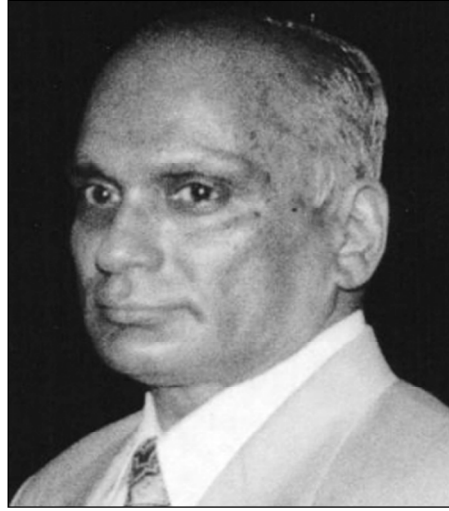


IUPJAE INTERVIEW

AN INTERVIEW WITH PROFESSOR U SANKAR

Interviewed by GRK Murty, IUP Publications



Right from the school days, Ulaganathan Sankaranarayanan, a giant of environmental economics, cultivated resilience to capitalize on the available opportunities. He went to a school located five km away from home by a bullock cart and instead of clamoring for what is not available, he mastered whatever is offered by the local institutions. He obtained MA in Economics from Annamalai University in 1957. After working for a brief period at Annamalai University as a lecturer and as a research associate at the Gandhian Institute of studies at Varanasi, he went to the University of Wisconsin, Madison, USA in 1963 for doing his PhD.

This descriptive economist, who had no formal education in mathematics/econometrics, once joined Arnold Zellner, a noted statistician and economist at the University of Wisconsin, so metamorphosed himself into such an econometrician that he could analyze production functions in the Indian manufacturing sector and their implications for economic development using Bayesian methods for PhD thesis and also presented a paper, “On Errors in the Variables” at the Econometric Conference at Berkeley in 1966 jointly with Zellner. After obtaining PhD in 1967, he joined the University of

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Wisconsin, Milwaukee as Assistant Professor, and within nine years, became a tenured Professor in 1976, besides becoming Chairman of its Graduate Studies Committee.

In 1977, he returned to India to join Madras University as a Professor in Economics Department. In the year 1978, he established the Department of Econometrics. He himself taught a wide array of subjects. He was known as a great teacher “not only imparting wisdom and knowledge to students but also kindling enthusiasm in them for the subject”. In the words of Dr G Mythili, his former student and presently Professor at IGIDR, Mumbai, Prof. Sankar’s “dedication for teaching is unparalleled”. He guided 14 scholars for PhD. According to Professor Mythili, “His style of mentoring [research scholars] was very unique. It went beyond simply passing on intellectual ideas. He would show the direction and give space for students to think independently which builds tremendous confidence in them to take on challenges at the next level”. She indeed feels very proud to have been taught and guided by Prof. Sankar. This professor of “noble principles”, simultaneously worked on two important projects funded by the Government of India and UGC: one on groundnut production, productivity and farm level decision making under uncertainty, and the second one about pricing policies in multiproduct public sector enterprises. Dr. Sankar’s critical studies in the field of pricing of public utilities and services were well received both nationally and internationally and made him an authority in the field. He thus nurtured the econometrics department of Madras University into a formidable breeding ground of econometricians who proved themselves later both nationally and internationally.

Unlike many other professionals, who, nearing retirement age, tend to ease up on their research pursuits, Dr. Sankar, teaming up with Dr. Raja Chelliah, established the Madras School of Economics (MSE) in 1995. It is from here that he actively pioneered the promotion of Environmental Economics as a discipline in India. In 1997, he was appointed as the National Program Coordinator for the Environmental Economics of the World Bank’s Environmental Capacity Building Program in India. He trained many economists and administrators in environmental economics besides developing curriculum for teaching environmental economics. His contributions to environmental economics that range from designing economic instruments for addressing pollution problems in specific industries, analyzing trade and environment linkages, identifying appropriate eco-taxes on polluting inputs and outputs, to prioritizing low-carbon strategies for fostering green economic growth in India, and leadership played a key role in the establishment of a Center of Excellence in Environmental Economics at MSE by the Ministry of Environment and Forests.

Later he undertook techno-economic analysis of Indian space program, which was hailed by fellow economists as “truly one of its kind”. His contribution towards operationalization of sustainable development in India is quite significant. As a member of various professional bodies, editorial boards, academic councils, policy bodies, etc., his contributions are immense. He served Indian Econometric Society for many years as its member, vice-president and president. UGC honored him with Swami Pranavananda Saraswati National Award in Economics for 2006.

As Arnold Zellner observed in his essay, “In Honour of Prof. Ulaganathan Sankar”, it is by “his strong determination, strength of character, fine intellect, willingness to work very hard, and excellent judgement in choice of research topics” that Dr. Sankar could keep on transiting from one field to another in his long career of five decades with ease leaving behind a vast number of publications, including seminal textbooks in the respective fields.

His untiring quest for learning and unflagging commitment to analyze economic problems that matter for India’s development and the breadth and depth of his accomplishments is what you would enjoy reading in the following pages.

GRK: At the very outset, I wish to thank you very much, Professor Sankar, for accepting our request for an interview and granting your time. To begin the interview, you may please tell us about your childhood and early education.

US: My native place is Sivasailam in Ambasamudram taluk, Tirunelveli district, Tamil Nadu. It was a small village with poor transport facility and no middle school. But it has a famous Siva temple. My father, S N Ulaganatha Pillai, was a small farmer with only school education. My mother’s name was U Gomathy. Their first son was born in 1930. To find a good school and also suitable employment they shifted to Ilanji, about 25 km from Sivasailam. I was born on May 11, 1936. My family is large with three boys and four girls. My parents worked hard to bring up the children but gave importance to boys’ education.

I joined the primary school in Ilanji in 1940 and completed 1st to 3rd standards. I studied 4th to 8th standard at Ramaswamy Pillai Middle School, Ilanji. I had good schooling there. Then, I went to Board High School, Tenkasi, 5 km from Ilanji. I used to travel to the school in a bullock cart with my friend I S Chellappa. As a government school, it had poor facilities. It did not even offer optional mathematics (algebra and analytic geometry). Only 30% of the students who appeared for the Secondary School Leaving Certificate examination from the school passed the examination in 1951.

- G:** In your Intermediate course, you took history as the main subject, but in BA you opted for Economics as the main subject. What was the idea behind this switchover?
- S:** I joined St. Xavier's College at Palayamkottai, 55 km away from Ilanji. My classmates in Tenkasi School, I S Sivaraman, P K Sankaranarayanan and V Subramanian also joined the same college. It is a Jesuit college with good hostel. It is a highly disciplined college. At that time the hostel gates were closed at 6 p.m. I could take only Ancient history, Modern history and Logic (III group), because I did not have the necessary background in mathematics and I was weak in science. I liked logic. At St. Xavier's college there were only two choices at BA level – mathematics or economics and history. Therefore, I had no choice except taking economics and history. I had good teachers there. I came first in BA Economics in that college and was awarded Silver Jubilee Medal, as best student in economics in BA.
- G:** As a natural progression, you have joined MA Economics in Annamalai University. But did you have any specific reason to choose Annamalai University? By the way, did you select statistics as the optional subject in your MA course? Any fond memories of the campus that you would like to share with us?
- S:** I chose Annamalai University for MA Economics, because my brother U Nallaperumal was a lecturer in chemical engineering there. Hence, I stayed with my brother's family in Chidambaram. I used to go to Nataraja temple frequently. I used to walk 2.5 km from my brother's house to the economics department. My brother advised me to choose statistics as an optional subject. The department had good teachers like A Ramaswami, M K Munisamy, V Anantaraman, and M C Madhavan in economics, and P K S Raja in politics and Srinivasaraghavan in statistics. The university library was quite good. I did well in courses, getting first or second rank in class. In 1955, I attended All-India Writers Conference at Annamalai University in which Jawaharlal Nehru, S Radhakrishnan and C P Ramaswamy Iyer participated. I got second rank in the university. I missed first class.
- G:** Would you please tell us about your research and teaching experiences in Annamalai University?
- S:** I joined first as Economic Investigator in a Survey of Farm and Non-Farm Employment in south Arcot district and later as Economic Investigator in Cost-Benefit Analysis of Cauvery Mettur Irrigation Project, funded by Planning Commission. I was selected as Lecturer cum Research Assistant. I had to assist Professor Sonachalam in his research work and taught basic economic course. The Indian Economic Conference was held in December 1959. I learnt applied economic research from Professor K S Sonachalam.
- G:** Interestingly, leaving your lecturer post in Annamalai University, you have joined Gandhian Institute of Studies, Varanasi as a Research Associate. What made you to shift from Tamil Nadu to a far-flung Varanasi that too as a Research Associate? Also, share with us the nature of your job at Varanasi.

