

**DATA COLLECTION, STATISTICAL ANALYSIS
AND POLICY - CONTRIBUTIONS OF
PROFESSOR MAHALANOBIS AND THE
INDIAN STATISTICAL INSTITUTE***

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It is a great privilege and an honour to be invited to give the keynote address at a conference celebrating Statistics Day, a day dedicated to the memory of the late Professor Prasanta Chandra Mahalanobis and his enormous contributions to statistics. I thank the Reserve Bank of India for inviting me.

If you will permit me, I will begin with a few personal remarks. I count myself as belonging to the Guru Āishya Parampara of the Professor, as he was always called at the great institution, the Indian Statistical Institute (ISI), which he founded in 1932. In 1953, I joined the two-year Professional Training Course at the ISI, which at that time did not have the authority to grant degrees. My Guru then was Dr. C.R. Rao (who was always called Dr. Rao in the ISI), himself a Āishya of the Professor along with his contemporary, the late and legendary V.M. Dandekar. A decade after completing the course, and with a Ph.D. in economics from Yale, I joined the Planning Unit of ISI at Delhi where I had an opportunity to interact with the Professor till his death in 1972. If I have time left at the end, I will recollect some amusing and revealing anecdotes about the Professor from those days.

* Keynote address.

The Professor emphasized that statistics is a "key technology" that is fundamental to all natural and social sciences in that validity of any scientific hypothesis can only be evaluated by using statistical tools. In applied sciences and policy analysis, once again statistical tools are fundamental. Dr. Rao, in his little book "Statistics and Truth," elaborates this fundamental role of statistics, a book that is fun to read and cites many anecdotes and examples on the uses and misuses of statistics. While this role is well known and accepted, what is not as well known and deserves to be, is that because statistics is, to use the terminology of statistician L.J. Savage cited by Dr. Rao, "parasitic" in that it lives and thrives on the work of natural and social scientists, it is essential therefore that for the advancement of theoretical and applied statistics statisticians are not only aware of developments in natural and social sciences but also interact with the scientists. In his convocation address in 1968 at the ISI, Dr. Rao said that "Mahalanobis argued, the improvements in statistical methods (statistical research) are possible only through new problems and situations arising in scientific investigations of the real world. In establishing high level research units in selected scientific areas such as [anthropology, biology, economics, physics, psychology, and sociology], the Professor wanted to provide the much needed interface between statistics and other disciplines and also to promote interdisciplinary research. This view is also reflected in the educational and training programmes at ISI where statistics is taught as part of an integrated course in natural, biological and social sciences." Indeed, the Professor's vision of ISI was that it should become a multidisciplinary and multi-locational research institute. The galaxy of scientists of various disciplines who were invited to and visited ISI in the fifties and sixties bear testimony to the Professor's vision. These included: Norbert Wiener, R.A. Fisher, Ragnar Frisch, Academician Kolmogorov, John Kenneth Galbraith and many others. The multi-locational aspect of the vision was by and large successfully implemented, but the

multidisciplinary aspect had minor success for reasons. This is not the occasion to delve into the reasons.

An amusing and instructive example taken from Dr. Rao's book on the use of statistics, and which has a curious connection to the Professor himself, is the evaluation of the effects of "mind over matter" or more generally, the effect of psychosomatic processes on biological functioning of the body. Dr. Rao points out that there has been no experimental evidence one way or the other on this but cites two studies of David Philips of the University of California, San Diego. In one, he examined the death rates over a 25-year period among elderly Chinese-American women around a key holiday and found that death rates dip 31.1% below the norm one week before and peak at 34.6% above the norm a week after, suggesting that perhaps one can exercise willpower to postpone death until after an auspicious event. Even more interesting is his analysis of data on months of birth and death of 1,251 famous Americans. He found, as in the data on Chinese-American women, that the number of deaths in the month before is smaller than those in the months during and after the birth month. Interestingly, Dr. Rao found the same to be true in a much smaller numbers of 18 deceased Indian FRS The Professor who was a FRS died on June 28, 1972, a day before his birthday. Of course, there is no way to tell whether he tried hard to postpone his death until after his birthday and failed! Dr. Rao cites another famous example of Thomas Jefferson who died on July 4, 1826, after reportedly asking "is this the fourth?" As is well known, Jefferson was a signatory of the Declaration of Independence, signed exactly 50 years before on July 4, 1776. Dr. Rao rightly cautions against making too much of such findings – he points out that it is not uncommon that in a large number of studies of the same problem, only those with positive results are reported. Dr. Rao reports on what are often believed to be low probability coincidences which turn out to be in fact much more probable than commonly believed.

