India Studies in Business and Economics

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GHG Emissions and Economic Growth

A Computable General Equilibrium Model Based Analysis for India

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Preface

We decided to get this book published to help the larger audience make sense of the discussion on climate change and its implications for economic growth in India. Issues linking climate change and economic growth are now at the centre of discussions regarding climate friendly development strategies which are increasingly becoming a necessity rather than an option for late-industrialising countries like India. This book contributes to this discussion by systematically analysing the relationships between economic growth and GHG emissions in India with explicit reference to all major economic sectors. Although the science of the impact of climate change on earth and its inhabitants is moving rapidly in the direction of certainty and precision, lack of clarity on how emerging economies can manage their developmental imperatives in the face of pressing carbon constraints with judicious policy interventions persists. Whether a global carbon price will help incentivising developmental actors to choose low-carbon growth strategies is still an open and debatable issue. Many suggest carbon tax at the border or nationally implemented under sovereign national fiscal regimes. Suggestions for benchmarking-monitoring-reporting-verification of all activities by best practices are also on the table. So, it is quite a complex issue for anybody to try to resolve without detailed knowledge and information on pros and cons of each of the alternative interventions and institutional arrangements suggested. Moreover, the impact of climate change is all pervading. It is not confined to one single activity or sector but extends to each and every economic activity and sector and to people of all socioeconomic groups.

Our joint effort in this area began in 2006 when India's Ministry of Environment and Forest, gave a small research grant to National Council of Applied Economic Research (NCAER) and Jadavpur University (with the former and latter being then the institutions of affiliation for the first three authors and the fourth author respectively), to provide them with knowledge and analytical support on India's GHG emissions profile. The necessity and inevitability of pooling multiple expertises to get this empirical investigation accomplished brought all of us together with the lead author of the book also availing the opportunity to find an interesting and relevant research topic for his Ph.D. work which he eventually completed by virtue of hard labour and patience to our great pleasure.

This book estimates latest Social Accounting Matrix (SAM) for India. It provides a very important database describing the complete circular flow of income and input-output transactions among the sectors of the economy. Striking novelty of the book lies in the fact that for the first time to the best of our knowledge, a SAM for Indian economy has been prepared with environmental indicators and detailed methodology is also presented in the book. The environmental social accounting matrix (ESAM) based analysis has been included in the book to show direct and indirect linkage between economic growth and GHG emissions.

The work we present here goes beyond SAM and applies computable general equilibrium (CGE) modelling to conduct climate change policy analysis and simulations. The analysis is an important contribution in the current debate around carbon tax and its possible impacts on macroeconomic growth. Knowledge sharing by Dr. Pradipto Ghosh on CGE modelling as applied to climate change issues needs special mention.

During the course of this detailed work we received help from a number of excellent people in various forms. Administrative support from Prof. Binay Kumar Pattanayak, Director ISEC, Director General of NCAER, Dr. Shashanka Bhide, senior research councilor, NCAER, Dr. Anushree Sinha, Senior Fellow, NCAER, Mr. N. J. Sebastian, Former Secretary and Librarian, NCAER; and Dr. Nandita Bhattacharyya of Faculty of Arts, Staff members of Department of Economics-Jadavpur University, made the progress of the work smooth. Comments and academic advice received from Prof. Pradeep Biswas, CSIR-NISTADS, Prof. Rajashree Majumder, University of Burdwan, Prof. M. R. Naryana, ISEC, Prof. K. V. Raju, ISEC, Prof Meenakshi Rajeev, ISEC, and Mrs. B. P. Vani, ISEC needs special acknowledgement. Study material collected by NCAER library staff, from Dr. Maniparna Shyam Roy, and Dr. Duke Ghose of Global Change Programme of Jadavpur University were immensely useful. Lastly, we thank for never ending family support for each one of us.

What has driven us and kept us together until we finished this book is the genuine wish to advance the knowledge on the subject and deep concern for saving our planet and ourselves from extinction if global warming remains unchecked.

Last but not least, the results expressed in this book are those of the authors and are not attributable to the institute/organization to which they belong.

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Dr. Barun Deb Pal is currently an Assistant Professor at the Institute of Social and Economic Change, Bangalore. He has been working in the field of SAM based CGE modelling for the last 7 years. He has also worked on climate-smart agriculture and land-use planning models for South Asia as a key researcher at the International Food Policy Research Institute (IFPRI). He has a long professional affiliation with the National Council of Applied Economic Research (NCAER), working on climate change CGE modelling. He has published papers in journals of international repute with one of his publication being "A Social Accounting Matrix for India", published in 2012 in Economic Systems Research (Taylor and Francis). His current areas of research interest include various developmental issues and their linkages with climate change, low carbon agriculture, Infrastructure, and public utility pricing.

