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On Allocating Resources for Fertility Reduction  
in Developing Countries

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### Abstract

For most of the population of the developing world, official national policy seeks fertility reduction as one way to promote development and welfare. As experience has accumulated, calls are increasingly heard for greater efficiency in the allocation of resources to that end. However, given the present state of the art, with reference to conceptual and technical issues as well as availability of data, definitive answers to the questions of efficient allocation not only are unavailable now but are likely to remain so for some time. In this paper, methods of applied welfare economics are brought to bear on the matter, in a pioneering attempt to reach toward a better answer than now exists. In the absence of scientific empirical studies of the fertility response to various interventions in several situations, both social and programmatic, and their marginal returns, the analysis in this paper relies upon expert judgments of relative effectiveness--not unlike those now actually determining the allocation of resources in this field. From a matrix of 108 options--12 strategies in 3 social settings with 3 degrees of program implementation--first the range of effectiveness ratings and the prototypic "effectiveness profiles" reflecting different expert judgments are presented. On that basis, the allocation of \$200 million a year in donor funding in this field is analyzed: by 2 ways of assessing expert views (average ratings, sum of individual ratings); by 3 sets of strategic interventions (the entire 12, an internally independent set of 7, an available set of 6); by the 5 prototypic profiles; by an assumption of population redistribution to different settings and implementations within countries; and finally, by comparison to current allocations as made. Among other findings, the results indicate the extent to which efficiency per se does or does not provide a realistic guide to allocational issues, and echo once more the familiar dilemma of public policy for welfare ends: what is more efficient may be less feasible.

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Since the early 1960s governments throughout the developing world have adopted policies to reduce the rate of population growth. The adverse effect of rapid population growth on economic development has been the primary motivation, and the reduction of fertility has become the primary means. By 1976, 33 countries with 76 percent of the population of the developing world had official policies to reduce their population growth rates, and another 31 countries with 16 percent of that population provided official support of family planning for non-demographic reasons.<sup>1</sup> As a result, substantial resources are being applied to fertility reduction both by the countries themselves and by international donors. Indeed, in the past few years, an average of \$250-\$270 million per year was provided in "population assistance" by the donor agencies alone.<sup>2</sup>

In view of the importance of the objective and the large volume of resources involved, the efficiency with which the resources are allocated is a significant question: often raised, seldom explicitly addressed. In general, the allocation decisions on population are made largely independent of more general investment decisions to generate economic growth. Within the population field, what are the efficient strategies of intervention to secure fertility reduction? Can a superior allocation of resources be determined that would secure a larger reduction in fertility? This paper is addressed to these questions. Given the conceptual, technical, and data problems which surround the evaluation of fertility reduction policies, we cannot claim to have reached definitive answers to the questions posed. But we have combined the methods of applied welfare economics with information on the determinants of fertility reduction to shed some light on this issue.

To begin with, we consider that the expenditures made for fertility reduction divert real resources from alternative activities, and hence represent real social costs. The value of the foregone outputs is taken to be equal to the costs of producing them. Set against this social cost is the

benefit yielded in the form of fertility reduction. While the interventions have benefits beyond fertility reduction--for example, improved child and maternal health, enhancement of women's status, and eventually economic development itself--our approach focusses on fertility reduction, not as an end in itself but as one determinant of the ultimate objectives of socio-economic development and increased human welfare. Implicitly, then, we presume that fertility reduction in developing countries is positively related to gains in education and literacy, health and nutrition, jobs and housing, and development and modernization in general.

In this analysis, we do not attach a monetary value to the fertility reduction accomplished by the interventions. In principle, such valuation could be made, since individuals and governments are willing to pay for reduced fertility levels. Additional individuals associated with higher fertility rates absorb both consumption and investment goods that would be available to others, and impose both congestion and environmental pollution costs on others. To the extent that such costs exceed the value of the production stream yielded by the individual and the consumptive value that his/her existence affords others, there is a net social willingness to pay to avoid the marginal birth.<sup>3</sup> While we do not attempt such an evaluation, we proceed on the assumption that fertility reduction conveys net social benefits in developing countries.

The estimates used here are not based on scientific empirical studies of the fertility response to various interventions under various social and political conditions. That knowledge does not now exist. This is not to say, however, that nothing is known, believed, or acted upon with regard to the fertility effects of various interventions. Numerous studies and analyses have tried to track the success of differing approaches under differing conditions, and strong convictions are held about appropriate policy interventions. Such studies, plus personal observations and experiences, do

enable experts in the population field to judge the relative effectiveness of different interventions in different social and political settings. Our inquiry is based upon such judgments. To repeat, because the marginal contribution to fertility reduction from an additional dollar spent on each strategy under specified conditions is not known, we rely on informed judgment as the best available surrogate. This, of course, is what policymakers also do. The difference is that we have explicitly gathered the information and judgments pertinent to this issue, and organized it so as to bring it to bear directly on the question at issue.

The judgment of experts regarding patterns of relative effectiveness among fertility reduction strategies is insufficient by itself for determining optimal resource allocation decisions. What is required in addition is the pattern by which fertility reduction per dollar varies in response to the number of dollars applied to an intervention in a particular setting. Incremental expenditures on any strategy are likely to yield less fertility reduction than that achieved by prior marginal expenditures on the same intervention -- a diminishing returns pattern. The form of that relationship is also unknown. Hence, as we describe below, we again rely upon judgment as to the pattern of returns under various conditions.

Finally, because the investment of resources in economic development activities generally (i.e., popular education, nutrition, health, sanitation, industrialization, agriculture, transport, community development, women's status, and the like) yield indirect reductions in fertility over time, it could be argued that our analysis should encompass expenditures for this purpose, as well as expenditures on fertility reduction interventions. However, such inputs are not included here except insofar as they are under the allocational control of the donor agencies in the population field. An analysis of the total allocation of resources to economic development generally--in which "fertility reduction" would be but one of many activities<sup>4</sup>--

is conceivable but even more difficult than the task we have undertaken. We would note, however, that this exploratory effort to discover the structure of allocation decisions by international donor agencies in the population field, if it is fertility reduction which is desired, has implications for national expenditures for fertility reduction as well.

After this brief review of some considerations underlying this analysis, we describe the nature of the data, then present our results on the implications of expert opinion on the relative effectiveness of possible interventions, and finally discuss the implications of our analysis for efficient resource allocation.

#### The Data and Their Collection

The first step in our analysis was to delineate the means by which fertility reduction could be achieved through expenditures by donor agencies. By compressing a comprehensive array of 31 such means (see Exhibit A, Appendix A), we identify 12 strategies representing major approaches to reducing fertility now being pursued or proposed in developing countries. These strategies of intervention (SI) are shown in Table 1. (The symbols in parentheses indicate the items on the more detailed list that were aggregated into each strategy.)

Each of these strategies can be undertaken in a variety of circumstances. Whereas they may vary in their effectiveness in reducing fertility per dollar of expenditure, effectiveness also depends on other factors. As a second step, we identify two other factors that can determine the effectiveness of any expenditure in reducing fertility: the social setting (SS) of the society in which undertaken, and the strength of program implementation (PI) by the government. Social setting refers to those conditions of economic and social development that are or are believed to be determinants of fertility behavior--for example, infant mortality rate, percentage of school age population in school, and per capita gross domestic product.<sup>5</sup> Program

Table 1

Strategies for Fertility Reduction

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Strategies involving the supply of fertility control means

1. Improve public sector access to current contraceptive methods, i.e., "family planning programs" (A1, A5-9 in full array)
2. ...plus sterilization (A2)
3. ...plus abortion (A3)
4. ...plus new and improved methods with better acceptability, continuity, and/or effectiveness (B)
5. Improve private sector distribution of current means of fertility control (A4)

Strategies seeking to influence the demand for fertility control

6. Advance socio-economic determinants of fertility singly or collectively; e.g., general development, popular education, infant/child mortality income, industrialization, women's status, urbanization (C)
  7. Promote information, education, propaganda on fertility control (D)
  8. Manipulate incentives and disincentives affecting fertility behavior, e.g., maternity costs, child assistance, housing, social security, social services (E1-4, E6)
  9. ...through direct payment of money or gifts for desired fertility performance (E5)
  10. Manage community "pressure" for an anti-natalist consensus (F)
  11. Impose legal sanctions on age at marriage, internal migration (G1-2)
  12. ...limits on family size (G3)
-

implementation refers to a country's commitment and capacity to vigorously implement any policy intervention.<sup>6</sup> Hence, effectiveness can vary by strategy (among the 12), by the socioeconomic characteristics of the participating society (from favorable to unfavorable), and by political commitment and administrative capacity in the public sector of that society (from strong to weak). For purposes of analysis, we establish three SS categories (high, medium, low) and three PI categories (strong, moderate, weak).

From this framework, then, we obtain a matrix of 108 cells: 12 SI categories x 3 SS categories x 3 PI categories. This matrix is shown in Appendix A. The question then becomes: By how much would fertility be reduced by an expenditure of \$N in each of the 108 cells? Answering this question requires an estimate of the impact on fertility from the same level of investment in each strategy-SS-PI combination. We refer to this measure of fertility impact as an effectiveness rating.

Obtaining an effectiveness rating for each of the 108 cells was the next step. In principle, one can conceive of obtaining the ratings by systematically surveying the relevant research studies and employing their findings to establish the fertility impact of the various strategies under different SS and PI conditions. That is not now feasible, but it is possible to obtain a kind of judgmental distillation of knowledge which is, in large part, based on evaluative research. The cumulative results of such research, in conjunction with practical experience and observation, have led to judgments on the relative effectiveness of various strategies in various settings among experts and scholars in the population field. It is such judgments that we employ in establishing effectiveness ratings. In our view, such ratings reflect informed judgment on the matter more or less equivalent to the (largely implicit) policy evaluations made by responsible officials for their own situations. As we have stressed, in both cases, firm empirical estimates are not available.