S: My appointment at Annamalai University was only until March 31, 1961. I did not get extension. Hence, I applied for various posts. Gandhian Institute of Studies ensured my salary. Jayaprakash Narayan was our Chairman. In the beginning I had language problem because I did not know Hindi. But my colleagues talked to me in English. Even Jayaprakash Narayan, noting my presence, addressed in English. As the Institute was located in Sarvaseva Sangh, Kashi, everyone had to observe simple rules. For example, we had to clean the vessels after eating.

The Institute provided good atmosphere for learning Gandhian values. Jayaprakash Narayan was concerned that if India followed Nehru-Mahalanobis model of development, poverty would not be abolished even 50 years after independence. He preferred intermediate technology. He invited British scholar, E F Schumaker, author of the book, *Small is Beautiful*, to head the institute, but he could not come. Jayaprakash Narayan used to organize seminars on alternatives to development, inviting people like C Subramaniam, M L Dantwala, Raj Krishna, Amlan Datta and Gandhians. I used to attend lectures of J Krishnamurthy in nearby Besant College. One thing I admired about the great philosopher was that when someone asked him a question he would make the person think and elicit the answer from him.

I was working on Intensive Area Scheme of Rural Development in Pusa Road in North Bihar along with Tallat Mohamed Kamal (Sociology) and Vijayaranjan Dutta (Political Science). We stayed in Khadi Gramodyog Bhavan at Pusa Road, leading a simple life. Mr Chaube, a Hindi-speaking person, helped me in my interviews. Based on this research work I published a paper on, "Levels of Living in Rural Areas" in *Indian Journal of Agricultural Economics*, Conference Volume 1962. I used to go to Kasi Viswanath temple with Dr. Gopalkrishna, a historian, every week.

G: In 1963, you left for Wisconsin University on a fellowship for pursuing PhD under Dr. Arnold Zellner. With the kind of mathematical background you have had from Annamalai University, how confident were you to work under the well-known Bayesian econometrician? How did you manage this transition?

S: It was a big challenge and a great opportunity. Zellner understood my weak background in mathematics and statistics and encouraged me to take courses: Statistics for Economists, Calculus and Linear algebra along with Microeconomics and Macroeconomics in the first year and Mathematical Statistics, Econometrics and Advanced Economic Theory courses in the second year. V K Chetty, who was a lecturer in Statistics, Annamalai University, joined the University of Wisconsin earlier. He helped me in Statistics. With hard work, I got 'A' grades in most courses. By the third year I developed the capacity to carry out econometric analysis. I am grateful to Zellner for his guidance and encouragement. Also working with him enabled me to understand issues in applied econometric research.

G: You have worked on the problem, "Production Functions in Indian Manufacturing Industries: Implications for Economic Development", and submitted your thesis in

1967 for the award of PhD. How did you select the problem, I mean the thought process behind its selection? Please share with us the final recommendations of your thesis.

- S:** When I was a PhD student, the Constant Elasticity of Substitution (CES) Production Function developed by Arrow, Chenery, Minhas and Solow excited many young scholars, because (a) it was a generalization of Cobb Douglas production function, with elasticity of substitution varying from zero to infinity; and (b) its nonlinearity posed challenges in estimation. Most of the estimates at that time were based on the marginal conditions for profit maximization. Bayesian approach provided an opportunity for direct estimation of CES production function. H Thornber, University of Chicago, developed a computer program for direct Bayesian estimation of the production function. Since I was with Zellner at University of Chicago, as a visiting traveling scholar under Ford Foundation Fellow, and familiar with Census of Manufactures and Annual Survey of Industries data, I used the data relating to Indian manufacturing industries and Thornber's computer program for my PhD thesis. Unlike in conventional econometric analysis, I could get the posterior distributions of critical parameters such as the elasticity of substitution between capital and labor. My main findings in PhD thesis were two: (1) Economies of scale were important in many Indian manufacturing industries. Hence, to achieve lower unit cost of production firm size is important; (2) In many Indian manufacturing industries, the elasticity of substitution was significantly above zero. This has implications for labor policy. I published a paper based on my thesis in *International Economic Review* in 1969. I also published a paper on Bayesian Estimation of CES Production Function with V K Chetty in *The Review of Economic Studies* in 1970.
- G:** You have also presented a paper, "On Errors in the Variables" with your Prof. Zellner at the Econometric Conference at Berkeley in 1966. Was it out of an extension of your PhD work?
- S:** No. Zellner assigned me the analysis of Survey of Consumer Finances panel data during the first two years. We found serious discrepancies between macro estimates of savings from the surveys and macro estimates of savings from the Securities and Exchange Commission (SEC). The survey estimates were around 50% of the SEC estimates. I read Oskar Morgenstern's book, *On the Accuracy of Economic Observations* and articles on sampling and non-sampling errors. There were articles in the *Journal of American Statistical Association* about the sources of errors in savings data. The errors include non-reporting of accounts, underreporting of amounts as well as response errors. In the context of estimating economic relationships, if the errors in the regressors in linear regressions are additive, the estimates of slope coefficients would be unaffected; if the errors are proportional in the logarithmic regression, the slope coefficients would be unaffected. If the errors are random, then the estimated coefficients will be biased and it becomes an 'errors in the variables problem'. At that time people used maximum likelihood estimators. We were motivated to analyze the problem under weaker assumptions using Bayesian approach. We used Houthakker's data on cross-country savings.

- G:** You then joined University of Wisconsin at Milwaukee in 1967 as Assistant Professor, became Associate Professor and then Professor. Do you have any fond memories of your teaching in the university that you wish to share with us?
- S:** At the University of Wisconsin-Milwaukee (UWM), Professors Perlman, Lurie, Leon Schur and Lee provided all the help I needed. Initially, I taught mathematical economics, statistics and macroeconomics at undergraduate level. Then I was asked to teach microeconomics and econometrics for graduate students. The university received accreditation for PhD and by teaching microeconomics for PhD students, covering developments in theory in the last 10 years, I improved my knowledge. My students eagerly participated in discussions. They provided a conducive environment for my academic work. In collaboration with Sol Shalit of UWM Business School, I published a paper on “The Measurement of Firm Size” in *The Review of Economics and Statistics* in 1977.
- G:** You were awarded a postdoctoral fellowship in public utility economics by AT&T. This must have given you an opportunity to study the unique features of privately-owned American enterprises offering public services. Please tell us about your work under this fellowship.
- S:** At that time US public utilities were considered for privatization. The transition from natural monopoly status to competitive environment raised questions about economies of scale, economics of scope and service obligations. AT&T being the largest company with Bell laboratory, the largest think tank at that time, sponsored seminars on public utility regulation in selected universities. It started *The Bell Journal of Economics and Management Science*. I had an opportunity to participate in the seminars and benefit from discussions by economists, accounting experts, and lawyers. I published two papers on investment functions in electric and telephone industries in the journal. I also taught a course on public utility regulation covering institutional aspects of public utility regulation.
- G:** Surprisingly, despite being a tenured Professor in the University of Wisconsin at Milwaukee, you returned to India in 1977 to join Madras University as Professor of Economics. What prompted you to take such a decision?
- S:** I and my wife felt that we should live closer to our parents in their old age. Another reason was that if we were to settle in India, it was the right time when our children were young. I was excited to get invitation from a renowned educationist, Malcolm Adisheshaiah, for the post of Professor. Secondly, at the time of my departure to America, Jayaprakash Narayan advised me to return to India after learning the necessary skills and engage in development studies.
- G:** When the then Vice Chancellor Dr. Adisheshaiah asked you in 1978 to establish Econometrics department, what was your initial reaction? You might have had lot many sweet/painful memories about this venture. Please share all that with us.

