Applied Statistics for Development
Administration

by **William A. Neiswanger**

In opening the National Institute of Development Administration in 1966, the Prime Minister, H.E. Field Marshall Thanom Kittikachorm, said:

> " *The Government has decided to establish this Institute with the aim of expanding the scope and upgrading the standards of academic and professional training in the fields of public administration, business administration, development economics and applied statistics, which are essential to the development of the country.* "[1]

The unique educational objectives of the Institute derive from the two words in its title " Development Administration ". This phrase was originated by Dr. George F. Gant now Special Representative of the Ford Foundation in Southeast Asia when, as an officer in the Tennessee Valley Authority in America, he and his associates had the responsibility of administering a pioneering development project in a large depressed area of the United States.

Development administration as observed there had much in common with business administration but its scale, welfare objectives, complexity and social orientation set it apart. Today the scope of development administration in the less developed countries is nation—wide; its objective is to create a viable economy with a rising level of life; its complexity derives from the interaction among economic variables; from the dependence of each on the behavior of the economy as a whole and the dependence of the aggregate behavior on the parts which comprise it.

Put this scope, objective and economic complexity into a political environment where there are conflicting interests and goals; where motivations are apt to be clouded by individual self interest and conflicts for power and one wonders how any educational institution could develop curricula to teach individuals how to achieve the goals of development administration in such a milieu. Yet this, I think, is the mission to which the faculty of this Institute, the curricula and courses are devoted

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[1]National Institute of Development Administration, *National Institute of Development Administration Inagural Edition July 22, 1966* (Bangkok: Mongkol Karnpim, 1966), p. 11.

CHOICE OF TOPICS AND EMPHASIS

When one turns from the imponderables of education for development administration in general to a consideration of the content and level of a course of study in applied statistics for NIDA the problems are indeed simpler but by no means easily solved.

First I will deal with some of the easier decisions which had to be made in preparing these lectures.

It was clear from the beginning that they should be devoted to applied statistics. The purpose is to show how to obtain, from statistical data, information needed in development planning and administration. When statistical methods are applied to economic data, for example, there is in the solution an implicit and unavoidable combination of mathematics, statistics and economics. This will involve us in many difficulties. Each of these disciplines is "other worldly" in the sense that each rests on certain premises and when the conditions assumed in mathematical logic, in statistical analysis and in economic theory are not satisfied the use of them in combination to solve problems in "this world" may produce strange or even nonsensical[2] results. Assumptions in all three areas—mathematics, statistics and the field of application must be emphasized and the constraints they impose be understood if useful information is to be obtained by methods of applied statistics.

Professor P.C. Mahalanobis the distinguished head of the Indian Statistical Institute while not denigrating theoretical statistics has made clear the serious consequences to underdeveloped states when there is what he calls a "gap between theory and practice".[3] In these lectures, an attempt will be made to bridge this gap.

From this first decision another follows—these lectures in applied statistics are by no means intended to equip fully the young people in the less developed areas to do statistical work. Those who wish to become statisticians will have other courses both in mathematics and theoretical statistics which must be mastered if that role is to be played. In this work he will find a background in undergraduate mathematics to be an excellent foundation on which to build.

There was another easy decision—it was to include in these lectures what might be viewed as a basic core of descriptive and classical statistics. This should be included in any course of applied statistics whatever the area of application.[4]

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[2] William A. Neiswanger, *Elementary Statistical Methods*, Rev. Ed. (The Macmillan Company, New York, 1956), Chapter 13.

[3] "Statistics as a Key Technology" an address before the American Statistical Association on the occasion of its 125th Anniversary celebration, Boston, Mass., U.S.A. 1964 published in *The American Statistician*, April 1965.

[4] The core contains frequency distribution analysis; probability concepts and classical statistical inference. These materials plus sample design occupy the first 39 Lectures.

Within this basic core, however, questions arise as to the starting point and the treatment to be given the various parts—especially as to level, detail and exhaustiveness of explanations. The educational background of students in the less developed areas dictates the answers to such questions.