The judgments were requested of 19 individuals. All have been long-standing and close observers of international population efforts, all have published

substantially on the issues involved, and several have participated in the allocation decisions within the donor community. (None was directly involved at the time with such programs in an individual country.) Six are demographer-sociologists, four are demographer-economists, four are economists with strong interests in population issues, two are public health doctors, and the remaining three are administrators of agencies concerned with population policy. Eight are Americans, and the other eleven are citizens of nine different countries. As a whole, the group would be perceived as representing a wide range of knowledge, experience, and views as to preferred population strategies. Their policy positions would probably be perceived as ranging from a strong "family planning" position through a middle or "neutral" position to a strong "developmental" position.

The basic description of our procedure was sent to each respondent along with a request (Appendix A). In our request we asked for a

. . . professional judgment on the relative effectiveness of the 108 strategy-social setting-implementation combinations in the matrix, given the same investment of funds.

As you can see, we have entered one effectiveness rating in that table--the middle value in the top row. This was done in order to anchor the ratings. Hence, each of your judgments of relative effectiveness should be made in comparison with that number given the same amount of resources. That is, if a given amount would yield 7 units of fertility reduction in the anchor cell, how much would it yield in every other cell? Hence, a combination which you think might be a little more effective than the combination with the filled-in rating might be assigned a 9; and one that is significantly more effective might be given a rating of, say, 15.

In short, we are asking you to fill out the table according to the following instructions: Assume that the only objective is to reduce fertility. Each of the 108 options in the table represents a way in which donor agencies could allocate a given amount of money (realistically estimated) in order to achieve such reduction. Assume a scale from 0 to 20, taken to express the possible range of effectiveness in fertility reduction per amount expended. The filled-in cell is given a value of 7 on that scale. Using that as the anchor point, indicate the value which you believe each of the cells should be assigned--that is, try to make the deviation of the scores from the anchor value of 7, up or down, reflect your judgment of the relative effectiveness of the other options relative to that particular option. In other words, if a given amount of funds allocated to strategy 1 in middle-level social

settings and with a moderate degree of program implementation is given a rating of 7, what rating would you assign to the other combinations, from 0 to 20? Please use whole integers with no decimals or fractions.

Note that the effectiveness ratings requested are judgments of the impact on fertility if the specified strategy were carried out in each of the three social settings by the three degrees of program implementation. They do not take into account, for example, the political or religio-cultural acceptability of the strategies (e.g., sanctions on abortion) or the probability of a new method's emergence. They simply represent estimates of the impact on fertility of a designated intervention in a designated setting at a designated level of implementation.

After reviewing the first round of replies, we sought to clarify certain issues by further explanation of the instructions, and by resubmitting the materials to the panel with a request for reconsideration (Appendix A). In addition, at the suggestion of one panelist, we introduced a "Supplementary Form" in the second round. That form directly addressed the question of allocation by asking for optimal allocations both of existing donor funding and of a substantial increment to the funding, both for direct strategies of intervention and for other forms of donor funding in the population area (Appendix B).

We received 16 responses on the 108-cell matrix and 13 responses on the Supplementary Form.<sup>7</sup> They constitute the information on which our analysis is based.

#### Effectiveness Ratings for Fertility Reduction

The full 108-cell matrix with entries representing the mean effectiveness ratings for the 16 respondents is presented in Table 2; Figures 1 and 2 present a summary of responses by strategy, SS, and PI.

In the view of the panel, substantial differences in ratings exist among the strategies. Moreover, regardless of strategy, both social setting and

Table 2  
 Mean Effectiveness Ratings, All 16 Respondents  
 (Scale from 0 to 20)

Strategies of Intervention	High Social Setting			Middle Social Setting			Low Social Setting			Row Average
	Program Implementation			Program Implementation			Program Implementation			
	Strong	Mod.	Weak	Strong	Mod.	Weak	Strong	Mod.	Weak	
<u>Supply</u>										
1. Public sector, current methods (A1, A5-9)	13.1	10.1	6.9	9.7	7.0	4.4	5.9	4.1	1.9	7.0
2. ...plus Sterilization (A2)	14.8	12.0	8.6	11.4	8.8	5.6	7.6	5.5	3.1	8.6
3. ...plus Abortion (A3)	16.6	13.8	10.6	13.3	10.8	7.3	9.4	7.1	4.3	10.4
4. ...plus New method (B)	16.4	13.9	10.7	13.4	10.8	7.4	9.4	7.0	4.3	10.4
5. Private sector distribution (A4)	12.1	10.0	8.2	9.2	7.1	5.1	5.4	3.9	2.3	7.0
<u>Demand</u>										
6. Determinants (C)	8.0	6.5	5.6	7.3	5.9	4.4	4.9	4.0	2.9	5.5
7. Information (D)	7.7	6.3	4.9	6.4	4.8	3.1	3.1	2.3	1.2	4.4
8. Incentives (E1-4, E6)	8.5	6.5	5.0	7.1	5.7	4.2	5.1	3.6	2.7	5.3
9. ...Money (E5)	8.0	5.9	4.7	6.4	5.1	3.8	4.8	3.3	1.9	4.9
10. Community "pressure" (F)	13.0	9.6	6.5	11.3	8.2	5.1	8.3	5.3	3.0	7.8
11. Sanctions (G1-2)	11.3	7.8	5.1	10.1	6.8	4.2	6.9	3.8	2.1	6.5
12. ...Limits on family size (G3)	10.6	7.5	5.5	8.9	6.0	3.9	5.8	2.9	1.5	5.8
Column average	11.7	9.2	6.9	9.5	7.3	4.9	6.4	4.4	2.6	
Social Setting average		9.2			7.0			4.8		
Program Implementation average	9.3	7.2	4.5							

**Figure 1**  
**Average Effectiveness Ratings**  
**of Strategies of Intervention**

(Scale from 0 to 20)

