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MEASURES OF EFFICIENCY FOR FAMILY PLANNING EVALUATION

By
George B. Simmons

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George B. Simmons

During the past ten years evaluation and management specialists. have separately developed procedures for assessing program performance. In a paper which will eventually be published by ESCAP, I have tried to outline procedures for measuring efficiency and some uses to which efficiency measures can be put.

We were not aware at the time of writing this material of the extensive literature on management information systems. It is our impression that it should be quite positible over the next few years for these literatures to be better integrated, that is for the evaluation techniques to be better developed for use as managerial tools. What follows are some selected passages from the ESCAP manuscript which may help to further discussion among management experts on this subject. The full report can be obtained from ESCAP.

CHAPTER I

Conceptual Framework and Objectives

A. Efficiency as a tool for evaluation

Since the central purpose of evaluation is to collect and analyze information that can be used eventually for decision-making purposes and because decisions relate to a wide range of issues made at different levels, it is necessary to have a variety of evaluation tools appropriate for different purposes. "Efficiency" is understood in the evaluation literature to describe the way a programme utilizes the resources at its disposal; typically, it is measured as a ratio between inputs and outs. It is contrasted with "effectiveness" which measures the extent to which a programme achieves its goals. Statistical measures relating inputs to outputs can serve many purposes within a family planning evaluation system but before discussing uses for these efficiency measures some indications of the theoretical context is appropriate.

B. The Theoretical Basis for Measurement of Efficiency

The economic model of production can serve as a useful framework of the analysis of evaluation issues which relate to efficiency. Within the economic model, there is an attempt to separate out technical issues relating to the way in which resources can be combined for production and the economic issues regarding which particular method of production is likely to be most appropriate for producing a given commodity. The technical side of the production function is a specification of the relationships between the resources used in producing a given commodity and the amount of output of that commodity which is produced on the assumption that the resources are used efficiently in a technical sense. That is, for a given level of resources the production function indicates the maximum achievable output. Conversely, for - - -

a given level of output the production function describes the minimum required levels of inputs.

Production units which use one of those combinations of inputs which are specified in the production function are said to be "technically efficient." However, for reasons which we will examine below, a unit may be characterized by technical inefficiency; that is, it will employ more resources than are minimally required to produce a given output. The existence of technical inefficiency has not been extensively treated in economic literature, but nevertheless remains an important consideration.

Production decisions are affected not only by the nature of the production function, but also by the nature of the economic constraints operating in the environment. Thus, there will be some restrictions on the resources available to the producing unit, in the form of prices which the producing unit must pay for those resources. Not all input combinations which are technically efficient are equally costly. If labor is expensive and equipment relatively inexpensive, it will be economically more efficient to choose a production process which uses a relatively higher ratio of equipment to labor than would be the case if labor were cheap and equipment scarce. Thus, a production process can be economically inefficient even if it is technically efficient. Such inefficiency is defined by the possibility that the cost of producing a given amount of output is not held to a minimum or that increases in output could be achieved by changing the mix of inputs without increasing the overall level of expenditure.

The difference between a production unit's observed costs and those cost levels attainable with technically and economically efficient production has been called "X-inefficiency" by Liebenstein.[1] It is generally presumed that, in the private sector, a firm operating in a compototive industry must produce efficiently or face being driven out of business. For firms whose markets are more protected, however, inefficiencies may arise. In the case of a monopoly, for example, there is little risk involved in allowing unit costs to rise above the minimum since, at least within a range of cost increases, the firm's existence will not be threatened. The manager, therefore, may not have a strong incentive to cut down on waste. In fact, he may receive substantial personal benefits from non-productive activity, in terms of the ease of running the firm, professional interests, or executive prerequisites. For instance, a manager might choose not to lay off obviously unproductive workers for fear of provoking labor unrest, or he and his staff may attend more professional conferences than their management tasks would justify. To the extent that such X-inefficiency is allowed to occur, the manager is in effect trading off investor profits for the rewards of other activities which are, for him, sources of positive utility.[2] He is limited in the degree to which he may substitute unproductive activity for profits by the responsiveness of capital markets, the risk of detection and the nature of the production process.

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[1] Liebenstein, Harvey, "Organizational or Frictional Equilibria, X-Efficiency and the Rate of Innovation", Quarterly Journal of Economics, November, 1969, pp. 600-623.

[2] Williamson, Oliver. The Economics of Discretionary Behaviour: Managerial Objectives in a Theory of the Firm. Englewood Cliffs, New Jersey: Prentice-Hall, 1964.

The distinction between organizational and personal managerial goals becomes even more pronounced in the public sector. As has long been recognized, most public bureaucracies, including the staff of family planning programme, operate without any effective competition. Production can therefore occur at higher than efficient costs without jeopardizing the existence of the organization. Furthermore, it may be very difficult to define and measure public sector output, much less to specify the efficient relationship between program inputs and outputs. Thus, even though the rules of recruitment and operating behavior for public service may be designed to avoid personal abuse of the system, other sources of inefficiency may arise. The environment of family planning service delivery in developing countries may place considerable strain on productive efficiency. Local clinic administrators are often quite vulnerable to political pressures exerted on behalf of their workers. In rural areas it may be that the quality of management suffers because the best managers would rather not sacrifice their professional contacts and goals for the demands of rural service and so those managers who are pressed into service may exhibit only an indifferent attachment to formal family planning goals.[3] In these circumstances, it would not be surprising to find that a substantial amount of X-inefficiency exists.

Even if only technically efficient production processes were chosen and inputs were combined so as to minimize the cost of production at every level of output so that the producing unit was operating at some point on its long-run average cost curve, there still remains the possibility that

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[3]Misra, B.D., Ashraf, Ali, Simmons, Ruth, and Simmons, George B., "Organization for Change: A Systems Analysis of Family Planning in Rural India" (forthcoming book), 1979.

a producing unit would operate inefficiently because of an inappropriate choice of the "scale" of activity. Scale refers to the number of units of output generated by the producing unit and in terms of family planning program it may refer to the number of acceptors or the number of births prevented. Scale may vary as the result of either a variation in the number of eligible couples from which a program recruits "acceptors" with the acceptance rate remaining constant or from a change in the acceptance rate with the number of eligible couples remaining constant or from a combination of both. Since in this study we will be referring to the evaluation of family planning in public programs where the geographic unit (and thus the number of eligible women involved) cannot be raised at the discretion of program administrators, we will assume that "scale" refers to changes in the number of acceptors from a population of a given size.

First, unless there are constant returns to scale over the relevant range of interest (and that seems unlikely if we assume a fixed number of eligible women in a given region), then it is to be expected that the average costs will vary over the possible range of output and that beyond some level average cost will be rising. Thus, alternative scales will involve different costs per unit of output. Second, the fact that average and marginal costs will vary implies that there may be an optimal scale of activity where the net gain from a given unit's activity is maximized. It is an elementary principle of efficiency analysis that whenever possible, the global level of activity among all producing units should be pushed to the point where the net social gain is maximized. This principle has as a corollary that the level of activity should be set at an optimal level for the independent sub-units as well. Scale should be increased until the marginal cost of a unit of output equals the marginal benefit, of both the entire program and of the sub-units. Anything less than the scale associated with maximum net social gain is inefficient in the sense that an opportunity is being lost to add to social well-being (See Figure 1.1). Moreover, within a program, if the existence of a budget constraint makes it impossible to achieve global optimization, then efficiency still suggests that the marginal gains per unit of expenditure should be the same in all programs. Thus, scale is extremely important as a determinant of global efficiency.

There are a number of ways in which scale efficiency can be approached. Much of the health literature, for example, has been devoted to the determination of scale economies and the point of minimum average cost of production for various kinds of medical service delivery systems. The assumption implicit in this long-run scale analysis is that the producing unit is small relative to the total demand for output so that the relevant question becomes the extent to which scale economies - that is, decreases in unit costs - can be achieved by altering the number of producing units so that each remaining unit's output is produced at minimum cost. If substantial scale economies do exist, then there is a justification for such a reallocation of market shares. However, this kind of analysis sidesteps the question of the optimal level of output because it deals exclusively with average and marginal costs. Thus, the determination of marginal benefits and of the point of global efficiency - difficult issues especially with regard to public sector programs - has been left unresolved. For the purpose of evaluating the operational efficiency of sub-units in a national family planning program, it is appropriate to assume that scale as measured by the number of acceptors in the region served by a unit is, at least after a point, somewhat beyond the jurisdiction of that unit. The central question to be addressed in this study, then, is within the range of output achievable by a given unit, how well has it performed?

In summary, an economic analysis of production divides the question of efficiency into several sub-components. First, the economic analysis would attempt to define a production function as being the set of technically efficient combinations of resources which produce a given output. Second, given that definition of a production function, the analysis would then proceed to define the maximum output that could be produced with a given budget. This procedure is equivalent to choosing, among a number of technically efficient input combinations, the one combination which has the least cost. Finally, the economic analysis would examine the question of the optimal level of output of a given commodity, given the nature of the market for that commodity, or in the case of public production, the nature of the benefits that could be expected from that activity. That is, choosing the optimum scale of productive activity would involve choosing the economically efficient input combination which maximizes the net gain to society.

The key problem for the analysis of empirical data regarding efficiency, especially in the process of evaluating programs, is to separate out these three kinds of efficiency.[4] The separation of technical efficiency and economic efficiency on a given scale of output is particularly awkward. Oftentimes, the data which we are given for the evaluation process are too limited to make a complete distinction between these two measures of efficiency, and even under the best of circumstances distinctions of this kind depend heavily on the assumptions that are made in the analysis.

In the effort to realize greater efficiencies, evaluative systems in general and input-output ratios in particular may serve to generate comparative norms which will affect production decisions. Two general types of decisions are likely to be improved through the use of input-output or efficiency measures. The first one concerns the optimal scale of activities in a family planning programme and its subprogrammes, and involves comparison of the unit gain from an activity to its unit cost. For this kind of analysis it is particularly important that the measurement of costs take into account the opportunity cost to society of a given use of resources. This opportunity cost is not necessarily identical to the financial cost of the resources. Moreover, it is important that both costs and benefits be measured in units that are commensurable.

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[4]Wheeler, J. Economic Efficiency and Optimum Scale in the Production of Ambulatory Medical Care Services. Doctoral Dissertation: University of Michigan, 1976.

Hoch, I. "Estimation of Production Function Parameters Combining Time-Series and Cross-Section Data," Econometrica 30 (January 1962), pp.39.

Boaz, R. "Manpower Utilization by Subsidized Family Planning Clinics: An Economic Criterion for Determining the Professional Skill Mix." Journal of Human Resources 7 (Spring 1972), pp. 191-207.

Ideally both might be measured in terms of some well accepted social welfare criterion.[5] But this use of input-output relationships is the subject of cost-benefit analysis and will not be discussed in detail in this work.

The second use of input-output analysis is in making evaluative judgments concerning the performance of individual subunits in a programme by assessing how well resources are used for the accomplishment of programme objectives. Such judgment could provide the basis for decisions concerning allocation or reallocation of resources to different subunits and organizational restructuring, and distribution of rewards to the personnel responsible for particular levels of performance. It is this use of input-output relationships which is the primary focus of the empirical work presented in this report.

The two major uses of input-output statistics described above are closely related. In economic decision-making, measures of unit cost (e.g., cost per birth averted) are compared with unit benefits to establish the prospective or retrospective national gains from the activity. If one is able to calculate the costs and the benefits of different levels of programme activity then it should also be possible to estimate the marginal benefits and costs. Figure 1.1 indicates schematically the

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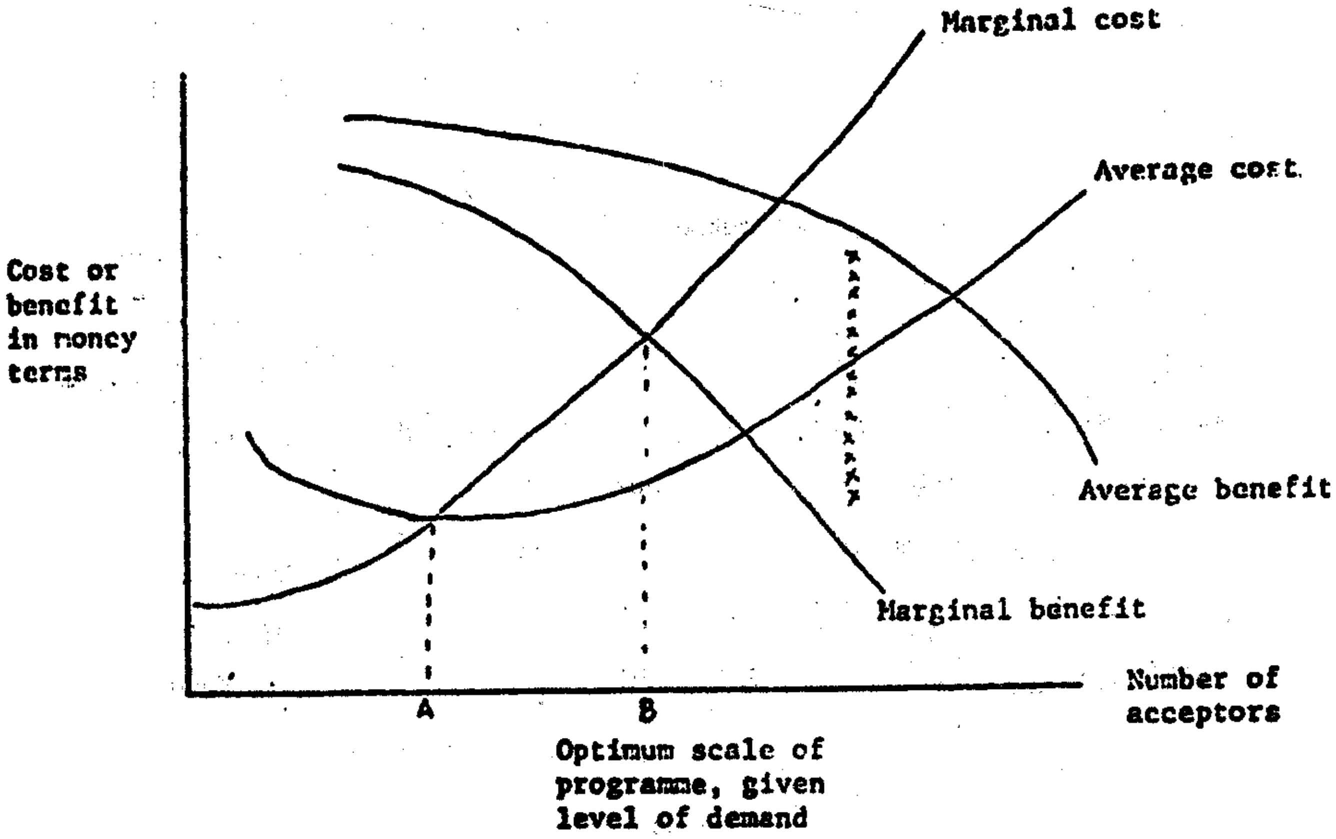
[5]See George Simmons, "Public Expenditure Analysis and Family Planning Programs".

On commensurability see Warren Robinson, "The Methodology of Cost-Benefit Analysis of Expenditures on Population Control Programmes," The Population Debate: Dimensions and Perspectives, Papers of the World Population Conference, Bucharest, 1974 (New York: United Nations, 1975), pp. 550-559.

See also R. N. Grosse, "An Introduction to Cost-Effectiveness Analysis," reprinted in Cleland, David, and King, William, Systems Analysis and Project Management, New York: McGraw-Hill Book Company, 1968.

Figure 1.1


Marginal cost
Average cost
Cost or benefit in money terms
Average benefit
Marginal benefit
Number of acceptors
A
B
Optimum scale of programme, given level of demand

different average and marginal costs and benefits associated with diff ent programme scales.

Under our assumptions about the nature of family planning program the average and marginal costs associated with the programme may vary from one programme scale to another. The examination of these measures for different programme scales suggests that the optimal level of activity from the point of view of resource allocation will come where marginal benefit equals marginal cost; that is, at the rate of output corresponding to point B. Programme activities beyond that point would lead to marginal costs greater than the marginal benefit. It should be noted that point B is in the range of output where, in our diagram, decreasing returns to scale apply. Scale efficiency is attained at point A, at minimum average cost. Given the level of demand faced by the producing unit, the optimum rate of output---that which maximizes total program benefits---may not occur at the scale-efficient point. It should also be noted that the average or unit cost beyond the optimum point B may remain below the average benefit; thus one should attempt to distinguish between average and marginal effects. This type of analysis and conclusion illustrates the first use of efficiency measures previously discussed. It should be observed that decisions concerning programme scale will require information regarding the average and marginal benefits for each programme scale in addition to the information on average and marginal costs.

The diagram also indicates another possible source of confusion in the interpretation of cost/benefit or input/output ratios. Assume that the diagram refers to the activities of a typical clinic within a system such as that in India where the clinic (a PHC) is the basic unit in the delivery system. There are, of course, many hundreds of clinics offering services. At any given scale of activity there are likely to be a large number of clinics, and their average costs may vary a great deal as indicated by the set of x's on the diagram. Their differing cost structures will result from the underlying variation in the technical and economic efficiency of the unit. If there exists a deterministic causal relationship between the use of resources in a family planning programme and the output, one would expect the ratio of inputs to outputs to remain constant among the various subunits which operate with the same resources in the face of the same environmental conditions. In reality, however, the costs per acceptor vary a great deal from one unit to another as the result of both random influences and as a result of different levels in the skill with which resources are used. It is this measure of level of impact of using a given set of resources that is given the same "efficiency" in common language. Units which accomplish a great deal with a given set of resources are said to be efficient; those which do not are termed "inefficient". From our earlier discussion it should be clear, however, that this common notion of efficiency has both technical and economic components.

Thus, there are basically two interpretations that can be placed on differing input-output ratios. First, they can be taken to indicate the levels of cost associated with programme scale, and second, they can be taken to indicate the efficiency with which resources are used in a given programme at a given scale of operation. In the second use it may be meaningful to say that a subprogramme with lower unit cost is performing better than a subprogramme with high unit costs, but in the first use there can be legitimate variations in unit cost that result from programme scale. Since the basic efficiency indices will not indicate perfectly which of these interpretations is most appropriate, a crucial task analysis will be to distinguish between the two.

There are many additional problems in the empirical analysis of efficiency. One particularly difficult problem is choosing between the efficiency and effectiveness implications of a programme status. For example, one must be extremely careful to guard against the conclusion that lower average or marginal costs are necessarily indicative of a higher level of performance. As figure 1.1 indicates, there is no reason to think that, given the level of demand, the optimum level of activity will be one where the cost per acceptor will be minimized. Quite to the contrary, it may be that average cost will be much higher than the minimum and that this expenditure is fully justifiable if the expected benefits are sufficiently large. If comparisons between clinics are based on average costs alone, then there may be a perverse incentive for managers to minimize these costs even if that means that they operate at a sub-optimal level.

B. <u>The Empirical Measures of Efficiency</u>

As the preceding discussion indicates, three kinds of data were required for the study: data relating to programme outputs, inputs, and environmental characteristics of the subunits. A discussion on the nature and measurement of these data as well as a description of the kinds of data that were actually collected in the participating countries is given in the following chapter. In this section we shall explore the types of analysis to which input-output data were subjected.

