabilities. There exist particular types of capabilities (e.g. scientific, technological, cultural, etc.) which are crucial inputs for the growth of other capabilities. These constitute kinds of "capital capabilities," capable of being accumulated within social institutions, networks, and the like. We can postulate a ℶmatrix, a ($n \times n$) matrix whose coefficients indicate the quantity of capability i which must be invested in capability j in order to increase capability j by one unit in the next period. This more causally plausible, dynamic model, with a somewhat more complex structure, would give rise to a new eigen-equation, with new eigenvalues and

	1. Activities	2. Commodities	3. Capabilities	4. Private sector	5. Public sector	6. External Sector	7. Investment	8. Total
1. Activities		Gross outputs	(Capabilities in production)					Gross outputs
2. Commodities	Intermediate demand		(Capability creating outputs)	Private consumption	Public consumption	Exports	Investment demands	Total demand
3. Capabilities			Capability transformation table		(Capability creation)	(Capability creation)	(Capability creation)	(Total capabilities)
4. Private Sector	Value added		(Capability distribution)		Social transfers			Private sector income
5. Public Sector		Sales taxes		Direct taxes		Foreign grants and loans		Public sector income
6. External Sector		Imports	(Capability creation)					Foreign exchange outflow
7. Savings				Private sector savings	Public sector savings	External savings		Total savings
8. Total	Gross outputs	Total supply	(Total capabilities)	Private spending	Public expenditure	Foreign exchange inflow	Total investment spending	

eigenvectors.

If even more realism is desired, a policy simulation approach could be adopted, exploring the effects, departing from given initial conditions, of different investment strategies for capability growth over time, instead of looking for general abstract conditions for balanced growth.

This latter more realistic model would require a detailed knowledge of the structure of the whole socioeconomic system, as that provided by the social accounting matrix (SAM). It is possible to conceive of a SAM in which both the production and exertion of capabilities, and all the usual economic transaction accounts, are given in homogeneous time units. As far as I know, there are no empirical implementations

of social accounts in time units, that is, in terms of the labor theory of value.

However, it is possible to conceive an intermediate, transitional approach, in which a capability transaction table in heterogeneous physical units forms the center of the SAM, as in Table 1 in the article cited above. The capability accounts interact with the different economic accounts in monetary terms, but do not add to them. I admit that I should be happy to be among the researchers trying to prove the empirical viability of ℵ if, or when, the time should arrive.

Jorge Buzaglo

Published papers and books in IOA and related methods

Next ESR issue

Economic Systems Research

Journal of the IIOA

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CAN THE CARBONIZING DRAGON BE DOMESTICATED? INSIGHTS FROM A DECOMPOSITION OF ENERGY CONSUMPTION AND INTENSITY IN CHINA, 1987–2007. ZHANG H. and LAHR M.L.

China has relied on energy to stimulate its booming economy. As a result, its share of world energy consumption rose to 17.3% in 2009 from 7.9% in 1978. Somewhat surprisingly, through 2000 its rate of energy consumption was about half its rate of economic growth. This trend changed after 2001 as energy consumption rose about 1.3 times more rapidly than did gross domestic product through 2005. Through heavy governmental influence, energy intensity subsequently reduced through 2007, but just marginally. This paper uses the structural decomposition approach to understand key drivers behind changes in China's energy intensity and its energy consumption from 1987 to 2007. In our model, energy intensity change was decomposed into five factors: changes in energy efficiency, changes in share of value added, changes in input structure, changes in consumption structure, and changes in consumption volume. This paper provides insights into how changes in China's economic structure, technology, urbanization, and lifestyle affect energy intensity and energy consumption.

REDUCE EMPLOYERS' SOCIAL SECURITY CONTRIBUTIONS AND CONTROL LABOR FRAUD: REMEDIES FOR SPAIN'S AILING ECONOMY? ÁLVAREZ-MARTÍNEZ MT. and POLO C.