The contributions of the Professor to theoretical and applied statistics are many. The same is true also of his work on planning and aspects of economic policy. I cannot hope to touch on all of them in one lecture. I will concentrate on his contributions to data and analysis, particularly sample surveys, the National Sample Survey, crosschecking and validation of data, national income accounts, statistical quality control and briefly on policy. The late Dr. Ashok Rudra, my teacher at ISI when I was a student, and later my colleague at ISI, Delhi, left behind an almost complete biography of the Professor before his untimely death. It was published after his death by ISI. It is the best source for a complete account of the Professor as a person, as a scientist and as an employer as well as the history of ISI.

2. Sample Surveys

2.1 Crop Statistics

A very well known contribution of the Professor (and ISI) was to the field of large scale Sample Surveys for the collection of socio-economic data. My late classmate at ISI, M.N. Murty has surveyed the contributions in his paper, excerpts from which are included in Rudra's biography. The fact that a well-designed Sample Survey "is capable at very trifling expense of ascertaining with more than the necessary precision such facts as the actual yield of a district or a province of any chosen crop" was highlighted in a 1938 memorandum of the great Statistician Sir R.A. Fisher to the Government of India (GOI) in support of the proposals of the professor in 1937 for starting work on paddy crop. The Professor repeated the proposal year after year in 1939, 1940 and in 1941. In a fascinating paper on the organization of Statistics after the Second World War, presented in 1943 at the National Institute of Sciences of India and published in the Institute's Proceedings in 1944, the Professor describes the saga of the proposals: "on 28th March 1942 I submitted to a high official in the GOI a definite scheme for the Survey of Paddy in Bengal and Bihar. Between July and October,

1942, I wrote several letters to Bengal officials urging to the best of my ability the immediate taking up of a rice census in the province but to no avail. I am glad to state, however, that at the last moment in August 1943, orders at the insistence of the Honourable Mr. H.S. Suhrawardy for a Survey of the paddy crop in Bengal for the first time on scientific lines." Mr. Suhrawardy was not a bureaucrat but a politician of Bengal who later became Prime Minister of Pakistan after partition.

The Professor pointed out in the same article that the thorough unreliability of agricultural statistics, especially those relating to Bengal and other permanently settled areas had long been known and had led to distrust of official statistics and forecasts of rice output. This distrust led to tragic consequences during the Bengal famine. To quote the Professor "in spite of the alarming nature of the official rice forecast, the Government of Bengal took no notice of it, and as late as December, 1942 did not make any attempt to secure additional supply from outside the province and thought price control to be entirely unnecessary. In fact, on several occasions in previous years [forecasts were] much lower than that of 1942-43 and yet nothing untoward had happened. It was, therefore, not unnatural on the part of the Government of Bengal to take the view that the official estimate for 1942-43 was unduly pessimistic as on many previous occasions. The cry of wolf had been so often raised in vain in the past that it was not surprising that everyone was caught unaware when the wolf really did come . . . What is [surprising and] to be regretted is that in spite of the strong and unequivocal condemnation of existing crops statistics by a series of most authoritative committees and commissions for 1876 to 1940, no steps whatever had been taken, even in a period of grave war emergency to improve the collection of statistics relating to rice." Amartya Sen in his much celebrated book on Poverty and Famines discusses the Professor's analysis of the Bengal Famine in this and other papers.

