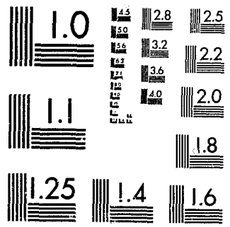

INTERPRETING PERFORMANCE MEASUREMENTS:

BASES FOR JUDGING AGENCY PERFORMANCE

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Measuring performance implies the ability to compare two pieces of data. First is the performance measurement, or the information that describes how some agency is operating for some specific time period. An example of a performance measurement would be, probation agency A's average cost per offender supervised in 1981 was $800. Second is a benchmark to which the performance measurement can be compared in order to judge how well the agency is operating. Continuing with the average cost measurement as the example, assume that lower costs are better than higher costs and that the benchmark established is $1000. When compared to the benchmark of $1000, one would then conclude that agency A's average supervision cost of $800 means that its performance in 1981 was good.

What is the source of the benchmark against which one compares a performance measurement? Possible sources include an agency's goals, objectives, or targets; standards established by relevant professional associations; the performance of other probation agencies; the agency's own historical performance record; and optimal or technically efficient performance levels (Cameron, Grizzle, Hatry).

This paper discusses statistical models that facilitate comparisons based on three of these sources:

(1) the agency's own objectives;

(2) the optimal level, given specified environmental and technical constraints;

(3) the performance of other agencies.

Each section below presents a model, illustrates its usage with examples for probation and parole agencies, and discusses the model's advantages and disadvantages.

Performance Ratio Model

Busy administrators would prefer a single measure that captures an agency's total performance instead of many measures of different aspects of an agency's performance. Faced with dozens of separate performance measurements, the administrator must decide which to heed and which to ignore or how to combine the different measurements in some way to come up with an overall assessment of the agency's performance.

The performance ratio model combines many measurements to produce an overall indicator of agency performance. This model uses an agency's objectives to develop ratios of actual performance to objectives. It combines data on cost and outcomes with objectives, permitting the incorporation of both efficiency and effectiveness performance dimensions. The equation is as follows:

$$P = \sum_{i=1}^{n} w_i \frac{O_i}{G_i} \div \frac{A}{B},$$

where P is the indicator of overall performance, $G_i$ is the goal or objective set for the ith performance measure, $O_i$ is the actual performance measurement for the ith measure, $W_i$ is the weight or importance of the ith measure relative to all other measures in the set, A is the actual total spending by the agency, and B is the agency's total budget for the period for which performance was measured.



If all measurements equal the objectives and actual spending equals the budget, then P, the overall performance indicator, will equal 1.00. If performance exceeds the objectives, P will be greater than 1.00. Similarly, if objectives exceed performance, P will be less than 1.00.

To illustrate the equation's usage, assume that a probation/parole agency received a budget for 1981 amounting to $200,000. Of this amount, $183,000 was actually spent. Further, for the sake of brevity in developing this example, assume that the chief probation officer selects 4 measures that adequately capture the important aspects of the agency's performance. These 4 measures, the objectives for 1981, the performance measurements for 1981, and the relative importance of each measure are listed below:

| Performance Measure | Performance Objective | Performance Measurement | Relative Importance |
|---|---|---|---|
| % of agency effort devoted to offender supervision | 75% | 60% | 10% |
| % of offenders who successfully complete their sentences without violating their conditions of probation/ parole | 50% | 55% | 40% |
| % of offenders with financial obligations who keep payments current | 90% | 40% | 30% |
| % of offenders employed or otherwise socially productive fulltime | 70% | 80% | 20% |
| | | | 100% |

Applying the performance ratio model to these data yields a performance indicator of .96:

$$P = \sum_{i=1}^{n} w_i \frac{O_i}{G_i} \div \frac{A}{B}$$

$$P = [.10(\tfrac{60}{75}) + .40(\tfrac{55}{50}) + .30(\tfrac{40}{90}) + .20(\tfrac{50}{70})] \div \tfrac{183,000}{200,000}$$

$$P = (.08 + .44 + .13 + .23) \div .915$$

$$P = .88 \div .915$$

$$P = .96$$

Note that the first term in the equation is the agency's effectiveness when outcomes are compared with objectives. These objectives should be set for some specific funding level. If, during the course of the year, spending is held below the original budget (possibly due to freezes placed on positions or across-the-board cuts to keep spending within revised revenue projections), the second term in the equation acts to lower the level of performance expected of the agency. In doing so, the equation assumes constant returns to scale.

One advantage of this model is that its simple arithmetic permits making the calculations by hand. Another advantage is that it is easy for people who have little statistical or mathematical background to understand.

One problem in using the model is the necessity of obtaining weights for the relative importance of the various performance measures included in the equation's first term. In our illustration, the chief probation officer might sit down by himself and decide that the first measure is the least important, the second measure is 4 times as important as the first, the third measure is 3 times as important as the first, and the last measure is twice as important as the first. Depending upon management style, the chief might instead hold a group meeting where all the agency's probation officers arrive



at the weights by consensus. Many techniques have been developed for estimating such weights on a systematic basis. These techniques carry such names as the analytic hierarchy procedure, multiattribute utility theory, and social judgment theory. Hwang and Yoon classify seventeen of these methods.