The aim of this paper is to quantify the impact of the reduction on social security contributions (SSCs) of employers recently claimed by the Spanish enterprisers? organizations on the main macroeconomic variables. The effects of this tax reform are evaluated with a Computable General Equilibrium model with the neoclassical closure rule. The model is calibrated with a Social Accounting Matrix for the year 2000 (SAMES-00) elaborated by the authors. Results show that lower SSCs of employers raise employment, households? welfare and real gross domestic product (GDP) but also increase the public deficit. These positive effects remain when the reduction is compensated with personal income taxes to keep the public deficit/GDP ratio constant and also when the compensating variable is value-added tax (VAT). Unlike in previous studies, the most positive effects are obtained when the lower public revenues are compensated via lower coverage of unemployment benefits.

GREENHOUSE GAS EMISSIONS AND ECONOMIC STRUCTURE IN URUGUAY. PIAGGIO M., ALCÁNTARA V. and PADILLA E.

Using input-output analysis, we identify the key sectors in greenhouse gas (GHG) emissions of the Uruguayan economy. The responsibilities of each sector in terms of its emissions are decomposed into an own component, generated during the activities of the sector, and an indirect component, generated by the induced activities in other sectors. This has important implications for the design of mitigation polices, as the appropriate policy measures are contingent on the nature of the pollution. Technical improvements and best practices are effective only when applied to directly polluting sectors, while demand policies may be more appropriate for indirectly polluting sectors. In addition, we analyze pollution generated during the production of exports. The results show that demand policies are going to be effective in the Building, the Hotel and restaurants, and the Wholesale and retail trade; and repair of motor vehicles and motorcycles sectors. These policies complement GHG emissions? mitigation policies in directly polluting sectors (mainly the Cattle farming and the transport-related sectors). Finally, methane and nitrous oxide emissions are mainly the consequence of production for exports, while carbon dioxide emissions are mainly driven by production for domestic consumption.
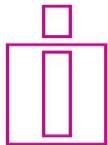
USING I–O TABLES FOR ESTIMATES OF CZECH GROSS DOMESTIC PRODUCT 1970–1989. SIXTA J. and FISCHER J.

The paper describes the transformation of original macroeconomic data for the Czech Republic in the period of socialism to the current methodology of national accounts. Since the Czech Republic was a part of former Czechoslovakia, such estimates were not usually published. The key approach is based on symmetric input-output tables (SIOTs) that allow the description of several segments of the economy. SIOTs were compiled directly from data sources on a regular basis instead of supply and use tables. We used SIOTs for 1973 and 1987 to investigate thoroughly the differences between the previously used Material Product System (MPS) and the System of National Accounts. After that, we identified the most important differences between MPS and SNA, and constructed the time series of Czech gross domestic product for 1970-1989. The estimated time series are fully consistent with official figures of the Czech Statistical Office published from 1990 onwards.

A NON-SIGN-PRESERVING RAS VARIANT. LENZEN M., MORAN D.D., GESCHKE A. and KANEMOTO K.

We have developed a variant of the RAS generalised iterative scaling method that is able to change the sign between successive iterates, and thus fulfil constraints that are infeasible for existing RAS variants. Like earlier RAS variants, our method can handle constraints on arbitrarily sized and shaped subsets of matrix elements, include reliability of the initial estimate and the external constraints, and deal with negatives.

ON BRÓDY'S CONJECTURE: THEORY, FACTS AND FIGURES ABOUT INSTABILITY OF THE US ECONOMY. MARIOLIS T. and TSOULFIDIS L.

Bródy's conjecture regarding the instability of economies is submitted to an empirical test using input-output flow tables of varying size for the US economy, for the benchmark years 1997 and 2002, as well as for the period 1998?2011. The results obtained using input-output tables of various dimensions lend support to the view of increasing instability (in the sense of Bródy) of the US economy over the period considered. Furthermore, our analysis shows that only a few vertically integrated industries are enough to shape the behaviour of the entire economy in the case of a disturbance. These results may usefully be contrasted with those derived in a parallel literature on aggregate fluctuations from microeconomic-idiosyncratic-shocks.

MEASURING SPILLOVER EFFECTS OF SHOCKS TO THE ALASKA ECONOMY: AN INTER-REGIONAL SOCIAL ACCOUNTING MATRIX (IRSAM) MODEL APPROACH. SEUNG C.K.