After independence, a large number of princely states with diverse systems of land tenures and for collection of agricultural statistics were incorporated into the Indian Union. Reform of agricultural data system was initiated with the adoption of Sample Surveys for estimation of crop areas in previously permanently settled areas. For the rest of India with ryotwari system, the traditional village revenue official (patwari) based system of collection of area statistics was continued. There was an active debate between Sample Survey statisticians from ISI and supporters of the patwari system including the eminent agricultural statistician, the late V.G. Panse. The large discrepancies between survey-based estimates by the National Sample Survey (NSS) and official statistics led to a victory of the supporters of the patwari system and abandonment of Sample Surveys for estimation of crop areas. However, for the estimation of yields per hectare, estimates from crop harvests from a sample of plots was adopted, initially for major food grains and progressively for all major crops.

I cannot resist recalling here the training I received on official statistics including agricultural statistics as a student at ISI. We were taught the sources for various data and examined on them. I remember being asked to name an accessible source of data for electricity sold and generated. Fortunately, I knew it was, as you might have guessed, the monthly publication Reserve Bank of India Bulletin! The various systems of land tenure and land revenue were explained to us. We were taken to Giridih (then in Bihar, now in Jharkhand) to receive practical training in crop cutting for yield estimation. Rudra describes the connection of Giridih with the family of Mahalanobis and ISI. It was natural for ISI students to be taken there.

At that time the two leading candidates for crop-cuts were circular and rectangular cuts of the same area. In theory, since a circle has the least circumference enclosing a given area, it is clear that possible "boundary"

bias in classifying a crop strand at the boundary as falling within or outside the sample cut is minimized with a circular cut. The circular cut was adopted officially after extensive experimentation with both. In our training we harvested randomly chosen circular and rectangular cuts on the same plot of land as well as the whole plot so that we could compare the estimates of the plot yield from the harvest from circular and rectangular cuts with the actual harvest of the whole plot. The trip to Giridih in addition to augmenting our knowledge also was an exciting excursion to natural beauty of the region.

After our final examination at the end of two years, there as an oral examination called 'sophistication' meant to test a student's imagination and quick thinking. One of my examiners was the Professor himself. The other was Dr. Rao. The Professor asked me to imagine being incarcerated and asked what sort of data could I collect while in prison, and I mumbled data on my pulse rate in response. Quick came the Professor's dismissal of my answer "you forgot you would have no way of computing the pulse rate since your wrist watch would have been confiscated as you were admitted into the prison". To this day I cannot think of a correct answer to his question.

2.2 National Sample Survey Organization (NSSO)

The Professor was instrumental in the establishment of the NSS and the transfer of the Central Statistical Organisation from the Ministry of Commerce to the Cabinet Secretariat where it was for a considerable time. The NSS was established in 1950 on the basis of a proposal from the Professor to fill up data gaps for socio-economic planning and policy-making through a nationwide, large-scale, continuous sample surveys conducted in the form of successive rounds. Currently the 65th round (July 2008-June 2009) is being canvassed. In March 1970, the NSS was reorganized and all aspects of its work, from Survey design and field operations, were brought

under a single Government organization, namely, the National Sample Survey Organization (NSSO). ISI was responsible for the design and execution of the Surveys of NSS. Responsibility for execution was withdrawn from ISI in 1972 just a month before the Professor's death. NSSO's Sample Design and Research Division (SDRD) is located in Kolkata where the main campus of ISI is located. I happen to believe that creative work on sampling and sample designs atrophied in ISI after the transfer of NSS from ISI. Perhaps it is a government organization SDRD has not been as creative. But I have no way of establishing my belief.

Experimentation in data collection methods is a basic characteristic of the ISI tradition. From early on, NSS has experimented with and modified its sample design on the basis of results of experimentation. I have already referred to the studies that compared the relative accuracies of circular and rectangular (square) cuts for estimating crop yields. Another is the early attempt to collect self-reported morbidity data from household surveys in rounds 7, 11, 12 and 13 in the late fifties. It was found that the results were sensitive to the choice of the reference period with the estimates of perceived disease prevalence rates being higher with shorter reference periods.