- S:** My problem was of getting good quantitative economists. P A V B Swamy who joined in 1977 decided to leave in 1978. I could manage with the support of A M Nalla Gounden, E Max, S Sivakumar and N S S Narayana. Fortunately, I could get good students with BA mathematics for this course. Throughout my stay in the university all the vice-chancellors supported me. Introduction of econometrics course at Madras University also resulted in introduction of a similar course at Venkateswara University and econometrics as a subject in colleges in Tamil Nadu. C T Kurien, Director, Madras Institute of Development Studies, requested me to arrange quantitative courses for scholars in the institute.
- G:** In 1981, you secured a project from Ministry of Agriculture to study the problems associated with groundnut production in north and south Arcot districts of Tamil Nadu. Please share with us the findings of your study and how it helped Tamil Nadu to become one of the top four groundnut producing states.
- S:** This was a large project based on a three-year survey of groundnut farmers. Even though the Agro-Economic Research Center was functioning in the University, the Directorate of Economics and Statistics, Ministry of Agriculture entrusted the project to me. Our main findings were: seasonal variability in yield due to weather factors, lower yields in unirrigated areas, lack of success in developing drought-resistant high-yielding varieties of groundnut, high requirement of seed-output ratio (about 0.125) which makes spread of new varieties slow, and poor implementation of agricultural price support system for oilseeds in the districts. See U Sankar and G Mythili (1987), *Studies in the Economics of Farm Management on the Problems of Increasing Groundnut Production in North and South Arcot Districts*, Directorate of Economics and Statistics, Ministry of Agriculture, Government of India.
- Data from this study was used by four PhD students (K R Malathy, G Mythili, D Jayaraj and Rathnam Nadar). With ICSSR support, a book on *Uncertainty and Farm Production Decisions* (with G Mythili) was published by Himalaya Publishing Co. 1991.
- G:** You secured a project from UGC for studying 'Optimum Rate Structure for Public Enterprises'. Your experience under AT&T postdoctoral fellowship might have come handy in its pursuit. This study indeed made you an authority on pricing of public utilities. Please share your experiences under this project.
- S:** Yes, my research and teaching at University of Wisconsin-Milwaukee helped me. I and R Hema computed long-run marginal costs of supplying electricity for different consumer categories in Tamil Nadu and the extent of subsidies and cross-subsidies in the existing electricity tariffs. My presentation on public utility pricing at the Indian Econometric Society Conference at Ahmedabad in 1985 influenced my future career. Dr. Sukhamoy Chakravarthy, the then Economic Adviser to Prime Minister Indira Gandhi, who chaired the panel discussion, complimented me and recommended my name to Dr. Vijay Kelkar, then Chairman, Bureau of Industrial Costs and Prices and T L Sankar, Director, Institute of Public Enterprises, Hyderabad to utilize my services. I was a member of Air Tariff

Committee of the Planning Commission with Vijay Kelkar as Chairman. For the first time, we computed long-run marginal costs of air services for different sectors for Indian Airlines and identified the uneconomic routes. This report was published by the Planning Commission in 1989. Kelkar requested me to study telecom tariff and also made me a member of the Committee to assess CSIR institutions.

- G:** In 1985, you became the Academic Coordinator of Madras University School of Economics and Econometrics. Please share with us your experiences in nurturing this child into a formidable adult.
- S:** This UGC special assistance program provided eight teaching positions, computer support, library support and support for visiting scholars. Many Indian economists including Y Alag, Brahmananda, Raja Chelliah and foreign economists—Shubik, Hurwicz, Zellner—visited MUSE. Dr. Nalla Gounden and I guided 12 PhD scholars. During this period I could undertake many research projects. I and Dr. Lakshmanasamy organized a seminar on “Methodology of Applied Economic Research” and a book with the same title was published by Sterling Publishers in 1993.
- G:** You went on sabbatical to National Institute of Public Finance and Policy (NIPFP) in Delhi. What was it like working in an institute focused on researching policy issues, I mean in what way it was helpful in advancing your research pursuits?
- S:** My original plan was to work on subsidies. But Dr. Sudipto Mundle persuaded me to work on pollution control. He, myself and Shekhar Mehta did research on water pollution abatement. This resulted in a book, *Controlling Pollution Incentives and Regulations*, published by Sage in 1997. This was one of the first attempts to estimate pollution abatement costs and recommend pollution taxes in India. At NIPFP, I served on the Board of Governors and later as member of the Ford Foundation Postdoctoral Committee in Economics. I had an opportunity to visit National Environmental Engineering Research Institute (NEERI) at Nagpur and got water pollution data. The Director complained that he could not find an economist who could work with NEERI scientists on estimation of environmental costs. Mundle and I presented our results to Centre for Science and Environment in New Delhi. I had an opportunity to meet economists at JNU, Delhi School of Economics and Indian Statistical Institute.
- G:** You are the founder Director of the Madras School of Economics (MSE) that was established in the year 1995 at the behest of Dr. Raja Chelliah. Please share with us the role you played in leading this school towards its vision of becoming an advanced center for teaching and research in economics.
- S:** Dr. Chelliah was unhappy about the status of teaching and research in economics in Tamil Nadu. In 1993, he told me the idea of establishing a teaching and research institution for economics in Chennai. He said that he was in a position to help and get the necessary financial support. He asked me to help him in this task. We agreed that the new institute should not depend on the state government for financial support in the form of recurring grant because it would limit freedom in faculty recruitment and

student admission because of the reservation policy of the state government. Link with the University of Madras would also create a problem as some faculty members did not like the establishment of an economic institute with a quantitative bias. We were aware of the problems such as raising funds, getting good people, and in getting recognition of our MA degree. Fortunately, former President Venkataraman; C Subramaniam, former Finance Minister, GoI; N Ravi of *The Hindu*; industrialists A C Muthiah and A Sivasailam; economists C Rangarajan and K Basu; Vice-Chancellor Dr. M Anandkrishnan; and Tamil Nadu government Finance Secretary N Narayanan welcomed the idea and promised support. MSE was registered as a Society in 1993. I joined MSE as Founder Director on July 1, 1995. We started a PG Diploma course in 1995. We prepared good syllabi for the new MA course. Even though there was resistance for recognizing MA Economics course in an engineering university by some faculty members of Anna University, with the help of Dr. M Anandkrishnan, Vice-Chancellor, Anna University and Dr. Kunthala Jayaraman, Director of Biotechnology, Anna University, we could get the approval of the Academic Council of Anna University and start MSc in Economics from 1996. PhD program offered by MSE was recognized by Anna University and Madras University. We had Dr. Nandakumar from Sweden, Velu Pillai from Cambridge and Dr. S Ambirajan in our faculty.