An inter-regional social accounting matrix (IRSAM) model is used to estimate the spillover effects occurring between economies of two US regions ? (i) Alaska, which depends heavily on imports of commodities and factors of production from outside the region, and (ii) the rest of the US (RoUS). Multiplier decomposition is used to calculate intra-regional multipliers and spillover effects between the two regions. Results show that a significant percentage (46.3?70.8%) of the total secondary impacts of a shock to Alaskan industries leaks out of Alaska and flows to the RoUS. An analysis of household multipliers indicates that over 60% of the total secondary effects of an increase in Alaska household income accrues to the RoUS households. Policymakers are concerned with identifying the magnitude, nature, and geographic distribution of economic impacts from the policies they implement. The IRSAM model provides the framework for a better understanding of the intra-regional and spillover effects of policies.

Highlights in Books

SPATIAL STRUCTURE OF THE ISLAND ECONOMY OF INDONESIA: A NEW HYBRID PROCEDURE FOR GENERATION INTERREGIONAL INPUT-OUTPUT TABLES. EDI MUNCHDIE. LAMBERT ACADEMIC PUBLISHING, 2011.

The research reported in this monograph had two main objectives. The first objective was to assess the relevance, feasibility and practicality of modeling the spatial structure of a developing island economy using a hybrid procedure to generate inter-regional input-output tables. The second objective was to apply the procedure to study the spatial structure of the island economy of Indonesia. The model proved useful for analyzing the spatial structure of the island economy of Indonesia as well as the impact of policy simulations. It offers further contributions in the evaluation, development and validation of methods to construct single region and interegional IOTs in Indonesia as well in other island economies of developing countries and applications to analyze the spatial-sector structure of Indonesia.

Highlights in journals

ZHANG H. and LAHR M.L. (2014) CHINA'S ENERGY CONSUMPTION CHANGE FROM 1987 TO 2007: A MULTI-REGIONAL STRUCTURAL DECOMPOSITION ANALYSIS. *ENERGY POLICY* 67:682–693

Increasing use of energy has helped to stimulate China's economy. Despite central planning, China has great differences in economic development, energy endowment and energy consumption across its regions. This paper uses the structural decomposition approach to uncover the regional disparities in energy consumption from 1987 to 2007. We also examine six possible key factors for the change in energy consumption by region. We find that final demand change outpaced efficiency improvements to drive up energy use in all regions between 1987 and 2007. More surprisingly, from 2002 to 2007, it appears that changes in production structure enhanced energy consumption in most regions. China produced more energy-intensive goods for capital investment and export. We contend that improving the energy efficiency of key energy-intensive sectors would lead a significant decline in energy intensity. Energy, directly or indirectly, is flowing from Northwest, Central and North China to coastal regions. Regional-specific policies should be designed to promote production structure change and curb energy demand.

LENZEN, M., GESCHKE, A., WIEDMANN, T., LANE, J., ANDERSON, N., BAYNES, T., BOLAND, J., DANIELS, P., DEY, C., FRY, J., HADJIKAKOU, M., KENWAY, S., MALIK, A., MORAN, D., MURRAY, J., NETTLETON, S., PORUSCHI, L., REYNOLDS, C., ROWLEY, H., UGON, J., WEBB, D. and WEST, J. (2014) COMPILING AND USING INPUTOUTPUT FRAMEWORKS THROUGH COLLABORATIVE VIRTUAL LABORATORIES. *SCIENCE OF THE TOTAL ENVIRONMENT* 485-486:241-251.

Compiling, deploying and utilising large-scale databases that integrate environmental and economic data have traditionally been labour- and cost-intensive processes, hindered by the large amount of disparate and misaligned data that must be collected and harmonised. The Australian Industrial Ecology Virtual Laboratory (IELab) is a novel, collaborative approach to compiling large-scale environmentally extended multi-region input–output (MRIO) models.