Before turning to the experiments with reference periods in household consumption expenditure surveys, let me mention the longstanding issue of the estimation of household savings and investment. As is well known the current practice in National Accounts Statistics is to derive what is termed "direct savings and investment by households" in the form of physical assets through the indirect residual method by subtracting direct data on investment by the corporate and public sectors from aggregate investment (as estimated by the commodity flow method). Data from financial institutions on changes in financial assets and liabilities are used to derive (once again, by the residual method) the household savings in financial assets. The sum of direct investment in physical assets and

financial savings by households is total savings by households (strictly speaking, the household sector includes unincorporated enterprises as well). The problems with this procedure have been examined by several committees. The most recent one, the Rangarajan Committee, submitted its report in March 2009. One of its major recommendations is the need to undertake a comprehensive income-expenditure survey for households. In order to pave the way for eventual introduction of periodical comprehensive survey, the NSSO has agreed to undertake such a survey of households with a pilot survey in 2010-11. The Committee expects that the proposed survey will enable the estimation of the savings of pure households instead of clubbing them with unincorporated enterprises.

It so happens that the NSSO had canvassed an integrated household schedule on income and expenditures from the 19th (1964-65) until the 25th round (1970-71) and had abandoned it thereafter, because, if my memory serves me right, the data collected proved unreliable. The reason for unreliability arose in my view, from the virtual impossibility of collecting income (properly defined) data for household surveys in the Indian context, notwithstanding that other organisations such as the NCAER, which are outside the ISI tradition do collect what they term an 'income' in their household surveys.

The NSSO experimented with different reference periods, both for frequently purchased goods such as food, paan and tobacco and less frequently and infrequently purchased goods such as clothing and durable goods in the annual rounds between 1994 and 1998. Until then, NSS used a uniform 30-day reference period for all goods, a period that itself had been decided based on experiments in the 1950s by the Professor. The new experiments used two alternative questionnaires, one with the traditional 30-day reference period and the other with 7 days for food, paan and tobacco, 365 days for others. The results of the experiments conducted

by the NSSO expert group on Non-Sampling errors under the direction of Nikhlesh Bhattacharya are available in a paper by Bhattacharya that is included in the volume entitled The Great Indian Poverty Debate edited by Angus Deaton and Valerie Kozel.

The poverty estimates from the so called thin rounds with smaller sample sizes between 1994 and 1998 showed no reduction. The thick quinquennial 55th round with a large sample size was eagerly awaited to establish the poverty trends more reliably. Unfortunately the design of the questionnaire for the 55th round had to be set before the results of the experiments with alternative reference periods became available. After a good deal of debate, a compromise was adopted with households were asked to report their expenditure during a 7-day reference period for food, paan and tobacco as well as a 30-day reference period. Besides for footwear, clothing, durables, education and institutional medical expenses, the traditional 30-day reference period was replaced by a reference period of 365 days only. There were other important changes as well. Nonetheless, for official poverty estimates, the 30-day responses were used, although estimates based on 7-day references were also released. The 30-day response based estimates showed a remarkable reduction in poverty between 1993-94 and 1999-2000 in comparison to the stagnant levels of poverty found in the thin rounds between 1994 and 1998. Naturally these results unleashed a series of critical articles including an influential one by Abhijit Sen, currently a member of the planning commission, who refers to the experiment in the 55th round with the compound questionnaire as a 'failed experiment.' Others tried to adjust for the changes introduced in 55th round in some fashion. All these studies are reproduced in the Deaton-Kozel volume.