Another objective to the performance ratio model might be that the effectiveness and spending terms are inadequate to capture other important performance dimensions. The illustration used ignores equity in the distribution of services or penalties and the quality with which the agency carries out its activities. To respond to this objection, the effectiveness term can be broadened to include equity and quality measures. Someone must still, however, make a judgment about the relative importance of outcome, equity, and quality measures.

## Linear Programming Model

This second model permits developing an optimal level of performance against which to compare actual performance. Developing the optimal level of performance requires knowing three things:

1. the laws, procedural regulations, and resource constraints under which the agency must operate;
2. the technology by which the agency achieves its objectives;
3. the rate at which agency activities translate into achievement of objectives.

The statistical model consists of an objective function that is to be maximized subject to a series of equations representing the agency's technology and the environmental constraints within which it must operate. An illustration follows.

Suppose that a probation agency has two major tasks--conducting pre-sentence investigations and supervising offenders placed on probation. Supervision consists of some contacts with probationers that are made in the field and other contacts that are made in the probation office. Assume the following set of constraints:

1. The agency's officer hours available for these activities in a month total 2200. The average time requirements to complete one pre-sentence investigation is 6 hours; to complete one field contact, 2 hours; and to complete 1 office contact, 1 hour.
2. The objective to maximize is the number of violation-free offender days. It has been determined that an office contact has the effect of producing 12 violation-free offender days, a pre-sentence investigation contributes 6, and a field contact contributes 30.
3. Each month an average of 100 new cases is added and 100 cases are terminated. The total average caseload is 1100. For new offenders, the first contact must be in the office, not the field. All offenders must be contacted at least once a month, either in the office or the field.
4. An average of 150 offenders are sentenced each month. Judges in the agency's jurisdiction require pre-sentence investigations on about one third of the offenders before sentencing.

Given these policy and resource constraints, what is the optimal level of performance possible for this agency? We begin by stating the objective function to be maximized:



$$\text{Maximize objective attainment} = 12X_1 + 30X_2 + 6X_3,$$

where $X_1$ = the officer hours allocated to office contacts, $X_2$ = the hours allocated to field contacts, and $X_3$ = the hours allocated to pre-sentence investigations. The coefficients are the transformation rates described in assumption 2 above. This objective function is subject to the following constraints:

a) $X_1 \geq 100$ (all the new cases must be contacted in the office the first month)

b) $X_1 + X_2 \geq 1100$ (all cases must be contacted at least once during the month)

c) $X_1 + 2X_2 + 6X_3 \leq 2200$ (the effort devoted to all three activities must not exceed 2200 hours during the month)

d) $X_3 = 50$ (one third of offenders sentenced in a month must be investigated before sentencing).

Solving this set of equations indicates that the optimal objective attainment is 27,900 and that this optimum can be achieved when the agency spends 100 hours on office contacts for new cases, 300 hours on investigations of offenders, 1600 hours on 800 field contacts, and 200 hours on 200 office contacts.

$$\text{Maximum violation-free offender days} = 12X_1 + 30X_2 + 6X_3$$

$$= 12(300) + 30(800) + 6(50)$$

$$= 3600 + 24000 + 300$$

$$= 27,900$$

By inserting the actual number of hours spent on each of the three activities into the objective function, one can estimate actual

objective attainment for a given month. If the policy, resource, and technological constraints have been accurately represented in this statistical model, it would not be possible for actual performance to exceed the optimum estimated by the model. By dividing optimal attainment into actual attainment, one can calculate the actual number of violation-free offender days as a percentage of the best attainment possible, given the existing technology and policy and resource constraints.

The linear programming model makes more severe information demands than does the performance ratio model. To use this model, one must identify the important activities that contribute to attaining the agency objective, calculate the resources required to produce a single unit of each of these activities, and estimate the contribution that each unit of activity makes toward achieving the objective. Estimating the contribution that each activity makes toward achieving an objective such as violation-free offender days is not a simple matter. One empirical method would be by using a two-stage production function.[1] In the first stage, the agency's outputs would be estimated. In the second stage, these outputs would be entered as independent variables along with other influencing variables to estimate the outcomes or objective attainment. The coefficients of these outputs from the second-stage production function could be used to estimate coefficients for the objective function used in the linear programming model.

Linear programming also makes the following assumptions:



1. Allocations of resources to activities are made under conditions of certainty.
2. Variable inputs and outputs are divisible.
3. Activities can be added together.
4. Relations between variables are proportional (i.e., constant returns to scale).

These assumptions seem to be reasonably well met in the hypothetical illustration described in this section.

As is the case for the performance ratio model, the linear programming model is not hard for the nonstatistician or nonmathematician to understand. It is, however, usually too tedious to solve by hand and is usually solved by computer.