The utility of the IELab product is greatly enhanced by avoiding the need to lock in an MRIO structure at the time the MRIO system is developed. The IELab advances the idea of the "mother–daughter" construction principle, whereby a regionally and sectorally very detailed "mother" table is set up, from which "daughter" tables are derived to suit specific research questions. By introducing a third tier – the "root classification" – IELab users are able to define their own mother-MRIO configuration, at no additional cost in terms of data handling. Customised mother-MRIOs can then be built, which maximise disaggregation in aspects that are useful to a family of research questions.

The second innovation in the IELab system is to provide a highly automated collaborative research platform in a cloud-computing environment, greatly expediting workflows and making these computational benefits accessible to all users.

Combining these two aspects realises many benefits. The collaborative nature of the IELab development project allows significant savings in resources. Timely deployment is possible by coupling automation procedures with the comprehensive input from multiple teams. User-defined MRIO tables, coupled with high performance computing, mean that MRIO analysis will be useful and accessible for a great many more research applications than would otherwise be possible. By ensuring that a common set of analytical tools such as for hybrid life-cycle assessment is adopted, the IELab will facilitate the harmonisation of fragmented, dispersed and misaligned raw data for the benefit of all interested parties.

WERLING J., KEEHAN S., NYHUS D., HEFFLER S., HORST R. and MEADE D. THE SUPPLY SIDE OF HEALTH CARE. *SURVEY OF CURRENT BUSINESS* 94(4):1-9

There is a common assertion that health care is over one-sixth (or about 18 percent) of the economy. This conclusion, however, is based only on a measure of health care demand. It is much more difficult to identify a corresponding ratio in the supply side data of the economy, that is, in terms of value added and employment.

Our work reconciles information about the supply and demand sides of the national health sector. We use input-output techniques to link the final demand values from the
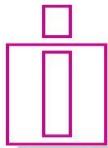
National Health Expenditure Accounts (NHEA) to domestic production and imports of commodities, industry value added, and industry employment. We translate NHEA levels by spending categories (hospitals, physicians, drugs, devices, insurance, construction, investment, research, etc.) into equivalent National Income and Product (NIPA) final demand concepts and then translate these products and services expenditures into final demand by commodity. We then use input-output accounting to determine, by sector, the total output, value added, and employment levels required to satisfy health care demand. The value added and employment levels are identified not only for medical service sectors but also for medical manufacturing industries and for supporting sectors such as distribution, support services, and government production. We find that in 2012, health care production required about 15.4 percent of total value added and 18.7 percent of civilian employment. In addition, domestic health care demand required about 1.5 percent of GDP in imports.

CARDENETE M.A., LIMA DIAZ M.C., SANCHO F. (2013) ARE THERE KEY SECTORS? AN APPRAISAL USING APPLIED GENERAL EQUILIBRIUM, THE REVIEW OF REGIONAL STUDIES 43(2/3):111-129.

An extension of the hypothetical extraction method to a general equilibrium setting is considered. This has the advantage of re-interpreting output changes as efficiency gains or losses, which may be of use in identifying "key" sectors in an interconnected economy.

The categorization may be relevant for the evaluation of intersectoral synergies and for improving policy planning and orienting economic strategy. We argue that the standard measures based on gross outputs may not capture all of the relevant impacts and this is so because of some self-imposed modeling and accounting limitations. An economy-wide Computable General Equilibrium (CGE) approach provides a modeling platform that overcomes these limitations since it offers (i) a more comprehensive measure of linkages and (ii) an alternative way of accounting for linkages' relevance that is in closer accordance with the standard statistical magnitudes used in national or regional accounts.

Latest ESR articles

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Latest articles (up to April 15th, 2014)

HOUSEHOLDS' BEHAVIOUR AND ENVIRONMENTAL EMISSIONS IN A REGIONAL ECONOMY. DUARTE R., REBAHI S., SÁNCHEZ-CHÓLIZ J. and SARASA C.