My point is not to summarize this debate, let alone contribute anything new to it, but only to say that the experiment was in the established tradition of experimentation in the NSS, though its execution was somewhat

deficient. Its importance and relevance is unaffected by the controversy surrounding the particular experiment in the 55th round. In any case, the controversy and also the critical and public papers on the 55th round also illustrate the almost unique Indian tradition of critical evaluation of data and statistics, to which I now turn.

3. Cross examination and validation of data and recognition of sampling and non-sampling errors

The Professor and others in the ISI tradition emphasized the importance of looking at the data carefully to see whether they reveal any errors and inconsistencies that could have arisen in the data collection process. Such cross examination of data is prior to statistical analysis, be it a purely descriptive analysis of data summarization or more sophisticated analysis. Indeed the Professor emphasized the human factor in the collection process and the possible conscious or unconscious errors – biases that could creep into the data because of it. To quote the Professor "This brings me to a most important point, the human factor in the collection of primary statistics, I have learnt by bitter experience the difficulty of securing reliable primary investigators. In the course of our work on jute acreage, we made careful experiments in this matter in 1937 and 1938. We had plot-by-plot enumeration carried out in the same area by three or four sets of investigators. The results were amazing. We found the absolute discrepancy was of the order of 70% or 80%. In the paper for the National Institute the Professor cites the classic example of the attempt in 1939 to carry out a complete or plot-by-plot census of acreage under jute in Bengal, as a prelude to the introduction of a system of licenses to grow jute. The results were untrustworthy and had to be rejected. At the Professor's request the records for several districts were sent to him for examination. He found that in several districts the acreage under jute as reported were higher than the geographical area! The Professor remarks "to any experienced statistical

worker the results can cause no surprise; in fact, they were just what were to be expected. In view of the impending introduction of the jute regulation scheme every cultivator wanted to register as high a figure for jute as he thought was likely to be accepted by the investigators." The Professor rightly concluded;" Statistics relating any controversial issue are likely to be biased". Of course this applies not just to India but everywhere

I recall in the early days of the green revolution, states deemed as surplus in the production of food grains were cordoned off from deficit states to ease the cost of procurement of food grains for the public distribution system. Since agricultural output estimate was whatever the state government reported for the procurement decisions, each state wanted to minimize its estimates of production and maximize its demand so as to minimize procurement by surplus states and maximize transfer from the central pool by deficit states. This tendency led the then director of agricultural statistics, J.S. Sarma to exclaim "if we accept what states claim to be their production the international acclaim for India's success with the green revolution would be thoroughly undermined!" The net result was that output data became a matter of negotiation between the centre and states, with the differential political muscle of different states with the centre coming into full play.

The Professor's innovation for estimating sampling and non-sampling errors inherent in data collection from random sample surveys is the use of interpenetrating network of sub samples. For example, a random sample of a given size could be canvassed either as a single random sample, from the population or set of independent sub-samples, each of which provides a valid estimate the statistic being estimate. As such the differences among the estimates from different sub-samples could be used to estimate the inherent sampling and non-sampling errors, if each of the independent sub-samples were canvassed by different teams of investigators. Moreover, in the old days when computer capacities were limited, the sampling errors

from a complicated multi-stage and stratified design was probably proportional to size sampling of the ultimate units directly from the design features was naturally impossible. The sub-sample differences provide an estimate of the sampling error of non-sampling errors could be deemed low. The NSS steadfastly practices the use of interpenetrating sub-samples. To the best of my knowledge, others such as the NCAER do not.

The Professor also emphasized the tabular and graphical presentation of data and drawing inferences from the pictures. His classic 1960 paper in *Econometrica* on Fractile Graphical analysis (FGA) is not only an illustration of the success of this approach but is one of the earliest examples of non-parametric analysis of data. The statisticians of ISI later provided a statistical foundation for FGA.