Exploration of that educational background lead to the next decision. The lectures must start on the core material at a very elementary level. The arithmetic processes and algebra used should be taught as the statistical methods are developed. A Manual for this purpose accompanies these lectures. This is for the reason that those who hold baccalaureate degrees from universities in the Far East, in economics for example, may have had no formal training in mathematics at any level. The low level start in these lectures may hurt the pride of the occasional mathematics major who is required to attend them. He should realize, however, that while is pride may be hurting a little the probability is high that he will be learning much about the use and meaning of some of the theorems he may have memorized.

A fourth decision was more difficult. It was necessary to decide what topics of applied statistics, outside the "core", should be included in lectures intended for students in the less developed areas. The answer would seem to be obvious—the choice should depend on the nature of the problems confronting such areas. That is to say, there should be no mere reproduction of what we put in our text-books in the more developed economies—there should be selections, additions and deletions. I shall attempt to show in the remainder of this lecture how and why choices made relate to the problems of the less developed areas.

Determining Conditions

Students of development economics recognize that in all development planning whether economic or educational it is first necessary to examine the existing conditions from which it is hoped the planned developments will take off. Three such conditions were found to be particularly important in preparing the topical outline for these lectures:

(1) the attained level of development and the unique problems of analysis at that stage.

(2) the kind, amount and quality of the data available for analysis in that society.

(3) the decision makers role in the processes of development administration under the conditions found to exist.

I will now attempt to demonstrate the importance of condition I by considering the unique problems of quantitative analysis in a developed market economy and then explore more adequately the same problems in less developed states. The thesis I intend to develop is that government controls intended to induce orderly

long—rang development are mainly **indirect** in the more developed mixed economics of the west and are mainly **direct** in the less developed areas of south and east.

Indirect controls operate through the markets and are used to regulate the aggregate behavior of the economy in general. Direct controls, in contrast, are applied to individuals and are intended to assign economic resources into one use rather than another.

The methodological implications of this distincton are important.

ECONOMIC GROWTH AND DEVELOPMENT
IN
ADVANCED MIXED ECONOMIES

The economy of the United States is characterised as a mixed economy, that is, the general economy is often thought of as being composed of two large sectors, a public sector and a private sector.

In the private sector where the market mechanisms are relied on to allocate resources—to industry, to trade, to households and so on—government controls are mainly used to influence the level of total economic activity. The purpose is to provide relatively stable economic conditions and growth rates sufficiently high to employ fully the expanding resources of the economy.

As has been stated the controls used for this purpose are **indirect** rather than **direct** and are called into play when the system is threatened with excessive pressures or, at the opposite extreme, with undesireable depressive influences. Very simply stated, expansive pressures are excessive when the aggregate demand of the public and private sectors taken together exceeds the capacity of the system to produce—with resulting inflation. Or, occasionally, the aggregate demand is not large enough to provide full employment of available resources. This is a condition conducive to deflation and economic instability in the short run with adversed effects on longer range economic development.

The indirect controls employed in the effort to achieve consistent long—term growth are fiscal and monetary in nature and they are used to expand or contract the aggregate demand for goods and services as the condition requires.

As you may remember from your elementary economics course, fiscal policy is usually made effective by (1) raising or lowering personal and corporate income taxes, or (2) decreasing or increasing public expenditures, or (3) both of these actions which may be used simultaneously in suitable combinations. Monetary policy works through controls over money and credit supplies as administered by central banks. I assume the devices used and their effects are familiar to you.

By following such policies as needed, economic forces are brought into play which influence the behavior of individuals who constantly watch markets for singns of expansion or contraction and adjust their actions accordingly. Each such observer—the merchant, the manufacturer, the banker, the importer, the invester, the householder—makes his own decision whether to expand or contract his inventories, his output, his credit, his foreign obligations, his investments or his savings.

It is mainly through the use of such indirect controls over the behavior of individuals on markets and hence over the economy in general that relative economic stability has been achieved in recent years while the economy as a whole has followed a long-term growth path at a desired rate of increase.

The public sector is much smaller and typically accounts for some 23 to 24 percent of the aggregate demand for goods and services in the United States. In general, the public sector includes those economic activities which, for one reason or another, do not receive desired allocations of resources through the automatic processes of competitive markets. The public sector is, of course. composed of many sub—sectors such as education, urban—renewal, highway construction, national defense, a variety of welfare activities and so on.