I undertook a research project jointly with Om Prakash Mathur of NIPFP, funded by the World Resources Institute, on “Economic Instruments for Environment Sustainability”. The report was published by NIPFP and MSE. I and G Mythili undertook a project on “Accelerating Growth of Indian Agriculture through Globalization”, jointly with K P Kalirajan of Australian National University. I visited Australian National University during summer 1999. Kalirajan and I published an edited book *Economic Reform and the Liberalization of the Indian Economy* published by Edward Elgar in 2003. I retired as Director MSE on December 31, 1999 and continued as Honorary Director, MSE.

When the Central University was established in Tamil Nadu at Thiruvavur, a MOU was signed between the Central University and MSE on recognition of MSc Economics of MSE, development of five-year integrated Masters Course with first three years at the university and last two years at MSE, and a PhD program. MSE is now recognized as an institute of special importance by Tamil Nadu government and will have a Centre on Public Finance. MSE is also recognized by AICTE for conducting PG diploma courses in Management and Data Analytics.

- G:** In your early stages of career in Madras University, you have guided good many scholars for PhD. But thereafter you appeared to have rescinded from this role. Any specific reason? By the way, please share your perception of guiding a scholar for PhD.
- S:** I also guided PhD students in the areas of public utilities (Hema, Muralikannan, and Vijayamohan Pillai), finance (Indumathi, Sreejata, and Subba Reddy), manufacturing industries (Annamalai) and housing (Nancy David). I continued to guide PhD scholars until 2002. I guided V Anuradha and Sreejata Banerjee at MSE. Thereafter I concentrated

on environmental projects such as eco-taxes on polluting inputs and outputs, multilateral environmental agreements, and trade and environment and advising Ministry of Environment and Forests (MoEF) on biodiversity, green economy and coastal zone management. I published a book on *Trade and Environment* (OUP) in 2006 and another with Chelliah, Appasamy and Rita Pandey on *Ecotaxes on Polluting Inputs and Outputs* by Academic Foundation in 2007. Our recommendation of a cess on coal was accepted by Government of India. I guided 12 PhD students in India and two in USA.

A PhD scholar must be willing to learn new subjects, when necessary. He/she must be prepared for hard work. If it is field work the person must equip himself/herself with survey techniques and learn to apply statistical packages.

- G:** You have published as many as a dozen papers on pricing of public utilities. You must have encountered difficulties in identifying costs and benefits, particularly in the context of many externalities. How did you resolve all those complexities and design effective models to arrive at answers?
- S:** When the interest is on pricing or subsidies, one must learn to convert accounting data in balance sheets and income expenditure statements into data suitable for economic analysis. Using appropriate deflators one must compile investments at constant prices. Sometimes, as in the case of multiproduct firms, cost allocation is necessary. For computing long-run marginal cost, one needs data for the last plant with the latest technology. Nowadays, there is a lot of literature on cost allocation methods including ones based on cooperative game theory.

Externalities are important in polluting industries. In India, projects in mining, thermal power and chemical industries are required to undergo environmental clearances. These provide information about the status of the environment before the project and the likely impact of the project on air, water and other natural resources. The concerned expert committees may suggest measures to minimize the adverse environmental impacts. A researcher can use this information and also can gather the necessary data.

- G:** Starting your research career with manufacturing industry, you have surprisingly moved away from it later in toto. Of course, you have revisited it in the 1990s enquiring into pricing policies both in private and public sector. Please share with us your findings thereof.
- S:** At a suggestion from Professor V R Panchamukhi, my book, *Public Sector Pricing: Theory and Practice*, was published by the Indian Economic Association Trust for Research and Development. It covered developments in public sector pricing including two-part tariff, multipart tariff, measurement of subsidies and cross subsidies, and chapters on electricity, airlines, telecom and posts and telegraph. My presidential address to the Indian Econometric Society in 1994 was “On the Regulation of Utilities Facing Competitive Fringe”. It was published in the *Journal of Quantitative Economics* in 1994.

- G:** You have extensively researched environment-related issues and published more than 30 papers. How did you get interested in environmental economics? And what was the experience like?
- S:** My interests in environmental economics came from the following: 1. Ronald Coase, 'The Problem of Social Cost', *The Journal of Law and Economics*, 1960; Baumol and Oates book on *Theory of Environmental Policy*, Cambridge University Press, 1988; and Cropper and Oates, 'Environmental Economics: A Survey', in *Journal of Economic Literature*, 1992. I continued my interest when I was at NIPFP in 1992. Kaushik Basu asked me to edit the book *Environmental Economics under Readers in Economics* series, by OUP. It contains articles by Coase, Partha Dasgupta, Hotelling, Nordhaus, Ostrom Robert Solow and many others. It went into several reprints. I was given an opportunity to coordinate with the World Bank—Ministry of Environment and Forests Capacity Building Program in Environmental Economics during 1998-2002.
- G:** In one of your papers on environmental economics, you have suggested to the 13th Finance Commission to "integrate environmental considerations into public policy making" so as to achieve sustainable development. You have even called for 'ecological-fiscal reforms'. Do you think these observations were followed by the subsequent Commissions?
- S:** The later Finance Commissions provided grants for forests and water conservation. However, more needs to be done.

The optimum management unit for an ecological activity may be a group of contiguous states having a common ecosystem. For example, Western Ghats, an ecological region covers eight states. We need a mechanism to minimize cross-state spillover effects by creating an authority. The argument is valid for managing major river-flows and controlling interstate pollution. The advantages of such regional structures are that they help not only in internalizing the environmental externalities and ensure decision making by the affected people but also in fostering regional cooperation. Even within a state there must be some institutional mechanism for handling spillover effects. For example, reduction in pollution and better solid waste management, can reduce health expenditure for government and households.

One practical problem is lack of data on ecological services provided by forests, mangroves, wetlands and other ecosystems. Some of the services, e.g., supporting services, regulating services and cultural services are not marketed but they offer benefits to society. The Finance Commissions can incentivize states to introduce a system of payments for ecosystem services.

- G:** In some of your papers you have proposed economic instruments for environmental management. What does your research tell about the impact of such eco-taxes on industrial growth and employment?
- S:** Eco-taxes will affect the polluting industries in the short run, but they incentivize the polluting firms to search for and adopt cleaner technologies, processes and inputs. The

firms' environmental ratings may go up and this may be reflected in the share prices. If the eco-tax revenues are used to help the firms to create common industrial support systems or transfer of cleaner technologies, the firms will be better off.

- G:** Do you think mere taxation would protect the environment from the problems of industrial pollution? Or, should there be 'command and control instruments' too? Should taxes be revenue-neutral or revenue-augmenting? Please enlighten us on all these intricacies.
- S:** Taxation is not the only option; the government can create tradable pollution markets and generate revenues by auctioning the initial pollution permits. Command and control is desirable when the pollution levels are high, but these measures must be designed in such a way that the penalties must increase with the emissions. It is possible to design a revenue neutral scheme by collecting the taxes from the polluters and using the revenues to compensate reduction in income or commodity tax rates. This is a politically preferred option in many countries.
- G:** In some of your papers you have argued for policy instruments for achieving low carbon emission. Looking at the way in which the power and transport sectors are growing today, do you think such measures suffice?
- S:** One policy option followed in many countries is to close dirty plants/disallow motor vehicles after a certain age. The rationale is that pollution intensity is higher for old firms or old vehicles. We have options for going from coal-based power plants to wind mills and solar power. India is providing incentives for renewable energy. The government is also committed to reduction in energy intensity of GDP. Electric cars are also desirable.
- G:** In the light of launching GST, there was an obvious need for integrating environmental taxes with the overall regime of taxation of goods and services. What in your opinion is the current status of such integration and the way forward?
- S:** My colleagues D K Srivastava and K S Kavi Kumar addressed the issue of how to handle environmental tax in a GST regime in their book, *Environment and Fiscal Reforms in India*, published by Sage. My position is simple. First, internalize the negative externality by adding private marginal cost to the abatement cost to get the social cost. Second, levy GST with no rebate for the abatement cost/pollution tax.
- G:** Leather industry is one which is known to have highly polluted the water-systems, and agricultural lands, causing indefinable harm to people in the margins. You have studied this problem very diligently. What does your research tell us about this phenomenon and what does it suggest to mitigate this hazard?
- S:** The enforcement of pollution laws must be strict, free from political pressures and rent-seeking. The state governments require the tanneries either to have their own effluent treatment plants or to join as members of Common Effluent Treatment Plants (CETPs). In my paper, I recommended measures for improving operational efficiency of the CETPs by governance reforms, See U Sankar, "Pollution Control in Tanneries",