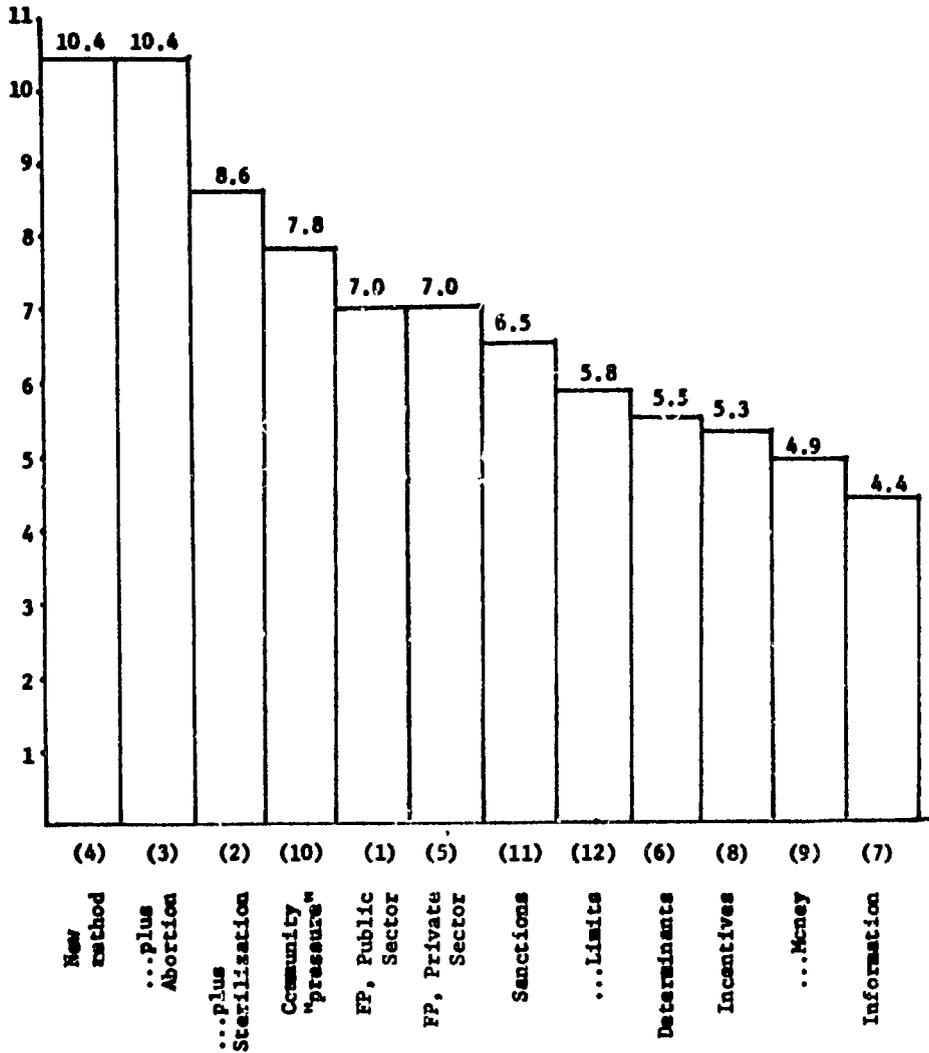


Figure 2

Average Effectiveness Ratings, by Social Setting and Program Implementation

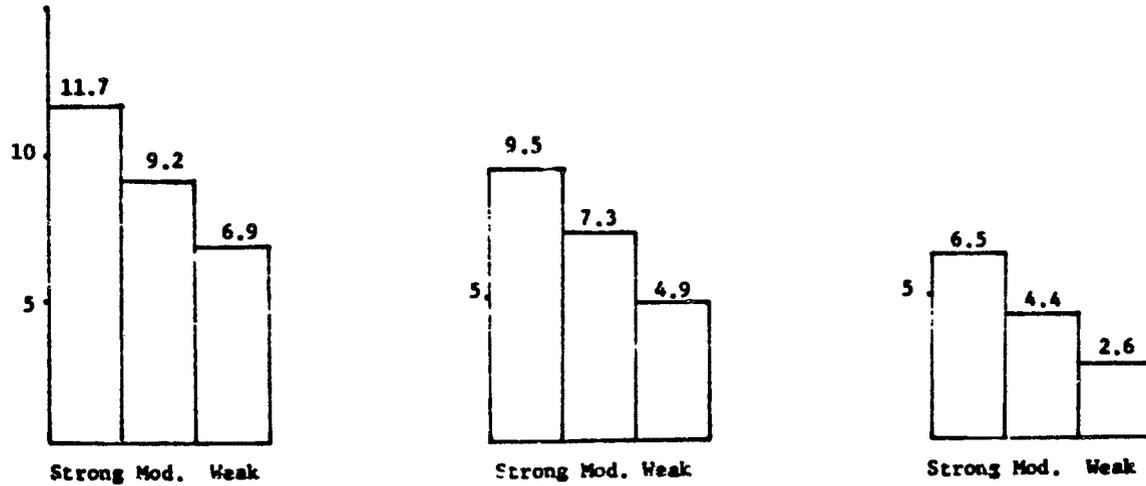
(Scale from 0 to 20)

SOCIAL SETTING

High

Middle

Low



PROGRAM IMPLEMENTATION

II

program implementation are judged by the respondents to have a substantial impact on effectiveness. We note these main findings based on panel judgments:

- <> On average, the most effective strategies are judged to be augmented family planning programs that would include abortion (3) or a new method (4). The least effective are information campaigns (7) and incentives (8 and 9). The others are intermediate and are clustered within about 3 points of one another. Among the individual respondents, 11 ranked strategies 3 and 4 either first or second, and 9 ranked strategy 6 (determinants) either last or next-to-last.
- <> The supply strategies as a whole, have an average rating of about 150 percent of the demand strategies, with averages of 8.7 and 5.7 respectively. No respondent gave the demand interventions as a group a higher average rating than the supply interventions. However, note that the rating for strategy 1, the traditional family planning program, is only of average magnitude without the augmentation of sterilization, abortion, or a new method.
- <> Without exception, the effectiveness ratings are positively related to average strength of social setting and program implementation.<sup>8</sup> Within strategy categories, High SS and Strong PI have effectiveness ratings about double that of their Low and Weak counterparts. Across the entire range of strategies, the rating for the High/Strong combination is over four times greater than for the Low/Weak combination (11.7 as against 2.6). On average, each step up or down on either the SS or PI variable means a difference in effectiveness of about 2.3.
- <> The two variables characterizing an intervention (SS and PI) are of approximately equal strength in contributing to effectiveness. That is, a Strong PI in a Low SS has an effectiveness rating about equal to that of a Weak PI in a High SS (6.4 vs. 6.9). Other appropriate comparisons off the diagonal convey the same result.
- <> In our second instruction, we suggested that the rating was considered to be double the points off the crude birth rate (CBR) in 15-20 years. By that standard the most effective strategy-SS-PI combination would take about 8 points off the CBR and the most effective strategy or setting or implementation about 5 points. The overall average rating would take off 3.5 points, not far from what can be discerned in such settings.
- <> With respect to the 108-cell matrix, the five most effective combinations are strategies 3 and 4 in the first two columns and strategy 2 in the first column; and the five least effective are all in the last column (strategies 7, 12, 1, 9, and 11).

Table 3 presents the range of effectiveness ratings among the 16 respondents. These are the major findings:

- <> The range across the strategies averages 9.4, or nearly one-half of the maximum possible range.<sup>9</sup> In other words, there is a wide disparity of view within this group of experts as to what is and is not effective in reducing fertility per unit of investment.
- <> On average there is a larger variation in responses on demand strategies than on supply strategies, with mean ranges of 10.8 and 7.4, respectively.
- <> As might be expected, there is almost twice as much variation in judgment with lesser-tried strategies (determinants, limits and sanctions, community "pressure", and private sector distribution) than with those more fully experienced (traditional family planning programs, plus sterilization, and information efforts).
- <> The ranges among SS and PI categories do not differ substantially except perhaps at the two extremes, occasioned by high ratings in the High/Strong and low ones in the Low/Weak column.
- <> Extreme ranges of judgment can be found in individual cells. Examples are the absolute maximum in the bottom left cell and close to the maximum for other cells in strategies 6 and 12 and a few others, e.g., strategies 8 and 10.

#### Profiles of Effectiveness Ratings

The pattern of effectiveness ratings can be viewed as a strategic profile. Such a profile can be displayed for an individual respondent, for subgroups of respondents, or for the group as a whole. The 16 individual profiles are shown in Appendix C. They suggest a wide range of viewpoints, from high on the family planning options (1-5) to high on determinants (6), "pressure" (10), and sanctions (11). In short, there is not much of a consensus among the respondents. Various types and levels of knowledge, various perceptions and experiences, and various political and ethical commitments generate major disagreements as to the most effective strategies to pursue. Given the amount of the literature and the duration of the debate, one might have expected somewhat less controversy. In spite of such disagreements, however, some consistencies do occur. For example, there is general agreement on the pattern of effectiveness among the strategies grouped under the supply heading, in that options 1 and 5 fall below options 2, 3, and 4 for nearly all the respondents.

Although substantial inconsistencies occur among individuals, there are clusters of respondents who have similar appraisals of the pattern of

Table 3  
 Range of Effectiveness Ratings Within Cells  
 (Scale from 0 to 20)

Strategies of Intervention	High Social Setting			Middle Social Setting			Low Social Setting			Mean Range
	Program Implementation			Program Implementation			Program Implementation			
	Strong	Mod.	Weak	Strong	Mod.	Weak	Strong	Mod.	Weak	
<u>Supply</u>										
1. Public sector, current methods (A1, A5-9)	10-16	8-13	4-11	8-12	-	2-6	3-8	2-6	0-4	4.9
2. ...plus Sterilization (A2)	12-18	10-15	4-12	9-14	8-10	2-8	4-10	2-8	0-6	5.6
3. ...plus Abortion (A3)	12-20	12-16	6-14	10-18	9-17	3-13	5-14	2-10	0-8	7.9
4. ...plus New method (B)	11-20	10-17	7-13	10-17	9-13	4-12	6-14	2-13	0-8	7.6
5. Private sector distribution (A4)	5-19	5-14	4-14	4-14	4-14	2-12	2-14	1-13	0-11	10.9
<u>Demand</u>										
6. Determinants (C)	0-17	1-14	0-15	1-18	0-15	0-12	0-12	0-11	0-10	13.6
7. Information (D)	4-13	2-10	1-9	2-10	1-8	0-7	0-6	0-4	0-3	6.7
8. Incentives (E1-4, E6)	0-15	0-11	1-10	4-12	3-10	1-8	2-12	0-10	0-9	9.6
9. ...Money (E5)	2-14	1-12	1-10	3-10	2-9	1-8	1-9	0-7	0-5	8.1
10. Community "pressure" (F)	4-18	3-15	1-12	3-18	2-12	0-9	0-16	0-12	0-10	12.1
11. Sanctions (G1-2)	5-18	1-14	0-12	4-15	1-12	0-10	0-14	0-13	0-12	12.1
12. ...Limits on family size (G3)	0-20	0-16	0-13	1-17	0-15	0-8	0-15	0-10	0-5	13.1
Mean Range	11.5	9.5	9.7	9.8	8.7	8.2	10.1	9.0	7.6	9.4

effectiveness. In selecting the respondents, we made a deliberate effort to have a wide range of perspectives represented. Indeed, at the time of selection we informally classified the potential respondents into three groups of roughly equal size: those generally viewed as advocates of "the family planning approach," those viewed as advocates of "demand creation" or development," and those viewed as neutral or eclectic. We did this recognizing that on such a complex issue each respondent would have a distinctive characterization of his/her position, in a highly differentiated and sophisticated manner. Later, we shall give some indication of the correspondence of the results to our ex ante classification.

By inspecting the actual patterns of ratings of the respondent, however, we discerned a complex set of common clusters. In Figure 3, the 16 respondents are grouped into 5 clusters on the basis of their actual patterns of response.