Although there are a number of possible input-output relationships that might be employed as measures of efficiency, three measures were considered.

Ratio Measures

1. Productivity Meausres: couple-years of protection (CYP) or per acceptor of a particular method per man-hours or other inputs. (This category would actually consist of a set of indices - one for each type of input).

2. Cost-Effectiveness Measures: cost per CYP or per acceptor of a particular method.

Complex Measures

Efficiency Index -- an index based on the difference between actual observed output of a subprogramme and the output expected on the basis of some estimated statistical relationship where environmental influences have been controlled.

Each measure of efficiency could be reasonably defined for each of the subunits in the national family planning effort and for each time period. If the programme consists of several independent subprogrammes (defined in terms of programme method, forms of delivery, etc.) and each operates in many geographic regions, obviously the number of possible efficiency estimates that could be generated would be enormous. Most of the work reported here concentrates on the efficiency of subprogrammes as defined by geography. In the original study design, it was hoped attention could also be given to the dimensions represented by contraceptive type and method of delivery, but these topics are discussed only in the country reports and not in great depth.

Two varieties of problems were anticipated in the use of each of the measures described earlier. First, there would be difficulties in computing some of the derived indices due to the lack of data or the complexity of the calculations required. The second type of problem related to the adequacy or inadequacy of the measure itself as an indicator of efficiency.

As rough indices of efficiency, the ratio measures (1 and 2) described above are appropriate to the extent that the problems discussed earlier in this chapter can be avoided. The first index would consist of a series of ratios, one computed for each major input into the programme. The principle drawbacks of these ratios are that they do not always permit a distinction between the role of scale and other factors affecting efficiency, they do not identify contributions from the individual factors of production, and they fail to take account of the particular circumstances affecting the work of a region or clinic. For example, two clinics may score the same on either of these measures of efficiency, but one clinic may be situated in a region where the working conditions are much less favorable to the acceptance of family planning than in the other. The administrator who used such measures to decide the allocation of resources or to give rewards for performance would have to take special account of the circumstances involved.

Complex measures such as the Efficiency Index can help to overcome these problems, but only at the expense of greater difficulties in estimation. The estimation procedure used is that of multiple regression, where the relationship between family planning acceptance and a number of other inputs could be estimated using an equation of the form:

$$O = f(I_i, E_j)$$

where O is a measure of the output of a family planning programme, I_i, are measured inputs into the family planning programme, and E_j, are the key environmental influences on family planning acceptance. Variables are defined in terms of ratios per eligible woman or per unit of population to avoid an excessive influence of variation in the population of the various geographical regions. The equations in this study are stated in linear form or in log linear form, although other functional forms merit exploration in any follow-up research. This estimated equation is then used to calculate the expected level of acceptance in a particular region, and the deviation from that expected performance taken as a measure of the clinic's performance. The resulting measure is considered to be an improvement on the simpler input-out measures.

Equations such as those used in the calculation of the Efficiency Index have been estimated by Hermalin[6] and Schultz[7] for Taiwan province of the People's Republic of China where sufficient data exist to use the level of fertility as the dependent variable, by Simmons[8] for India,

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[6] Albert I. Hermalin. "Taiwan: Appraising the Effect of a Family Planning Program Through an Areal Analysis", Taiwan Population Studies Working Paper No. 14, Ann Arbor, Population Studies Center, University of Michigan (mimeographed).

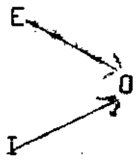
[7] T. Paul Schultz, Evaluation of Population Policies: A Framework for Analysis and its application to Taiwan's Family Planning Program. A reported prepared for Agency for International Development. Santa Monica, CA: Rand Corporation, June 1971.

[8] George B. Simmons. The Indian Investment in Family Planning, Bridgeport, Conn.: The Population Council, 1971.

by Laing[9] for the Philippines, and by T. Johnson[10] for Malaysia. Typically, the principal measured input into family planning was the number of man-months of staff time, and the chief environmental controls were variables such as literacy or child mortality. The general statistical theory associated with the use of multivariate analysis for the study of areal variations in contraceptive use in fertility has been discussed in a distinguished paper by Hermalin.[11]

In simple formulation, output is assumed to be a function of both the inputs which go into a family planning program and the environment into which that program is introduced. This framework could be described as follows:

Model II



where E represents the environmental variables, I presents the inputs variables and O represents the output variables. The model suggests that

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[9] John E. Laing, "Family Planning Clinic Density and the Acceptance Rate: Evidence from the Philippines", Manila, Population Inst. (mimeo) 1972. See also his very helpful review of the density lead literature, "The Density Lead: Summary of Current Status", Draft, October 74, mimeographed memorandum to ICARP members.

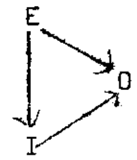
[10] T. Johnson, Evaluation of Family Planning Programs: Presentation of A General Model ... Dissertation, 1973, U of M., School of Pub. Health, Ann Arbor, Michigan.

[11] Albert I. Hermalin. "Regression Analysis of Areal Data", Chap.8 in C. Chandrasekharan and A. Hermalin. eds. Measuring the Effects of Family Programs on Fertility, Fregi, Belgium, Int. Union for the Scientific Study of Population, 1976. pp. 245-299.

the input and the environmental variables have separate and additive effects on acceptance. In this model, single equation linear regression techniques may be the best way of estimating the empirical relationships.

A second way of describing these relationships would be to permit the environmental variables to affect the input variables as well as the output variables. Thus the model would be modified to look as follows with the variables given the same interpretation as in Model I:

Model II:



In this case the quantity of inputs is affected by the environmental conditions which prevail. Staff, for example, may be reluctant to live in very remote areas which lack facilities. In such circumstances the environmental characteristics of a region may affect output both directly as in Model I and indirectly through their effects on the quantity of inputs. Within this framework, for many purposes it is necessary to distinguish these two effects and therefore a somewhat more complex empirical strategy may be necessary.

There are a number of complex issues associated with empirical work in this area quite independent of which model is chosen. One major issue relates to the choice of variables for analysis, for the list of potential variables measuring both program inputs and environmental influences is much longer than could be used for detailed analysis. A second major issue of importance to this study concerns how to deal with number of people residing in the unit of observation. Doubling the population to be served in a region may affect each relationship between input and output variables in ways that cannot easily be understood merely by treating this cale factor as an environmental variable. These issues are discussed in more depth in the context of the analysis included in Chapters III and IV.

But despite the advantages of the suggested efficiency measures, some serious problems remain. Neither all of the environmental influences nor all of the changes over time can be adequately treated by these measures. Thus, it may be desirable to supplement these measures of efficiency with additional information indicating changes over time.

CHAPTER II

Descriptive Measures and Relationships Among Variables

Previous chapter has described the background to this study, its theoretical underpinnings and the way in which the data were collected. Both this chapter and the following chapter describe empirical relationships which were discovered and their use for evaluation. The focus in the present chapter is on a description of the basic variables that were collected and a preliminary view of the relationships among some of the important variables. Some attention is given to the basic findings from the four studies, but in the interests of making a clear presentation, the treatment is necessarily somewhat selective. The individual country reports contain a more detailed description of many of the results.

Since the primary focus is on efficiency at the sub-program level, the unit of observation is the local geographical area, which is in most cases the basis for service delivery. Thus, in India the unit of observation is the primary health center or the block, and in Korea it is the rural county or the urban ward. In both instances these local regions are also the basic unit in the delivery system of the program, i.e., there is a single unified delivery system in each of the local units which provides most of the publically sponsored services offered in the area. In Malaysia the unit of observation is the district, which is the basic unit of delivery but which may have a number of clinics. In the

Philippines the unit of observation is the municipality which may have more than one clinic organized in some cases by different groups.

Any attempt to measure efficiency should be based on a theory of production. The theoretical structure gives meaning to the empirical results. In chapter I a general theory of production in family planning was introduced. Output is assumed to be a function of both the inputs in a family planning program and the environment into which that program is introduced. This framework is a point of departure for defining the variables which are of primary interest for the development of useful measures of efficiency.

There are a number of difficult issues associated with empirical work in this area quite independent of which theoretical approach is chosen. One major issue relates to the choice of variables for analysis, for the list of potential variables measuring both program inputs and environmental influences is much longer than could be used for detailed analysis. A second major issue of importance to this study concerns how we deal with the number of people residing in the unit of observation. Doubling the population to be served in a region greatly affects the relationship between inputs and output variables in ways that cannot easily be captured just by treating this scale factor as an environmental variable. These and other empirical issues will be discussed in the context of the substantive discussion in the remainder of this chapter.

A. Descriptive Statistics for Variables Collected in the Four Countries

Tables II-1 through II-4 present a basic set of descriptive statistics for selected variables from the four studies. Variables included in the table fall into three categories: those which pertain to inputs, those which relate to outputs, and those which measure some aspect of the environment in which family planning is undertaken.

For most of the discussion in this report we have concentrated on a short list of selected variables. For example, the environmental variables included in this discussion represent only a small portion of all the environmental variables that might have been included, but since many represent alternative measures of roughly the same phenomenon we have chosen to deal with a relatively small number. Similarly, we deal mainly with aggregated measures of staff size or budget rather than with the long list of disaggregated variables.

These administrative units vary in size from one country to another and within countries. While in the Philippines, most of the municipalities are relatively small, in the other three countries the observed units tend to have more than 10,000 eligible couples. For each variable, a mean, a standard deviation, coefficient of variation, and the upper and lower ends of the range of observed variation are presented. It will be observed that there is no consistent pattern in the way these descriptive statistics vary among the different countries. For example, in the case of the Philippines, there tends to be a great deal of variation in the amount of inputs and outputs which are available in each municipality while in Korea the variation in these observed variables tends to be much less. India and Malaysia tend to fall somewhere in between these two extremes. In each country, some environmental variables also have relatively high coefficients of variation. Often these variables reflect the degree of urban influence in a given areal unit. In part, the degree of variation in the observed variables is a function of the degree of homogeneity in the size of administrative units. For example, in India primary health centers or blocks tend to be defined on the expectation that the population which they serve will be on the order of 100,000. There is no such expectation concerning the size of population of a Philippine municipality or Korean county, and as is clear in the measures of the range and the coefficient of variation the total population of the units can indeed vary a great deal. The magnitude of this variation is particularly great for the Philippines.

The importance of variations in the size of the population of eligible women can be illustrated graphically. Figure II.1 shows the variation in some of the basic output variables among the units observed in Korea. The upper panel in the figure shows the variation in the absolute number of acceptors while the lower panel shows the distribution per eligible woman. The distribution of the total number of acceptors is highly skewed and somewhat irregular while that for the acceptor ratio is much more regular. Similar patterns can be shown for the outputs of the other countries and for the staff inputs as well.

B. Relationships Among the Variables

Figure II.2-A shows a scatter diagram illustrating the relationship for Korea between the size of the county family planning budget and the number of acceptors. Each point on the graph represents a single county and indicates the budget and the number of acceptors in 1974 which characterize that county. Digits printed on the graph represent multiple observations with the same values. It will be observed that there is a strong relationship between the two variables. The higher the budget the greater is the number of acceptors. A similar scatter diagram is shown for Malaysia in Figure II.3-A. These relationships do indicate a strong relationship between inputs as measured by staff salaries and outputs as measured by the number of acceptors of contraceptive methods, but it is necessary to exercise some caution in interpreting this relationship. To a large extent the relationship is only stating that the number of acceptors is greater in a county or a district with a larger population. Such geographical units have a larger complement of staff assigned to them and it is "only to be expected" that they will produce more acceptors. It should be stressed that while this relationship between inputs and outputs is expected, it is nonetheless real. More inputs are associated with more output.

Figures II.2-B and II.3-B show the parallel relationship when the inputs and the output are both divided by the number of eligible women. Notice that in this case the relationship is not nearly as strong as it is when the salary and acceptance measures are shown in absolute terms.

For both the absolute and the standardized variables the scatter diagrams indicate that the relationships under discussion are not exact. There are factors other than budget or staffing patterns which help explain the relationship between the two variables.

Figure II.4 shows a scatter diagram relating the number of acceptors per eligible woman to the percentage of houses which are electrified in the districts of Malaysia. The relationship is positive as one might

TABLE 2.1. Descriptive Statistics for Malaysia

Variable	N	Minimum	Maximum	Mean	Std. Dev.	Coeff. of Var.
1.) TSALFPA	56	0.00	28362.00	7532.30	5391.30	.71
2.) STAFF	56	1.00	20.00	5.2	4.19	.79
3.) TOTSAL	56	3256.00	95697.00	21813.00	20231.00	.93
4.) TSAL/EW	56	153.45	2295.10	978.31	491.50	.50
5.) ELECT%	56	4.00	95.00	39.75	21.32	.54
6.) LITF%	56	11.00	76.00	47.57	9.08	.19
7.) Income	56	56.00	263.00	127.02	40.02	.31
8.) EW	56	4978.00	138730.00	23213.00	21307.00	.92
9.) FPACC/EW	56	0.00	27.26	5.84	7.52	1.29
10.) TOTACCPT	56	92.90	3745.7	654.85	657.76	1.00
11.) FPACC	56	0.00	2446.00	204.13	415.87	2.04
12.) ACC/EW	56	7.00	52.10	28.13	10.93	.39

KEY

1.) Total Salaries of all Family Planning Assistants in District
2.) Total FPA's, sisters, sister nurses, TAN's, and Clerks in District
3.) Salaries of Total District Staff
4.) Total Salaries per 1000 Eligible Women
5.) % of families with electricity in their homes
6.) Female literacy rate
7.) Average income of district population, per month
8.) Number of eligible women
9.) Acceptors brought in by FPA's per 1000 Eligible Women
10.) Total Acceptors
11.) Total Acceptors brought in by FPA's
12.) Total Acceptors per 1000 Eligible Women

TABLE 2.2. Descriptive Statistics for the Philippines

	Variable	N	Minimum	Maximum	Mean	Std. Dev.	Coeff.
I	1.) CLI/MWRA	100	1.25	41.88	11.46	6.32	.5
	2.) MD/MWRA	100	1.25	38.29	11.14	5.81	.5
	3.) NUR/MWRA	100	0.00	30.90	8.74	6.26	.7
	4.) MID/MWRA	100	0.00	46.61	14.66	8.27	.56
	5.) MOT/MWRA	100	0.00	57.78	14.10	10.43	.74
	6.) TOT/MWRA	100	3.75	147.80	48.65	25.71	.53
	7.) TOTMTHS	100	32.91	10169.00	357.94	1095.8	3.06
II	8.) Urban %	100	0.0	100.00	32.40	33.28	1.02
	9.) Radio %	100	7.06	86.66	47.94	17.25	.36
	10.) Litrate	100	42.39	94.63	76.17	10.71	.14
	11.) Municipal Income	100	12.30	421.60	71.30	82.76	1.16
	12.) Infmrate	100	11.00	427.00	79.44	65.35	.82
	13.) MWRA	100	740.00	154,730.00	8124.90	18,512.00	2.28
III	14.) Totaccpt	100	116.82	120,840.00	3732.50	12,861.00	3.44
	15.) ACC/MWRA	100	11.00	1000.00	364.70	218.81	.59

KEY

1.) Clinic Months per 1000 Married Women of Reproductive Age
2.) Doctors Months per 1000 Married Women of Reproductive Age
3.) Nurse Months per 1000 Married Women of Reproductive Age
4.) Midwife Months per 1000 Married Women of Reproductive Age
5.) Motivator Months per 1000 Married Women of Reproductive Age
6.) Total Months per 1000 Married Women of Reproductive Age
7.) Total Months
8.) Percent of Population in Urban Areas
9.) Percent of Population with Radios
10.) Percent Literate
11.) Municipal Income in Pesos, per thousand
12.) Infant Mortality Rate
13.) Married Women of Reproductive Age
14.) Total Acceptors
15.) Acceptors per 1000 Married Women of Reproductive Age

TABLE 2.3. Descriptive Statistics for Korea

Variable	N	Minimum	Maximum	Mean	Std. Dev.	Coeff. of Var.
1.) BUDGET	193	8200.30	78142.00	24918.00	10535.00	.42
2.) BUD.EW	193	430.00	3506.00	1531.80	542.45	.35
3.) MCMEMBER	183	53.00	27971.00	3985.90	3884.90	.97
4.) MCMEM.EW	183	2.19	1546.20	281.73	276.76	.98
5.) MOMSCLUB	183	3.00	811.00	158.67	123.53	.77
6.) FARM %	187	0.20	88.60	56.27	29.49	.52
7.) RADIO %	192	11.00	98.70	55.28	16.20	.29
8.) LITERACY	193	62.50	95.90	81.80	7.47	.09
9.) Y.PC	193	228.50	1095.6	460.26	158.24	.34
10.) EW	193	3298.00	160790.00	21306.00	23694.00	1.11
11.) AGEMARR	192	20.40	26.90	22.84	0.95	.04
12.) ACCEPTS	193	66.40	1825.10	407.55	257.44	.63
13.) ACC.EW	193	7.88	36.13	22.62	5.63	.25
14.) CYP	193	81.79	2901.80	548.42	398.48	.73
15.) CYP.EW	193	11.90	66.60	29.50	7.42	.25

KEY

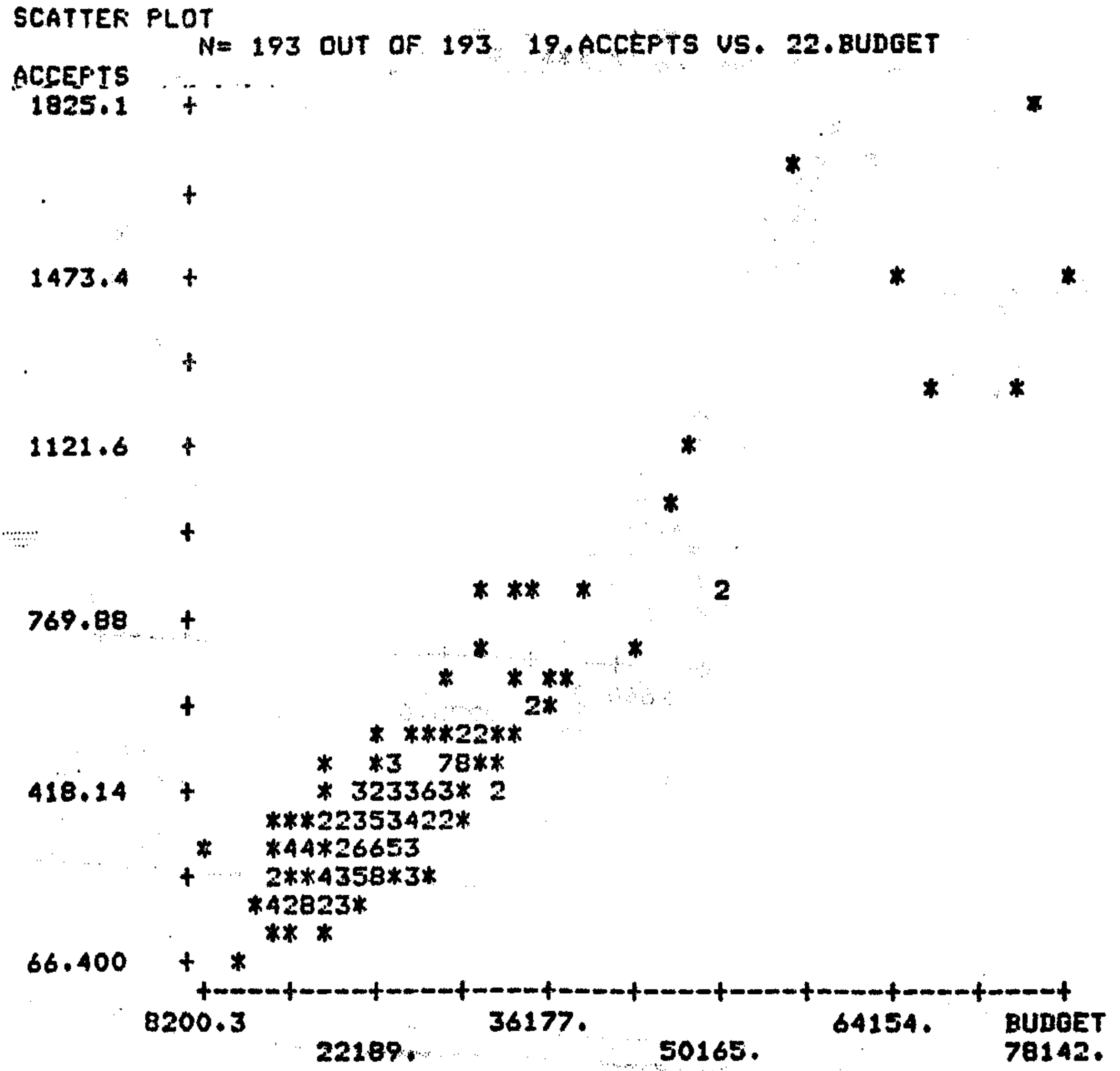
1.) Total Budget
2.) Total Budget per 1000 Eligible Women
3.) Mothers' Club Members
4.) Members per 1000 Eligible Women
5.) Number of Mothers' Clubs
6.) Percent of Population on Farms
7.) Percent of Population with Radios
8.) Literacy Rate
9.) Per Capita Income
10.) Number of Eligible Women
11.) Mean Age at Marriage
12.) Number of Acceptors
13.) Number of Acceptors per 1000 Eligible Women
14.) Couple-Years of Protection
15.) CYP per 1000 Eligible Women

Figure 2.1.