Cost Function Model

This last model permits comparing an agency's performance with the performance of other agencies. The great diversity of corrections agencies, both in terms of what these agencies do and what they intend to accomplish, requires that one exercise special care when making interagency performance comparisons. Interagency performance comparisons are most appropriate when these conditions are present:

(1) When performance is measured in terms of efficiency, agencies have common work products or outputs.

(2) When performance is measured in terms of service quality, agencies have common service characteristics.

(3) When performance is measured in terms of equity, offenders in the agencies' caseload have similar characteristics.

(4) When performance is mesured in terms of effectiveness or cost-effectiveness, the types of outcomes expected are similar among agencies that are compared to each other.[2]

(5) Agencies use the same definitions, data collection and reduction procedures.

(6) Data collection and reduction techniques are practical and relatively cheap.

(7) Agencies have an opportunity to explain unusual situations.

(8) Timely data collection and reporting occurs.[3]

(9) Agencies operate under similar laws, procedural regulations, and resource constraints.

Direct comparisons among agencies when these conditions do not hold are likely to be misleading as well as unfair to some of the agencies whose performance is being compared. Cost functions can, however, statistically take into account some of these differences among agencies and provide appropriate comparisons of agency efficiency. Cost functions are appropriate statistical models when these conditions hold (Trumbull and Witte):

(1) The probation agencies included share common processes.

(2) The number and types of offenders are determined by someone outside the probation agency.

(3) The prices of the resources consumed by the probation agency (e.g., labor, office expenses, travel costs) are determined outside the probation agency.

For the cost function, cost is the dependent variable. Cost functions that include as independent variables vectors capturing



output quality, offender and staff characteristics, and socioeconomic variables, as well as output quantity and prices of inputs, may be necessary to compare costs fairly across agencies. Including these other independent variables in the cost function would make it possible to estimate their effect upon agency costs. Costs for probation agencies with similar cost-influencing characteristics could then be compared with each other instead of with the average cost for all agencies.

Cost functions demand more data than the other two models discussed. Cost functions require multiple observations of an agency over time, observations over many agencies, or observations over several agencies over time. In an effort to assess the feasibility of using this model, we examined the data available from 5 probation/parole agencies located in 3 states. Monthly data for the following independent variables relating to adult supervision was obtainable:

1) the quantity of several outputs--total caseload, number of offenders processed at intake, number of warrants issued, number of revocations, number of early terminations, number of regular terminations
2) the quantity and price of major inputs--number of officers, amount of travel, amount of office space
3) staff characteristics--average number of months' experience per officer, turnover rate, ratio of officers to supervisors

Not easily obtainable by month were

1) offender characteristics, such as prior criminal record and severity of the offense;
2) sociodemographic characteristics that conformed to the agencies' area boundaries, such as the unemployment rate and per capita income.

Another disadvantage of working with cost functions is their complexity. Once the data are collected, they must be fitted with the appropriate functional form. This part of the process requires both computers and someone with considerable statistical expertise. The amount of data required and the complexity of the statistical modeling make cost functions the most costly of the three models discussed. Yet many observers of probation/parole agencies have a keen interest in comparing performance across agencies. Given the interest in cross-agency comparisons, further research on these models seems warranted.

## Summary

Each of the three statistical models discussed permits comparing an agency's performance to some benchmark. The performance ratio model compares performance to the agency's own objectives. The linear programming model estimates an optimal level of performance to which the agency's performance can be compared. The cost function model permits comparing the agency's performance to the average performance of other agencies with similar cost-influencing characteristics. Table 1 summarizes the salient characteristics of these models.



Table 1

Comparison of Three Models for Comparing Agency Performance

| Model | Type of Comparison | Data Requirements | Difficulty of Interpreting Results | Calculation Aids Required |
|---|---|---|---|---|
| Performance Ratio | Agency's own objectives | Least | Easy | Paper and Pencil |
| Linear Programming | Optimal performance level | Intermediate | Intermediate | Computer and software |
| Cost Function | Similar agencies | Most | Difficult | Computer and software |

## Footnotes

[1]For this idea I am indebted to Ann D. Witte, Associate Professor of Economics, University of North Carolina at Chapel Hill.

[2]Definitions of the terms underlined in these 4 conditions may be found in Grizzle.

[3]Conditions 5 through 8 were adapted from Dressel.



## References

CAMERON, K. (1981) "The enigma of organizational effectiveness." New Directions for Program Evaluation 11:1-24.

DRESSEL, P. L. (1976) Handbook of Academic Evaluation. San Francisco: Jossey-Bass.

GRIZZLE, G. A. et al. (1980) Measuring Corrections Performance. Raleigh, N.C.: The Osprey Company.

HATRY, H. P. (1980) "Performance measurement principles and techniques: an overview for local government." Public Productivity Review 4:312-339.

HWANG, C. L. and YOON, K. (1981) Multiple Attribute Decision Making Methods and Applications: A State-of-the-Art Survey. Berlin: Springer-Verlag.

TRUMBULL, W. N. and WITTE, A. D. (1980) Determinants of the Cost of Operating Large Scale Prisons with Implications for the Cost of Correctional Standards. Chapel Hill, N.C.: University of North Carolina.

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