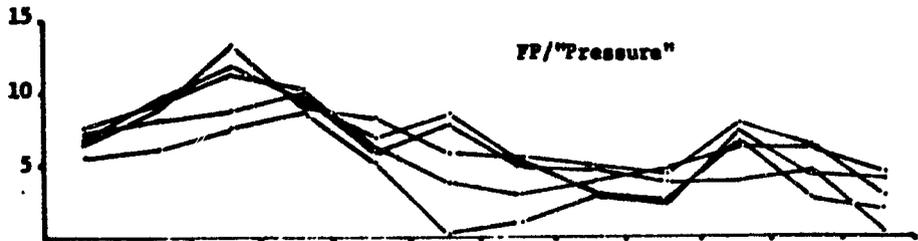
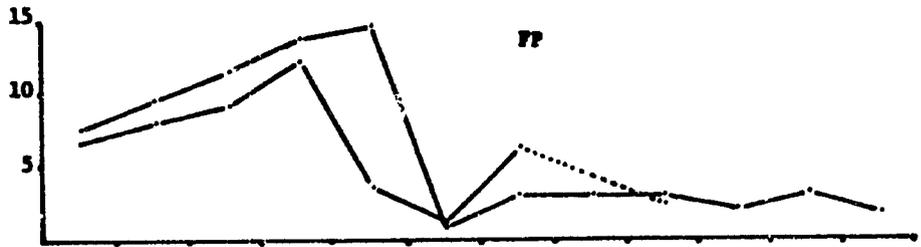
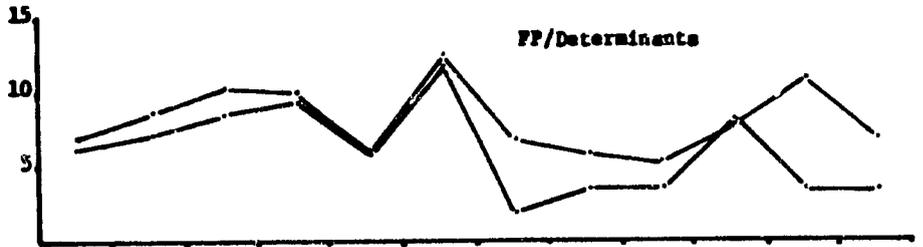
These patterns can be described as follows:

1. Family planning/Determinants: This profile is strongest on determinants (6), with family planning (2-3) in secondary place. (2 respondents)
2. Primarily family planning: This profile gives very high ratings to the supply side options, especially as augmented with sterilization, abortion, and new methods. Relatively low effectiveness is assigned to the other interventions. (2 respondents)
3. Family planning/Pressure: This profile has two main concentrations: high ratings for the augmented family planning interventions (2-3), especially abortion (3), and a smaller peak for community "pressure" (10). This profile can be seen as intermediate between 2 and 4. (5 respondents)
4. Family planning/Sanctions: This profile also has two emphases: augmented family planning interventions (2-3), especially abortion, and the harder measures culminating in sanctions (11) and limits (12). (3 respondents)
5. Low differentiation: The effectiveness ratings in this profile are relatively high for all interventions, with relatively little differentiation among them. (4 respondents)

The average profiles for these clusters of respondents, plus the overall profile for all 16 respondents, are shown in Figure 4. They are the evaluations of the major strategies of intervention toward fertility reduction in

Figure 3

Average Strategic Profiles for Subgroups and Total  
(Effectiveness ratings on a scale from 0 to 20)



(1) FP, Public Sector  
 (2) ...plus Sterilisation  
 (3) ...plus Abortion  
 (4) New method  
 (5) FP, Private Sector  
 (6) Determinants  
 (7) Information  
 (8) Incentives  
 (9) ...Money  
 (10) Community "pressure"  
 (11) Sanctions  
 (12) ...Limits

Figure 3 (cont.)

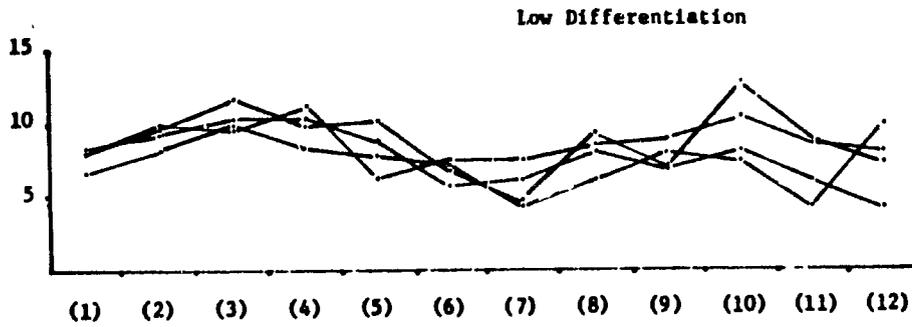
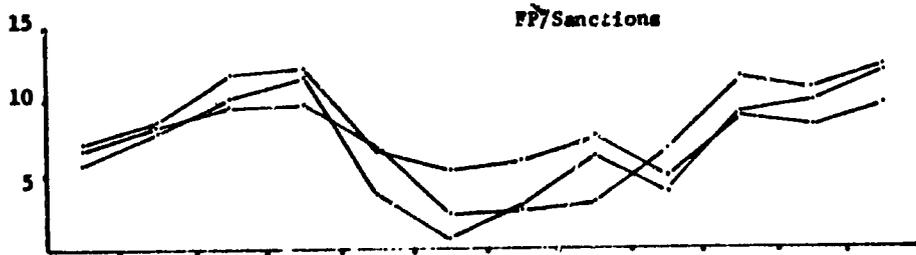


Figure 4

Average Strategic Profiles for Subgroups and Total  
(Effectiveness ratings on a scale from 0 to 20)

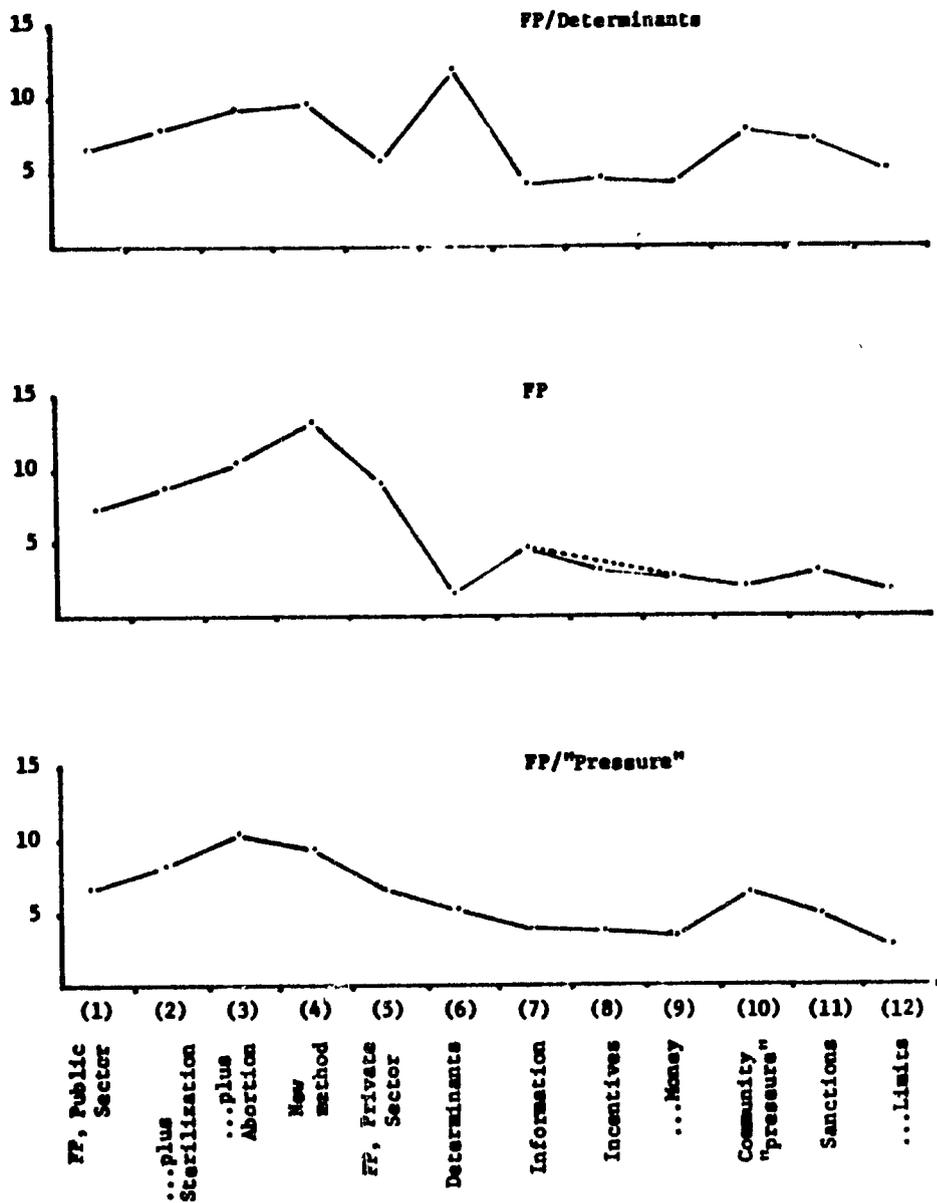
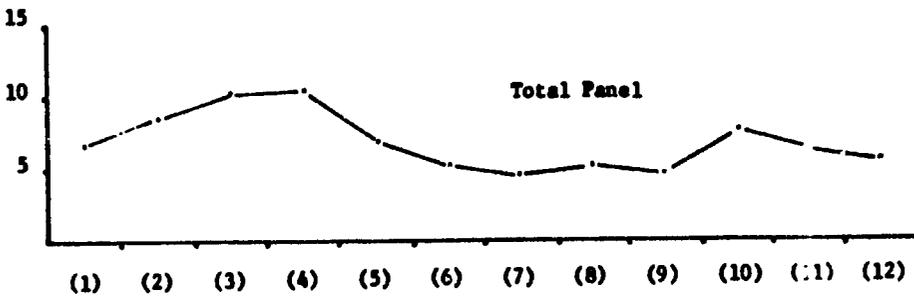
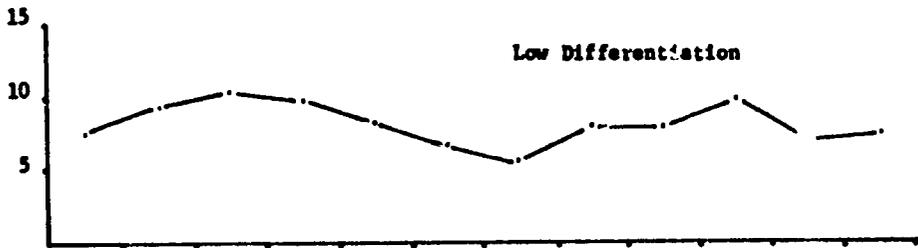
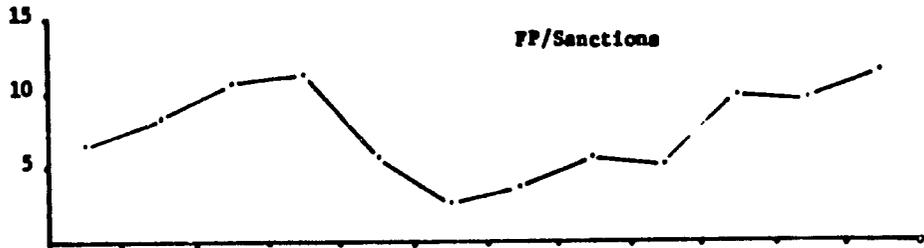


Figure 4 (cont.)



developing countries as estimated by our panel of respondents. The curves reflect their judgment of the relative merits of distinctive options for the efficient allocation of resources devoted to fertility reduction.