Histograms for Output Measures in Korea

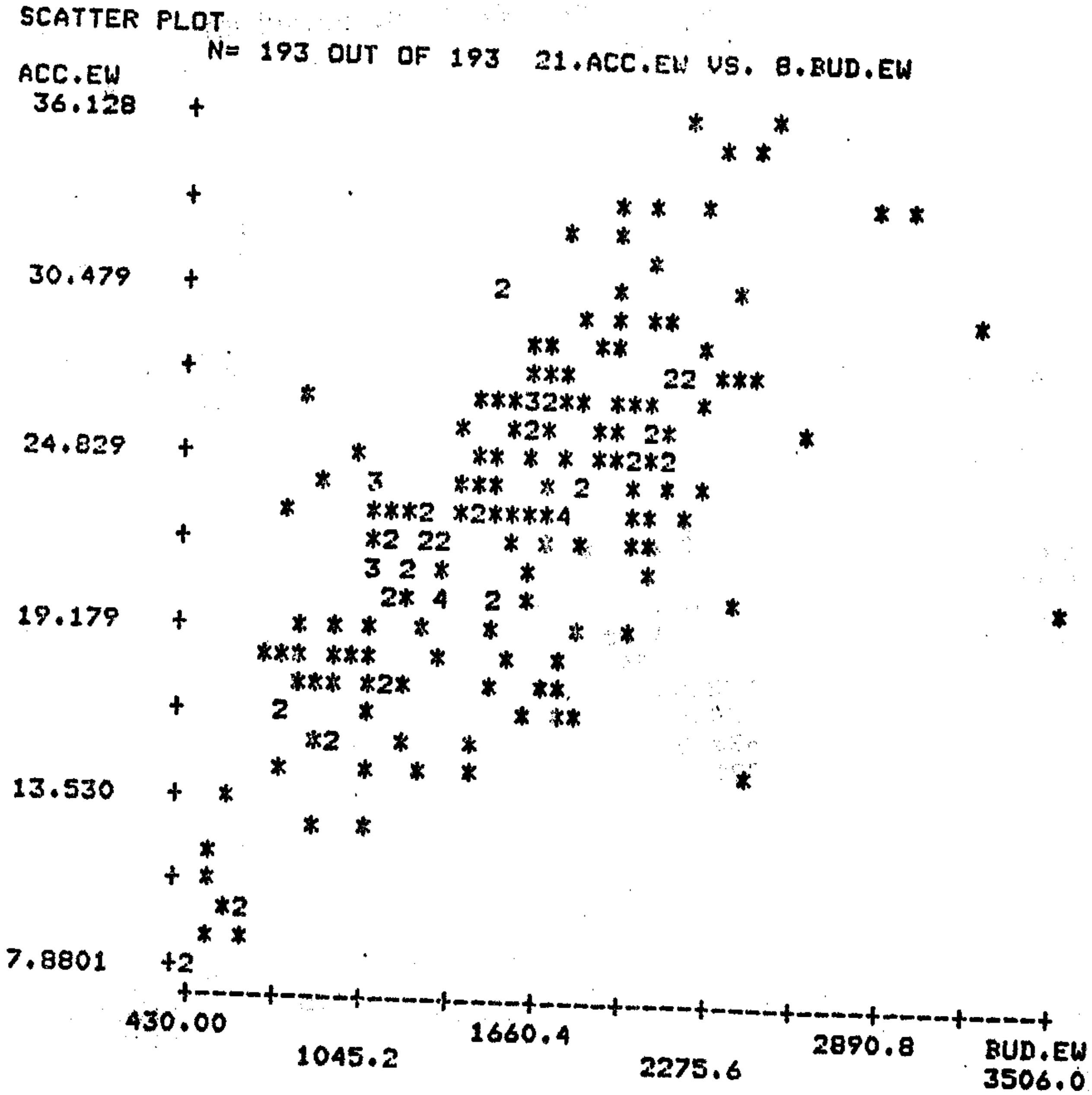
```
HISTOGRAM

LEFT-END    HIST%  COUNT FOR 19.ACCEPTS   (EACH X= 2)

0.            .5      1 +X
100.00       8.3     16 +XXXXXXXX
200.00      30.6     59 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
300.00      22.3     43 +XXXXXXXXXXXXXXXXXXXXXX
400.00      20.2     39 +XXXXXXXXXXXXXXXXXXXX
500.00       7.3     14 +XXXXXXX
600.00       2.6      5 +XXX
700.00       1.0      2 +X
800.00       3.1      6 +XXX
900.00       0.       0 +
1000.0        .5      1 +X
1100.0        .5      1 +X
1200.0       1.0      2 +X
1300.0       0.       0 +
1400.0       1.0      2 +X
1500.0       0.       0 +
1600.0       0.       0 +
1700.0        .5      1 +X
1800.0        .5      1 +X

TOTAL               193  (INTERVAL WIDTH= 100.00)


COMMAND
?hist v=21 int=(0,)/3 op=hist%,leftend


HISTOGRAM

LEFT-END    HIST%  COUNT FOR 21.ACC.EW   (EACH X= 2)

0.           0.       0 +
3.0000       0.       0 +
6.0000       1.0      2 +X
9.0000       3.6      7 +XXXX
12.000       5.2     10 +XXXXX
15.000      10.9     21 +XXXXXXXXXXX
18.000      14.5     28 +XXXXXXXXXXXXXX
21.000      21.8     42 +XXXXXXXXXXXXXXXXXXXXX
24.000      23.3     45 +XXXXXXXXXXXXXXXXXXXXXXX
27.000      10.9     21 +XXXXXXXXXXX
30.000       5.2     10 +XXXXX
33.000       3.1      6 +XXX
36.000        .5      1 +X
```

Figure ?.2.A: Scatter Diagram of Relationships Between To Budget and Acceptors by County in Korea.



—AND
SCATTER V=21;8

Figure 2.2.B: Scatter Diagram of Relationship Between the Number of Acceptors per Eligible Woman and Budget per Eligible Woman by County in Korea.



~~Table~~ Figure 2.3.A. Number of Acceptors and Total Salary by District for Malaysia

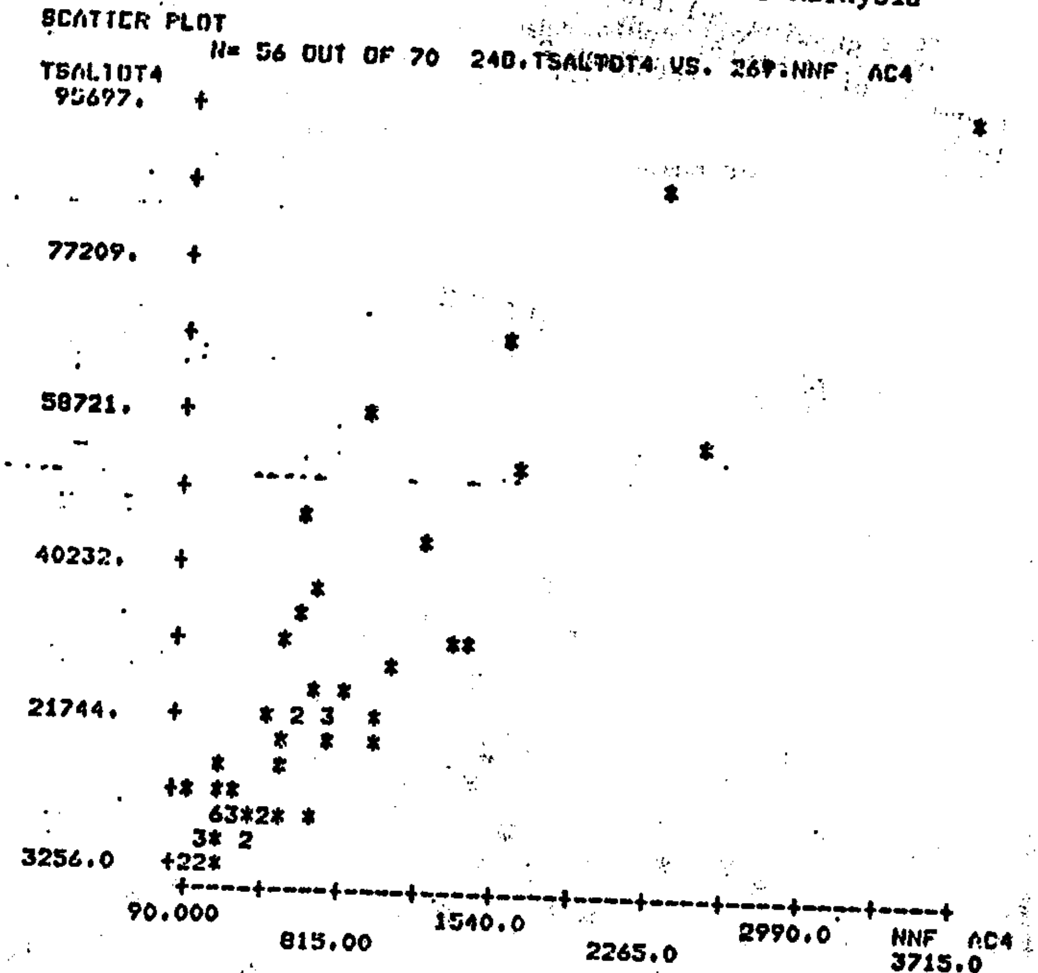


Figure 2.3.B: Scatter Diagram Showing Number of Acceptors per Eligible Woman and Total Salaries per Eligible Woman by District for Malaysia.

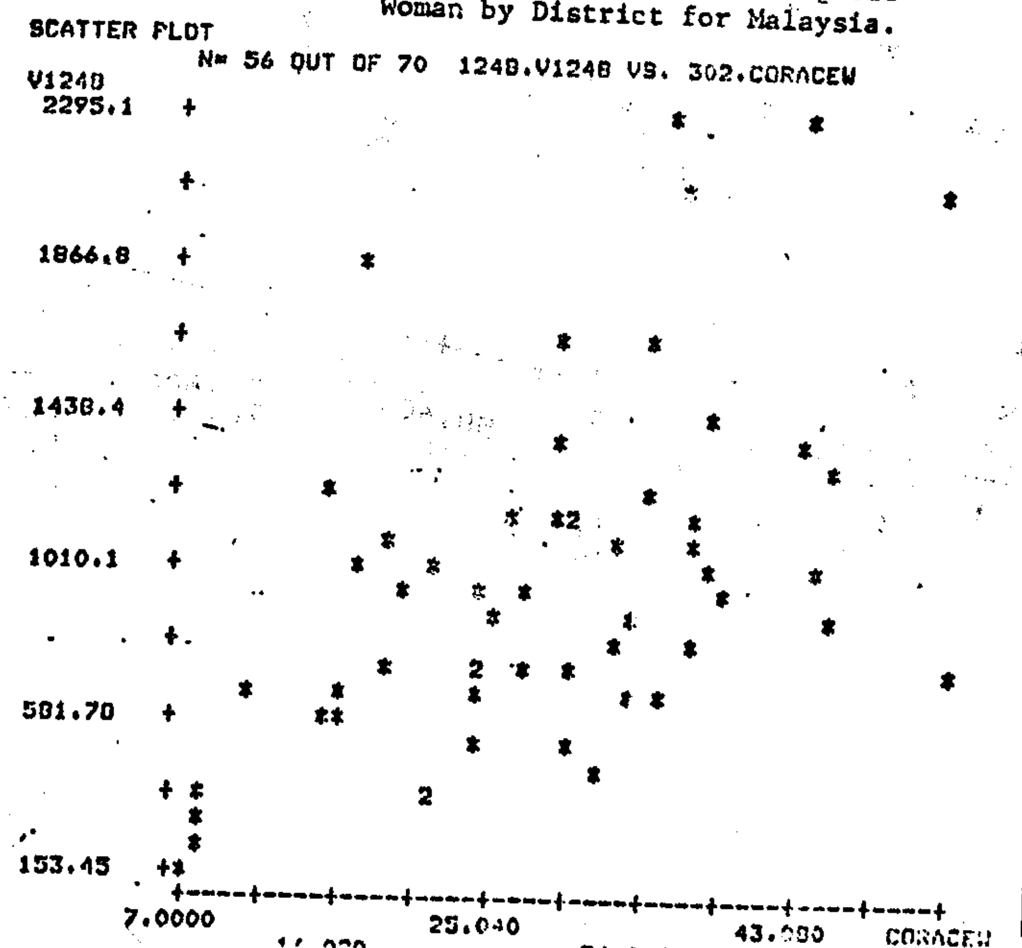
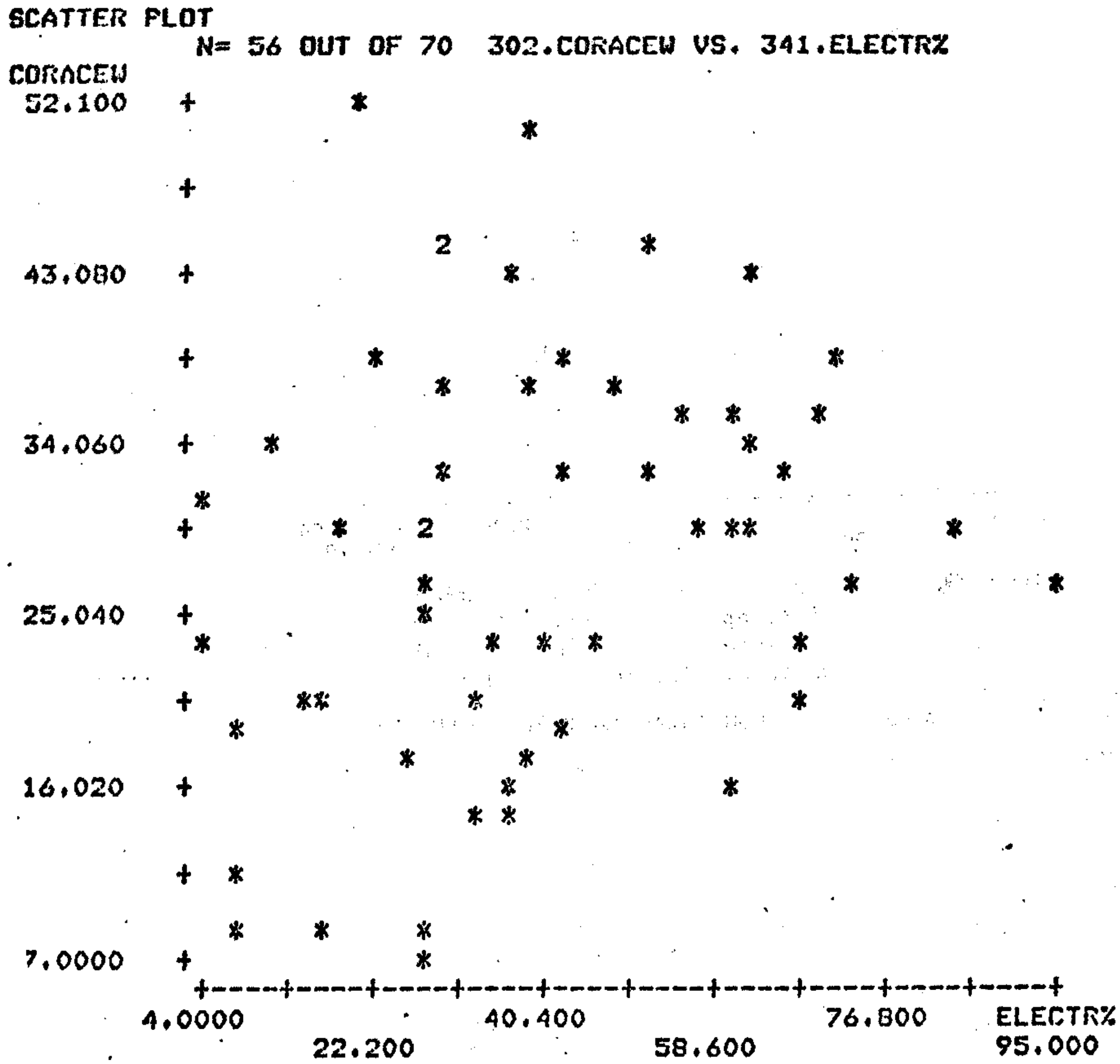


Figure 2.4: **Scatter Diagram Showing Relationship Between Number of Acceptors per Eligible Woman and the Percentage of Households Electrified by District for Malaysia.**



expect, but it is not as strong as the relationships between inputs and outputs for Malaysia. In all four of the countries under examination there are some environmental variables which seem to be closely related to output or output per eligible woman.