in Gopal Kadekodi (Ed.), *Environmental Economics in Practice*, OUP, 2004. In future, the policy should be to allow a big tannery with zero pollution and locate small tanneries in industrial clusters with effluent treatment and recycling facilities and encourage adoption of cleaner technologies/processes. In a joint work with A Damodaran, we recommended common environmental support system with effluent treatment plants, access to cleaner technologies and reduction of salt use for hide preservation.

I studied the environmental barriers affecting India's exports in *Trade and Environment: A Study of India's Leather Exports* (OUP, 2006).

- G:** Backed by your long years of research experience in environmental economics, how do you rate the current state of environmental quality in India and what else do you propose to sustain environmental quality for the benefit of future generations?
- S:** The status of environment, whether it is air quality, water quality or solid waste management, is unsatisfactory. The Central Pollution Control Board's monitoring of India's national aquatic resources shows that organic pollution continues to be the predominant form of pollution of aquatic resources. According to Indian Council of Agricultural Research and National Academy of Agricultural Sciences, degraded and waste lands accounted for 37% of the geographic area of the country. Degraded forest lands accounted for 41% of the forest cover of India. In 2017, 97% of the population was exposed to unhealthy levels of PM 2.5.

The major lacuna is poor enforcement of environment laws. The Command and Control (CAC) policy breeds corruption and rent-seeking. CAC policy can work if the penalties increase with the extent of violations. When pollution control costs are very high and penalties for non-compliance are low, firms find it cheaper to pollute. We must exploit the opportunity to recycle waste water and produce products from solid wastes. Regarding natural resource management, we must realize that the poor people are more affected by degradation of land and forests. The World Development Report 1992 notes that 'the poor are both victims and agents of environmental damage'. The indigenous and local people in forests used their traditional knowledge to coexist with wild life for generations. But during the British rule and in independent India until the Forest Rights Act, 2006 was passed, they were treated as encroachers. We need these people to help to conserve forest resources in a sustainable manner.

- G:** Often researchers complain about non-availability of quality databases and appropriate methodologies for assessing the impact of climate-friendly policies on environmental sustainability. With your long years of research in this field, you are the right person to comment on this. Please reflect.
- S:** Stern notes the following special features of climate change problem: (1) it is global both in its causes and consequences; (2) it is a global externality; (3) global warming is a public bad; (4) its impacts are persistent and develop over time; (5) the potential changes are non-marginal and irreversible when the average global temperature exceeds a certain threshold level; and (6) the uncertainties are considerable

(The Stern Review Report, 2006). Nordhaus was awarded the 2018 Economics Nobel Prize for integrating climate change in long-run macroeconomic analysis. Weitzman analyzes the implications of structural uncertainty for catastrophic climate change. He shows, “even when updated by Bayesian learning, uncertain structural parameters induce a critical tail fattening of posterior distributions” making cost-benefit analysis impossible (On Modeling and Interpreting Economics of Catastrophic Climate Change, *The Review of Economics and Statistics*, September 2009).

Thus, the problem awaits further methodological developments.

India has eight national missions on climate change under its National Action Plan on Climate Change in 2009. The reports are available. Government of India is submitting its reports on climate change to UNFCCC. India signed the Paris Agreement on Climate Change and has indicated its nationally determined contributions to climate justice. Data is available on greenhouse gas emissions and climate mitigation. For research on climate change adaptation at sectoral level one has to collect and analyze the data.

- G:** With the onset of Covid-19, the need for international cooperation in dealing with Global Public Goods (GPGs) has reached new proportions. How do you rate India’s preparedness in negotiating for such cooperation globally and what needs to be done further to strengthen its claims?
- S:** Covid-19 has become a global public bad, partly because of globalization. The International Task Force Report on GPGs says that international cooperation is a tool for altruistic purposes and it serves geopolitical interests. It is also a tool for nations to align their long-term enlightened national interests to achieve common goals. Rio Declaration 1992 contains principles for international governance such as equity, historical responsibility and ‘common but differentiated responsibilities’ of states. Agenda 21 gives an action plan. However, despite the establishment of the WTO in 1995, ratification of more than 200 multilateral environmental agreements, and the UN Millennium Declaration, the pace of international cooperation has been slow. The factors hindering international cooperation are: (a) governments’ unwillingness to accept binding international commitments because they restrict their policy spaces, (b) political myopia, (c) differences in preferences and priorities of governments, (d) lack of catalytic leadership, (e) inadequate funding, and (f) difficulties in creating effective institutions for implementation of the shared visions. At the Rio Conference in 2012, developed countries refused to accept the principle of common but differentiated responsibilities. Trump’s refusal to honor the Paris Agreement and refusal to support WHO dimmed the prospect for international cooperation in finding a solution to Covid-19. Election of Biden as US President in 2020 renews prospects for finding a global solution for Covid-19.
- G:** You have visited the theory of asymmetric information in the context of public utility pricing and pollution control, signaling government regulations as counteracting institutions for mitigating its deleterious effect. But when regulators are said to be less informed than the regulated, they are perhaps set to encounter implementation challenges. Please reflect.

- S:** You are right. Stigler says regulations are demanded by business and implemented for business. One solution to the problem is educating people to increase awareness of consequences of government regulations. If regulations are made after public hearing and are made transparent with time-bound solutions, some negative results can be avoided. In the case of electricity regulators, there is a demand that they must be accountable to parliament/state legislatures.
- G:** Besides researching environmental issues, you have also paid attention to developing curriculum for teaching environmental economics. You have also trained many economists in environmental economics. You must be having fond memories of this role which you would like to share with us. Please...
- S:** From 1998 to 2002, I was coordinating the World Bank-MoEF's capacity building program in environmental economics. It had four components: curriculum development and teacher training; training of pollution control officials and others; India-specific environmental economic research; and award of postdoctoral scholarships in foreign countries to college and university teachers. It was associated with four core institutions—IGIDR, IEG, MSE and NIPFP and 18 secondary institutions. It provided library support to the core and secondary institutions and colleges. My book on *Environmental Economics* (OUP) has more than eight reprints. About 200 teachers and 800 officials were trained. 20 teachers received postdoctoral fellowships. Five books were published. 75 university departments, institutes, and colleges received library support in environmental economics. Many eminent environmental economists, including Karl Goran Maler, Partha Dasgupta, Charles Perrings, Carter Brandon, Priya Shyamsundar and Jeffrey Vincent gave lectures in the training programs. I had opportunities to interact with many environmental economists – Kanchan Chopra, M N Murthy, G Kadekodi, Ramprasad Sengupta, A Damodaran, Joyashri Roy, R Bhattacharya, Madhu Verma, K Parikh, and J Parikh. I am thankful to N R Krishnan IAS, Environment Secretary for his support during the project. In recognition of the good work of MSE, the World Bank and the MoEF created a Center of Excellence in Environmental Economics in 2002 at MSE. MSE has also got an ENVIS center.
- G:** In the early stages of your career, you did commendable research in agricultural economics, but later gave it up. Again in the first decade of the new millennium, you revisited it to examine agricultural price policies, its sustainability, etc. Please comment on the challenges that today's agriculture faces in a globalized economy.
- S:** Recent farmers strike has raised questions about India's agricultural policies. We must realize that even USA and European Union subsidize agriculture. The producer's subsidy equivalent costs billions of dollars. These countries could afford these subsidies because farmers account for only 3% of population or less, but they distort world trade. In India, fertilizer subsidies are being phased out, but there is no political will to reduce subsidy on urea; it is an environmentally perverse subsidy. Subsidizing irrigation water and farm pump sets do not conserve water use. We need crop-specific, season-specific irrigation charges. Minimum support price is useful but we must avoid a situation

leading to over procurement and wastage of food grains due to lack of storage facilities. An effective crop insurance scheme must be in force. Presence of corporate firms in agricultural production is questionable but large firms may be allowed in agricultural marketing, particularly for exports, subject to certain conditions.