4. National Accounts Statistics

The Professor chaired the National Income Committee which submitted its final report in 1954. This report is still worth reading. The committee, fully aware that they were working with incomplete data subject to biases and measurement errors, provided estimates of the likely error in the value-added sector by sector. The errors ranged between less than 10 percent to a third depending on the sector and that for the net domestic product for 1948-49 was 10 percent. This exercise has not been repeated by the CSO since. As far as I know, there is no other country which provides error estimates for their national accounts data. I suspect the errors have grown over time, both because of deterioration in the data collection system and the growing importance of the service sector. As is well known the method of estimation of value added by the service sector in our National Accounts is seriously deficient.

I am afraid the Reserve Bank of India (RBI) is no exception to this deplorable practice of not providing error estimates for the data which it

collects and publishes. By estimates of error I do not mean a measure of sampling or statistical errors in a narrow sense but a broader measure in estimating which the data collectors use their judgment of the likely errors in various components that go into the aggregate. Let me cite just one example. As is well known, there is no reliable sample frame of companies which can be used to draw a proper sample. RBI provides estimates of savings and investment of the corporate sector by using data of accounts of the sample companies in the annual survey of companies by RBI and adjusting these for full coverage on the basis of data on paid up capital for all companies. I have no idea whether the companies for which paid up capital are available include the universe of companies in existence and in operation each year. I need not go into the well known problems of the RBI procedure, except to say that RBI provides no estimate of the likely error in estimates. More generally, the estimates of Savings and investment by the household sector is subject to significant errors arising from the fact they residually estimated so that errors in all the elements that go into the computation of the residual are reflected in them.

The reluctance to provide error estimates or equivalently to provide interval estimates rather than point estimates is universal among official agencies among which the most notorious is the World Bank. Nearly three decades ago when I was in the then Development Research Center of the World Bank, I tried with no success to induce the Bank to provide interval estimates. The Bank's flagship publication, World Development Indicators, gives a false sense of accuracy and comparability by putting together data from many countries in the same table.

The NSS was established in part to improve the data base for National Accounts Statistics (NAS). There is a long tradition in ISI to compare estimates derived from NAS with their counterparts in NSS data. One such comparison relates the estimates of aggregate household consumption directly estimated from NSS household expenditure surveys with

corresponding indirect estimates obtained by the residual method in NAS. In the period from the mid-fifties to the mid-sixties, Moni Mukherjee and G.S. Chatterjee of ISI found that the agreement between those based on revised NAS and NSS remained surprisingly close, although since 1963-64 there was a pronounced tendency of the NAS-based estimates to lie above NSS estimates. My paper with P.N. Radhakrishnan and A. Vaidyanathan on the commodity-wise discrepancy between NAS-based and NSS estimates confirmed the results of Mukherjee and Chatterjee. The late B.S. Minhas published an extremely important paper in 1988 on the validation of large-scale sample survey data. His conclusion is worth repeating "the independent data set (NAS), it is fair to conclude, is far short of the touch tone of quality expected of an external validator data set. A number of its components are based [and I may add are still based] on unverified [and unverifiable] assumptions which seriously diminish its values in a cross-validation exercise. On the other hand, the NSS estimates of expenditure . . . on tobacco and intoxicants, and consumer durables and modern consumer services are of doubtful validity. Nevertheless, despite these difficulties, which need to be overcome in both data sets, an overwhelming proportion of household consumer expenditure data of the NSS and the independent private consumption estimates of the NAS do get cross validation." He cautioned against the dubious practice of inflating the mean consumption in NSS by the higher figure from NAS while retaining the NSS data on distribution of expenditures among households for analyzing trends in poverty. The three papers have been reproduced in Deaton-Kozel volume .An egregious example of this dubious practice that Minhas cautioned against is by Surjit Bhalla for India and Xavier Sala-i-Martin for other countries.

5. Statistical Quality Control

It is widely accepted that Japan's pre-second war reputation as a manufacturer and exporter of inexpensive low-quality products was

radically transformed into a reputation of exporter high-quality products after the war, in large part because of the introduction of Statistical Quality control (SQC) techniques pioneered by William Edward Deming and Walter Shewhart. The Professor, the pioneer that he was, knew the importance of introducing SQC and Operations research into India. Rudra describes the efforts of the Professor in this regard even before independence. SQC units were established in major industrial centres in India by the ISI in the early fifties, some of which were headed by dynamic individuals. One such unit was in Mumbai, and then located at the Central Government Offices Building in what was then called Queen's Road. It was directed by Dr. S. P. Vaswani, a remarkable and formidable lady.