Table 2.5 shows in more detail the relationship between various measures of output per eligible woman and the joint variations in environmental and input variables. In general, it will be seen that as hypothesized in our earlier discussions, the amount of output or the amount of output per eligible woman at rish varies positively with the amounts of inputs and with the degree of modernization implied by the development variables which are used. The relationship is of course not perfect, and even within the selected tables there are reversals in the relationships. For Malaysia, the number of acceptors per eligible woman increases both with the proportion of households which are electrified and with the intensity with which the inputs are applied. For Korea, however, while there is a clear positive relationship between the intensity of inputs and the number of acceptors per eligible woman, the relationship between the level of literacy and acceptance rates is more irregular. In the case of the Philippines the relationship is relatively regular as in Malaysia, but in India while the general pattern is clear there are reversals in both directions. These relationships, while selective, demonstrate, however, that in all four countries, both input and environmental variables affect output. They also demonstrate that the relationships vary greatly in strength which suggests that restraint should be shown in their application. Table 2.6 shows the variation in the absolute

TABLE 2.5 : Variations in Acceptance Rates by Input per Eligible Woman and Environmental Variables

TABLE 2.5 A. Malaysia

Electricity %	Acceptors per Thousand Eligible Women Total Salary/ E.W.		
	LOW	MED	HI
LOW	15.667 (9)	27.600 (5)	35.000 (5)
MED	26.125 (8)	30.200 (5)	37.333 (6)
HI	30.571 (7)	31.857 (7)	40.250 (4)

TABLE 2.5 B. Philippines

Literacy	Acceptors per Thousand Women of Reproductive Age TOTAL INPUTS/MWRA		
	LOW	MED	HI
LOW	160.8 (10)	321.54 (13)	469.0 (11)
MED	260.67 (6)	362.94 (18)	455.3 (10)
HI	265.71 (14)	496.90 (10)	529.25 (8)

TABLE 2.5 C. Korea

Illiteracy	Acceptors per Thousand Eligible Women Budget/EW		
	LOW	MED	HI
LOW	173.(47)	207.(9)	231.(9)
MED	211.(10)	226.(28)	291.(14)
HI	182.(8)	246.(30)	266.(41)

TABLE 2.5 D. India

	Acceptors per Thousand Eligible Women EXPENDITURES		
	LOW	MED	HI
LOW	54.8	52.7	96.4
MED	35.2	67.6	106.4
HI	62.5	69.6	71.1

TABLE 2.6: Variation in Total Number of Acceptors by Inputs and Environmental Variables

TABLE 2.6 A.

Malaysia

NFPB Acceptors

Elec.%	Total Salary		
	LOW	MED	HIGH
LOW	242.07 (14)	361.50 (2)	656.00 (3)
MED	540.33 (3)	365.80 (10)	1053.30 (6)
HIGH	232.00 (2)	478.43 (7)	1486.10 (9)

TABLE 2.6 B.

Philippines

Total Acceptors

Literacy	Total Inputs		
	LOW	MED	HIGH
LOW	790.29 (10)	1565.30 (13)	1078.60 (11)
MED	921.33 (6)	1576.90 (18)	1764.00 (10)
HIGH	3852.20 (14)	9537.50 (10)	16,535.00 (8)

(No comparable Indian table)

TABLE 2.6 C.

Korea

Total Acceptors

Illiteracy	Total Budget		
	LOW	MED	HIGH
LOW	2588.8 (30)	4207.1 (14)	3941.4 (5)
MED	2636.4 (18)	3252.8 (15)	3968.4 (24)
HIGH	2448.2 (19)	3301.6 (34)	3873.3 (30)

number of acceptors by total inputs and various environmental variables. The relationships are similar to those discussed earlier but somewhat stronger.

Tables 2.7 through 2.10 show the zero order correlations among the variables which are the primary focus of analysis. There are a number of interesting results in these tables. First, it is noteworthy that there is a general tendency for the variables within each of the three variable sets to be strongly associated in all four of the countries involved. The various output measures tend to be highly correlated; for example, in Korea the number of CYP's generated has a correlation of 0.97 with the number of acceptors. Similarly, inputs tend to be correlated among themselves although at somewhat lower levels, and environmental variables are strongly associated suggesting that the selected variable measures reflect some basic underlying characteristics such as "development."

Second, in most of the countries under examination there is a strong correlation between the absolute number of acceptors and the absolute amount of inputs. This is, as noted in earlier discussions, in large measure a reflection of the considerable variation in the scale of programs in the various geographical subunits of analysis. Third, it is interesting that in most countries and especially in Malaysia and the Philippines, the basic hypothesized relationships implied in the models discussed at the beginning of the chapter are supported to the extent that they can be by then simple correlations. In Malaysia, for example, the number of acceptors per eligible woman is correlated both

Table 2.7

Correlations of Selected Input, Environmental, and Output Variables for Malaysia (Four-year totals on program variables.)

N = 56 DF = 54 R@ .05 = .2632 R@ .01 = .3415

I	1. TSALFPA	1.00											
	2. STAFF	.83	1.00										
	3. TOTSAL	.78	.97	1.00									
	4. TSAL/EW	.26	.30	.31	1.00								
II	5. ELEC%	.40	.58	.62	.35	1.00							
	6. LITF%	.21	.19	.11	.19	.32	1.00						
	7. INCOME	.11	.31	.33	.30	.57	.43	1.00					
	8. EW	.62	.86	.87	-.09	.45	.12	.33	1.00				
III	9. FPACC/EW	.32	.49	.52	.17	.56	.24	.26	.43	1.00			
	10. TOTACCPT	.62	.89	.89	.06	.49	.20	.37	.93	.45	1.00		
	11. FPACC	.39	.65	.69	-.05	.38	.19	.48	.88	.40	.79	1.00	
	12. ACC/EW	.16	.24	.21	.52	.23	.28	.32	.01	.12	.32	.01	1.00
		TSALFPA	STAFF	TOTSAL	TSAL/EW	ELEC%	LITF%	INCOME	EW	FPACC/EW	TOTACCPT	FPACC	ACC/

Table 2.8A Correlations of Selected Input, Envi[illegible]mental Output Variables for the Philippines (full s[illegible] including 8 cases defines as "outlie[illegible]").

N = 100 DF = 98 R@ .0500 = .1966 R@ .0100 = .2565

VARIABLE	CLI/MWRA	MD/MWRA	NUR/MWRA	MID/MWRA	MOT/MWRA	TOTMWRA	TOTMTHS	URBANZ	RADIOZ	LITRATE	MUNY/TH	INFMRATE	MWRA	TOTACCPT	ACC.MWRA
1 CLI/MWRA	1.0000														
2 MD/MWRA	.78	1.0000													
3 NUR/MWRA	.65	.72	1.0000												
4 MID/MWRA	.69	.66	.32	1.0000											
5 MOT/MWRA	.61	.69	.57	.61	1.0000										
6 TOTMWRA	.81	.87	.77	.74	.87	1.0000									
7 TOTMTHS	.13	.15	.25	-.02	-.03	.09	1.0000								
7 URBANZ	-.10	-.09	-.06	-.23	-.18	-.14	.35	1.0000							
9 RADIOZ	.01	.03	.06	-.10	-.09	-.02	.26	.58	1.0000						
10 LITRATE	.02	-.00	.03	-.05	-.13	-.04	.24	.57	.66	1.0000					
II 11 MUNY/TH	-.13	-.13	.01	-.25	-.24	-.17	.45	.61	.45	.43	1.0000				
12 INFMRATE	-.08	-.05	-.14	.13	-.07	-.04	-.11	-.12	-.28	-.13	-.17	1.0000			
13 MWRA	.00	.01	.12	-.14	-.17	-.05	.96	.48	.34	.33	.58	-.12	1.0000		
III 14 TOTACCPT	.11	.12	.21	-.06	-.07	.05	.99	.38	.27	.26	.46	-.11	.95	1.0000	
15 ACC.MWRA	.65	.56	.52	.31	.29	.50	.27	.19	.30	.14	.12	-.24	.19	.30	1.0000

KEY

1. Total Budget
2. Total Budget per 1000 Eligible Women
3. Mothers' Club Members
4. Members per 1000 Eligible Women
5. Number of Mothers' Clubs
6. Percent of Population on Farms
7. Percent of Population with Radios
8. Literacy Rate
9. Per Capita Income
10. Number of Eligible Women
11. Mean Age at Marriage
12. Number of Acceptors
13. Number of Acceptors per 1000 Eligible Women
14. Couple-Years of Protection
15. CYP per 1000 Eligible Women

of staff size, acceptance rates, and population size.)

N = 92 DF = 90 R@ .0500 = .2050 R@ .0100 = .2673

VARIABLE

N = 92 DF = 90 R@ .0500 = .2050 R@ .0100 = .2673

	VARIABLE	CLI/MWRA	MD/MWRA	NUR/MWRA	MID/MWRA	MOT/MWRA	TOT/MWRA	TOTMTHS	URBAN%	RADIO%	LITRATE	MUNY/TH	INFMRATE	MWRA	TOTACCPT	ACC.MWRA
I	1. CLI/MWRA	1.0000														
I	2. MD/MWRA	.77	1.0000													
I	3. NUR/MWRA	.64	.71	1.0000												
I	4. MID/MWRA	.70	.66	.32	1.0000											
I	5. MOT/MWRA	.59	.68	.58	.60	1.0000										
I	6. TOT/MWRA	.80	.87	.77	.74	.87	1.0000									
I	7. TOTMTHS	.07	.18	.30	.10	-.04	.16	1.0000								
II	8. URBAN%	-.11	-.09	-.06	-.17	-.15	-.12	.28	1.0000							
II	9. RADIO%	.02	.05	.07	-.04	-.06	.01	.36	.51	1.0000						
II	10. LITRATE	.06	.03	.02	.02	-.06	.01	.26	.54	.65	1.0000					
II	11. MUNY/TH	-.11	-.12	.03	-.16	-.20	-.12	.37	.45	.37	.32	1.0000				
II	12. INFMRATE	-.07	-.04	-.14	.12	-.06	-.03	-.15	-.07	-.26	-.11	-.14	1.0000			
II	13. MWRA	-.30	-.27	-.12	-.26	-.41	-.29	.79	.47	.38	.33	.50	-.16	1.0000		
III	14. TOTACCPT	-.05	-.02	.08	-.11	-.27	-.09	.77	.45	.41	.34	.44	-.15	.83	1.0000	
III	15. ACC.MWRA	.62	.55	.54	.32	.22	.47	.34	.16	.32	.23	.18	-.29	.14	.50	1.0000

Key

1. Total Budget
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7. Percent of Population with Radios
8. Literacy Rate
9. Per Capita Income
10. Number of Eligible Women
11. Mean Age at Marriage
12. Number of Acceptors
13. Number of Acceptors per 1000 Eligi[illegible]

Correlations of Selected Input, Environmental, and Output Variables for Korea.

N = 180 DF = 178 R@ .0500 = .1463 R@ .0100 = .1915

	VARIABLE	BUDGET	BUD.EW	MCMEMBER	MCMEM.EW	MOMS-CLUB	FARM%	RADIO%	LITERACY	Y.PC	EW	AGE MARR	ACCEPTS	ACC.EW	CYP	CYP.EW
	BUDGET	1.0000														
	BUD.EW	-.33	1.0000													
	MCMEMBER	.07	.06	1.0000												
	MCMEM.EW	-.13	.36	.88	1.0000											
	MOMSCLUB	.20	.07	.76	.57	1.0000										
	FARM%	-.13	.58	.31	.41	.47	1.0000									
	RADIO%	-.03	-.21	-.06	-.06	-.06	-.45	1.0000								
II	LITERACY	.11	-.44	-.15	-.23	-.25	-.78	.57	1.0000							
	Y.PC	.33	-.47	-.15	-.23	-.18	-.59	.45	.58	1.0000						
	EW	.84	-.61	-.08	-.27	-.06	-.47	.16	.37	.47	1.0000					
	AGE MARR	.14	-.41	.01	-.11	.01	-.36	.33	.38	.57	.23	1.0000				
	ACCEPTS	.86	-.56	.05	-.18	.08	-.36	.08	.29	.38	.86	.20	1.0000			
III	ACC.EW	-.17	.61	.26	.43	.19	.49	-.30	-.37	-.45	-.46	-.24	-.14	1.0000		
	CYP	.85	-.56	.03	-.18	.05	-.44	.13	.35	.45	.89	.25	.98	-.19	1.0000	
	CYP.EW	-.14	.52	.25	.39	.15	.26	-.14	-.19	-.28	-.34	-.12	-.07	.84	-.04	1.0000

Key

1. Total Budget
2. Total Budget per 1000 Eligible Women
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9. Per Capita Income
10. Number of Eligible Women
11. Mean Age at Marriage
12. Number of Acceptors
13. Number of Acceptors per 1000 Eligible Women
14. Couple-Years of Protection
15. CYP per 1000 Eligible Women

2.10: Variables for India. (10) Year : [illegible]

Correlation matrix [illegible]

Var	8	11	17	18	19	20	21	22	44	45	51	55	56	59	1	2	3	5	6
	Input variables								Environmental variables						Output variables				
8	1.000																		
11	-0.009	1.000																	
17	0.167	0.031	1.000																
18	0.031	0.252	0.210	1.000															
19	0.041	0.157	0.172	0.675	1.000														
20	0.074	0.147	0.204	0.459	0.657	1.000													
21	0.155	0.219	0.103	0.749	0.615	0.757	1.000												
22	0.186	0.239	0.703	0.817	0.660	0.824	0.805	1.000											
44	0.059	0.009	-0.164	0.032	0.012	0.040	-0.016	0.030	1.000										
45	-0.163	0.011	0.035	0.271	0.113	0.172	0.175	0.221	-0.475	1.000									
51	0.540	-0.101	0.093	-0.035	-0.105	0.121	0.027	-0.041	0.126	-0.177	1.000								
55	0.022	0.225	-0.001	0.263	0.430	0.267	0.173	0.257	-0.246	0.232	-0.147	1.000							
56	-0.024	0.141	0.024	0.116	0.232	0.014	0.039	0.071	-0.152	0.276	-0.136	0.011	1.000						
59	0.012	-0.320	-0.012	-0.563	-0.474	-0.382	-0.503	-0.513	-0.139	-0.120	-0.024	-0.076	-0.070	1.000					
1	0.110	0.032	0.257	0.567	0.427	0.551	0.602	0.551	0.143	-0.013	0.097	0.094	0.055	-0.355	1.000				
2	0.051	0.109	0.059	0.323	0.310	0.230	0.372	0.223	0.045	-0.036	-0.015	0.221	0.225	-0.170	0.457	1.000			
3	0.051	0.031	0.219	-0.070	-0.021	-0.034	0.022	-0.015	-0.074	-0.051	0.013	-0.049	-0.050	-0.002	0.511	-0.023	1.000		
5	0.329	-0.057	0.211	0.317	0.131	0.313	0.358	0.341	0.070	-0.047	0.112	-0.040	-0.054	-0.210	0.556	0.213	0.209	1.000	
6	0.202	0.024	0.270	0.543	0.282	0.519	0.558	0.548	0.133	-0.013	0.077	0.053	0.016	-0.244	0.957	0.446	0.490	0.774	1.000

(11) Year : [illegible]

Correlation matrix [illegible]

Var	8	11	17	18	19	20	21	22	44	45	51	55	56	59	1	2	3	5	6
	Input variables								Environmental variables						Output variables				
8	1.000																		
11	-0.125	1.000																	
17	0.150	0.032	1.000																
18	0.097	0.044	0.051	1.000															
19	0.077	-0.097	0.150	0.171	1.000														
20	-0.026	0.200	0.193	0.592	0.391	1.000													
21	0.072	0.170	-0.295	0.475	0.175	0.784	1.000												
22	0.103	0.215	0.221	0.553	0.371	0.793	0.796	1.000											
44	0.120	-0.004	-0.148	0.022	0.014	-0.093	-0.095	-0.027	1.000										
45	0.071	-0.119	0.026	0.047	0.137	0.010	0.127	0.030	0.227	1.000									
51	-0.053	-0.015	0.010	-0.004	-0.156	0.200	0.050	0.063	0.037	-0.243	1.000								
55	0.034	0.212	0.015	0.276	0.253	0.143	0.247	0.157	0.260	0.230	0.121	1.000							
56	0.030	0.016	0.012	0.065	0.276	-0.039	0.025	0.022	0.106	0.345	0.398	0.723	1.000						
59	0.058	-0.247	0.004	-0.367	-0.242	-0.592	-0.515	-0.557	-0.103	-0.563	-0.061	-0.074	-0.055	1.000					
1	0.165	-0.278	0.208	0.509	0.330	0.425	0.474	0.392	0.199	0.190	-0.055	0.097	0.369	-0.300	1.000				
2	-0.012	0.000	0.050	0.215	0.240	0.259	0.321	0.230	0.044	-0.127	-0.210	0.130	0.147	-0.251	0.420	1.000			
3	0.227	-0.217	0.114	0.012	0.055	-0.153	-0.095	-0.119	0.258	0.298	-0.045	-0.068	0.075	0.030	0.563	-0.042	1.000		
5	0.256	0.015	0.167	0.100	0.057	0.153	0.217	0.077	0.033	0.153	0.052	0.012	-0.014	-0.145	0.213	0.056	0.223	1.000	
6	0.237	-0.216	0.239	0.265	0.292	0.120	0.476	0.157	0.275	0.211	-0.010	0.079	0.122	-0.291	0.915	0.342	0.572	0.700	1.000

(9)

II. Table showing correlation matrix

Name of the variables used in the correlation matrix

Variable Number	
	OUTPUT VARIABLES
1	No.of Vasectomies done to block-residents per 1000 EC during 1971-1974.
2	No.of Non-camp Vasectomies done to block-residents per 1000 EC during 1971-1974.
3	No.of Vasectomies done in Primary Health Centre.
5	No.of IUDs + Tubectomies done to block residents per 1000 EC during 1971-1974.
6	No.of Vasectomies + IUDs + Tubectomies done to block residents per 1000 EC during 1971-1974.
	INPUT VARIABLES
8	Availability of physical facilities.
11	Index of data use.
17	Cumulative No.of Vasectomies + IUDs done in PHC per 1000 EC as on 1-4-1971.
18	No.of EEFT man months per 1000 EC in 1971-1974.
19	No.of AN woman months per 1000 EC during 1971-1974.
20	No.of MO man months per 1000 EC during 1971-1974.
21	No.of BEE man months per 1000 EC during 1971-1974.
22	No.of LHV woman months per 1000 EC during 1971-1974.
	ENVIRONMENTAL VARIABLES
44	Proportion of cultivated area to total area of the block.
45	Proportion of area under HYV to total cultivated area.
51	Accessibility of Primary Health Centre.
55	Proportion of literate and educated women among all women in the block.
	[illegible]

within the amount of inputs per eligible woman and with the number of indices of socio-economic development. The signs of the correlations are in the proper direction and in most cases they are statistically significant. The same general phenomenon is observed in the Philippines. In India and Korea, however, the relationships are not as clear. In India, for example, while the correlations between inputs and outputs per eligible woman are significant, those between the environmental variables and the output variables tend to be small or barely significant. In Korea, the situation is even more complex since when all of the observations for Korea are used, the environmental variables are related to family planning outputs in a direction opposite to that which is hypothesized in the basic model.