#### Toward Efficient Resource Allocation for Fertility Reduction

The data presented above provide the basis for estimating how expenditures should be allocated among the various Strategy-SS-PI combinations, if fertility reduction is the objective and if the judgments of the respondents are accepted, or respected as reasonable approximations to empirical fact. However, before the data reflecting the judgments can be used to guide resource allocation, some further specifications are needed in order to relate the effectiveness ratings to expenditures on various options. We first present the procedures we employ in specifying the relationships, and then describe the resource allocation that results.

As indicated above, in order to determine an efficient allocation of resources among a set of options, the relationship between inputs (expenditures) and output (fertility reduction) must be specified for each of the options. While the panel's effectiveness ratings are available for the 108 options, these ratings reflect judgments on average effectiveness. Allocation decisions, however, must be concerned with marginal effectiveness--with the relationship between effectiveness and additional resources devoted to any option. Because of the diminishing returns phenomenon, additional investment in a given combination (or set of combinations) in the matrix will after some point yield smaller returns. If this were not the case, the optimal policy would be to allocate all of the resources to the cell(s) with the highest effectiveness rating. What is required, then, is some estimate of the shape of the diminishing-returns curve(s) for incremental investments on various options.

To obtain this marginal input-output relationship, the strategies of intervention were assigned diminishing returns patterns as follows:

	<u>Strategy</u>	<u>\$N</u>	<u>\$2N</u>	<u>\$3N</u>
1	Traditional family planning (FP) programs	1	1.6	2.0
2-5	Augmented FP programs	1	1.5	1.9
6	Determinants	1	1.9	2.7
7-8	Information, incentives	1	1.4	1.6
9-12	Money, pressure, sanctions	1	1.75	2.4

These patterns were chosen judgmentally. For strategy 1, for example, the relationship states that if the investment of the first \$N in the traditional FP program yields x units of fertility reduction, an increment of \$N will yield .6x units, and an additional increment of \$N will generate .4x units of fertility reduction.

The rationale underlying these choices of diminishing returns patterns is that societies can absorb substantial investments in determinants—e.g., expanding education or advancing modernization in general—without encountering substantial diminishing returns, while the absorptive capacity for investments in monetary incentive or community re-organization programs or even applied sanctions is somewhat less. More significant diminishing returns are encountered for other strategies. Family planning programs, both traditional and augmented, are viewed as encountering more severe diminishing returns than determinants, money incentives, or pressure and sanctions, even though their effectiveness for \$N of investment—the effectiveness rating—may be higher than for the latter options. Finally, societies are viewed as having the least absorptive capacity for information and nonmonetary incentives and hence these strategies encounter diminishing returns most quickly.

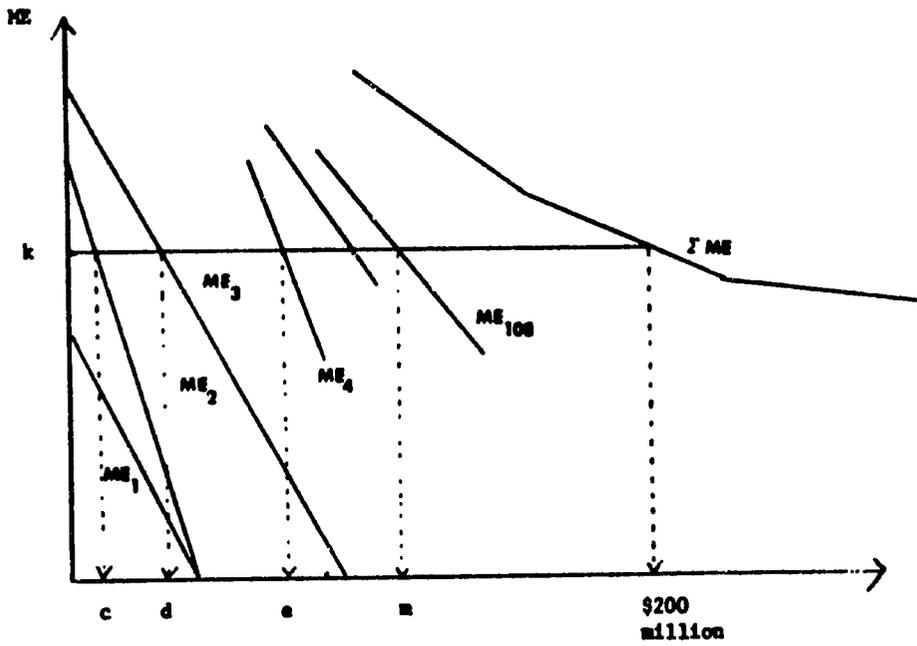
Given the effectiveness ratings and the specified patterns of diminishing returns, a total effectiveness curve can now be defined for each option. For each of the 108 options in the matrix, the effectiveness rating (averaged over the 16 respondents) was associated with \$N million of annual expenditure. Applying the diminishing returns patterns for \$2N and \$3N of expenditure gives three observations of total expenditure and effectiveness. Fitting a curvilinear function statistically to these three points (with the origin representing

zero effectiveness with zero expenditure) yields a total effectiveness curve for each of the 108 combinations.

Associated with each total effectiveness curve is a marginal effectiveness curve. It indicates the additional effectiveness of an added increment of spending, at each total spending level. Technically, the marginal effectiveness at each total spending level is given by the slope of the total effectiveness curve. Hence, each of the 108 total effectiveness curves has a marginal effectiveness curve related to it. Because of the nature of the equation employed for the total effectiveness curve, each of the marginal effectiveness curves is linear. With the full family of 108 marginal effectiveness patterns established, the total investment can be allocated optimally among the 108 options, or any selected sub-set thereof. This is done by allocating the funds among the combinations so that marginal effectiveness of money allocated to each combination is identical and so that the amount of money allocated sums to the total available (in this case, \$200 million, as explained below).

This optimal allocation procedure can be illustrated graphically. All of the 108 marginal effectiveness curves are aggregated horizontally. This aggregate curve is depicted as ME, as in Figure 5. The individual marginal effectiveness curves are shown as  $ME_1, ME_2, \dots, ME_{108}$ . The value of the ME curve, when x is designated as the total expenditure to be allocated, is the overall marginal effectiveness level. For an optimal allocation, the marginal effectiveness must be equal for each combination, and, in turn, equal to the overall marginal effectiveness. Suppose that ME is k when x is \$200 million. The funds are to be allocated to each of 108 combinations so that marginal effectiveness of expenditure in each combination is equal to k. Some combinations may be allocated no money as shown by the example of the leftmost ME curve in the figure. Note also that  $c + d + e + \dots + m + \dots = \$200$  million, since the point k on ME is the horizontal summation of c, d, e . . .  
n . . . .

**Figure 5**  
**The Optimal Allocation of Fixed Investment Among**  
**Alternatives of Varying Effectiveness**



This procedure, involving the equalization of marginal effectiveness for all the options, can be more clearly illustrated by means of a simple example. Consider a total investment of \$100, which is divided equally among 4 projects --\$25 to each. Assume that the last dollar spent on each of the four projects returns, respectively, \$2, \$1.50, \$1.00, and \$.50. The investor can increase the return on his total investment by reallocating the last dollar from the lowest return project (hence, losing \$.50) to the highest return project (hence, gaining \$2). The reallocation will drive down the return on the first project as more investment is allocated to it, and simultaneously increase the return on the last project. This will occur because of the diminishing returns phenomenon. From the shape of the marginal effectiveness curves it can be seen that additional investment in a project will reduce marginal returns, while reduced investment will increase returns at the margin. From this, it can be seen that the investor should continue reallocating funds until, at the margin, the return is equalized among all of the projects. In essence, it is this optimization procedure which is being applied here to the total investment in fertility reduction.

Through this procedure, defined more precisely in Appendix D, the optimal allocation of a fixed investment so as to secure maximum fertility reduction is achieved. In implementing this procedure, we used \$200 million as the total investment to be allocated. It approximates the amount the donor community is currently applying to activities directly aimed at fertility reduction, as against other support such as research, training, institutional development, data collection, etc. In recent years, according to the best available estimates, about 70% of "population assistance" is applied to the former set of activities and about 30% to the latter set. Thus of the total figure of \$290 million for 1975, we consider that about \$200 million is now devoted directly to the goal of fertility reduction, mainly to family planning and associated support.<sup>10</sup>

In the following section, the results of the analysis of resource allocation is presented in various forms:

- 1) Allocations among strategies based upon
  - a) the average ratings of the panel
  - b) the sum of allocations by individual panel members.
- 2) Allocations among strategies for different selections of strategies
  - a) the independent strategies
  - b) the available strategies.
- 3) Allocations among strategies based upon the average ratings of identifiable clusters of panel respondents.
- 4) Allocations among strategies when variation in population distribution within countries is assumed.