Legislative bodies, after much debate, make appropriations and hence allocate resources to specified sub—sectors. This direct action by federal, state and local governments by—passes the market mechanism through which resource allocation takes place in the private sector.

The way in which public and private sectors interact under fiscal policy controls is another subject you must consider in your advanced economics and statistics courses. It should be observed, however, that as total expenditures in the public sector, with its direct allocation to projects, becomes larger relative to those of the private sector indirect controls become less and less effective. In the United States the free market sector is of such size and sensitivity as to justify continued reliance on them.

Returning now to the question of educational policy and the content of lectures, it is interesting to observe how the use of indirect controls has stimulated the study of macro—economics and quantitative methods of analysis in the United States.

The Stage of Development and Quantitative Methods

If NIDA had a close counterpart in the United States it would no doubt reveal the same recent changes in emphasis and subject matter which graduate faculties in related fields have brought about there. In the area of economics, for example, there has been a maked shift toward mathematics in the analysis of macro—economic relations and in the use of quantitative methods. Advanced economic

analysis now involves the building of multi—equation models designed to simulate the economy or sectors of it and the estimation of the parameters of such systems of equations. The purpose is to measure the relations among markets and sectors and to show the influence of their behavior on some characteristic of the economy in general.

Young persons now in graduate schools of economics, therefore, study matrix algebra and related topics in mathematics along with economics, statistics and econometrics. Each of these subjects is needed if economic models are to be built and solutions obtained when actual economic data, with their unique problems of analysis, are used.

The attained stage of ecomomic development, the nature of the problems which emerge at that stage and the techniques used in coping with them have greatly influenced the direction of this educational development, The development is, in part, a response to the analytical needs of a society which places great reliance on indirect controls in solving its problems of stability and growth.

Perhaps it is obvious to you that the use of indirect controls in the large private sector and welfare associated direct expenditures in the public sector are essential features of a modern competitive system with its associated freedoms.

Now, after a very brief glimpse at the decision makers role when indirect controls are used, we will look ot some features of a "typical" less developed economy and see how they relate to our educational problem of teaching quantitative methods in these lectures.

Decision Making and Uncertainty

Those persons in the more advanced mixed economies of the West who are called on to make decisions as to what particular fiscal or monetary policy should be used in each case; how strong the action should be and when it should be applied are assailed by those uncertainties which harass all decision makers to greater or less degree depending on the extent of their ignorance and the importance of the decision.

Social as well as private benefits result when the level of uncertainty in economic planning and development administration can be reduced. It can only be reduced by (1) increasing the amount of relevant information or (2) improving our quantitative methods so that the data at hand can be made to provide more information or (3) combining both of the above effects. We will return to this subject frequently later.

ECONOMIC GROWTH AND DEVELOPMENT
LESS DEVELOPED ECONOMIES

It is obvious that the 92 less developed states listed by the United Nations Conference on Trade and Development (UNCTAD) in 1968, vary greatly among themselves and any generalization about them will be a less than perfect fit to any individual country. In listing some characteristic of less developed states which are relevant to the content of these lectures, I am thinking of states with per capita Gross Domestic Product per year of about $US 250 or less located in Southeast Asia.

Direct Versus Indirect Controls

The first generalization I will make concerning such economies is that direct rather than indirect controls are used in the less developed states in the attempt to achieve growth and development.

In making this generalization, it is recognized that ministries in less developed economies do give favored tax treatment to promote invesment in some desired projects. This is a direct use of the tax power to aid individual enterprises which is not included in the term fiscal policy. Monetary management is limited to regulation of the paper money supply in an attempt to avoid extreme inflation and stabilize the external value of the currency in terms of the US dollar or the British pound. No attempt is made to coordinate fiscal and monetary policy or to use either separately beyond these limited objectives.

Typically, in the less developed economies planning proceeds on a project by project basis. The various ministries of a government are asked to prepare proposals for development and to submit those to some planning office where decisions are reached. Many of the projects proposed will relate to the so—called infrastructure—highways power plants, harbors irrigation systems, universities, railroad lines and so on. Projects for the infrastructure must vie with other proposals designed, for example, to improve the balance of payments by stimulating the production of import substitutes; reducing the total value of imports by encouraging domestic assembly plants for foreign made parts; by developing promising local mineral deposits for export and so on.