Acceptance per eligible woman is positively related to the percentage of farm households in the population and negatively related to per capita income. These relationships raise the question of whether the underlying model which we are postulating is appropriate for Korea. The correlation matrices underscore the importance of scale as a confounding variable in the analysis. In the case of Malaysia, for example, the correlation between the number of acceptors in a given district and the number of eligible women is 0.93. In contrast, the correlation between the number of acceptors per eligible woman and the total number of eligible women in a district is close to 0. This suggests that while those districts which are larger had more acceptors, they do not have more acceptors as a proportion of their population of eligible women. It also suggests that the analysis of any variables which are highly correlated with scale is going to confound the determinants of output. The fact that there are more acceptors in districts which are larger and furthermore, that there are more units of input in districts which are larger, indicates that there is a relationship, albeit a relatively superficial one, between inputs and outputs which should not be ignored. The most obvious way of dealing with the scale factor is to divide both inputs and outputs by the number of eligible women, but this in a way eliminates the most direct relationship between inputs and outputs, and essentially restates the hypothesized relationships about the absolute quantities of inputs and outputs as relationships between the intensity of inputs and the intensity of outputs. While each of the relationships may have some validity, they are not the same, and we must be careful to distinguish them in further analysis. It is worth noting that the same problem seems to exist for all of the countries involved.

CHAPTER III

Multivariate Relationships among Input, Output, and Environmental Variables

In Chapter II, the input, output and environmental variables and the bivariate relationships among these were described. The present chapter takes the analysis one step further by discussing the relationship among these variables in a multivariate context. The central purpose of the analysis in this chapter is to establish statistical relationships among various variables which could be used as a basis for a study of efficiency. The material presented here is intended to serve as a link between the theoretical discussion of Chapter I, the empirical observations described in their basic form in the last two chapters, and the empirical results concerning efficiency which are described in detail in the following chapter. A common framework is used as the basis for the analysis of each of the four national data sets. The discussion of the material from Tamil Nadu is somewhat less complete than it is for the other three studies, since that data set was not subjected to any secondary data analysis for the intercountry report. However, in all four cases an attempt was made to establish the relationship between input and environmental variables on the one hand and the output variables on the other.

Methodological Issues

Before discussing the detailed results from the four participant countries, it is important to indicate some methodological issues common to all analyses of this kind. Measures of efficiency must be based on the theory which links the scarce resources which were used for programs with the attainment of program objectives. The empirical results described in this and the following chapters have meaning to the extent that they can be related to the theoretical framework presented in Chapter I. There it was suggested that the output of family planning programs would be decided by the quantity of resources which are devoted to a program in a given region and by the environmental characteristics of the region. At that level the theory is very general. It does not provide guidance as to exactly which input measures or which measures of environmental characteristics should prove most important. It does, however, suggest that at a minimum both sets of considerations should be dealt with in any empirical treatment of efficiency.

One of the first methodological issues confronted in the empirical analysis of efficiency is how to select from the large range of possible variables, those which would give the most useful measures of efficiency. Ideally, one would have a large body of studies of fertility or of contraceptive behavior upon which to base the choice of appropriate variables. In the absence of such material, we have selected variables from a combination of the general theoretical considerations of Chapter I and the availability of variables. For each of the countries we have made a list of the available environmental and input variables. We have then tried to select from among each of these longer lists a subset of variables, relatively limited in number, which would yield good predictions on the output of the family planning program across the areal units under study. Oftentimes, there were alternative variables which seemed redundant. For example, among the input variables it would be redundant to use both a measure of budget size and a measure of staff size, since they are alternative measures of the overall quantity of inputs which were available to the program. Similarly, the lists of environmental variables for all the countries included a number of alternative measures of modernization. While the very concept of "modernity" is difficult to define, it would clearly be inappropriate to use a large number of alternative indices of the same underlying construct. Our procedure for the selection of environmental variables was to take those measures which were relatively strongly associated with program output, but were not highly associated among themselves. This process was undertaken in two steps. The first, in examination of the zero-order correlation matrix provided an initial winnowing of the key variables, and second, where it was unclear which variables should be used, a step-wise regression procedure was employed to select the most important among alternative indices.

A second major kind of methodological issue is a specification of the relationship to be fitted among the variables. The basic technique used is that of multiple regression. Multiple regression can be used with variables of a wide variety of forms, and furthermore, the relationships among the variables can be specified in different ways. The simplest form would be to use the number of acceptors or some other indicator of output measured in absolute numbers, as the dependent variable, and to use appropriate measures of the absolute numbers, as the dependent variable, and to use appropriate measures of the absolute quantities of inputs and the absolute prevalence of some environmental characteristic as the independent variables. Specification of relationships in this form would have given us a predictive equation for the number of acceptors expected in any region on the basis of the inputs and the environmental characteristics of that region. We rejected this approach, however, on the grounds that the number of eligible couples in each areal unit varies greatly within each of the countries studied. This variation in the basic scale of a region has the unfortunate byproduct that it creates a high correlation among the potential independent variables measured in absolute numbers which could be used in the equation. Thus, it seems necessary to adjust the variables to the scale of a region. For example, an equation specified in absolute numbers may look as follows:

$$Acc = a + b\ SM + c\ Lit + e$$

where Acc = the absolute number of acceptors; SM = the absolute number of staff months of inputs; Lit = the absolute number of literates; a, b, and c are parameters to be estimated, and e is the error term in the regression.

One way to adjust for the scale of the region is to divide each observation by the number of eligible women or some other variable indicating population size. Then an equation in ratio form would look roughly as follows:

$$\frac{Acc}{EW} = a + b\frac{SM}{EW} + c\frac{Lit}{Pop} + e$$

where the variables are all expressed in ratio form.

YEAR : 1971-1974.

NUMBER OF OBSERVATIONS – 91.
(Excluding Tanjore Dist.)

DEPENDENT VARIABLE No.6 – No.of Vasectomies + IUDs + Tubectomies done to block residents per 1000 EC during 1971-1974.

Variable Number	Name of the variable	Partial regression co-efficient	Std. Errors of partial regression co-efficient	t s
21	No.of BEE man months per 1000 EC during 1971-1974	39.123	14.837	2.6
53	Proportion of female workers among females	111.409	96.433	1.1
49	Proportion of area under HYV to total cultivated area	-57.145	24.597	2.3
19	No.of ANM woman months per 1000 EC during 1971-1974	2.921	1.858	1.5
11	Index of data use	-11.757	3.915	3.0
12	Mean man/woman months of MOs (G+FP) per individual	1.296	0.401	3.2
25	Proportion of trained HIFP man months among total HIFP man months	57.472	35.156	1.6
8	Availability of physical facilities	4.836	2.270	2.1
24	Proportion of trained BEE man months among total BEE man months	-18.859	13.769	1.3
14	Mean woman months of LHVs per individual	0.334	0.791	.4
17	Cumulative No.of Vasectomies + IUDs done in PHC per 1000 EC as on 1-4-1971	0.063	0.038	1.6
44	Proportion of cultivated area to total area of the block	84.205	37.412	2.2
45	Proportion of wet area to total area	22.099	28.047	.7
47	Proportion of workers in transport, storage and communications among total workers in the block	173.269	219.250	.7
60	Average family size	-28.927	15.540	1.8
57	Proportion of male workers among all males	228.414	138.323	1.6
55	Proportion of literate and educated women among all women in the block	-187.194	136.634	1.3
52	Proportion of non-agricultural workers to the total No.of workers in the block	136.608	75.224	1.8
54	Proportion of ST and SC to the total population of the block	58.361	62.414	.9
43	Total area of the block (in acres)	0.001	0.0002	5.0
46	Acres of cultivated area per 1000 cultivators and agricultural labourers	0.189	0.101	1.8
27	Proportion of trained LHV woman months	29.703	18.113	1.6
59	Fertiliser use per 100 acres of total cultivated area	-55.209	55.550	.9
55	Proportion of literate and educated men among all men	118.346	112.332	1.0
22	No.of LHV woman months per 1000 EC during 1971-1974	14.245	9.922	1.4

Output variable	Total contribution explained %	Major variables	Contribution of inputs %	Major variables	Contribution of environmental variables %	Major variables
Vasectomy+ Tubectomy 1000EC block [illegible]	53.3	Supervisory months Proportion of female workers	48.7	Supervisory months Index of data use	30.2	No.of eligible couples Proportion of female workers Proportion of non-agricultural workers

NUMBER OF OBSERVATION=129.
(All strata)

DEPENDANT VARIABLE No.6 - No.of Vasectomies + IUDs + Tubectomies done to block residents per 1000 EC during 1971-1974.

Variable Number	Name of the variable	Partial regression co-efficient	Std. Errors of par. regression co-efficient
21	No.of BEE man months per 1000 EC during 1971-1974	33.946	14.292
11	Index of data use	-10.261	3.136
44	Proportion of cultivated area to total area of the block	76.131	35.045
45	Proportion of wet area to total area	57.591	23.703
18	No.of HIFP man months per 1000 EC in 1971-1974	3.419	1.460
23	Proportion of trained man/woman months of MOs among total man/woman months of MOs	10.041	16.648
17	Cumulative No.of Vasectomies+IUDs done in PHC per 1000 EC as on 1-4-1971	0.064	0.043
16	Mean woman months of ANMs per individual	1.378	0.762
12	Mean man/woman months of MOs (G+FP) per individual	0.808	0.413
53	Proportion of female workers among females	77.416	88.175
8	Availability of physical facilities	4.300	2.200
15	Mean man months of HIFPs per individual	-1.289	0.729
25	Proportion of trained HIFP man months among total HIFP man months	37.907	29.875
19	No.of ANM woman months per 1000 EC during 1971-1974	0.837	0.734
14	Mean woman months of LHVs per individual	-0.460	0.678
57	Proportion of male workers among all males	162.435	153.337
27	Proportion of trained LHV woman months	15.542	14.753
43	Total area of the block (in acres)	0.0001	0.0002
59	Estimated No.of eligible couples in the block	0.001	0.001
24	Proportion of trained BEE man months among total BEE man months	-14.107	14.298
46	Acres of cultivated area per 1000 cultivators and agricultural labourers	0.054	0.097
60	Average family size	-14.159	16.504
54	Proportion of SC and ST to the total population of the block	52.655	52.468
58	Fertiliser use per 100 acres of total cultivated area	-46.391	57.536
50	No.of industrial units (both non-household and household) per 1000 population	-0.076	0.075

...pat ...able	Total contribution explained %	Major variables	Contribution of inputs %	Major variables	Contribution of environmental variables %	Major variables
...f vasec-...y+IUDs+ ...ectomies ...00 EC ...k resi-...ts	51.2	Man-months of supervisory personnel; Index of data use; Proportion of cultivated area	34.6	Man-months of supervisory personal; Index of data use	22.1	No.of eligible couples; Proportion of wet area; Proportion of cultivated area
			37.9	Trained supervisory man-months; BEE man-months; Index of data use		

The second form of the equation has the advantage that covariation which would occur among the number of staff months and the number of literates across the districts and provinces just because districts and provinces varied in population size would be removed. In situations where the variation in scale is unimportant, i.e., where the population among the area units under observation varies very little, it may not be necessary to specify the relationships in ratio form; however, it is perfectly appropriate to use the specification where there is any question of this kind. In order to predict the absolute number of acceptors expected for any given region it is only necessary to multiply the expected number of acceptors per eligible woman by the number of eligible women in the district. It is worth noting, however, that it is not appropriate to mix the variables measuring the absolute quantity of inputs or outputs with ratio measures of environmental characteristics. Any such mixing for the predictive purposes under examination would have the unfortunate effect of yielding predictions that were greatly affected by the scale of a region.

The use of logarithmic transformations is an alternative to the use of ratios for controlling the scale. Thus the equations can be estimated not in terms of the original variables but in terms of their logarithms. Thus, the estimating equation may look as follows:

$$\ln \frac{Acc}{EW} = \ln a + b \ln \left(\frac{SM}{EW}\right) + c \ln \left(\frac{Lit}{Pop}\right) + e$$

This specification has the advantage that the logarithm tends to reduce the extreme outliers in the data set and to eliminate the factor of scale even more completely from specification. The logarithmic form of the equation, however, essentially involves estimating not the linear additive equation but a multiplicative equation of the following form:

$$\frac{Acc}{EW} = a \left(\frac{SM}{EW}\right)^{b} \left(\frac{Lit}{Pop}\right)^{c} e$$

This form of equation is often used in economic studies of production, and may be highly appropriate for studies of efficiency. It makes potentially possible the estimation of optimal patterns of allocation based on the marginal product of a given input. Such estimations are less interesting in the linear form of the production relationship in which the marginal products are constant. The logarithmic specification does, however, involve some additional mathematical complexity, and for the program evaluation issues discussed here it is important to examine whether the relationships are sufficiently stronger with multiplitive specification than with the additive specification to justify the added complexity. This subject will be discussed in Chapter IV.

A final methodological issue is the choice between single and multiple equation approaches. The evaluator or researcher can estimate either some measure of output as the dependent variable or can estimate a set of simultaneous equations based on the recognition that the determination of output of the family planning program involves a relatively complex system of interrelationships. Essentially, the question is whether the output of family planning programs can be thought of as determined by a set of independent exogenous factors in the form of inputs and environmental conditions or whether family planning output itself or one or the other independent variable sets are interrelated among themselves. The most important candidate for an alternative specification would seem to be the recursive system of the kind specified in Chapter I. To test the validity of this possibility we have estimated for the three data sets for which secondary analysis was possible, two equations measuring the environmental determinants of family planning inputs.

For each of the countries examined in the following pages, there is set of alternative specifications of multivariate relationships among the variables under examination. First, we estimate the family planning output per eligible woman as a function of inputs per eligible woman and the environmental characteristics specified in ratio form. Second, we test directly the influence of scale by modifying the original specification to include an extra term which measures the scale directly. Third, we test the relationship in log form by estimating the linear relationship between the log of output per eligible woman and the log of inputs per eligible woman and the log of the environmental variables. Fourth, we test the same relationship but add the log of the scale effect as a possible third type of independent determinant of log output per eligible woman. Fifth, we examine the determinants of inputs specified in ratio form, and sixth, we examine the same relationship in log form. Thus, for each of the three countries for which secondary analysis was done, six regressions are estimated. In addition to the Philippines, some additional regressions have been estimated to adjust for some difficulties with outliers in the original sample of municipalities. In each set four of the basic equations assess multivariate determinants of family planning output, and two of the equations specify the additional relationship between inputs per eligible woman and environmental variables. The countries are discussed in the following order: Malaysia, the Philippines, Korea, Tamil Nadu State in India.

Malaysia:

Table 3.1 presents the basic set of six regressions for Malaysia. For each equation, the dependent variable is specified and the regression coefficients are shown beside relevant variables. Beneath each regression coefficient in brackets is a t statistic which can be used to test the hypothesis that the regression coefficient in question is significantly different than zero. On the line below the equation is presented the R^2, the F-test for the significance of the equation as a whole, the number of observations and a measure of the significance of the equation as a whole. Finally, at the bottom of the page is a list of the variables used in the regressions contained at the top of the table.

For the Malaysia data set, we have chosen to take the total salaries per district as the measure of family planning inputs. In Equation 1, the family planning inputs and the two environmental variables, the percentage of the population which is literate and the percentage of residences in the district served with electricity, are used as independent variables. These two variables are chosen from among a longer list discussed in earlier chapters because they seemed relatively highly related to acceptors per eligible woman in bivariate relationships and because they seem to present somewhat different dimensions of modernization. The electricity variable, while not important as a determinant

TABLE 5.1: Multivariate Correlates of Family Planning Acceptance in Malaysia

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Equation #	Model	Test Statistics
1.	Acc/EW = 7.09 + .01 TSal/EW + .22 Lit% + .001 Elect% (1.03) (3.87) (1.49) (0.02)	R^2 = .300 F = 7.44 N = 56 $p < .0003$
2.	Acc/EW = 4.10 + .01 TSal/EW + .22 Lit% - .005 Elect% + .31 lnEW (.18) (3.59) (1.48) (.06) (.13)	R^2 = .300 F = 5.48 N = 56 $p < .001$
3.	ln[Acc/EW] = -1.53 + .55 lnTSal/EW + .28 lnLit% - .01 lnElect% (1.67) (5.64) (1.36) (.13)	R^2 = .452 F = 14.27 N = 56 $p < .0001$
4.	ln[Acc/EW] = -2.18 + .58 lnTSal/EW + .30 lnLit% - .04 lnElect% + .05 lnEW (1.57) (5.50) (1.44) (.44) (.63)	R^2 = .456 F = 10.68 N = 56 $p < .0001$
5.	TSal/EW = 3238.8 + 12.01 Elect% + 2.75 Lit% - 292.94 lnEW (3.34) (3.30) (.40) (3.04)	R^2 = .259 F = 6.04 N = 56 $p < .001$
6.	lnTSal/EW = 8.09 - .07 lnLit% + .45 lnElect% - .27 lnEW (5.57) (.25) (4.16) (2.53)	R^2 = .272 F = 6.48 N = 56 p .001

KEY

I	TSAL/EW	--	Total Salaries per 1000 Eligible Women
II	ELECT%	--	Percent of families with electricity in their homes
	LIT%	--	Female Literacy Rate
	EW	--	Number of Eligible Women
III	ACC/EW	--	Total Acceptors per 1000 Eligible Women

of acceptors per eligible woman, is significant as a determinant of the total inputs into family planning and thus can be thought to be an important determinant within the system taken as a whole rather than in the first four specific equations.

The first equation suggests that the dominant determinant of acceptors per eligible woman is the amount of total salary per eligible woman. The measure of the proportion of the population which is literate is significantly related to the number of acceptors per eligible woman at the ten per cent level, but is not as strongly related as one might have hypothesized. Moreover, the proportion of households with electricity is not at all associated with the number of acceptors per eligible woman. The level of explanation for the equation taken as a whole is significant but not extremely high.

Alternative specifications increase our understanding of these relationships somewhat. The second equation, for example, shows that the number of acceptors per eligible woman is not significantly related to the log of the number of eligible women taken as a measure of scale. This suggests that any scale effects are already captured in the original specification of the relationship as a ratio. It may be noted, however, that the addition of the scale variable has the effect of reducing the size of the constraint term. The third and fourth equations in the basic set indicate that the overall relationship among the variables is greatly strengthened when the underlying relationship is defined as multiplicative. The R^2 for the equation increases from .30 to .45, and the strength of the relationship between the input variable and the number of acceptors per eligible woman is considerably increased while the significance of the environmental variables remains much as it was in the non-log specification. The increase in the R^2 is largely a function of the reduction in the amount of variance to be explained in the log transformed dependent variable, and is not directly comparable with the R^2 in the first two equations in the set.

Equations 5 and 6 show the relationship between salary per eligible woman and the environmental variables, the proportion literate and the proportion served by electricity, and the scale variable. It is seen that the proportion having electricity greatly influence the amount of expenditure per eligible woman. Thus, while environmental variables have a weak direct impact on the number of family planning acceptors per eligible woman, they exert a stronger indirect effect through their influence on the amount of inputs per eligible woman. For research purposes, the total influence of environmental variables should be calculated as the sum of these two separate influences.[1] For the predictive purposes of this monograph, given that the system is recursive, the predictions from equations 1-4 can be appropriately used for the assessment of efficiency.