- G:** You have also studied sustainability of agriculture in the light of climate change and changing economic policies. Please share your findings thereof.
- S:** In the context of climate change, encourage organic farming, solar power for pump sets, incentives for short duration crops, traditional varieties, and draught resistant-varieties. Reduce area under water-intensive crops like sugarcane.
- G:** You have also studied the concept of sustainable development from different perspectives such as energy, environment, inclusiveness, reforms, technology, trade-offs, globalization, etc. Obviously, there are opportunities and challenges. What does your research suggest to tackle this conundrum?
- S:** India has accepted Sustainable Development Goals (SDGs). The goals must be implemented in a time-bound way by different departments. One problem in implementing SDGs is balancing and integrating the three pillars—economic, social and environmental—in policy making. The trade-offs must be understood and necessary shadow prices/weights be assigned to the three pillars. This task may be assigned to research institutions.

There are challenges whenever you undertake reforms. The vested interests will try to block reforms. In this context, application of behavioral economics in policy making is necessary. “Nudging” is recommended in policy making. People must be educated on the short-run and the long-run effects of continuation of existing policies formulated in the past, and inform the better options available now. People must be told that populist policies can deliver at the most short-run benefits. Case studies of successful implementation of sustainable development programs, both from abroad and India, must be put in the public domain.

- G:** Way back in the 1970s you studied the investment behavior in the US power and telephone industry. Subsequently, you also examined our reforms in power and telecom sector and regulatory mechanism thereof. Against this backdrop, how do you explain the kind of disruptions that we are today witnessing in Indian power and telecom sectors?
- S:** I think privatization has delivered good results in telecom. Now people have more choices. Now telephone is not a luxury but a necessity. We must ensure access to telephone services for all people in rural and remote areas. Uniform social service obligations must be enforced on both the public and private firms.

As for electricity, populist policies like highly subsidizing electricity for certain categories must be avoided; for a regulated utility, cross-subsidization may not be feasible when private electric utilities enter. I gave a report to the Finance Commission, headed by Dr. Venugopal Reddy (see “Insulating Public Utility Pricing from Policy Fluctuations

for Sustainable Growth: Power and Transport Sectors”). The Commission did not make any recommendation in this regard. Later Dr. Reddy said that the populist policy of giving electricity free or at highly subsidized prices would continue until the Electricity Act is amended to disallow free power. We need nudging to educate the public on the consequences of this policy like high debt burden to the utility and non-metering of electricity consumption in some states. We must also move from current cost-based regulation to two-part tariff or prices based on long-run marginal costs. Whenever electricity costs increase for reasons beyond the utility control, automatic price increase must be allowed. What we aim at is uninterrupted good quality electricity supply at reasonable prices.

- G:** You are one of that rare breed of economists who kept on changing the line of research at regular intervals as easily as a fish takes to water. I am quite enthusiastic to know the trigger behind your quantum jump into space and its economics. Please enlighten us.
- S:** In early 2000, Dr. Kasturirangan, then ISRO chairman, deputed two senior officials to MSE to request me to carry out economic analysis of India’s space program, as recommended by Vijay Kelkar, then Finance Secretary, Government of India. They assured me all possible help including technical support in carrying out the job. Professor Chandrasekhar, IIM Bangalore [a former ISRO scientist who reviewed my book in *Economic and Political Weekly* (Vol. 42, No. 19, 2007)] traces the origin of the book to a question by Dr. Manmohan Singh to Satish Dhawan, ISRO Chairman around 1977-78 “to justify the investment that was going into the space program on economic grounds”.

I received technical support from S Raghavan, former Deputy Director General, Meteorology, Indian Meteorological Department; Dr. D P Rao, former Director, National Remote Sensing Agency; T S Subramanian, former member, Telecom Board and V S Sundaramurthy, former Director – Engineering, All India Radio and Doordarshan. Mr. H N Madhusudana, Director – Budget, ISRO, coordinated the work, arranged meetings with heads of various divisions in ISRO and also meetings with other experts. Dr. Kasturirangan and G Madhavan Nair provided all help I needed.

Chandrasekhar says: “Reading Sankar’s erudite and scholarly work on the *Economics of India’s Space Program*, many of us feel vindicated that... an ‘independent’ economist evaluates the program and states clearly and categorically that the program has more than paid for itself”. Dr. Abdul Kalam, former President of India and ISRO scientist noted this work as “a good effort and analysis”. The book had several reprints; it was distributed to members of Union Cabinet and all MPs. It was a challenging but intellectually rewarding effort. Murthy, Sankar and Madhusudana wrote an article in *Current Science* in 2007. An article by me “The Rupee Goes Farther in Space” is included in the book, *Innovative India Rises*, edited by L K Sharma and published by Medialand, London. It is interesting to note that, commending India’s 100th space mission, the then Prime Minister Manmohan Singh, justified the expenditure on the

space program, saying critics who ask whether a “poor country” can afford, it should see the enormous national benefits generated by this venture (*The Economic Times*, September 9, 2012).

- G:** As an economist, you have evaluated India’s space program and categorically stated that the program has more than paid for itself. Would you please explain how the benefits that spread across the society in the form of many spillovers and spin-offs were monetized and the costs thereof identified when there are so many value chains within the system to arrive at that conclusion?
- S:** Let me begin with the basics of India’s space program. The Indian Space Program began in 1962 with Vikram Sarabhai as the Chairman. The goal was to use space technology for socioeconomic development of India. India’s program is grouped under four categories: (1) The Indian National Satellite (INSAT) program is a multipurpose and multi-agency program launched in 1983. The first four satellites were procured from USA. INSAT-2 series were launched during 1992-99. They were used for broadcasting, telecommunications and meteorology. At an altitude of 35,800 km from the equator, the orbital period of a satellite is 24 hours, so it revolves at the same rate as the earth is. Hence, it is a convenient platform for broadcasting, telecom and meteorology services. (2) The Earth Observation System (EOS) providing space-based remote sensing, commenced in 1988. (3) The space transportation includes manufacture of satellite launch vehicle to place INSAT and EOS satellites in the required orbits. In 1980, India launched Satellite Launch Vehicle (SLV). In 1994, an indigenously built Polar Satellite Launch Vehicle (PSLV) was launched for placement of satellites in polar sun-synchronous orbit. Geosynchronous Satellite Launch Vehicle (GSLV) successfully put GSAT-1 in the GTO orbit in 2001. This component of the program is highly risky and requires foreign assistance, but it enriches a country’s technological capacity. (4) There are spin-off effects. The Government of India incurred an expenditure of ₹13,434 cr (book value) till March 31, 2001; about 40% of the expenditure was on learning and experimental phases. Compared with USA and USSR, the share of space expenditure in India’s GDP is small.