It so happened that during my second year as a student, there was a conference on SQC at ISI in 1955. I served as one of the student volunteers at the conference and later assisted the then joint secretary of ISI, S.C. Sen in transcribing the audio recording of the conference proceedings. In the eyes of S.C. Sen my service was enough to qualify me for a position to serve in the Mumbai SQC Unit! After my graduation I was sent to Mumbai to serve there.

Dr. Vaswani was an extremely successful practitioner and proselytizer of SQC. However, unlike my colleagues at the SQC Unit, I was not temperamentally suited in moving around the textile mills and cycle factories to install control charts on spinning (ring) frames, looms and machines and to try to instill in workers how to read and act on the signals from control charts. The workers had no motive in seriously following control charts. Nor was the management interested in making them pay attention to the charts. After all with the insulation by policy of Indian producers from domestic and import competition, there was not much of a pressure to improve quality and reduce costs. I spent two miserable years trying to practice SQC but did develop and interest in the then

emerging tool of linear programming which ultimately led to my admission to Yale's Economics Ph.D. programme in 1957. I am recounting this tale only to emphasize that competition and incentives matter. Japan being an export-dependant economy, its exporters, to be internationally competitive, had the incentive to improve quality and control costs. This is just like the Professor's example of the bias in the data on jute as a result of the incentives created by the impending introduction of licensing of jute production, except in my example, the incentive was to ignore the data the control charts were generating. Since I am addressing an audience of economists, I need not elaborate on the vital role of incentives.

6. Mahalanobis and Indian Economic Policy

The Professor himself emphasized the role of incentives and disincentives in another important context. Long ago in his Review of Gunnar Myrdal's *Asian Drama* in 1969, the Professor had this to say of our still unreformed labor laws "certain welfare measures tend to be implemented in India ahead of economic growth, for example, in labour laws which are probably the most highly protective of labour interests in the narrowest sense, in the whole world. There is practically no link between output and remuneration; hiring and firing are highly restricted. It is extremely difficult to maintain an economic level of productivity or improve productivity . . . the present form of protection of organized labour, which constitutes, including their families, about five or six percent of the whole population would operate as an obstacle to growth and would also increase inequalities."

He had argued in 1961 in his Talks on planning that "it would seem better to try to attain the highest possible efficiency of labour and increasing productivity, and use the additional value obtained in this way to create more employment rather than lower the industrial efficiency by slack or restrictive practices through overstaffing." He proposed the setting up of a

Labour Reserve (LR) "to absorb such industrial workers as may be considered surplus and be 'laid off' by existing industrial enterprises at their discretion, and also to serve as a pool for other enterprises to draw upon, again, at their own discretion. The Labour Reserve Service (LR) would then act as a buffer against unemployment and would serve as a (perhaps socially more useful and psychologically more preferable) form of or substitute for unemployment insurance. . . . The LR would provide training of various kinds and would continually try to use the men for productive purposes. Workers in the LR would have an incentive to find better jobs at the earliest opportunity." I fervently hope that the newly elected Government would at last act on the Professor's sage advice.

The Professor served as the Honorary Statistical Adviser to the Government of India and also as a member of the Planning Commission. His contribution to Planning, including laying the analytical foundation for India's development strategy through his independent formulation of the Two-Sector Model of Growth, originally due to Grigori Feldman for the Soviet Union, and the report on the Distribution of Standards of living and many others left an indelible mark on India's economic policy in the past in the independence era. The empirical and theoretical contributions of ISI researchers in support of the Professor in his capacity as a member of the Planning Commission were very significant and in many instances pioneering. There is no parallel to this in any developing country.