Households have significant demand-side potential to drive reductions in atmospheric emissions, including both direct and indirect emissions. Our analysis focuses on the behaviour of a regional economy (Aragon, Spain) and its impact on greenhouse gases (GHG) and sulphur dioxide (SO2). Using a CGE model, we simulate scenarios and evaluate the environmental impact of adopting changes considered

in the Aragonese Climate Change and Clean Energy Strategy. Specifically, we analyse the impact of electricity savings and the promotion of public transport (bus or train) versus private car use. The results indicate that 1 MWh of saving in electricity consumption by households could reduce emissions of GHG by 0.112 kt of equivalent CO2 and 8.209 kg of SO2 with a shift in demand preferences and 0.022 kt of equivalent CO2 and 7.612 kg of SO2 with an efficiency improvement. Moreover, household changes in demand preferences regarding private/public transport, also contribute to reduce emissions.

A NEW SUT CONSOLIDATION METHOD TESTED BY A DECOMPOSITION OF VALUE ADDED AND CO2 EMBODIED IN EU27 EXPORTS. BOUWMEESTER, M.C., OOSTERHAVEN J. and RUEDA-CANTUCHE J.M.

This paper develops a method to consolidate national supply-use tables (SUTs) into a single supra-regional SUT. The method deals with mirror trade statistics problems, such as the different valuation of imports and exports, and it corrects for double-counting re-exports. The method is tested by means of a decomposition of value added and CO_2 emissions embodied in EU27 exports to third countries. When the national SUTs for the period 2000?2007 are used, neglecting intra-European Union spillover and feedback effects results in an underestimation of the embodied value added of 12?15%. Not consolidating the national tables properly leads to a further underestimation of 11?16%. With these underestimations removed, EU27 foreign exports still only explain around 11% of EU27 Gross Domestic Product, whereas they explain
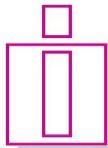
17% of the EU27 CO_2 emissions. Hence, the income benefits of these exports are, in relative terms, considerably smaller than their CO_2 emission cost.

DEVELOPMENT OF REGIONAL SOCIAL ACCOUNTING MATRICES WITH DETAILED AGRICULTURAL LAND RENT DATA AND IMPROVED VALUE-ADDED COMPONENTS FOR THE USA. MONGE J.J., BRYANT H.L. and ANDERSON D.P.

We describe a method for creating social accounting matrices (SAMs) with detailed agricultural land rent data for any arbitrary subset of the 48 contiguous states in the USA. Data on land use and land rents from various public sources is merged with national accounts data. The method reorganizes the rental income of persons concept present in national accounts to payments to conventional primary factors of production. This method also reallocates portions of the indirect business tax account to the appropriate sales and import tax accounts. SAMs created using this method should be useful inputs into input-output or computable general equilibrium models explicitly representing a heterogeneous land market and analyzing the economic effects of agricultural, bioenergy, water and climate policies on land-use change, land rents, agricultural commodity markets, trade and households? welfare. The method's implementation is freely available, enabling others to rapidly create SAMs with their own desired region and sector aggregations.

Forthcomming in journals

SU B. and ANG B.W. ATTRIBUTION OF CHANGES IN THE GENERALIZED FISHER INDEX WITH APPLICATION TO EMBODIED EMISSION STUDIES. *ENERGY*.

The Fisher index and its extensions have been used in multiplicative decomposition analysis applied to energy and emissions. In this study, we extend the concept of "additive decomposition of the Fisher index" in the national accounts and propose an attribution analysis of the generalized Fisher index in the context of structural decomposition analysis (SDA). The proposed attribution analysis allows changes of an aggregate index derived through the application of the generalized Fisher index decomposition in SDA to be attributed to give the contributions of the individual components at a finer level. Using the proposed approach, we attribute changes in the carbon emissions embodied in China's exports and show that valuable information at the industry sector level
is revealed.

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LENZEN M., and REYNOLDS C.J. A SUPPLY-USE APPROACH TO WASTE INPUT-OUTPUT ANALYSIS. *JOURNAL OF INDUSTRIAL ECOLOGY*

In this article, we extend Namakura and Kondo's waste input-output (WIO) framework by incorporating a supply-use formalism, resulting in waste supply-use tables (WSUTs). We present the theoretical underpinnings of the WSUT and, in particular, the transition from Nakamura and Kondo's WIO form to the new WSUT form. Further, we offer a mathematical proof of the equivalence of WIO and WSUT multipliers. We illustrate the workings of the WSUT calculus using economic and waste data for the Australian economy in 2008–2009.