The operational plan of economic development so generated in the less developed economies can, therefore, be thought of as a set of selected projects classified sector by sector[5] with projections of the expected level of output to be obtained in each year of the planning period. Operational plans of this kind rely on direct controls to bring about the desired growth.

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[5] as for example, (1) agriculture, forestry, fishing (2) mining (3) manufacturing (4) construction (5) public utilities (6) services including education, health.

Sometimes, of course, sector projections prove to be thoroughly unrealistic. This may be because the economy is unable to obtain from its own or foreign sources the necessary capital inputs to finance the projects on the hoped for scale. Possibly complimentary industries required to supplement or service the projected development are lacking. Perhaps it is discovered belatedly that a market for an import substitute does not actually exist. There are, of course, many way in which plans go awry. Lack of "facts" is a common cause according to Professor Stolper[6] as these illustrations suggest.

Hopefully to avoid such pitfalls most development planners attempt to demonstrate the feasibility of the plan as a whole. This demonstration usually requires aggregation of sector plans into large groupings. From these, attempts are made to forecast the capital requirements for the total plan: the amount of capital expected from each source such as private saving; government revenues, foreign loans and grants; the overall effect on the balance of payments, on the national debt and the magnitude of resulting inflationary pressures, if any.

A question has been raised whether such a collection of approved projects should be called a development plan unless there is some functional coordination among the many separate projects and unless they are, when viewed together, consistent with longer range national aspirations. Whatever the proper designation of such efforts there is little doubt of their popularity in less developed areas or of the hope reposed in them.

Reasons for Direct Controls

Economic conditions and accepted concepts of the role of governments explain this use of direct controls in our "typical" less developed area. As I list them please bear in mind that they have no special reference to any one of the 16 independent and less developed states of this area. Among the economic conditions which are relevant to our analysis are: (1) the unequal monetization of the economy; (2) the self-sufficiency of large populations in rural areas; (3) agriculture, typically insensitive to generally applied indirect controls, is the most important single industry; (4) other leading products are sold mainly on world markets which are usually uninfluenced by the fiscal or monetary policies followed in any one of the supplier states; (5) the scarcity of investment funds (due to the low per capita income); (6) the high marginal propensity to consume and, of course, the resulting; (7) low marginal propensity to save. Further (8) the existing supply of venture capital is controlled to a considerable extent by banks which are integrated into the political power structure and (9) monopolies and partial monopolies supported

[6] Professor Wolfgang F. Stolper, *Planning without Facts.* (Cambridge, Massachusetts: Harvard University Press, 1966).

by officers of government impede the flow of competitive funds. (10) The affiliation between established business enterprises and government, created through stock ownership in individual concerns by Ministers and other high officials and by membership on Boards of Directors by them, is a widely used method of business risk reduction in the "typical" less developed state.

The consequences of these various conditions which seem to explain the use of direct controls and their perpetuation are subject to much discussion in the "typical" state but to little if any, basic research. One conclusion relevant to our analysis seems justified, however: neither money, commodity nor capital markets exist with the form, scope or function required to make monetary or fiscal policy an effective instrument of development administration.

TOPICS OF METHODOLOGY

Now I will return to the thesis with which I started this discussion of the stage of development and its relation to the content of these lectures. In the less developed states where controls are direct, as I have used this term, planning involves a crop by crop, industry by industry, area by area analysis. Historical rates of growth are estimated for the varies series, projections of output are made and related to forecast requirements over the planning period. Finally, such estimates are brought together sector by sector.

Time series analysis and forecasting. Methods of estimating growth trends where time is the sole explanatory variable, the pitfalls of this simple method and the making of forecasts in the time series context must be explored in these lectures. This subject of methodology, important in the less developed states, has been almost completely phased out of modern texts produced in the more developed economics of the West. See Lectures 56 through 60.