The space program has construction stage and exploitation stage. Its outputs consist of a bundle of private goods, social goods, public goods and values like national prestige. I give below the methodology adopted to measure them:

Methodology Followed in Benefit-Cost Analysis of India’s Space Program	
Stage/Sectors	Nature of Benefit/Valuation
I. Construction Stage	Self-reliance cost-effectiveness
INSAT system	” ”
Earth observation system	” ”
Launch vehicle development	National prestige

(Cont...)

Stage/Sectors	Nature of Benefit/Valuation
II. Exploitation Stage INSAT system Broadcasting AIR, Doordarshan Private TV	Cost savings Private good
Telecommunications Public switched network Remote area, public phones Govt. services social network Private networks	Social good, cost savings ” ” ” ” Private goods, commercial
Meteorology Weather forecasts, disaster management Agriculture, aviation	Public goods, cost savings Can be private goods
Earth Observation System Mapping, land use, forest cover, disaster management, archive Bioprospecting	Public goods Private good
Spin-off effects	Private goods, public goods

I carried out cost-effectiveness of certain segments based on long-run marginal costing method. Mr. Madhusudana of ISRO provided data on capital expenditure and current expenditure at book values. I converted the figures at constant prices using WPI and 12% discount rate. My economic costing of INSAT-2 and 3 satellites revealed that India had comparative advantage in these products, largely because of lower labor costs. I found that the quoted international non-preemptible lease charges in 1999-2000 for C-band 36 dbw zonal beam transponders quoted by international suppliers were above the costs computed for INSAT-2C band transponders in our study. The unit transponder costs of INSAT-3C and 3E were much below the corresponding lease charges for 2E, due to experiences gained in learning. The launch vehicle costing exercise was most challenging. The cost per kg worked out to \$28,856 for 2A and 2B, \$30,243 for 2C and 2D and \$26,667 for 2E, while the corresponding costs of the US were \$40,871, \$34,172 and \$29,267, respectively. Thus, India could achieve cost-effectiveness in INSAT launching. We could not do similar analysis in the case of remote sensing due to lack of comparable data.

In many services where the markets did not exist or imperfect, we estimated the cost savings due to application of the space technologies. In remote sensing, the advantages are: synoptic coverage, multi-spectral capability, multi-temporal capability and digital capture of data. I and D P Rao estimated direct returns and economic benefits. The potential cost savings are large. For spin-offs, we conducted a survey of service providers to ISRO to find out how ISRO partnership helped them in technological upgradation, access to new markets and development of new products and services.

India has a large collection of remote sensing satellites. National Natural Remote Sensing Management System has been established to apply satellite technology for natural resource management. PSLV completed 51 launches by end of 2020. As for the geosynchronous orbit, at present India is launching satellites weighing up to 3 tons; it continues to depend on Ariane space for launching heavy satellites. ISRO's partnership with industry is growing. ISRO ventured into landing on Moon and Mars.

- G:** How could you untangle the complex connections within the space system—with so many wheels within wheels—and arrive at the realistic assessment of costs and value the benefits? Did you face any hurdle in applying the known econometrics to evaluate India's space program?
- S:** I did not use econometrics, I relied on social cost-benefit analysis. First, I reviewed the whole program, then studied sector-wise and finally gave a macro picture.
- G:** That's prompting a question. Researchers often say that social cost-benefit analysis is associated with problems in the areas of economics, politics and ethics. Did you encounter any such problems, I mean theoretical/methodological concerns, concern about narrow problem definition and incomplete specification of alternatives, selection of a discount rate, etc.? Please enlighten us on this whole gamut.
- S:** You are right. I discussed political and ethical issues also. Political and military issues influenced space policy. USA and USSR were primarily interested in dominance in space. Other goals such as national security, enhancing knowledge of the earth, the solar system, and the universe influenced their space policies. In 1968, Vikram Sarabhai articulated India's goal as: "We are concerned that if we are to play a meaningful role nationally, and in the comity of nations, we must be second to none in the application of advanced technologies to the problems of man and society which we find in our economy".

An important ethical issue is access to space. The 1979 Moon Treaty is based on the principle of common heritage of mankind, which means that no single nation or private company has the right to appropriate commonly-owned resources. We must remember that in geosynchronous orbit only limited number of satellites can be parked. A similar question arises in the case of mission to moon/mars/or other planets; the first mover advantage is there.

Regarding the social discount rate, its choice is an ethical issue in problems like climate change because of the issue of intergenerational equity; some would question the rationale

of discounting. In the case of India, capital is scarce and there is an opportunity cost in using government funds. I followed the convention of using 12% discount rate as recommended by Planning Commission at that time.

- G:** Coming to launch vehicles, how did you assess the developmental costs with long gestation periods coupled with risk of failures and operational costs and quantify the benefits that are spread across many avenues in monetary terms to justify the investment?
- S:** It is a convention in development of capital-intensive high-risk technologies, to ignore learning and experimental costs and consider costs in operational stage only.
- G:** Having worked in various facets of economics in conjunction with other disciplines, you are the right person to comment on the opportunities for multidisciplinary research and the challenges thereof. Please reflect.
- S:** Multidisciplinary research is needed in areas such as climate change, biodiversity, ecological economics, and ecosystem services. The opportunities are there. In USA, it is common in places like Carnegie Mellon, MIT and Stanford. In India, even in IITs and CSIR institutions where researchers in different disciplines are available, such research is not flourishing. There are two factors responsible for this situation. First, shifting from one discipline to another discipline involves learning costs. One must understand the language, tools, etc. other disciplines use and must develop the communicating capacity. Meanwhile, one may lose the opportunity to do research in his own field. Second, some engineers and scientists do not consider association with economists seriously and are reluctant to share their time. Hence, economists must do the homework to convince others that the joint work would be mutually beneficial. A system of incentives, e.g., research grants and avenues for publication would encourage multidisciplinary research.
- G:** Amidst your engagement in teaching and research, you have also published as many as 13 books, some of which are considered seminal. And I also see a pattern in it: after a few years of research and feeling sufficient body of knowledge is accumulated, you appear to have authored these books. Please share with us the inspiration behind this intellectual labor.
- S:** You are right. Most of my books were based on my outputs in research projects. Some ideas originated during discussions in meetings/seminars.
- G:** Now turning towards your personal life, I am quite enthusiastic to know one thing: You have made the transition from descriptive economist to econometrician to agricultural economist, to environmental economist to space economist and today you are working on biodiversity and in all with grand success. How did you manage this phenomenal transition?
- S:** Most of the transitions occurred when some senior colleagues/officials requested my service. Sometimes, I had to take up the work when I was not even ready. I accepted the work on trade and environment because Dr. Prodipto Ghosh, then Secretary, MoEF,

entrusted the work to me. Similarly, I would not have undertaken economic analysis of space program but for Dr. Kelkar's confidence in my abilities and Dr. Kasturirangan's full support. Mr. Jairam Ramesh when he was Minister, Environment and Forests, asked me to study the effects of trade measures on climate change policy. I published "Trade Measures in Climate Policies and Their Consistency with WTO and UNFCCC", in *The Indian Economic Journal* in 2009. When a request came from DRDO to undertake a study similar to ISRO, in 2009, I declined because it was too large and I might not get the required data because of defense secrecy.