AMORES A.F. and TEN RAA T. FIRM EFFICIENCY, INDUSTRY PERFORMANCE AND THE ECONOMY: THREE-WAY DECOMPOSITION WITH AN APPLICATION TO ANDALUSIA. *JOURNAL OF PRODUCTIVITY ANALYSIS*

An economy may perform better because the firms become more efficient, the industries are better organized, or the allocation between industries is improved. In this paper we extend the literature on the measurement of industry efficiency (a decomposition in firm contributions and an organizational effect) to a third level, namely that of the economy. The huge task of interrelating the performance of an economy to industrial firm data is accomplished for Andalusia.

Fellows corner

Ronald Miller

How was that you started working on IOA? Are there people or events that have been influential in your career?

For me, it all began in 1953 in the spring term of my sophomore year at Harvard. I started with the intention of majoring in mathematics, and in my freshman year I did well enough in the introductory math course. The next year I elected to take an introductory economics class, in which I did very well, and also the standard second-year mathematics course, in which I did not do well. In the economics course I was assigned to a "section" taught by Robert Kuenne (these were small classes that met twice weekly after huge once-a-week lectures by a series of well-known professors). Bob was a graduate student finishing his Ph.D. dissertation ("The Use of Input-Output Techniques for the Estimation of Employment in the Delaware Valley") supervised by Walter Isard, who, in turn, was working with Wassily Leontief at the Harvard Economic

Research Project. The task that Leontief assigned to Isard was to explore interregional extensions of the input-output model. Those economics classes with Bob Kuenne turned out to be pivotal for me, because he included an introduction to the input-output model in his lectures. (Perhaps not so surprising, since he had taken graduate courses from both Isard and Leontief. He later told me that it was the first time input-output had been covered in an undergraduate economics course—anywhere.) That brief exposure to input-output piqued my interest, and in short order I switched my major from mathematics to economics. In my senior year I wrote an honors thesis, under Bob's continuing encouragement and guidance, on aluminum in the Pacific Northwest ("The Impact of the Aluminum Industry on the Pacific Northwest: A Regional Input-Output Analysis"). The topic was Bob's suggestion, and later it became my first publication—a 1957 *Review of Economics and Statistics* paper with the same title.

So in short order I had learned about input-output, become an economics major, done an empirical regional input-output study, and published it (and all without knowing a line of matrix algebra). I had fallen under the spell of a trio of input-output masters. My first (and only) academic affiliation began in 1962 with the Regional Science Department at the University of Pennsylvania, founded and chaired by that same Walter Isard; it was probably the center of input-output activity at that time. I was immediately assigned the Department's graduate course on linear models, with input-output as a major topic in the course, and the textbook with Peter Blair, some years later, was a direct outcome of that teaching experience. (I first met Pete in the 1970's when he was a graduate student in another program at Penn and audited the I-O segment of my course.)

You have impeccable credentials (degrees, professorships, fellowships, etc.), but having degrees doesn't automatically prepare one to do great research work like you have done. How did you pick up your impressive reasoning skills? What sets you apart from other researchers? What's your secret?

Thank you, but I really have no idea.

What are from your point of view the hot topics that IOA could address and has not done yet (or too slightly)? What other disciplines could enhance IOA the most?

I think this was well explored in the lead article in the December 2013 issue of *ESR*.

What do you think the most important recent developments in the field have been? What do you think will be the most exciting and productive areas of research in IOA during the next few years?

One interesting development is the creation of massive multinational data sets [like those cited in the March 2013 ESR special issue on "Global Multiregional Input-Output Frameworks" or in the Murray and Lenzen (eds.) 2013 book]. These have expanded tremendously the possibilities for huge multi-sector, multi-country, multi-period analyses —presenting opportunities and also problems (see below).

Positive and negative elements of IOA?