6. Concluding Remarks

Let me conclude.

The Professor was, as Dr. Rao described him in his remarks at a special service at ISI dedicated to his memory, "an outstanding personality of our times, the like of whom is born perhaps once in several generations . . . I cannot think of any other in recent times who distinguished himself in so

many diverse fields as the Professor ". . . Be it in arts, literature or science, he had a highly original approach to any problem, which led to fundamental contributions. Everybody knows him as the founder of the Indian Statistical Institute, the architect of the Second Five Year Plan, a close associate of Rabindranath Tagore and as one who had richly contributed to the social, cultural and intellectual life in Bengal. All those in the statistical profession are aware of his deep contributions to statistical theory, his efforts in providing a sound data-base to the Indian economy, and the part he played in placing India not far from the centre of the statistical map of the world. Those who have been closely associated with him have witnessed his indomitable courage and tenacity in fighting opposition for a good cause and clearing obstacles for propagating right principles. . . .We miss the Professor; the Professor who opened the doors of new knowledge for us, who encouraged and inspire us in our work and under whose care and protection we grew. Above all we miss his love and affection."

The Professor's spiritual evolution as revealed in his letter to his future wife, Rani, reproduced in Rudra's biography is fascinating: from rejecting faith in the particular God that is worshipped in the Brahma Samaj in favour of faith in something much bigger, and having no faith in a personal god, he became convinced that ideas of "Ananda" s constituted God. He later regretted missing s Personal God. He threw himself on Rabindranath Tagore with the plea, "please say something to me. I am drifting. Do say something." He was convinced that "My going to Rabibabu was in a way my salvation." His note on "Why Brahma Samaj needs Rabindranath" and his pamphlet "Brahma Bibaha Bidhi (Brahma Marriage Rules)" are also fascinating particularly for their positions on what it means to be Hindu, inter-caste marriages, inter-caste dining and other taboos of the period. Interestingly, when I was a student I was invited to the marriage ceremony of the Professor's niece at which the Professor officiated as the priest.

T.N. Srinivasan

The Professor's deep knowledge of the Vedas and Upanishad's led him to choose as the motto for ISI and all its activities the following verses from the Samvanana Sooktam of the Rg. Veda.

Sam Gacchadhvam Sam Vadadhvam Sam voe Manaamsi Jaanataam
Devaa Bhaagam yathaa poorvey Samjaanaanaa upaasatey ||

Samaano Mantraha Samitih Samaanee Samaanam manaha saha
Chittameyshaam
Samaanam Mantramabhi Mantrayey vaha Samaaneyna voe Havishaa
Juhoemi ||

Samaanee va Aakootih Samaanaa Hrudayaani vaha
Samaanamastu voe Manoe yathaa vaha Susahaasati ||

In translation it reads,

Proceed united in a right direction with dedication. All of you speak together in one voice. Let your minds have a unanimous perception. You remain united just as the Gods were united in getting their shares of the offerings from sacrificial fires (Yajnaas and Yaagaas).

Let your concerns be unanimous, let your meetings be for unanimous objective, let your thoughts lead all of you to unanimous insights. My prayer for all of you is same, my offerings into the sacrificial fire for the sake of you all together is same.

Let the inner feelings, thoughts and intentions of all of you be same and unanimous so that excellent unanimity prevails among yourselves.

Not only these verses are apt as a motto for ISI but also apt objectives for the nation.

The Professor and Rani Mahalanobis accompanied Tagore on his tour of Europe before the Second World War. The Professor took photographs of Tagore's meeting with Sigmund Freud in Vienna.

I recall vividly my reading a note by the Professor to the stream of visitors of the ISI on "How to See the Taj." Alas, it appears lost. I am unable to trace it anywhere in the ISI archives. The Professor considered himself an architect and his residence "Amrapali" at the Kolkata ISI campus and the campus itself bears witness to his architectural ideas.

I can never forget the kindness of the Professor and Ranidi to me personally.