Bayes theorem and decision theory. On the other hand, modern decision theory of the Bayesian kind has, as yet, made its way into only a few recent text-books on applied statistics. This subject is to be developed in these lectures. It will be explored partly to show a logical method of structuring a decision problem; partly to show how probability theory can be used by the decision maker when he is confronted by events he can neither control nor forecast; and partly to show how to choose among various alternative in view of the payoff expected from each and the associated probabilities.

The ultimate purpose is to enable the decision maker to choose the best course of action among the alternatives presented. This is, in grand scale, the essence of the problem confronting those who would allocate resources by direct controls. In smaller scale, it is also the essence of the policy problem which confronts the business executive in deciding how to use the limited resources of the firm.

Unfortunately, much of the data needed for the pay-off table may not exist and the probabilities used will be entirely subjective, initially at least, but the logical processes of decision theory, once understood, will endure as an intellectual tool until data supplies become more adequate. As one of NIDA's graduate students said after being introduced to modern decision theory "I like it very much. I understand it and it has completely changed my thinking about decision problems." I hope that you may come to share this student's understanding. See Lectures 59 through 83.

Regression analysis and forecasting. These topics are usually treated in modern texts but the emphasis should be changed for our use. In the less developed areas, simple bivariate models are excessively used. These simple models must be understood by development planners and administrators; their limited usefulness explained and the substantially improved analysis and quality of estimates obtained from multi-variate analysis must be demonstrated. Also, methods of appraising the usefulness of results need to be elucidated. I hope to show in these lectures that no regression or correlation results should be accepted, unless certain tests are made using appropriate methods of classical statistical inference. Gross errors in estimates may otherwise result though, when superficially viewed, the correlation may seem very convincing. The question: Why do we sometimes get nonsense results? is particularly relevant here. See Lectures 45 through 55 and 61 through 68.

The construction and use of index numbers. Price index numbers play large roles in development planning and administration. All development administrators carefully observed their behavior as signals of inflation or deflation. Planners necessarily record many economic magnitudes in monetary rather than physical terms. When it is necessary to transform the monetary values to "real" terms index numbers have to be used, for better or worse.

Index numbers need more than traditional treatment in countries which are only now attempting to fill their kit with the statistical tools required for development planning and administration. See Lectures 40 through 44.

Input-output tables and their use. My colleagues in quantitative analysis will be greatly surprised to see that input-output tables are discussed in these lectures. The surprise is because the data traditionally reported in these tables have not yet been developed to the point where they can be treated statistically—they contain no error estimates—but the data and their arrangement are of such basic importance in the intellectual preparation of development administrators that all students should see the form the tables take, the meaning of technical coefficients and how expansion in one part of an economy is repercussive throughout.

Again, none of the economies in this area of Southeast Asia have the data to complete any but the most aggregative tables of this kind—but no one having

studied the structure of input—output tables and their interpretation will ignor the interaction effects and fail to make some, perhaps crude, allowance for them. See Lectures 84 through 90.

Errors, their measurement and control. As can be seen by looking at early lectures the reliability of statistics is stressed from the outset. The need for this emphasis on errors, their measurement and control in the less developed areas is patently clear.

Sample design and data collection. Finally, the topics of sample design and data collection must be included in these lectures. These topics, which traditionally have had but little emphasis in texts on applied statistics are of first order importance in the less developed parts of the world, as we will now see.

AVAILABILITY OF DATA

A second major consideration effecting the content of these lectures relates to the kind, amount, and quality of data available for analysis in a society.

In his **Planning without Facts**[7] Professor Stolper says: *"'Lack of Facts' suggests to a planner first of all lack of statistics. And indeed, statistics, especially in underdeveloped countries, are neither plentiful nor easily interpreted. No economies can do without them; he will make use of all the statistics he can get his hands on, and he will, of course, organize the collection of more and better statistics."*

This typical lack of information in the less developed states is due partly to their recent origin in their present political form. In this part of the World, for example, Laos, Cambodia and Vietnam emerged from colonial rule in 1954; Burma in 1948; Singapore and malaysia become separate states as recently as 1965; Indonesia, independent since 1945, came to include West Irean only in 1963. Two of these countries have yet to make their first census of pupulation[8] and information is almost non—existent relating to economic activities in large areas or states within large federations.