#### Implications of Responses for Investment Allocation--Average Ratings

The results presented in Table 4 show how the \$200 million of fertility reduction expenditures would be allocated when the average response of the 16 respondents (as shown in Table 1) sets the level and composition of the total effectiveness curves. These results contain several points of interest:

- <> The allocation would be concentrated in only 25 of the 108 cells, and the top 5 cells receive \$71 million, or 35% of the total. Whole sections of the matrix receive no allocations whatever--including the last 4 columns of SS-PI categories and, with one trivial exception, strategies 6-9. If each of the 12 strategies could be implemented and if impact on fertility reduction were the only criterion, then investment based on effectiveness ratings would be limited to a relatively small number of SS-PI-strategy combinations, according to the panel's judgment as defined.
- <> The supply strategies would receive the bulk of the allocation--a total of \$153 million. And strategies 3 and 4--family planning plus abortion and family planning plus a new method--would receive by far the highest allocations, each receiving nearly a quarter of the total.
- <> The bulk of the allocations would also be assigned to High SS and Strong PI circumstances--\$148 and \$137 millions, respectively.

Table 4

Optimal Allocation of \$200 Million to Twelve Strategies:  
Allocation from Average Ratings  
(in millions of dollars)

Strategies of Intervention	High Social Setting			Middle Social Setting			Low Social Setting			Total
	Program Implementation			Program Implementation			Program Implementation			
	Strong	Mod.	Weak	Strong	Mod.	Weak	Strong	Mod.	Weak	
<u>Supply</u>										
1. Public sector, current methods (A1, A5-9)	11.2	3.6		3.6						\$18.4
2. ...plus Sterilization (A2)	13.4	8.0		5.5						26.9
3. ...plus Abortion (A3)	16.0	11.9	5.5	10.1	5.5					49.0
4. ...plus New method (B)	14.8	11.9	5.5	10.1	5.5					47.8
5. Private sector distribution (A4)	8.0	2.6								10.6
<u>Demand</u>										
6. Determinants (C)										
7. Information (D)										
8. Incentives (E1-4, E6)	0.4									0.4
9. ...Money (E5)										
10. Community "pressure" (F)	16.1	3.0		8.2						27.3
11. Sanctions (G1-2)	8.2			3.0						11.2
12. ...Limits on family size (G3)	8.2									8.2
Total	\$96.3	41.0	11.0	40.5	11.0					\$199.8

### Implications of Responses for Investment Allocation—Individual Allocations

An alternative way of deriving the budget allocations which would result from the panel's evaluation of effectiveness uses a procedure that allows the judgments of each respondent to be more directly reflected in the final allocation. In the previous allocation in which the mean ratings of the 16 respondents set the level of the effectiveness curves, the views of respondents with evaluations far from the norm tended to be submerged. Because their pattern of ratings is incorporated into a set of cell averages, and because those of the 108 combinations with the lowest averages receive no allocations, the views of such respondents may be given no effective weight. To assign such minority evaluations a greater weight, this second procedure in effect grants each respondent \$200 million ÷ 16 (= \$12.5 million) which is then allocated most efficiently by his/her own effectiveness ratings. Then, the resulting allocations to each of the 108 cells are summed over the respondents.

The distribution of the \$200 million if the respondents' judgments were reflected by this procedure is shown in Table 5. This allocation displays some of the broad patterns reflected in Table 4, but it contains some substantial differences as well:

- ◇ A far greater number of cells, 76 of the 108, would receive allocations with this technique of reflecting individual evaluations, and the top 5 would get only \$55 million. In short, this allocation would be less concentrated, but many combinations would still receive only small allocations (the lowest 31 of the 76 cells receive less than \$1 million in total).
- ◇ The majority of the \$200 million would still be concentrated on the supply strategies, which would receive just over one-half, or \$115 million.
- ◇ Again, strategies 3 and 4 would be assigned the highest allocations, a total of \$71 million. However, in this distribution strategies 1 and 2 (the major ongoing family planning efforts) would get substantially less funding and strategies 6 (determinants) and 11 and 12 (sanctions) would get substantially more.
- ◇ While the High SS and Strong PI categories would again be assigned major allocations (\$133 and \$137 million, respectively), the lower SS categories would fare slightly better with this method, though not the lower PI levels.

**Table 5**  
**Optimal Allocation of \$200 million to Twelve Strategies:**  
**Individual Allocations**  
**(in millions of dollars)**

Strategies of Intervention	High Social Setting			Middle Social Setting			Low Social Setting			Total
	Program Implementation			Program Implementation			Program Implementation			
	Strong	Mod.	Weak	Strong	Mod.	Weak	Strong	Mod.	Weak	
<b>Supply</b>										
1. Public sector, current methods (A1, A5-9)	8.1	1.8	0.2	1.3						\$11.4
2. ...plus Sterilization (A2)	10.2	4.7	0.5	3.6	0.2		0.3			19.5
3. ...plus Abortion (A3)	12.8	8.6	2.2	7.0	2.5	0.6	1.2	0.1		35.0
4. ...plus New method (B)	12.5	8.4	2.4	7.3	2.6	0.5	1.6	0.7	0.2	36.2
5. Private sector distribution (A4)	5.8	2.3	1.4	1.9	0.8	0.2	0.5	0.4	0.1	13.4
<b>Demand</b>										
6. Determinants (C)	6.9	2.6	2.3	5.0	3.2	0.6	0.7	0.1		21.4
7. Information (D)	1.0			0.3						1.3
8. Incentives (E1-4, E6)	1.7	0.2		0.2	0.1		0.3			2.5
9. ...Money (E5)	2.2	0.4								2.6
10. Community "pressure" (F)	10.7	3.1	0.4	6.3	0.6		2.3	0.4		23.8
11. Sanction (G1-2)	8.7	1.1	0.1	4.1	0.3		1.9	0.7	0.4	17.3
12. ...Limits on family size (G3)	5.7	3.8	0.3	4.0	1.0		1.1			15.9
<b>Total</b>	<b>\$86.3</b>	<b>37.0</b>	<b>9.8</b>	<b>41.0</b>	<b>11.3</b>	<b>1.9</b>	<b>9.9</b>	<b>2.4</b>	<b>0.7</b>	<b>\$200.3</b>

Implications of Responses for Investment Allocation With Different Sets of Strategies

Two additional allocations were made using these patterns of effectiveness ratings and diminishing returns. They involve selections from the 12 identified strategies:<sup>11</sup> (1) a set of 7 "independent" strategies and (2) a set of 6 "available" strategies.

The first set recognizes that some of the original set of 12 strategies are close substitutes and, hence, perhaps not fully independent options. The various family planning strategies are examples. To the extent that similar options are treated as independent, and to the extent that these options receive high effectiveness ratings, the allocation results will tend to favor such choices. To adjust for this result, an alternative list of strategies was obtained by selecting the strategies that are least substitutable. The aggregation used and the resulting set, hereafter termed the 7 independent strategies, is as follows:

Public sector family planning, current methods (strategy 1)

The most effective of the remaining Supply options for each respondent (the dominant of strategies 2-5)

Determinants (strategy 6)

Information (strategy 7)

The more effective of the two Incentive options for each respondent (the dominant of strategies 8 and 9)

Community "pressure" (strategy 10)

The more effective of the two Sanctions for each respondent (the dominant of strategies 11 and 12)

This list, with the SS-PI combinations, yields a 63-cell matrix (i.e., 7 x 9). Tables 6 and 7 present the expenditure allocations for the two allocation procedures (that based on average ratings and that based on individual allocations). These results are analogous to the 12-strategy allocations shown in Table 4 and 5.

The second compressed set, hereafter termed the 6 available strategies, includes only those strategies that are actually being used today in some substantial degree, namely:

Public sector family planning, current methods (strategy 1)

. . . plus sterilization (strategy 2)

Private sector distribution (strategy 5)

Determinants (strategy 6)

Information (strategy 7)

Incentives (the dominant of strategies 8 and 9)

This selection recognizes that abortion is not programmatically acceptable except very selectively, that the new method does not exist, and that pressures and sanctions are unacceptable in most places for a variety of reasons.

The data for the 54-cell matrix resulting from this compressed set of 6 available strategies are presented in Tables 8 and 9 for the two allocation procedures. These allocations can be readily compared with the earlier allocations in Tables 4-7.