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2. *Ecotaxes on Polluting Inputs and Outputs*, with R J Chelliah, P P Appasamy and R Pandey, Academic Foundation, New Delhi, 2007.
3. *The Economics of India's Space Programme: An Exploratory Analysis*, Oxford University Press, 2007.
4. *Environmental Economics, Reader in Economics*, Oxford University Press, Delhi, 2000. Oxford India Paperback, 2001; eighth impression, 2007.
5. *Trade and Environment: A Study of India's Leather Exports*, Oxford University Press, 2006.
6. *Economic Reforms and the Liberalization of the Indian Economy*, edited by K P Kalirajan and U Sankar, Edward Elgar, Cheltenham, UK, 2003.
7. *Accelerating Growth Through Globalisation of Indian Agriculture*, K P Kalirajan, G Mythili and U Sankar (Eds.), Macmillan, New Delhi, 2001.
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9. *Controlling Pollution: Incentives and Regulations* with S Mehta and S Mundle, Sage Publications, Delhi, 1997.
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11. Input-Output Transactions Tables (Agriculture and Manufacturing Sectors), Tamil Nadu, 1982, Department of Econometrics, University of Madras, 1995.
12. *Methodology of Applied Economic Research* (Eds. U Sankar and T Lakshmanasamy), Sterling Publishers, New Delhi, 1993.
13. *Public Sector Pricing – Theory and Applications*, by Indian Economic Association Trust for Research and Development, New Delhi, 1992.
14. *Farm Management Study on the Problems of Increasing Groundnut Production in North and South Arcot Districts of Tamil Nadu* (with G Mythili), Manager of Publications, Government of India, 1987.

G: I now wish to ask you to name the economists who influenced you the most and how?

S: Kenneth Arrow's work influenced me most. His work on Pareto optimality of competitive market under certain conditions, i.e., no economies of scale in production, no externalities and no public goods; his work *Essays in the Theory of Risk-Bearing*, particularly measures of risk aversion; and work on environmental economics, particularly cautions against use of contingent evaluation technique, and importance of natural capital in macro accounting influenced my thinking. I used his ideas in teaching and also my research in environmental economics. I had an opportunity to interact with him at SANDEE meeting in Dacca.

Baumol's work on simplification of Boiteux's work, "On the Management of Public Monopolies Subject to Budget Constraint", which appeared in *Econometrica* in French in 1956 in his article with Bradford, "Optimal Departures from Marginal Cost Pricing", in *American Economic Review* in 1970, influenced my work on public utility pricing. I used his book with Oates, *The Theory of Environmental Policy* (Cambridge University Press, 1988), for teaching and research in environmental economics.

Arnold Zellner's book, *Readings in Economic Statistics and Econometrics*, containing well-known articles in applied econometrics was helpful for deriving hypotheses from economic theory, econometric estimation and testing of hypotheses. His book, *An Introduction to Bayesian Inference in Econometrics*, Wiley, enabled me to understand Bayesian Econometrics. He visited India three times, and every time he came to Chennai to see me.

G: You have also accepted membership in more than 35 professional/policy making bodies/committees/associations besides being the Chairman of three associations. You have also accepted foreign assignments. How do you manage all those commitments? By the way, are they of any help in furthering your research activities?

S: These assignments gave me opportunities for interaction and fruitful discussion with experts on different subjects. They forced me to make necessary preparation for informed discussions. They also generated ideas for new research. I visited Australian National University in Summer 1999 as part of my project work with Dr. Kalirajan. I went to Rio de Janeiro in June 2012 to attend the UN Conference because I was working with the Joint Secretary on the Conference theme for a few years. It was a great opportunity to learn how international negotiations take place and how final agreements are reached.

G: Are there any major influences on your career that made you to reset your priorities and research goals?

S: My priorities in research changed due to circumstances, i.e., where I was working and with whom I was working. When some senior economist/scientist/policy maker asked me to work on something I obliged. In my case, changes in research topics could be attributed to external factors and my well-wishers.

- G:** As a teacher, trainer, researcher and author you have accomplished a lot, indeed pioneered research in many subsets of economics and won laurels. Of all those accomplishments, are there any that mean most to you?
- S:** I enjoyed teaching microeconomics, environmental economics and public utility economics. During my ISRO project on economic analysis of Indian Space Program, I had opportunities to interact with engineers and scientists in the disciplines of space science, meteorology, remote sensing, broadcasting and telecommunications and learned a lot. I learnt from AT&T seminars on public utility regulation, and the legal and administrative issues in regulation.
- G:** In all these accomplishments, your family, particularly, your wife Smt. Thilagavathy, must have played a supportive role all through. Please reflect.
- S:** I married Thilagavathy, a Zoology graduate from Nagercoil, in 1968. She came from a well-to-do family and her father was a lawyer. We lived in USA for nine years. We have two children: son Ganesh and daughter Gomathy. When we were to leave USA in 1977, both of us felt the need of supporting our parents and live closer to them, and the desirability of going to India when the children were young. After she came to India she studied MA Sociology but preferred to live as a housewife. She took care of all domestic chores including rearing of children. Ganesh is an instrumentation engineer and works as a Senior Regional Service Manager, Yokogawa, Houston. His wife, Tara, a Home Science graduate, is a housewife. Gomathy is an IT specialist and works as a Senior Manager, Data Engineering at Capital One in Washington DC. Her husband Dr. Appavu Sundaram is working on vaccine development as a Senior Scientist at Naval Research Medical Centre in USA. They provide a conducive environment for my academic work. I could not have undertaken many projects and committee assignments without my wife's wholehearted support and encouragement. She is a good companion and makes my life pleasant.
- G:** During the last five decades you have researched a variety of economic issues. Is there still any aspect of Indian economy that you would have liked to study but could not?
- S:** Even though there is a general agreement on the need for making pricing policy prescriptions based on current economic costs, current practices are based on historical/ accounting costs. Accountants and finance people prefer historical costs for administrative and audit purposes. In a competitive globalized economy, firms make pricing and investment decisions based on current economic costs. I hope things will change with time.

I favor application of incentive-based economic instruments for pollution control, limiting command and control instruments only in cases of serious environmental violations or/ where we are at the thresholds of planetary boundaries, as in the cases of biodiversity loss and climate change.

Greater recognition of natural capital in national accounting and its management is necessary for sustainable development and to achieve sustainable development goals.

G: You are 84 and still actively engaged in research. So, what can we look forward to in the years ahead?

S: It is gratifying that I could train a number of young econometricians in South India and a large number of environmental economists in India. I had several opportunities to advise governments and public enterprises. My work is getting recognition. ICSSR offered me national fellowship during 2002 and 2003. I was awarded the UGC Swami Pravananda Saraswathi Award in Economics for 2006. My doctoral students G Mythili and R Hema brought out a festschrift volume in my honor, published by Academic Foundation in 2005. It contains tributes to me by Arnold Zellner, Raja Chelliah and P P Appasamy as well as papers by, Chetty, Revankar, Krishna, Vaidyanahan, Kadekodi, Subramanian, Kalirajan and others. Sage published a book on *Environment & Development Essays in Honour of Dr U. Sankar*, edited by my colleagues K R Shanmugam and K S Kavikumar, in 2016. It contains a Foreword by Dr. C Rangarajan and 16 articles.

In the last three years, I have not taken any new research projects. I resigned my position as Chairman, Editorial Advisory Board, Sarvekshana and Chairman, Malcolm & Elizabeth Adisheshaiah Trust. Now I do not accept any new committee assignments or invited lectures requiring travel outside Chennai. However, I write papers for felicitation volumes on subjects in environmental economics.

G: What advice would you like to give to the graduate students of economics and young scholars in economics?

S: Apart from economics, train yourself in mathematical, statistical and computer skills for research. In policy-oriented research, consider legal and institutional environment under which policy is framed. Whenever opportunities come, seize them and accept them as challenges. Patience and perseverance accomplish wonders. Identify promising scholars when they are young, nurture them and support them. Do not get disillusioned by failures but learn from failures.

G: So, that brings us to the end of the interview. It is so nice of you to spare your quality time for the interview. I enjoyed my interactions with you. Thank you very much Professor Sankar for granting me the honor of interviewing you.

S: Thank you!

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