The withdrawal of the French, British, and Dutch administrators in the post World War II era was also a contributing factor to the present scarcity of statistical information. It become necessary for a new group of civil servants to take over governmental functions without preparation for the statistical aspects of their works.

It must be realized too that the collection of data for economic development has had and continues too have a very low priority in many of the less developed areas. This is partly because of the more urgent problems encountered in establishing

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[7] Op. cit. 4—6

[8] Laos and Vietnam.

new governments; in organizing institutional forms; in working out tax systems; in raising funds; in preparing for national defense and in making the necessary compromises required to create a reasonably stable power structure at home and desired foreign relations abroad.

This low priority on information essential for planning can also be attributed to a belated awareness that the statistics traditionally gathered, mainly as a by—product of tax administration and tax collection of imports—export duties, are not adequate for the new proposes. In long establish states like Thailand, for example, it is only since 1964 that an attempt has been made to bring together a coordinated set of national income accounts. This effort painfully revealed to Thai economists the voids and gaps in available information whic typically exist in less developed countries.

The paucity of basic data continues to be tolerated for a variety of reasons. Gross errors in statements of targets, estimates of need and appraisals of performance may never be known and their cost to the community in wasted resources never appraised. Ignorance is not bliss but in such cases it may contribute to social and political stability—not to mention the employment of those who do the estimating. We must recognize too that some useful services can be performed by statistical estimates containing large and unknown errors. For example, in critically important negotiations with representatives of the more developed economies where the purposes is to obtain credits and grants for development purposes, the per capita income statistics supplied by the underdeveloped countries are recognized by all parties as only very rough approximations design to support the generally accepted fact of poverty.

Similarly the reliability of data may not matter much when economic planning is used in a relatively burgeoning economy mainly to permit the government in office to claim credit for the expected growth. In this case, economic planning is essentially a political strategem and its statistical basis is relatively unimportant.

We will assume, however, that in our "typical" less developed country, statistics are not used for window dressing but are employed in the serious business of inducing growth and development when it might not, otherwise, occur.

Sample Surveys versus a long wait. The quality and effectiveness of economic planning in the less developed states will suffer for many years if a policy is followed of getting new information by waiting to observe the behavior of the economy and its parts as the years go by. The quickest and the best way to narrow the information gap is to design and operate sample surveys of the probability kind. The design of sample surveys of human populations is a topic which has been phased out of most text—books on applied statistics written in the developed societies. This topic has been phased out mainly because the lesson has been learned by those who

collect and interpreted sample survey data in those societies and the techniques are now widely accepted by practitioners.

The less developed societies are typically badly in need of persons expert in this phase of applied statistics—persons who not only know how to design sample surveys in the modern manner but who know also how to employ the methods of statistical inference in interpreting the results. In obtaining these skills, development planners and administrators will also learn how to distinguish among the various kinds of errors; how some kinds of errors can be reduced and how other kinds should be appraised and their influence considered in reporting results, in establishing needs and setting targets. For such reason as these Lectures 14 to 30 are devoted to the problem of sample design, sampling errors and classical statistical inference.

Omitted topics. Topics in applied statistics which might have been included in these lectures include variance analysis, except for that part which I have treated in the section dealing with correlation. This is the greatest loss from a conceptual point of view. From the standpoint of teaching satisfaction, nothing could equal the explanation of modern methods of estimating parameters in multi—equation models. Why commonly used least squares methods are now called naive and why two or three stage least squares methods or other more sophisticated methods are better will have to wait for other more advanced courses. An understanding of these methods requires, as a minimum, matrix algebra and this cannot be taught as an aside in the Manual in view of the very modest initial preparation in mathematics which can be assumed.

From a practical standpoint, however, it will be years before economic planners and administrators in the "typical" less developed economies will have enough information on sufficiently complex problems to require the analysis of models of the kind now so popular in the more developed economies of the West.[9] The actual loss in effectiveness by the omission of this topic from the lectures is therefore probably very small.

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[9] See W. Arthur Lewis, *Development Planning the Essentials of Economic Policy* (London: Unwin University Books, 1966). Chapter 1 for an elaboration of this view.