Table 10 summarizes the results from the allocation analyses for these two sets of strategies, and compares them with those employing the full set of strategies (i.e., Tables 4 and 5). In general, the allocations based on the selected strategies, as compared with the full list, indicate (1) a somewhat less concentrated allocation, though not such difference in the top 5 cells; (2) less spent on supply strategies in the independent list and correspondingly more on demand strategies, but the reverse for the available strategies; (3) essentially the same allocations to Strong PI and High SS situations; (4) increased spending on traditional family planning programs, especially with the available strategies, though even there only in the 20-25% range; (5) less on augmented FP in the independent list, though it is still a dominant category; (6) trivial amounts to determinants, information, and incentives except in the

Table 6

Optimal Allocation of \$200 Million to Seven Independent Strategies:  
Allocation from Average Ratings  
(in millions of dollars)

Selected Strategies of Intervention	High Social Setting			Middle Social Setting			Low Social Setting			Total
	Program Implementation			Program Implementation			Program Implementation			
	Strong	Mod.	Weak	Strong	Mod.	Weak	Strong	Mod.	Weak	
Public sector, current methods	15.4	8.9		8.9						\$33.2
Dominant of remaining supply options	19.1	15.7	10.3	15.7	12.4	1.0	7.9	1.0		83.1
Determinants										
Information	2.0									2.0
Dominant of incentive options	4.9									4.9
Community "pressure"	20.0	6.9		16.5	0.3		0.3			44.0
Dominant of sanctions	20.0	0.3		12.2						32.5
Total	\$81.4	31.8	10.3	53.3	12.7	1.0	8.2	1.0		\$199.7

Table 7

**Optimal Allocation of \$200 Million to Seven Independent Strategies:  
Individual Allocations  
(in millions of dollars)**

Selected Strategies of Intervention	High Social Setting			Middle Social Setting			Low Social Setting			Total
	Program Implementation			Program Implementation			Program Implementation			
	Strong	Med.	Weak	Strong	Mod.	Weak	Strong	Mod.	Weak	
Public sector, current methods	11.8	5.0	0.8	4.3	0.3		0.6			\$22.8
Dominant of remaining supply options	16.4	12.0	7.1	12.1	7.4	2.1	4.8	2.1	1.0	65.0
Determinants	9.2	4.2	2.6	6.8	3.5	0.9	1.3	0.2		28.7
Information	2.3	0.5		0.9	0.1					3.8
Dominant of incentive options	3.3	1.0	0.4	0.9			0.4			6.0
Community "pressure"	15.0	6.0	0.9	9.4	2.4		3.3	0.5		37.5
Dominant of sanctions	12.6	5.7	1.4	9.3	2.4		4.1	0.7	0.5	36.7
<b>Total</b>	<b>\$70.6</b>	<b>34.4</b>	<b>13.2</b>	<b>43.7</b>	<b>16.1</b>	<b>3.0</b>	<b>14.5</b>	<b>3.5</b>	<b>1.5</b>	<b>\$200.5</b>

Table 8

Optimal Allocation of \$200 Million to Six Available Strategies:  
Allocation from Average Ratings  
(in millions of dollars)

Strategies of Intervention	High Social Setting			Middle Social Setting			Low Social Setting			Total
	Program Implementation			Program Implementation			Program Implementation			
	Strong	Mod.	Weak	Strong	Mod.	Weak	Strong	Mod.	Weak	
<b>Supply</b>										
Public sector, current methods	18.4	12.9	2.6	12.9	2.6					\$49.4
...plus sterilization	19.5	15.6	9.1	13.8	9.1		5.8			72.9
Private sector distribution	15.6	11.7	5.8	9.1	1.7					43.9
<b>Demand</b>										
Determinants	14.0			1.0						15.0
Information	5.6									5.6
Incentives	8.1	2.5		2.5						13.1
<b>Total</b>	<b>\$81.2</b>	<b>62.7</b>	<b>17.5</b>	<b>39.3</b>	<b>13.4</b>		<b>5.8</b>			<b>\$199.9</b>

Table 9

Optimal Allocation of \$200 Million to Six Available Strategies:  
Individual Allocations  
(in millions of dollars)

Strategies of Intervention	High Social Setting			Middle Social Setting			Low Social Setting			Total
	Program Implementation			Program Implementation			Program Implementation			
	Strong	Mod.	Weak	Strong	Mod.	Weak	Strong	Mod.	Weak	
<b>Supply</b>										
Public sector, current methods	15.8	9.8	1.8	8.7	2.0		1.0			\$39.1
...plus sterilization	16.9	12.9	4.6	11.4	5.8	0.2	2.5	0.1		54.4
Private sector distribution	12.4	7.9	3.9	6.4	2.6	0.9	1.3	0.8	0.5	36.7
<b>Demand</b>										
Determinants	14.8	7.2	3.4	9.5	4.3	1.6	2.0	0.9		43.7
Information	3.6	1.7	0.4	1.9	0.4		0.2			8.2
Incentives	6.5	3.4	1.1	3.7	1.5		1.5	0.2		17.9
<b>Total</b>	<b>\$70.0</b>	<b>42.9</b>	<b>15.2</b>	<b>41.6</b>	<b>16.6</b>	<b>2.7</b>	<b>8.5</b>	<b>2.0</b>	<b>0.5</b>	<b>\$200.0</b>

Table 10

Comparisons of Allocation Patterns for All Twelve, Independent Seven,  
and Available Six Strategies, Two Allocation Methods

	Allocations from Average Rating			Individual Allocations		
	All 12 Strategies (108 cells)	7 Independent Strategies (63 cells)	6 Available Strategies (54 cells)	All 12 Strategies (108 cells)	7 Independent Strategies (63 cells)	6 Available Strategies (54 cells)
Concentration: Percent of cells with allocations	23%	33%	41%	70%	76%	83%
Percent of budget allocated to top 5 cells	36	46	42	28	34	36
Percentage of budget total allocated to:						
Supply strategies	71	58	83	58	44	65
Demand strategies	23	42	17	42	56	35
High SS	74	62	71	67	59	64
Strong PI	69	71	63	69	64	60
Traditional FP	9	17	25	6	11	20
Augmented FP	67	42	58	52	33	46
Determinants	0	0	8	11	14	22
Information, incentives	0	3	9	3	5	13
"Pressure," sanctions	23	38	0	29	37	0

second allocational method and even there not a large proportion; and (7) more to "pressure"/sanctions where available, i.e., in the independent list.

As for the two allocational methods, the relative comparisons are essentially the same among the three lists of strategies, though at different levels as indicated above, except as noted for determinants and information/incentives in the last column.

However, regardless of the allocation procedure or the number of strategies, several patterns persist. In all cases, most of the investment would go to Strong PI (60-71%) and to High SS (59-74%). Among the strategies of intervention, little would go to determinants (0-22%), and somewhat more to traditional FP programs (6-25%) and "pressure"/sanctions (0-38%). The heaviest allocation would be concentrated on augmented family planning programs (33-67%). In short, in all six analyses, family planning efforts plus "pressure"/sanctions would get from 65% to 99% of the investment.

#### Implications of Responses for Investment Allocation by Clusters of Respondents

In Figure 3, we distinguished 5 clusters of respondents by the similarity of their patterns of effectiveness ratings among the strategies. These clusters were described as: (1) Family planning/Determinants, (2) Primarily family planning, (3) Family planning/"Pressure," (4) Family planning/Sanctions, and (5) Low differentiation among all strategies. Given the procedure for transforming the patterns of effectiveness ratings into an optimal allocation of a fixed expenditure, it is possible to discern the budget allocation implicit in the effectiveness ratings of each of these clusters.

Table 11 presents the range of allocations among the SS and PI categories for the five clusters of respondents. In spite of the diversity of the responses among strategies, nearly all the clusters of respondents would allocate well over one-half of the resources to the High SS or the Strong PI categories. For some of the clusters, nearly 100 percent of the budget was allocated to these categories. Further, all of the clusters would allocate very little, often

Table 11

Range in Percentage Allocations Among Social Setting (SS) and Program Implementation (PI) for Five Clusters of Respondents, the Full List of Strategies and the Two Compressed Lists, Average Rating

	All 12 Strategies	7 Independent Strategies	6 Available Strategies
SS: High	55-88%	42-76%	50-80%
Middle	12-41	24-46	19-47
Low	0-13	0-23	1-12
PI: Strong	53-84	50-68	48-68
Moderate	16-32	28-31	28-34
Weak	0-17	3-19	2-21

none, to the Low SS or the Weak PI categories.<sup>12</sup> Despite different preferences among strategies, the investment would always be concentrated among the haves (High SS and Strong PI) relative to the have-nots.

There are, however, clear differences in allocation among the strategies. This is shown in full detail in Table 12 and summarized in Table 13. None of the clusters would allocate more than a trivial volume of resources to information or incentives (except when "pressure" and sanctions are eliminated, and even then not much), and none would allocate nearly as much to the traditional family planning programs as to the augmented ones. Moreover, all of the clusters would allocate at least 20 percent of the budget to the supply options. There the agreement ends. Beyond that, those strategies on which any given cluster would tend to concentrate its allocation are by and large omitted by the other clusters.

This is seen most clearly in comparing the allocations to the determinants, "pressure," and sanctions strategies across the clusters. The compressed display in Table 13 reveals three basic allocational patterns: (1) all to supply; (2) most to determinants, the remainder to supply; and (3) substantial shares to supply and "pressure"/sanctions with little in between. Again, only when the latter is eliminated, in the available set of options, would more than a trivial allocation go to information and incentives, and only one cluster would allocate a major share of resources to determinants.

As indicated above, prior to obtaining their ratings we had classified the respondents into three categories: Family Planning advocates, Development advocates, and Neutrals. If our classification were correct, significant differences in budget allocations among these groups should appear. Referring to the full list of strategies, we would expect to find the first group would allocate the budget primarily to the family planning strategies (1-5), the second group to the determinant strategy (6), and the final group would allocate the budget rather more equally across the strategies.