The basic results contained in the six equation support the general theoretical framework established in Chapter I. Both environmental and input variables influence output per eligible woman. There

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[1] Commonality analysis suggests that about 10% of the variance in acceptance rates can be attributed to environmental variables, about 27% to input variables and a negligible amount to the number of eligible women.

are other questions that may well be asked. For example, it would be desirable to break down the input variable into the component inputs and test for the influence of each of these constituent elements on output. This is difficult to do, for while the data set for Malaysia is unusually complete, it seems that the different designations of workers are not all represented in each of the districts, leaving a large number of zeros specified in the data set. A log specification would seem to be most appropriate for testing this more complete relationship, but log estimation is not possible in situations where some of the variables have zero values. Thus, for the Malaysia data set we have not attempted this more detailed breakdown. It has, however, been attempted for the Philippine data set which is discussed next.

The Philippines:

The Philippine case differs from that of Malaysia in two important respects. First, the unit of analysis for Malaysia is the district while for the Philippines it is the municipality. The municipality is a lower level administrative unit than the district, and as one might expect, it is characterized both by a smaller average population and by a larger variance in the population of the individual units. A greater variation of the population and other attributes of the Philippine municipalities suggests that for some purposes it may be desirable to use a restricted sample for analysis. The study of efficiency and the delivery of family planning services over an enormous range of structurally different administrative units may not provide great insight. In fact, it may interject a source of error into the estimation of the basic regressions which are used to construct measures of efficiency. Second, in the case of the Philippines, it is possible to present an analysis of the determinants of family planning acceptance using a much more detailed breakdown of staff inputs than is possible for Malaysia. As a result of these two differences, empirical analysis of the Philippine case involves the exploration of an even larger range of possible specifications than does the Malaysia set.

Empirical results are presented in Table 3.2. For convenience, we have kept the numbering of the equations analagous to that in Table 2.1 which refers to Malaysia. Where the additional complexity of the Philippine case is especially relevant we have introduced variations in the table which are numbered alphabetically below the major numerical heading. It should be noted that it is possible to estimate many more relationships than are shown in the table. Those which are shown relate to the somewhat limited sample for which the estimation procedure seemed most appropriate, and have been chosen to be consistent with the estimations which are used in the following chapter. The alternative specifications of the model are shown to make clear how the choice of these basic equations has affected the result. As before, definitions of the variables are shown at the bottom of the table.

The dependent variable in Equation 1 is the number of acceptors per thousand married women of reproductive ages. Staff inputs are measured by the total number of staff months per eligible woman and environmental conditions are measured by level of municipal income and the infant mortality rate. Both the staff inputs and the environmental variables

TABLE 3-2: Multivariate Correlates of Family Planning Acceptance in the Philippines

Equation #	Model	Test Statistics
1.	Acc/MWRA = 167.02 + 3.66 TOT/MWRA + .80 Muny − .52 IMR (3.27) (5.31) (2.54) (1.99)	R^2 = .300 F = 12.54 N = 92 p < .0001
2.A.	Acc/MWRA = 18.42 + 4.74 TOT/MWRA + .41 Muny − .36 IMR + (.27) (6.35) (1.24) (1.39) 86.95 lnMWRA (3.07)	R^2 = .368 F = 12.66 N = 92 p < .0001
2.B.	Acc/MWRA = 41.66 + 15.87 MD/MWRA + 10.14 Nur/MWRA + (.66) (3.18) (2.66) 4.37 Mid/MWRA − 5.11 Mot/MWRA + .32 Muny − (1.61) (2.14) (1.07) .43 IMR + 55.30 lnMWRA (1.79) (2.07)	R^2 = .505 F = 12.25 N = 92 p < .0001
2.C.	Acc/MWRA = 44.79 + 5.13 TOT/MWRA − .05 Muny − .48 IMR (.68) (6.79) (.19) (1.71) +81.75 lnMWRA (3.18)	R^2 = .373 F = 14.11 N = 100 p < .0001
3.	ln[Acc/MWRA] = 3.09 + .57 ln[TOT/MWRA] + .28 ln[Muny] − (4.73) (6.36) (3.56) .15 ln IMR (1.71)	R^2 = .376 F = 17.66 N = 92 p < .0001
4.A.	ln[Acc/MWRA] = 2.47 + .72 ln[TOT/MWRA] + .18 ln[Muny] − (3.79) (7.40) (2.19) .11 ln IMR + .26 lnMWRA (1.36) (3.20)	R^2 = .441 F = 1[illegible].19 N = 92 p < .0001
4.B.	ln[Acc/MWRA] = 3.40 + .71 ln[MD/MWRA] + .19 ln[Nur/MWRA] + (6.42) (4.24) (2.84) .07 ln[Mid/MWRA] − .10 ln[Mot/MWRA] + (.58) (1.92) .09 ln[Muny] − .06 lnIMR + .22 lnMWRA (1.17) (.77) (3.00)	R^2 = .554 F = 1[illegible].82 N = 8[illegible] p < .0001

Equation #	Model	Test Statistic
4.C.	ln[Acc/MWRA] = 3.80 + .66 ln[MD/MWRA] + .18 ln[Nur/MWRA] + (7.41) (4.01) (2.60) .09 ln[Mid/MWRA] - .10 ln[Mot/MWRA] + (.67) (1.88) .08 ln[Muny] - .09 lnIMR + .13 lnMWRA (1.04) (1.20) (2.09)	R^2 = .5 F = 13. N = 93 p .0C
5.	SSTMO/EW = 73.22 - .05 IMR + .03 Muny - 17.83 lnMWRA (12.25) (1.35) (.54) (4.98)	R^2 = .2 F = 9.2 N = 92 p .0C
6.	ln[SSTMO/EW] = 4.45 - .09 lnIMR + .04 ln[Muny] - (8.38) (.99) (.44) .40 lnMWRA (5.05)	R^2 = .2 F = 9.7 N = 92 p .0C

KEY

I
MD/MWRA - Doctors Months per 1000 Married Women of Reproductive Age
NUR/MWRA - Nurse Months per 1000 Married Women of Reproductive Age
MID/MWRA - Midwife Months per 1000 Married Women of Reproductive Age
MOT/MWRA - Motivator Months per 1000 Married Women of Reproductive Age
TOT/MWRA - Total Months per 1000 Married Women of Reproductive Age

II
IMR - Infant Mortality Rate
MUNY - Municipal income, per thousand
MWRA - Married Women of Reproductive Age, in thousands

III
ACC/MWRA - Acceptors per 1000 married women of reproductive age

are significantly related to acceptance. The influence of the aggregated staff variable is somewhat greater than that of the environmental variables but both affect the level of acceptance. The amount of variance explained by the equation is relatively limited but the overall relationship is highly significant. It will be noted that the sample size is 92. Eight units have been eliminated from the sample because they present extreme outliers in terms of the number of women of reproductive age or on either the dependent variable or the input variable. The equation set under heading 2 represents the same estimation with the provision made for the effects of scale. It will be seen in Equation 2A and all of the other equations, that when provision for scale is added to the equation the effects of the environmental variables are somewhat reduced and the overall level of explanation of the equation is increased. Thus, in contrast with the situation in Malaysia, the size of the population to be served by family planning within an administrative unit has a significant impact on the rate of acceptance. In this case, the larger the population to be served, the larger the acceptance rate. It will be noted that we have estimated the scale using the natural log of the number of married women of reproductive ages. Essentially the same result would be achieved through the use of the untransformed number of married women of reproductive ages, but the log transformation has the advantage of reducing the impact of extreme outliers. Equation 2B shows the relationship between the acceptance rate and input variables and environmental variables when the former are borken down into their basic components. It will be seen that by using the breakdown of staff inputs by designation in this equation, all four types of inputs are significantly related to the acceptance rate, although it must quickly be observed that while the number of motivators per married woman of reproductive ages is significantly related to the acceptance rate per thousand married women of reproductive ages, the relationship is in the reverse direction of what we might anticipate. The fewer the motivators per married woman of reproductive ages, the higher the rate of acceptance. It will also be noted that the R^2 for this equation is significantly greater than it was in the earlier specification of the equation. One could expect an increase in the R^2 just on the basis of the existence of more parameters in the equation, but it is noteworthy that the increase signalled here is greater than that required for statistical significance. The breakdown of the staff input variable into its component parts significantly increases the level of explanation. Equation 2C shows the same estimated relationship with the full sample of one hundred municipalities. It will be seen that the general magnitude of the coefficients and the overall significance of the relationships is similar to that of Equation 2A. The exception to this pattern is the coefficient of municipal income which becomes statistically insignificant and undergoes a sign reversal. Moreover, a detailed examination of the residuals suggests the existence of a number of extreme outliers which make the full sample inappropriate for use in the development of efficiency indices. This problem will be discussed further in the next chapter.

Equation 3A shows the same relationship estimated in Equation 1 except that the relationship is specified in log form. The general pattern of the relationship is as before, but its overall strength is increased. Equation 4A estimates in double log form the same relationship specified in Equation set 2. Here again, the general pattern is similar to that in Equation 2, although the significance of the coefficients is in most cases increased and at the same time the overall strength of the relationship is improved. Equation 4B shows the relationship in double log form with the breakdown of the staff input variables into its constituent elements. In this case, the R^2 reaches the highest level in this set of equations with 55 per cent of the variance being explained. The individual coefficients follow a similar pattern to that in Equation 2B with relatively minor exceptions. The coefficients for MD and nurse inputs are statistically significant while the midwife input is not. The motivator inputs are once again significant in the wrong direction. The environmental Variables are not significantly related with acceptance, but the scale variable is. Equation 4C shows the relationship estimated for the full sample.

Equations 5 and 6 have the staff size per eligible woman as the dependent variable and the basic set of environmental and scale variables as the independent variables. In this case it is seen that the coefficients of the environmental variables are of the hypothesized sign but insignificant while the influence of scale is highly significant. Thus, the large municipalities tend to have proportionately larger staffs. Scale influences acceptance rates in two ways, then. First, directly; and second, indirectly, through its influence on staff size.

Korea:

The case of Korea stands in interesting contrast to both that of Malaysia and the Philippines. Most important, the influence of scale and environmental variables is effective in large measure indirectly through the determination of the size of the budget per eligible woman. The basic empirical results for the case of Korea are presented following the same format used for Malaysia and the Philippines.

Equation 1 of Table 3.3 shows the determinants of acceptors per eligible woman. The most central result in this first equation is that the budget per eligible woman and the number of mother's club members per eligible woman are the two dominant variables in the system. Income per capita and farm percentage representing the environmental variables have some influence but it is less than that of the input variables. It should be noted that income per capita is inversely related to the number of acceptors per eligible woman; the higher the income per capita the lower the number of acceptors per eligible woman. The percentage of the population living on farms is positively related to acceptors per eligible woman suggesting that the more rural a given county the higher the acceptance rate. This last result is, however, not statistically significant. Both of these environmental variables are related in the opposite direction of what one might anticipate from the basic theory. Equation 2 leaves the central result largely unchanged. The influence of scale on the level of explanation is small. In general, the equations explain about 46 per cent of the variance of the number of acceptors per eligible woman.

Restating the equations in double log form changes the results very little. With the change to a log specification, the percentage farm variable changes direction, but the central results are not changed.

Equations 5 and 6 provide considerable insight into the overall workings of the Korean system. In these equations, it becomes clear that

TABLE 3.3: Multivariate Correlates of Family Planning Acceptance in Korea

uation #	Model	Test Statistics
1.	ACC.EW = 17.87 + .004 BUD.EW + .004 MCMEM.EW - .01 Y.PC + .01 FarmZ (8.99) (6.08) (3.41) (2.48) (.65)	R^2 = .45 F = 36.7 N = 181 p .0001
2.	ACC.EW = 6.78 + .01 BUD.EW + .004 MCMEM.EW - .01 Y.PC + .01 FarmZ + 1.01 lnEW (66) (4.86) (3.46) (2.69) (.42) (1.09)	R^2 = .458 F = 29.63 N = 181 p .0001
3.	lnACC.EW = 1.54 + .34 lnBUD.EW + .03 lnMCMEM.EW - .16 lnY.PC - .02 lnFarmZ (2.76) (6.49) (2.12) (2.71) (91)	R^2 = .446 F = 35.40 N = 181 p .0001
4.	lnACC.EW = .92 + .38 lnBUD.EW + .03 lnMCMEM.EW - .17 lnY.PC - .02 lnFarmZ + .04 lnEW (.94) (4.92) (2.01) (2.80) (.92) (.78)	R^2 = .448 F = 28.38 N = 181 p .0001
5.	BUD.EW = 6965.2 + .26 Y.PC + 5.42 FarmZ - 602.11 lnEW (17.14) (1.21) (5.83) (14.26)	R^2 = .720 F = 156.95 N = 187 p .0000
6.	lnBUD/EW = 11.14 + .002 lnY.PC + .08 lnFarmZ - .43 lnEW (24.74) (.03) (5.31) (15.26)	R^2 = .791 F = 231.37 N = 187 p .0000

KEY

I BUD.EW - Total Budget per 1000 Eligible Women
MCMEM.EW - Mother's Club Members per 1000 Eligible Women

II FARMZ - Percent of Population on Farms
Y.PC - Income per capita
EW - Number of Eligible Women

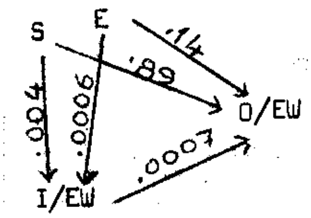
III ACC.EW - Number of Acceptors per 1000 Eligible Women the environmental variables have a strong influence on the amount of budget per eligible woman. Also, it is important to recognize that the amount of budget is very closely related to the size of the population in a given county. The larger the population of the county, the smaller the budget per eligible woman. Thus, all in all, we have a system where the influence of scale variables is felt most strongly indirectly through the determination of the budget per eligible woman and not directly as in the case of the Philippines.

The contrast between the results for the Philippines and Malaysia and those for Korea suggest the need to examine the appropriateness of the underlying model for Korea. In this work we are assuming that the number of staff and other resources on the one hand and the environmental characteristics of a region on the other hand are the constraints which work to limit the number of family planning acceptors. It is assumed that, given these constraints, the local program management and staff seek to maximize the number of acceptors. In this case, however, the very strong level of association between budget per eligible woman and acceptors per eligible woman in Equations 1-4 and between the environmental and scale variables and budget per eligible woman in Equations 5 and 6 suggests that an alternative mechanism may be at work. In Korea the existence of a system of targets may provide the explanation. The size of a target in a county is a function of the environmental variables. For example, the target is larger for those counties with a larger absolute population but there is generally a reduction in the size of targets per eligible woman in the urban and more developed areas on the grounds that these areas have a lower level of fertility already. The targets are administratively associated with a given budget that is the sign of the target determines the budget. Moreover, it seems to be difficult for local administrators to permit the number of acceptors to exceed the number that are budgeted, and the targets are set sufficiently low so that they are feasible for a large proportion of the counties. As a result, during the last part of the budget year of the time period under examination situations arose where little family planning work was done because targets had already been achieved and the budget was exhausted. It is also relatively difficult to obtain increases in the budget which would permit an increase in the county budget. Thus, taken as a whole, the system in Korea may be one for which the causal relationships are quite different than those postulated in the original model or than those which exist in Malaysia or the Philippines. This difference is only partially reflected in the statistical results.

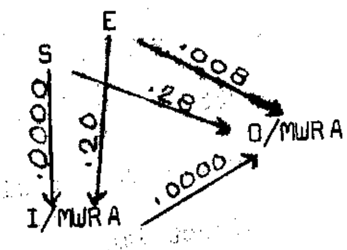
India

Table 2.5 D presents the multivariate correlates of family planning acceptance in Tamil Nadu. The basic format of this table differs from that used for the other three countries, since the data on PHCs from India was not available to do a reanalysis so that the format of the tables could be the same in all four cases. The Indian table includes more types of variables and a finer breakdown of the various categories of the variables such as staffing than is characteristic of the other tables presented in the inter-country report. Nonetheless, the basic pattern of relationships is clear in the table. Both input and environmental variables have some effect on the number of acceptors per eligible couple. The strength of the relationship is, however, not very strong given the large number of variables which have been used in the regression. This result is the equivalent of the results for Equation 3 and the other components of Table 2.5. We do not have the material for regression of the absolute number of acceptors on environmental and staff months, although the fact that PHCs in Tamil Nadu tend to be more homogeneous in size than are the areal units studied in the other countries suggests that estimated equations equivalent to equations 1 and 2 in the other tables would not show as strong a level of association between inputs and outputs as was experienced in the other studies. As discussed in earlier chapters, the Indian case is somewhat different from the other countries, since the period under observation was characterized by the use of considerable resources outside of the family planning program for the attainment of family planning goals. Since those resources are not adequately measured by the input variable, it is expected that the level of association in the Indian case would be less than in some of the other countries. Mobilization of general development resources and the resulting influence of family planning workers per se has undoubtedly had an important contributing effect in the generation of family planning acceptors, but the underlying behavioral model for this kind of situation differs considerably from that described by the other three countries. This underscores the need for a careful examination of the causal patterns which lead to family planning acceptance as a necessary precondition for the establishment of an evaluation system, and especially as a precondition to the establishment of an evaluation system which makes major use of input-output relationships.

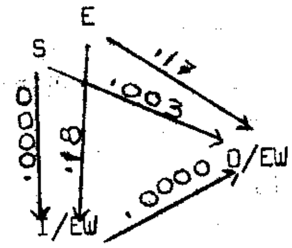
Each of the four countries yields results which have a number of unique features and some features which are shared in common. All are characterized by a situation in which both environmental and input variables influence acceptance rates. The magnitude and the mechanism by which these influences operate, however, differs from one country to another. The importance of different causal mechanisms in the three countries should be stressed. In terms of the path diagram presented in Chapter I, contrasting situations of Malaysia, the Philippines and Korea can be diagrammed as follows:



Malaysia



Korea



Philippines

In the diagrams the significance of a given relationship is indicated by the number beside the arrow which is the probability that the partial effects which are shown is zero. In instances where multiple variables are involved, e.g. environmental variables in Malaysia – the number indicates the significance level of the variable with the best fit. In all three cases, the direct association between inputs and outputs is highly significant. The influence of the environmental variables is, however, more diverse. For convenience, it is helpful to divide the environmental category of variables into the scale variable and the larger and more general category of environmental variables. In the case of Malaysia, environmental variables have a weakly significant direct relationship to output, but scale has no such effect. Both measures of the environmental characteristics of an administrative unit are significantly related to inputs. Thus, in Malaysia, the indirect effects of environmental variables outweigh the direct effects. In the case of the Philippines, both environmental and scale variables are related directly to output but the effect of scale is particularly strong. Scale effect of the environmental variables is significant, but the indirect effect of scale is again strong. Thus in the Philippines the population of eligible women exerts a strong direct and indirect effect on output. In the case of Korea, there is an entirely different pattern. There is a strong direct effect of environmental conditions on output per eligible woman, but the scale variable has no significant direct impact. On the other hand, the scale variable is extremely strongly related to the level of inputs per eligible woman. Thus scale is an extremely important variable in the system, but works its way entirely through the indirect path. In discussing these relationships, it would be emphasized that both the input and the output variables are defined throughout as ratios where the denominator is some measure of the number of eligible women in a region. Thus, when we speak of scale we are referring to the significance of effects beyond those that would be associated with an increase in the total number of acceptors in proportion to any increase in the number of eligible women in a region.