Studies based on huge data sets generate vast amounts of output. I believe it is already a challenge to researchers to come up with meaningful and comprehensible ways to present their multidimensional results (e.g., "heat maps" using color shading to differentiate
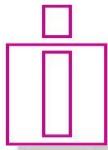
magnitudes); that is, to comprehend the forests and not just see the trees.

I also think it is necessary to pay attention to the quality of the massive amounts of data that underpin these big data sets. Accuracy of the data has always been a kind of elephant in the room for input-output researchers. Oskar Morgenstern voiced concerns over 60 years ago about the trustworthiness of results of complex calculations made on inherently questionable data (especially in his 1950 book *On the Accuracy of Economic Observations*).

Modern computing has only added to that complexity. It is clear that there will be enormous variability in the reliability of the entries in big data sets (e.g., data collected by different agencies in different countries at differing levels of sector detail). One illustration of ways to addresses these reliability issues is found in the University of Sydney's publications on their Eora model.

What is your pet peeve with IOA-related published papers?
I am not fond of papers in which researchers present too many tables with too many results (e.g., multipliers) with too many places to the right of the decimal point and too little helpful interpretation.

Do you have other tips for doing great applied research work?
Go to conferences; interact with others. I guess that's what's called "networking" these days.

The best books on IOA that you would recommend to any IOA practitioner?
No comment.

Your best work is...?
The early paper (1966) on interregional feedbacks has attracted a good deal of attention, as have both editions of the textbook with Pete Blair.

You obviously have a very successful research career. How do you feel now about the pressure to publish? Has your view changed over the years?
I have been retired too long to comment about current or even recent practice. When I came up through the academic ranks at the University of Pennsylvania I felt some but not intense publication pressure, but I suspect that there were a lot of special (comfortable) circumstances at that time (1960s-1970s) and in that place (Penn's Regional Science Department under Walter Isard). Clearly, things have changed, and generally not for the better, in my view.

Geoffrey Hewings

How was that you started working on IOA? Are there people or events that have been influential in your career?
Charles Tiebout introduced me to input-output analysis during my early days in the PhD program at the University of Washington. I attended an early UN sponsored I-O meeting in Geneva in 1971 where I met several folks who worked on regional input-output modeling, including

William Miernyk and John Cumberland (who was one of the first scholars to link I-O and environmental accounts). By this time, Tiebout had died and Miernyk and Cumberland were kind enough to introduce me to the intellectual leaders in the field including Stone and Leontief. Miyazawa's work and his development of the interrelational income multiplier and the social accounting developments pioneered by Stone, Pyatt, Round, and others generated a continuing interest in extended I-O systems.

You have impeccable credentials (degrees, professorships, fellowships, etc.), but having degrees doesn't automatically prepare one to do great research work like you have done. How did you pick up your impressive reasoning skills? What sets you apart from other researchers? What's your secret?
I have always been interested in how economies work and the challenges of trying to understand the complexities of interdependence brought me to IOA.

What are from your point of view the hot topics that IOA could address and has not done yet (or too slightly)? What other disciplines could enhance IOA the most?
We do very well in understanding how industrial interdependence works but less well in understanding the space-time representation of multipliers. Some early ideas about interregional feedbacks (pioneered by IIOA Fellow Ron Miller) have only rarely been explored at different spatial scales and over different time periods. We have developed a continuous-time version of our econometric

input-output model but a continuous-time analog remains to be developed. Further, our fixation on disaggregation in the industry part of I-O related systems has not been complemented by similar attention to the heterogeneity that is compressed into the representative household in most IO and CGE systems. Further, the interaction between the IO model and the labor market remains relatively underdeveloped. In essence, the demographic-economic interface has seen far less innovation than the environmental-economic interface. In addition, changes in the ownership and organization of production systems remains a further challenge for IOA as transfer pricing and the locus of expenditures becomes ever more intractable.

What do you think the most important recent developments in the field have been? What do you think will be the most exciting and productive areas of research in IOA during the next few years?

There appears to be some increasing recognition of the role of econometric estimation – both in CGE modeling (e.g., the recent book edited by Dixon and Jorgenson) and in econometric-input-output models (e.g., the FIDELIO system). Over the next decade, it is likely that these two modeling systems may become more similar as the attractive and most flexible parts of each are crafted into as "third stream" of modeling.