Dr. Vijay P. Ojha is a Professor of Economics at the Institute of Management Technology, Ghaziabad, India. A Computable General Equilibrium modeler (CGE) by training, he employed the CGE modelling technique to analyze the trade-offs among carbon emissions, economic growth and poverty reduction in India while tenuring as a post-doctoral Commonwealth Fellow at the Environment Department, University of York, United Kingdom in 2004. Ever since, he has been working on applications of CGE modelling in climate change and other areas like trade, human capital and inclusive growth. He has authored many published reports and academic journal papers His most recent publications are in the Journal of Policy Modeling (Elsevier) and Environment and Development Economics (Cambridge University Press).

Dr. Sanjib Pohit Professor AcSIR and Senior Principal Scientist, is presently working at CSIR- National Institute of Science, Technology & Development Studies (CSIR-NISTADS). He was educated at the Indian Statistical Institute. Previously, he held research positions (Senior Fellow/Chief Economist) at the National Council for Applied Economic Research, New Delhi and the Indian Statistical Institute and was also a visiting scholar at the University of Michigan (Ann Arbor, USA) and the Conference Board of Canada. He is an experienced modeler in the area of trade and environment with 20 years of modelling experience. He has he worked in the area of institutional economics, transport economics, input-output models, FDI, informal

trade, the automobile industry, and South Asian integration. He has co-authored 7 books, and has published more than 100 articles in journals/books. He has presented his research at seminars and conferences in different parts of the world—Japan, Canada, USA, India, Bangladesh, Switzerland, the Netherlands, Singapore, and Finland.

Dr. Joyashree Roy, an ICSSR National Fellow, is currently a Professor of Economics at Jadavpur University, Kolkata, India. Additionally, she coordinates the Global Change Programme and also directs the Ryoichi Sasakawa Young Leaders Fellowship Fund Project at Jadavpur University. In 2007 she was on the Nobel Peace Prize winning panel –IPCC (Intergovernmental panel on climate change). She has been involved in preparation of Stern Review Report, Global Energy Assessment and many other national and global reports. She has published more than 70 peer-reviewed articles in journals of national and international repute. Her research interests are in resource and environmental economics, particularly in the field of energy demand modelling, economic assessment of application of non-renewable and renewable resources for urban and rural problems, economic and social dimensions of climate change, water resource management and multidisciplinary research on sustainable development, sustainability transition, ecosystem services in the context of coastal ecosystem.

Abbreviations

AEEI	Autonomous energy efficiency improvement
AGRIM	Agriculture, growth and redistribution of income model
ANFI	Aggregate non-factor input
ASI	Annual Survey of Industries
CAB	Current account balance
CDM	Clean development management
CE	Compensation to employees
CES	Constant elasticity of substitution
CET	Constant elasticity of transformation
CGE	Computable general equilibrium
COP	Conference of the parties
CO_2EQ	Carbon equivalent
ESAM	Environmental social accounting matrix
FDI	Foreign direct investment
GAMS	General algebraic modelling systems
GCMs	General circulation models
GDP	Gross domestic product
GEF	Global Environment Facility
GVA	Gross value added
HYV	High-yielding variety
IO	Input output
KgOE	Kg of oil equivalent
LES	Linear expenditure system
LFPR	Labour force participation rate
MBI	Market-based instruments
MoEF	Ministry of Environment and Forests
NAMEA	National Accounting Matrix for Environmental Accounting
NAS	National accounts statistics
NATCOM	National communication
NCAER	National Council of Applied Economic Research
NHPCL	National Hydro Power Corporation Limited
NPCIL	Nuclear Power Corporation of India Limited

NSSO	National Sample Survey Organization
NVA	Net value added
OS	Operating surplus
PCE	Per capita emission
PFCE	Private final consumption expenditure
PPP	Purchasing power parity
PPM	Parts per million
PPB	Parts per billion
SAM	Social accounting matrix
SDA	Structural decomposition analysis
SGM	Second generation model
TERI	The Energy and Resource Institute
TFPG	Total factor productivity growth
TL	Translog
UNFCCC	United Nations Framework Convention on Climate Change
US$	US dollar

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