A negative coefficient on the scale variable implies that the shift from small units to larger units is associated with a decline in the rate of acceptance. A positive scale coefficient implies the opposite, that larger administrative units have higher rates of acceptance than smaller administrative units when everything else is held constant. The general importance of the scale variable and its especially strong importance in the case of Korea suggests that we should be cautious to examine the policy framework in which family planning is undertaken. As discussed in the case of the Korea results, the strong indirect relationship would seem to reflect the establishment of a policy on the part of the Korean authorities that Korean administrative units with large populations will be less intensively served by the family planning programs than those with small populations.

The diversity of results among the countries underscores the necessity of adjusting any evaluation mechanism to the characteristics of a given situation. We can neither assume that we can find a single rule which will operate under all countries or even that all of the observations within a given country can be easily dealt with using any particular analytic framework. Nonetheless, the results are strong enough to suggest that this general approach may provide a point of departure for the analysis of efficiency, which is the subject of the next chapter.

CHAPTER IV

Some Measures of Efficiency for Family Planning Programs

Efficiency is a concept of great concern to evaluators. This chapter describes alternative measures of efficiency for the four participating countries in this input-output study. Three different types of efficiency measures are introduced. The first two---productivity measures and cost-effectiveness measures----are closely related. Productivity measures of efficiency are defined by the ratio of output to input, e.g., the number of acceptors per staff year for a given type of staff. Cost-effectiveness measures take the form of costs per unit of output. These two measures are strongly related, especially in those cases where the cost of staff time is the major component of the budget. An alternative approach to the measurement of efficiency is derived from the theory of production in the area of family planning, which was presented in Chapter I. It takes the form of the ratio of the difference between observed and expected output and the number of eligible women residing in a given area. The chapter is divided into three parts. The first section deals with productivity and cost-effectiveness measures while the second focuses on alternative measures of efficiency. The last part of this chapter explores the relationships between the various measures of efficiency and draws some tentative conclusions.

A. Productivity and Cost-Effectiveness Measures of Efficiency

The simplest measures of productivity would take the form of a ratio between the number of units of output and the number of units of some specific type of input, such as number of hours of staff time on extension work. The greatest difficulty with this general approach to productivity is that the ratios are only interpretable when they follow from a discussion of some theory of production. Difficulties can be of several forms. One difficulty is that in a complex organization with a number of different types of output, for example the users of different types of contraceptives, there may be only a weak relationship between a particular kind of input and a particular kind of output. For example, the number of hours of input of male family planning extension worker time may have little relationship to the number of female method acceptors in the Indian program. A second problem is that in some sense output may be a function of the entire organization rather than a sub-part of the organization, and productivity measures based on the ratio of output to any given type of personnel may not adequately deal with this reality. With either of these above-mentioned difficulties, it is possible to construct ratios, but the ratios which are defined may not be very useful measures of efficiency. In fact, they may be positively misleading since they attribute output to categories of input to which they may not be causally related. Nonetheless, if inputs and outputs are defined broadly enough, productivity measures may be very helpful in assessing family planning programs.

TABLE .♦.-1

Measures of Productivity and Cost-Effectiveness

A. Malaysia

	N	Minimum	Maximum	Mean	Std. Dev.
Total Salary per Acceptor	56	13.36	109.82	36.74	16.87
Total Acceptors per Staff Year	56	41.33	321.00	125.26	51.47

B. Philippines

	N	Minimum	Maximum	Mean	Std. Dev.
Total Acceptors per Staff Month	100	2.20	41.30	8.68	6.29

C. Korea

	N	Minimum	Maximum	Mean	Std. Dev.
Budget per Acceptor	193	29.78	174.14	67.74	19.68
Acceptors per Mother's Club Member	183	.017	9.68	.43	1.07

Cost-effectiveness is an alternative measure of efficiency. As do productivity measures, cost-effectiveness measures take the form of a ratio between inputs and outputs, but in this case the input is measured in money terms rather than in physical input terms. Thus, productivity measures take the form O/I where O is a measure of output and inputs, I, are measured by hours of staff time or some equivalent measure. Cost-effectiveness measures, on the other hand, take the form of I/O where in this case the inputs are measured in costs, e.g., the total salary budget of a family planning clinic. Where costs and physical inputs are closely related these two measures will have a reciprocal relationship.

Table 4.1 shows the descriptive statistics for some measures of productivity and cost effectiveness for Malaysia, the Philippines and Korea. In Malaysia the number of acceptors per staff member per year varies from 41 to 321 with a mean of 125 acceptors per staff member per year. In the Philippines the variation is from 2 to 41 acceptors per staff member per month with a mean of nine.

For Korea and Malaysia we have measures of cost-effectiveness for the local administrative units. The descriptive statistics for these measures are shown in Table 4.1. The salary cost per acceptor varies from $M 13 to $M 110 in Malaysia. Thus, the range of variation is quite large. There is also considerable variation in cost per acceptor in Korea.

It is tempting to try to make comparisons among the four countries in terms of their productivity or cost-effectiveness, but it should be remembered that the four programs are very different and productivity is only one measure of program success. It is more appropriate to attempt to make comparisons among the regional sub-units within a given national program. Here also caution must be exercised, for as discussed in Chapter I, neither cost minimization nor productivity maximization is the overall goal of most programs. Sub-units work under very different environmental conditions, and some have higher complements of staff than others.

Tables 4.2 to 4.4 show some of the variation in productivity and cost-effectiveness for different environmental and input combinations. In each case the input and environmental variables have been trichotomized to array the observations into nine cells. For each cell the specified productivity or cost-effectiveness measure has been calculated. It will be observed that these cell means vary with changes in inputs and environmental conditions.

On the basis of the discussion of Chapter I, higher costs per acceptor or lower output per unit of input would be expected in those regions where family planning is pursued more intensively. Similarly, regions that are more modern would be expected to be more responsive to family planning; consequently, they should have a lower cost per acceptor or a higher productivity per worker for any given level of intensity of family planning activity. These results are not derived on the basis of the characteristics of the regional organizations which are delivering family planning services, but on the basis of the nature of the potential demand for such services in the community. It is assumed that the most highly motivated individuals or couples

Table 4.-2: Variation in Cost-effectiveness and Productivity as a Function of Environmental and Input Variables - Malaysia

A. Cost-effectiveness:
Dependent Variable: TSal/Acceptor

Total Staff Salaries/EW	Literacy % LO	Literacy % MED	Literacy % HIGH	
LO	28.78 (9)	23.21 (5)	33.11 (6)	28.69 (20)
MED	38.37 (8)	29.97 (9)	24.37 (1)	33.39 (18)
HIGH	53.15 (5)	45.60 (5)	48.58 (8)	49.02 (18)
	37.81 (22)	32.30 (19)	40.78 (15)	N = 56

B. Productivity:
Dependent Variable: Acceptors/Staff Year

Total Staff Salaries/EW	Literacy % LO	Literacy % MED	Literacy % HIGH	
LO	145.25 (9)	171.13 (5)	137.65 (6)	149.44 (20)
MED	104.57 (8)	147.35 (9)	147.44 (1)	128.34 (18)
HIGH	87.54 (5)	90.24 (5)	103.35 (8)	95.32 (18)
	117.34 (22)	138.58 (19)	120.01 (15)	N = 56

Table 4-3: Variation in Productivity by Environmental and Input Variables - Philippines

Acceptors/Staff

Municipal Income

Staff Size/EW	LO	MED	HIGH	
LO	6.50 (10)	8.75 (9)	17.95 (13)	11.79 (32)
MED	7.59 (10)	7.69 (15)	9.54 (5)	7.96 (30)
HIGH	4.87 (13)	6.00 (9)	5.41 (8)	5.36 (30)
Marginal x	6.19 (33)	7.52 (33)	12.48 (26)	N = 92

Table 4.-4: Variation in Cost-Effectiveness and Productivity as a Function of Environmental and Input Variables-Korea

A. Cost-effectiveness:

Dependent Variable: Budget/Acceptor

Farm %

Budget/EW	HIGH	MED	LO	
LO	66.02 (5)	54.93 (10)	51.34 (40)	53.33 (55)
MED	72.01 (8)	69.24 (34)	65.36 (20)	68.34 (62)
HIGH	100.15 (7)	83.80 (18)	77.75 (39)	81.90 (64)
	60.56 (55)	71.16 (62)	72.96 (64)	N = 181

Per Capita Income

Budget/EW	LO	MED	HIGH	
LO	58.52 (11)	51.02 (11)	52.37 (33)	53.33 (55)
MED	61.34 (22)	69.52 (29)	78.65 (11)	68.34 (62)
HIGH	83.16 (34)	80.06 (25)	82.52 (5)	81.90 (64)
	72.05 (67)	70.45 (65)	61.34 (49)	N = 181

Table 4-4: (continued)

B. Productivity:
Dependent Variable: Acc/MCMB

Farm %

Budget/EW	HIGH	MED	LO	
LO	.13 (5)	.13 (10)	1.34 (40)	1.01 (55)
MED	.14 (20)	.10 (34)	.84 (8)	.21 (62)
HIGH	.09 (39)	.11 (18)	.61 (7)	.15 (64)
	1.18 (55)	.11 (62)	.11 (64)	N = 181

Per Capita Income

Budget/EW	LO	MED	HIGH	
LO	.42 (11)	.53 (11)	1.37 (33)	1.01 (55)
MED	.27 (22)	.11 (29)	.34 (11)	.21 (62)
HIGH	.15 (34)	.10 (25)	.41 (5)	.15 (64)
	.23 (67)	.18 (65)	1.04 (49)	N = 181

will be the first to make use of availble services and that efforts to increase the proportion of users will require increasingly more intensive inputs. The more modern a location, the more favorable will be the basic response of the population. In general these expectations are born out by the accompanying tables.

In Malaysia there is a clear tendency for the cost per acceptor to rise with the level of intensity of services, even when the literacy of the region is controlled. For example, Panel A of Table 4.2 shows that among those districts with a relatively low literacy the total salary cost per acceptor increases from $M 28.78 per acceptor in areas of low intensity to $M 53.15 for those with high intensity. Similar increases are shown in the other two columns with only one small reversal in the case of a cell with a single observation. The pattern is very similar but in the reverse direction for the productivity measures shown in the columns of Panel B of the same table. On the other hand, both cost-effectiveness and productivity are more weakly related to the environmental variable. In both cases the relationship is in the expected direction for the medium and high intensity input areas, but is weak in the reverse direction for the low intensity districts.

In the Philippines, productivity is associated with both input intensity and environmental variables in the hypothesized direction. In general, holding the environmental variable constant and changing the intensity of staff inputs leads to a more consistent and stronger relationship than the reverse. It is also noteworthy that for areas of high input intensity, there is relatively little variation in productivity associated with changes in municipal income.

In Korea, there are two measures of efficiency. Variations in the cost-effectiveness measure are associated with both the environmental and the input intensity measures in the hypothesized directions and the relationships seem fairly robust. In the case of the productivity measure, Acceptors per Mother's Club member, the relationships are also in the hypothesized direction but are weaker. This result is to be expected since Mother's Club membership is only a part of the input into family planning in each county.

Overall the results from the three countries for which appropriate data is available suggest that there is likely to be systematic variation in efficiency by input intensity and environmental conditions. This result indicates that cost-effectiveness or productivity as indicators of efficiency are likely to be contaminated by their covariation with intensity and environmental conditions. Where alternative measures are unavailable, it may still be appropriate to use them for evaluative purposes, but the preceeding discussion should have underscored the need for caution. It is especially important to avoid confusing high cost per acceptor (or low productivity) which results from a high intensity of family planning activity with that which results from technical or economic inefficiency at a given scale or intensity of effort. The former case may be associated with general high performance while the latter may call for remedial administrative action. In the next section we discuss the use of indicators of efficiency which control for intensity and environmental conditions.

B. An Alternative Index of Efficiency

In Chapter I, a measure of efficiency was suggested which is an alternative to the productivity and cost-effectiveness indices discussed above. That measure of efficiency took the form of a ratio between 1) the residual between the observed performance of a given region and the expected or predicted performance in the numerator and 2) the number of eligible women in the denominator. The equation for this efficiency measure is as follows:

$$\text{Efficiency Index}_i = \frac{\text{Observed Performance}_i - \text{Expected Performance}_i}{\text{Eligible Women}_i},$$

where expected performance is the number of units of acceptance that would be predicted on the basis of a regression equation of the type discussed in Chapter III, and observed performance is the actual number of observed units of acceptance recorded for the given district, municipality, or county. Eligible women is the number of women or couples defined as at risk by the program and i indicates the region in question. The numerator of this equation is the residual, i.e. the difference between observed and predicted performance. It should have a mean of zero, since the least squares estimation procedure of the regression equation assumes that the average predicted value from the estimated regression equation will be equal to the mean of the observed performance. The numerator of the equation is of considerable interest in its own right as a direct measure of by how much the performance of a given unit exceeds or falls short of the norm for a unit with similar characteristics. The denominator of the equation provides a method for scaling the effects in a way that permits comparison among units of differing size. Other denominators might be used for this purpose, but some caution must be employed in the choice of an appropriate variable. When the expected performance variable was used as the denominator in a preliminary test of the index, some difficulties were experienced because of a few negative values in the expected performance variable.

In the examples to be presented here the choice of a denominator is made easier by the fact that all of the regressions presented in Chapter III upon which this work is based are specified in ratio form. Thus, the dependent variable in all of the equations 1–4 for Malaysia, the Philippines and Korea was the acceptance rate or its log. The acceptance rate is the observed performance divided by either the entire population of the geographical area in question or by the number of eligible women. The expected performance calculated from the equation is also expressed as a ratio. Thus the efficiency index can be redefined.

$$\text{Efficiency Index}_i = \frac{\text{Observed Performance}_i - \text{Expected Performance}_i}{\text{Eligible Women}_i}$$

$$= \text{Observed Performance Ratio}_i - \text{Expected Performance Ratio}_i$$

It is not necessary to divide the residual by the number of eligible women where the statistical estimation has already been done with the acceptance rate.

The procedure used in constructing the index can be made clear with an example. An index can, of course, be constructed from any of the regression equations with acceptance rates as a dependent variable. For

Malaysia, Efficiency Index-1 was constructed with the first regression equation from Table 3.1. In that estimation procedure, actual observations from 56 districts on the values of the dependent variable and each of the independent variables were used to estimate the values of the regression coefficients shown in the following equation:

$$\widehat{(Acc/EW)}_i = 7.09 + .01\ TotSal_i/EW_i + .22\ Lit\%_i + .001\ Elect\%$$

where the $\wedge$ on the dependent variable indicates that it is the predicted value which is indicated. The estimated relationship does not perfectly explain the variation which is observed in the dependent variable. In other words, the equation will not predict the actually <u>observed</u> level of acceptance in each of the districts in Malaysia. This estimated relationship can be used to make a prediction, but that prediction is likely to be somewhat incorrect, and it is the difference between this predicted value and the observed value which is the numerator in the efficiency index. To make a prediction the observed values of the independent variables are substituted into the equation as follows to compute a predicted value for the dependent variable which is consistent with the estimated statistical relationship and the actual data for a given region. Using the values for the first district in the list (see Table 4.8) we calculate

$$\begin{aligned}\widehat{(Acc/EW)}_1 &= 7.09 + .01\ TotSal_1/EW_1 + .22\ Lit\%_1 + .001\ Elect\%_1 \\ &= 7.09 + .01\ (785.3) + .22\ (61) + .001\ (66) \\ &= 29.074\end{aligned}$$

To calculate the value for the efficiency index for this district, based on Equation-1 it is only necessary to subtract this predicted value of the acceptance rate from the observed value:

$$\text{Efficiency Index}_1 = Acc_1/EW_1 - \widehat{(Acc/EW)}_1$$
$$= 32 - 29.074$$
$$= 2.956$$

The difference between the value of the acceptance rate predicted in this manner and that actually observed is a function of the extent to which the equation captures the essential relationships among the variables. The residual is a combination of the influence of random error and error resulting because some variables that may help explain acceptance rates have been left out of the equation. In this case we are assuming that the imperfect correspondence between the predicted and the observed performance is a measure of how efficiently resources have been used in the production process. In other words, it measures something we might call management.

The use of the regression equation for estimating the expected performance provides us with an estimate of efficiency which takes into account both environmental and input factors. The resulting index of performance is a measure of how well a given unit is performing by comparison with a standard of performance of all of the units in a country under observation when controlled for these factors. As long as the residual is divided by the number of eligible women or is based on acceptance rates, comparisons between units are possible.

The Efficiency Index used here has a number of advantages. First, it is empirical in nature. Second, it permits comparisons among various service delivery units. Such comparisons may be extremely useful for purposes of deciding which units need further resources or need technical assistance from the central administration. Third, since the regression equations used to define the index include a control for resource intensity or scale, differentiating between scale efficiency and economic or technical efficiency should not be as serious a problem as it is in the case of simple cost-effectiveness ratios.

A limitation of the efficiency index is that in and of itself it does not provide any information about the reasons for greater or less than average performance. In proposing that the index be used as a measure of efficiency it is assumed that the index measures some quality like the managerial skill of the leaders in a given region or the degree of teamwork among the staff---or in short, the managerial efficiency of the organization or organizations providing services in the area. But there is undoubtedly some random error in the determination of performance which will be reflected in the index as well.

A second limitation of this kind of index is that there are, of course, many different versions of the index that can be proposed. Each regression reported in Chapter III for which the acceptance rate is used as a dependent variable is associated with its own index of efficiency. Thus the analyst is left with a problem of choice. Clearly for administrative purposes it would be inappropriate and confusing to have multiple indices of the efficiency dimension of performance in use. What criterion should be used then to choose among the various measures? Two basic criteria suggest themselves. First, the index should be based on a statistical measure which has strong predictive power. Second, the index should be as simple as is consistent with its underlying intent so as to maximize the probability that it can be understood and used by program staff at all levels in the organization. These two criteria are obviously, to some extent, in conflict. For example, the use of logarithmatically transformed variables and the introduction of an additional term for the number of eligible women may increase the predictive power of the equation, but it also adds greatly to the complexity of the suggested relationship. This kind of trade off is clear in the comparison between equation one and equation four in the sets of regressions from Chapter III.

Multiple versions of the efficiency index were developed for Malaysia, the Philippines and Korea. Here we will concentrate on a presentation of the results for these indices based on equation one and to a lesser extent equation four from the earlier regressions. In all cases, as shown in Table 4.5, the values of the index range from a negative number to a positive number with a mean equal to zero. This follows from the definition of the index as the unexplained residual difference between the observed and predicted acceptance rates or their logs.