Positive and negative elements of IOA?

IOA analysis provides an economic photographic of an economy; it illuminates the nature and strength of interdependencies and provides the basis for more extensive modeling systems. Sadly, too many scholars only learn the

limitations of IOA (fixed coefficients, no economies of scale, limited substitution) but the WIOD project has re-energized the interest in IOA as a way, inter alia, to understand the nature of trade, global production chains and the role IOA can play in understanding the impacts of climate change.

What is your pet peeve with IOA-related published papers?

CGE modelers who fail to acknowledge the critical role the I-O system plays in their models and national level modelers who do not appreciate the complexities introduced in modeling subnational economies.

Do you have other tips for doing great applied research work?

Choose interesting problems that are likely to generate debate – e.g., how should we measure carbon footprints, should impact analysis always consider net effects, how do we identify the analytically most important elements in an I-O system, is increased trade always welfare enhancing and how should we measure the impacts of drug legalization?

The best books on IOA that you would recommend to any IOA practitioner?

The Miller and Blair book (second edition) is an excellent source but I would also encourage reading of earlier books by Leontief, Stone, and Miernyk (fora regional perspective) and, to provide some historical context, sampling the work of Quesnay, Cantillon, Walras, and others to appreciate why Leontief and Stone each received a Nobel prize for translating many of these ideas into a tractable form that still undergirds our modern modeling systems.

Your best work is…?

Still to be written….

You obviously have a very successful research career. How do you feel now about the pressure to publish? Has your view changed over the years?

The pressure has had positive effects in the continuous stream of excellent articles but the demand for journal space has resulted in a huge expansion of the number of journals such that IOA articles are now widely scattered over so many journals that it is difficult to stay abreast of recent developments.

Events

INTERNATIONAL CONFERENCE ON NEW THINKING IN ECONOMIC THEORY AND POLICY. September 13th-15th, 2014, Tokio (JP)

Guest Speaker: Prof. H.D. Kurz (University of Graz)

Submit abstracts to confyagi@kisc.meiji.ac.jp by July 31st. Full papers deadline: August 31s.

Contact: Prof. Takashi Yagi (Meiji University)

Organized by: Co-sponsored by:

ECONOMIC GROWTH, SECTORAL COMPOSITION, TRADE AND ENVIRONMENT July 7th-11th, 2014, Barcelona (Spain)

The Sectoral composition of modern economies is in constant evolution. This structural transformation, defined as the reallocation across agriculture, manufacturing and services, is considered as one of the main features of modern economic growth. In recent years, however, this process not only has significantly accelerated but also has crossed the borders of countries. Today, products and services are made in global supply chains and production processes are split into more and smaller pieces. This on-going international fragmentation has consequences on trade but also on the environment.

COURSE I. Structural Transformation and Economic Growth (Marc Teignier)

COURSE II. Trade, Environment and Growth (Erik Dietzenbacher)

Applications are being accepted until June 27th.

33rd General Conference of the International Association to Research in Income and Wealth August 24th-30th, 2014, Rotterdam (Netherlands)

Statistics Netherlands is proud to host this conference together with IARIW. The IARIW conference is a bi-annual meeting of academics and statisticians, focusing on topics closely related to national accounts and income and wealth distribution. The conference targets participants from universities and statistics offices from across the globe, offering an almost unique opportunity for discussion and exchange of ideas between academics and statisticians. Register now!

Remember: Submit NOW to 22nd IIOC!
Deadline for full papers submission through COPASS for the next IIOA conference is May 9th!

4th SHAIO Workshop September 25th-26th, 2014, Albacete (Spain)

The aim of the workshop is provide a forum to discuss last advances in the field of the Input-Output Analysis. For more information contact with Luis Antonio López or Jorge Enrique Zafrilla. See more information at SHAIO. Important dates are: June 30th for registration and July 31st for full papers submissions. Registration is free for SHAIO members and a €30 fee applies (includes a year of SHAIO membership) to all other researchers. All specialists interested in topics related to input-output analysis are encouraged to attend.