C. Comparisons Among Alternative Measures of Efficiency

The above discussion has a number of measures of efficiency in considerable detail. How do these measures compare? Table 4.6 presents the correlations among the various measures of efficiency which have been discussed in this chapter. Among the efficiency Indexes, only the correlations between Efficiency Index I and Efficiency Index 4 are shown. The other correlations are of the same order of magnitude. There are several

Table 4.5: Descriptive Statistics for Efficiency Indices for Malaysia, the Philippines, and Korea.

Data Set:	Variable	N	Min	Max	Mean	Std. Dev.
A. Malaysia	Eff 1	56	-22.29	27.81	0	9.14
	Eff 4	56	-.86	.85	0	.35
Data Set:						
B. Philippines	Eff 1A	92	-268.08	562.23	0	164.78
	Eff 4A	92	-1.08	1.02	0	.45
	Eff 1B	92	-266.86	549.31	0	141.99
	Eff 4B	86	-1.16	.98	0	.38
Data Set:						
C. Korea	Eff 1	181	-13.00	9.44	0	3.74
	Eff 4	181	-.66	.41	0	.17

TABLE 4 -6: Correlations among Efficiency Measures for Malaysia, the Philippines, and Korea

A. Malaysian Correlations

Sal/Acc	-			
Acc/Stf	-.74	-		
Eff 1	-.69	.68	-	
Eff 4	-.79	.73	.95	-
	Sal/Acc	Acc/Stf	Eff 1	Eff 4

B. Philippine Correlations

Specification A:

Acc/Stf	-		
Eff 1	.65	-	
Eff 4	.67	.86	-
	Acc/Stf	Eff 1	Eff 4

Specification B:

Acc/Stf	-		
Eff 1	.63	-	
Eff 4[a]	.59[a]	.90[a]	-
	Acc/Stf	Eff 1	Eff 4

C. Korean Correlations

Bud/Acc	-			
Acc/MCMemb	-.20	-		
Eff 1	-.64	.07	-	
Eff 4	-.67	.13	.96	-
	Bud/Acc	Acc/ MCMemb	Eff 1	Eff 4

N=92 unless superscript [a] N = 86

salient features to this table. First, the negative correlation of -.74 between the productivity and the cost-effectiveness measures for Malaysia underscore the similarity of these two measures. Second, there is a very high correlation between alternative efficiency indices which underscores the essential similarity of the prediction for the underlying regressions. Generally, alternative versions of this index are substitutes for one another. In very few cases does the correlation among alternative formulations of the efficiency index fall below 0.9. Finally, the Efficiency Indices are correlated with measures of productivity and cost-effectiveness, but generally not at the same level that they are correlated among themselves. These results suggest that all of the measures of efficiency are to some extent measuring a common phenomenon, but there are some differences among the various indicators.

Table 4.7 presents the correlations between the various measures of efficiency and a set of variables measuring inputs and environmental conditions. In general, the correlations are low. As might be expected given the way they are defined, the Efficiency Indices are less correlated with environmental and input variables than are the productivity and cost-effectiveness measures. This may be one advantage in using these somewhat more complex measures of efficiency.

D. The Application of the Efficiency Index

The potential for practical use of evaluation tools is their principal justification. The discussion in previous pages may suggest to the reader that the complexity of these tools, whatever their intrinsic merits, may be so great as to preclude administrative use. The author

TABLE 4-7: Correlations among Selected Efficiency Measures and Environmental Variables.

A. Malaysian Correlations

	Literacy%	Elect%	LMF	Staff/EW	EW
Sal/Acc	-.06	.11	.03	.45	-.11
Acc/Stf	.04	-.11	-.04	-.53	.20
Eff 1	.00	-.00	-.01	.08	.03
Eff 4	.04	.03	-.10	-.02	.03

B. Philippine Correlations

	MWRA	ClinHrs	Urban%	Radio%	Infmort	SStmo.EW	MunInc
Acc/Stf	.48	.30	.42	.34	-.16	-.40	.40
Eff 1A	.19	.38	.14	.23	-.00	.00	.00
Eff 4A	-.05	.08	.11	.18	-.05	.02	-.02
Eff 1B	.12	.20	.16	.22	-.00	.00	.00
Eff 4B	-.05	-.01	.11	.20	-.07	-.02	.01

C. Korean Correlations

	Mom's Clubs	Radio%	Illit.rate	Age@Marriage	EW
Bud/Acc	-.02[a]	-.02[b]	.29[b]	-.30[c]	-.37[b]
Acc/MCM	-.38[a]	.11[a]	-.28[a]	.13[d]	.26[d]
Eff 1	-.03	-.13	-.01	.10[e]	-.05
Eff 4	.02	-.11	-.01	.10[e]	-.11

N = 18 unless indicated by superscript pt. as below:

[a]N = 183

[b]N = 193

[c]N = 192

[d]N = 182

[e]N = 180

Table 4.8 Data and Estimates of. Measures of Efficiency for the Districts of Malaysia

INPUT OTSALEV	ENVIRONMENT LIT FE	ELECTRS	SCALE UNIT	OBSERVED ACCEPTANCE RATE CURACEW	PREDICTED ACCEPTANCE RATE PREDI	EFFICIENCY INDEX RESI	COST EFFECTIVENESS TELPACE	PRODU- TAC-
785.8	61.0	66.0	41.2	32.0	25.1	2.9	24.4	[illegible]
1225.1	55.0	63.0	23.4	34.0	32.4	1.6	36.3	[illegible]
673.2	51.0	41.0	42.3	24.0	25.6	-1.6	27.6	[illegible]
824.6	53.0	27.0	37.4	37.0	27.0	10.0	22.1	[illegible]
1160.3	50.0	47.0	19.3	37.0	30.6	6.4	31.1	[illegible]
893.9	49.0	29.0	9.3	45.0	27.6	17.4	20.1	[illegible]
522.9	47.0	27.0	17.8	30.0	23.1	6.9	17.6	[illegible]
2041.6	51.0	38.0	5.2	51.0	41.1	9.9	41.0	[illegible]
949.6	47.0	27.0	56.2	44.1	28.1	16.0	22.7	[illegible]
621.9	47.0	30.0	29.9	33.0	24.2	8.8	18.9	[illegible]
454.1	33.0	4.0	7.3	31.0	20.6	10.4	14.5	[illegible]
392.6	42.0	15.0	19.4	21.0	20.6	.4	19.0	[illegible]
897.8	46.0	42.0	16.4	33.0	26.9	6.1	27.0	[illegible]
1215.2	41.0	34.0	39.0	15.0	29.2	-14.2	79.1	[illegible]
250.4	34.0	17.0	11.6	8.0	17.6	-9.6	36.2	[illegible]
1052.5	35.0	8.0	13.4	19.0	26.1	-7.1	54.3	[illegible]
622.1	31.0	7.0	11.7	11.0	20.6	-9.6	55.9	[illegible]
1432.9	53.0	72.0	31.1	38.0	34.2	3.8	37.3	[illegible]
732.4	47.0	35.0	12.9	24.0	25.4	-1.4	31.0	[illegible]
2263.5	59.0	69.0	25.6	35.0	44.4	-9.4	64.3	[illegible]
354.1	54.0	28.0	17.5	8.0	22.9	-14.9	44.2	[illegible]
1869.3	55.0	38.0	7.3	17.0	39.3	-22.3	109.8	[illegible]
666.4	55.0	60.0	11.5	16.0	26.5	-10.5	43.0	[illegible]
2295.1	51.0	36.0	5.0	43.7	43.0	.1	53.1	[illegible]
1316.7	55.0	52.0	16.0	45.0	33.4	11.6	29.5	[illegible]
1081.4	45.0	52.0	9.4	32.0	28.7	3.3	33.9	[illegible]
1070.7	49.0	38.0	9.5	37.0	29.4	7.6	29.3	[illegible]
1164.1	46.0	19.0	8.4	29.0	29.7	-.7	39.0	[illegible]
1661.8	50.0	27.0	19.8	29.0	36.0	-7.0	56.9	[illegible]
1649.3	47.0	11.0	6.1	34.0	35.0	-1.0	47.6	[illegible]
1134.9	77.0	95.0	58.7	26.0	21.8	4.2	43.1	[illegible]
973.5	50.0	68.0	9.6	24.0	28.6	-4.6	39.5	[illegible]
730.3	48.0	63.0	25.4	30.0	25.6	4.4	24.4	[illegible]
2056.2	49.0	61.0	13.6	36.0	39.1	-3.1	57.1	[illegible]
677.6	76.0	55.0	10.0	35.0	31.2	3.8	19.6	[illegible]
941.2	51.0	29.0	9.8	27.0	28.5	-1.5	34.6	[illegible]
921.5	44.0	22.0	24.2	39.0	26.7	12.3	23.0	[illegible]
727.4	52.0	45.0	34.9	24.0	26.4	-2.4	29.5	[illegible]
705.7	57.0	43.0	29.7	19.0	27.3	-8.3	36.2	[illegible]
1013.7	41.0	43.0	20.2	38.0	27.1	10.9	26.9	[illegible]
1182.7	53.0	84.0	76.2	30.0	31.1	-1.1	38.1	[illegible]
1181.3	51.0	57.0	19.1	30.0	31.1	-1.1	39.3	[illegible]
603.3	46.0	36.0	33.3	15.0	23.8	-8.8	43.1	[illegible]
352.3	48.0	17.0	22.5	21.0	21.5	-.5	17.1	[illegible]
689.6	63.0	73.0	138.7	27.0	28.5	-1.5	25.8	[illegible]
1341.0	46.0	63.0	16.4	29.0	31.7	-2.7	45.6	[illegible]
564.0	47.0	37.0	17.0	16.0	23.6	-7.6	34.2	[illegible]
1395.5	52.0	63.0	37.0	43.0	33.6	9.4	32.7	[illegible]
511.0	50.0	67.0	15.2	20.0	28.0	-8.0	45.6	[illegible]
153.5	44.0	28.0	21.5	7.0	18.5	-11.5	22.7	[illegible]
695.0	44.0	21.0	12.3	52.1	24.3	27.8	13.4	[illegible]
248.9	36.0	8.0	14.5	8.0	17.7	-9.7	23.8	[illegible]
1030.8	40.0	25.0	31.8	17.0	26.9	-9.9	59.0	[illegible]
506.4	33.0	4.0	6.8	24.0	19.8	4.2	27.5	[illegible]
993.3	46.0	33.0	10.0	21.0	27.9	-6.9	47.7	[illegible]
863.2	46.0	27.0	8.2	25.0	26.5	-1.5	34.4	[illegible]
978.32	47.571	39.750	23.213	28.130	28.130	-.19032-14	36.735	[illegible]
491.50	9.0792	21.319	21.307	10.932	5.9912	9.1442	16.860	[illegible]

of this report feels, to the contrary, that the estimatión of relatively complex measures of efficiency is well within the competence of most national evaluation units and that their use could be explained to administration.

The first six columns of Table 4.8 shows for each of the 56 districts of Malaysia the basic used to estimate the efficiency indices discussed in this chapter. The last three columns show calculated values for the efficiency index, the cost-effectiveness index and the productivity index associated with each district. Administrators in possession of the information contained in these last three columns should be able to say something about the relative efficiency of each district. Of course, to be useful the index must be constructed on the basis of current information for input, output and environmental variables. Knowing the values associated with the efficiency index in the third from the last column, for example, they can identify districts which are particularly efficient or inefficient and attempt to sanction or reward those responsible or to learn more details so as to be able to increa the general efficiency of program operations.

CHPATER V

Conclusions

In this report, various measures of the inputs into family planning programs and their relationship to family planning outputs and environmental variables have been described. The relationship between the inputs and outputs can be given the broad label of "efficiency", and the study of efficiency is one sub-area of evaluation studies more generally defined. There are, of course, many measures of efficiency, and we have attempted in our discussion to clarify how any particular measure may relate to different aspects of the general subject.

Family planning evaluation has traditionally neglected the study of efficiency. This neglect may be common to new programs of social intervention which are much more concerned with justifying their very existence and with achieving measurable outcomes than they are with questions of how resources are used for achieving those ends. Nonetheless, as the field of family planning has matured, there has been an increasing concern with the efficiency with which resources are used to accomplish the ends of contraceptive use and reduced fertility. This shift in emphasis has been off-set by difficulties in defining those theoretical concepts with which evaluation systems should be concerned and by difficulties at the field level in gathering information concerning resources used for programs. Earlier parts of this report have dealt with both types of problems.

It seems clear that a number of different types of efficiency can be defined. "Technical efficiency" refers to the technical ability of a program to make maximum use of whatever resources it has at its disposal, independent of what those resources cost. A second concept of efficiency is "economic efficiency" which addresses the question of whether those technically efficient resource allocations are the most effective resource combinations that could be purchased with a given budget. In other words, economic efficiency is concerned with the implications that the costs of various factors of production have for defining which production process should be used. Finally, evaluators may be concerned with the issue of "scale efficiency" which deals with the question of whether the appropriate amounts of resources have been allocated to a given program given the social gains that can be expected to accrue from that program.

It is important for the evaluator to be aware of the various ways in which efficiency can be defined. For example, it is possible, as has been demonstrated in the empirical portions of this report, to define the cost per family planning acceptor. The particular numbers which result from the measurement of cost per acceptor can, however, only be properly understood within an appropriate general framework of evaluation. The cost per acceptor will vary as a function of each of the three levels of efficiency listed above. If, for example, a given clinic does not use its given allocation of staff and other resources to generate as many acceptors as possible then there is technical inefficiency. One of the ways that this technical inefficiency is reflected is in a greater cost per acceptor than would be the case if the unit were technically efficient. Similarly if the clinic uses a combination of inputs that are more expensive than another set of inputs that could have produced the same number of acceptors, even then if the clinic is technically efficient, it is economically inefficient resulting in unnecessarily high costs per acceptor. But high costs per acceptor can also exist in situations where environmental conditions are adverse or where particularly intensive efforts have been made to generate acceptors. How then do we distinguish among these three kinds of efficiency?

If the evaluator attempts to use the cost per acceptor as a means of measuring whether a given subprogram is technically or economically efficient, but is unable to control for the overall scale or intensity of a program, it may be impossible to draw any conclusions about whether a given cost per acceptor is an indication of high or low performance. That is, a given sub-program could have high cost per acceptor because they have pushed their program harder and have attempted to reach some of the more difficult potential cases in the population rather than because they have used more than the necessary amount of resources in order to get a given number of acceptors. These two situations present very different aspects of efficiency, and the simple ratio of costs to acceptors will not give us adequate guidance in distinguishing between them.

The distinction among the three types of efficiency is important on more than theoretical grounds because the diagnosis of what causes variation in cost per acceptor determines the remedies which should be prescribed for shortcomings, and these can be drastically different. In the case where high cost per acceptor is caused by technical inefficiency the remedy is to use better management techniques - i.e., closer supervision of staff, more careful use of scarce resources, rewards and structures for individual performance, etc. In the case where high costs are associated with economic inefficiency the solution is to shift to the less expensive resources. Finally, if high costs are caused by what we have called scale efficiency, there may be no need for a change at all, or the changes will involve the reallocation of resources from a region of high intensity and thus high costs to a region of low intensity where a given expenditure can be used to generate more acceptors. In this last instance the problem is one for regional or national resource allocation rather than local.

The alternative approach to the measurement of efficiency advanced here is to recognize that there may be some underlying production process which characterizes a given family planning effort. Efficiency can be better assessed within the context of that productive process than it can be by treating cost-effectiveness and productivity ratios in isolation. In this report it has been suggested that most family planning programs are characterized by a situation where the output of family planning acceptors is a function of both the amount of resources which are devoted to a program and the environmental characteristics of the region in which the program is implemented. As more resources are devoted to family planning, either in the sense of a larger absolute amount of resources covering a larger population or in the sense of more resources per unit of population one would expect the number of family planning acceptors to increase. Similarly, as a region becomes more developed, one would expect that the resident population would be more prepared to accept family planning, the communications of family planning workers would be easier and the recruitment and organization of family planning staff would be facilitated. Thus on balance, development should be associated with more family planning acceptors for any given level of family planning inputs.

This approach makes it possible to distinguish between technical and economic efficiency on the one hand and scale efficiency on the other. Given the existence of sufficient information it may also be possible to distinguish technical and economic efficiency, but the indices suggested in this report do not deal with that issue. Nonetheless, the possibility that the efficiency of a local program can be assessed with some confidence that the resulting assessments do not confuse the effects of scale with those of resource waste is already a step forward. It is also a step towards an evaluation tool that has genuine managerial uses.

In Chapter III this general approach to the study of efficiency was tested. Empirical research for Malaysia, the Philippines, Korea and Tamil Nadu confirms that there was indeed a fairly systematic relationship among input, environmental and output variables. In Chapter IV this result was used to construct an efficiency index which can be used to assess the efficiency of any given productive unit some degree more accurately than would result from the use of simple productivity or cost-effectiveness ratios. The establishment of such an index involves a higher degree of complexity than does the use of the simpler measures, and it is fairly clear that the use of the simple measures accomplishes some of the same ends. Which measures then should be used will depend on the particular situation existing in a given country. It seems clear, however, that the more complex measure has substantial advantages and should be given careful consideration by program administrators and evaluators. Most importantly, it places the whole evaluation question in a framework that is much more consistent with the wider questions that are asked by administrators, and therefore makes it possible for the evaluation system to play a more important role in the fundamental decisions to be taken by programs.

This study has demonstrated that inputs can be measured and that input-output relations can play an important role in family planning evaluation. It has in many respects raised as many questions for research as it has resolved. The best form of the statistical relationships that are associated with evaluation measures is addressed in only a preliminary fashion. The most appropriate specification of the theoretical productive relationships between family planning inputs and the desired ends of family planning programs has not been defined in any definitive way, and it is to be expected that further research will demonstrate that there may be alternative approaches which may be more appropriate for any given country. The best ways to measure inputs and to define environmental variables are also unresolved. Presumably, these should be grist for the mill in further research.

Several directions for future research are suggested by this report. First, an important contribution could be made by seeking to introduce some of the ideas suggested here into administrative practice in a particular country. Such experience should be carefully monitored to permit the further development of practical and useful measures of efficiency. Second, there is a need for the theoretical elaboration of many of the issues discussed here. How should one distinguish between technical and economic efficiency? How can the concept of scale efficiency be used to improve the resource allocation capabilities of national family planning programs?

Further research on efficiency in family planning programs should be directed towards the improvement of the underlying specifications of the productive process. One practical result of such research might be a specification of ways in which measures of overall performance could be decomposed so as to assign responsibility to one factor or another. Such information might make clear how the factor mix should be altered to increase output.

There are also important implications for related programmatic areas of concern. The evidence of production relationships of the kind discussed in Chapter III has important implications for the setting of targets. Targets should reflect not only the demographic characteristics of a region but the environmental and to some extent the input characteristics as well. A second programmatic implication is that improved methods of recording information on inputs and environmental variables should be defined and implemented.

If the purpose of evaluation is to help policy makers and administrators make decisions that will improve the performance of the organization, then the analysis of efficiency has a central role to play. Family planning programs have matured to the point where they will be