Table 12

Optimal Allocations to the Full and Compressed List  
of Strategies for Five Clusters of Respondents, Average Ratings

(in millions of dollars)

	FP/ Determinants	FP	FP/ "Pressure"	FP/ Sanctions	Low Differentiation
<b>Full list of Strategies</b>					
1. Public sector, current methods	\$ 4.3	\$ 16.4	\$ 22.7	\$ 7.9	\$16.7
2. . . . plus Sterilization	9.3	29.4	33.8	14.6	24.8
3. . . . plus Abortion	20.8	47.3	57.0	26.7	34.7
4. . . . plus New method	25.0	86.4	41.9	32.6	30.9
5. Private sector distribution	0.0	20.5	10.7	0.0	19.2
6. Determinants	131.3	0.0	0.0	0.0	0.0
7. Information	0.0	0.0	0.0	0.0	0.0
8. Incentives	0.0	0.0	0.0	0.0	6.3
9. . . . Money	0.0	0.0	0.0	2.2	7.4
10. Community "pressure"	0.0	0.0	28.7	26.3	40.9
11. Sanctions	8.9	0.0	5.7	31.7	7.4
12. . . . Limits on family size	0.0	0.0	0.0	58.1	11.5
<b>Total</b>	<b>\$199.6</b>	<b>\$200.0</b>	<b>\$200.5</b>	<b>\$200.1</b>	<b>\$199.8</b>
<b>Seven Independent Strategies</b>					
1. Public sector, current methods	\$ 5.4	\$ 49.2	\$ 33.9	\$ 11.9	\$24.1
2. Dominant of remaining supply options	32.8	147.6	82.2	50.8	54.3
3. Determinants	148.6	0.0	11.6	0.0	0.0
4. Information	0.0	3.2	2.2	0.0	0.9
5. Dominant of incentives	0.0	0.0	2.2	4.6	18.2
6. Community "pressure"	1.8	0.0	47.7	46.9	60.1
7. Dominant of sanctions	11.5	0.0	20.0	85.7	42.3
<b>Total</b>	<b>\$200.1</b>	<b>\$200.0</b>	<b>\$199.8</b>	<b>\$199.9</b>	<b>\$199.9</b>
<b>Six Available Strategies</b>					
1. Public sector, current methods	\$ 7.4	\$ 47.8	\$ 48.3	\$ 52.8	\$41.9
2. . . . plus Sterilization	14.4	72.7	67.6	71.4	54.6
3. Private sector distribution	0.0	76.6	39.3	29.5	48.7
4. Determinants	178.2	0.0	30.6	0.0	10.5
5. Information	0.0	2.9	6.0	3.7	6.7
6. Dominant of incentives	0.0	0.0	6.0	42.9	37.6
<b>Total</b>	<b>\$200.0</b>	<b>\$200.0</b>	<b>\$199.8</b>	<b>\$200.3</b>	<b>\$200.0</b>

Table 13

Percentage Allocations to Major Strategies,  
Full and Compressed Lists of Strategies Considered  
for Five Clusters of Respondents, Average Ratings

	FP/ Determinants	FP	FP/ "Pressure"	FP/ Sanctions	Low Differentiation
<b><u>Full List of Strategies</u></b>					
Supply (all family planning)	30%	100%	83%	41%	63%
Determinants	66	0	0	0	0
Information and incentives	0	0	0	1	7
"Pressure" and sanctions	4	0	17	58	30
<b><u>Seven Independent Strategies</u></b>					
Supply (all family planning)	19%	98%	58%	32%	39%
Determinants	74	0	6	0	0
Information and incentives	0	2	2	2	0
"Pressure" and sanctions	7	0	34	68	61
<b><u>Six Available Strategies</u></b>					
Supply (all family planning)	11%	99%	79%	77%	73%
Determinants	89	0	15	0	5
Information and incentives	0	1	6	23	22
"Pressure" and sanctions	0	0	0	0	0

In general these differences do appear, as shown in Table 14. The family planning advocates clearly favor supply strategies relative to the development advocates. They would allocate from 65 to 90 percent to the supply strategies, relative to the 20 to 55 percent which would be so allocated by the development advocates. An even clearer distinction is found by viewing the determinants strategy: while development advocates would allocate from 35 to 62 percent of the total investment to this option, the family planning advocates would allocate nothing. Except in the available strategy case, those respondents classified as neutral would assign even higher allocations to supply side strategies than would those respondents classified as family planning advocates, suggesting that a number of strong family planning advocates were misperceived in our initial classification.

#### Investment Allocation by Population Distributions

The results presented in the previous sections indicate the patterns of budget allocation implied by the respondents' ratings, again if the proximate objective were fertility reduction and if attainment of this objective depended only on the strategy chosen and the social setting and program implementation of the society in which the budget was spent. Not only were considerations of political and cultural acceptability assumed away (except insofar as they influenced the panel's judgment of PI) but the size of the society in which interventions were made was ignored. Implicitly, it was assumed that the "absorptive capacity" within any cell posed no problem, that the diminishing returns patterns were invariant to the size of the population in any cell.

It is indeed likely that the respondents took some account of the degree of political and cultural acceptability of the various strategies in the ratings given to the various program implementation categories, e.g., with regard to sanctions or even abortion. However, the analysis to this point implicitly assumes equal absorptive capacity or sufficient population in each of the cells—and hence in each of the columns of the matrix.

Table 14

Percentage Allocations to Major Strategies,  
when Aggregated List of Strategies Considered for  
Three A Priori Groupings of Respondents, Average Ratings

	Family Planning Advocates	Development Advocates	Neutrals
<b><u>Full List of Strategies</u></b>			
Supply (all family planning)	72%	55%	83%
Determinants	0	35	0
Information and incentives	0	0	2
"Pressure" and sanctions	28	15	15
<b><u>Seven Independent Strategies</u></b>			
Supply (all family planning)	65%	20%	90%
Determinants	0	58	0
Information and incentives	0	0	2
"Pressure" and sanctions	36	22	8
<b><u>Six Available Strategies</u></b>			
Supply (all family planning)	90%	38%	81%
Determinants	0	62	7
Information and incentives	10	0	11
"Pressure" and sanctions	0	0	0

In fact, absorptive capacity as indicated by population size is far from equally distributed among the cells. Table 15 presents the population distribution of the developing world by the 9 SS and PI categories. This was done by classifying 89 developing countries of 1 million population or more which are potential recipients of international population assistance (all except China and Burma).<sup>13</sup> The distribution figures, which correspond to the 9 columns of the basic matrix, range from 0 to 38 percent. Sixty-five percent of the developing world's population is in countries with low social setting by the measures used here, and half in countries with weak program implementation.

Thus, there is a wide disparity between the estimated budget allocations by SS and PI and the actual distribution of population in countries assigned to the various categories, as summarized in Table 16. The categories which would receive the bulk of the allocations contain countries with relatively few people.

This disparity between the distribution of population and the allocation of budget may be overstated by assigning all of the population in a country to the particular SS-PI cell in which the country is located. In point of fact, most countries are diverse entities, with a variety of SS and PI combinations represented among its regions, political jurisdictions, and rural-urban areas. If more complete data were available on the SS and PI characteristics of appropriate sub-populations within a country, some proportion of the population in a country classified as one SS-PI type would actually be found to belong in other neighboring classifications.<sup>14</sup>

To reflect this intra-country diversity, we establish a procedure to distribute the population within a country symmetrically around the SS-PI classification for the entire country. The percentage pattern of population distribution for the central cell—middle SS and moderate PI—was designated as:

Table 15

Percentage Population Distribution of Developing Countries,  
by Social Setting and Program Implementation

Program Implementation	Social Setting			Total
	High	Middle	Low	
Strong	3%	0%	1%	4%
Moderate	2	8	38	48
Weak	11	10	26	47
Total	16%	18%	65%	99%

Table 16

Comparison of Population Distribution and Investment Allocation,  
by Social Setting and Program Implementation

		Percent of population	Allocation, range of 6 procedures*
Social setting:	High	16%	59-74, or 67% (+51)
	Middle	10	26-34, or 30 (+72)
	Low	65	0- 9, or 5 (-60)
Program implementation:	Strong	4	60-71, or 66% (+62)
	Moderate	48	23-31, or 27 (-21)
	Weak	47	6- 9, or 8 (-39)

\*The six allocation procedures are represented in Tables 4-9.

Table 17

Percentage Population Distribution of Developing Countries,  
by Social Setting and Program Implementation Capability,  
after Redistribution as Indicated

Program Implementation	Social Setting			Total
	High	Middle	Low	
Strong	3%	4%	9%	16%
Moderate	6	10	22	38
Weak	10	13	24	47
Total	19	27	55	101

<u>Program Implementation</u>	<u>Social Setting</u>		
	<u>High</u>	<u>Middle</u>	<u>Low</u>
Strong	5	12.5	5
Moderate	12.5	30	12.5
Weak	5	12.5	5

While 30 percent of the population is retained in the SS-PI designation for the country as a whole, the remainder is distributed symmetrically around this designation. Following this pattern the distributions for the remaining 8 cells were designated as follows:<sup>15</sup>

<u>Four corner cells</u>		<u>Four marginal non-corner cells</u>	
Base cell	60 %	Base cell	42.5%
Contiguous cells	15 %	Contiguous corner cells	17.5%
Center cell	5 %	Center cell	10 %
Closest corner cells	2.5%	Non-corner cells on adjacent margin	5 %
		Cell on opposite margin	2.5%

With this presumed within-country distribution of population, the disparity between the distribution of total (developing world) population by its SS-PI classification and the allocation of optimally allocated fertility reduction funds is significantly narrowed. (The revised population distribution is shown in Table 17; it can be compared with the distribution in Table 15.) Accepting the resulting intra-country population distributions by SS and PI category and assuming that the optimally allocated fertility reduction expenditures by SS and PI classifications were distributed among countries so as to reflect this population distribution, the allocation of the \$200 million among the eligible countries was recalculated.

The effect of this procedure on the distribution of funds among countries classified by their overall SS-PI designation is indicated in Table 18. By considering the dispersion of population within countries in the distribution of the \$200 million, a substantial increase in support would be granted countries with low overall PI and SS ratings. For example, for the various allocations the distribution of funds to countries with moderate and weak PI classifications would increase by from 32-39 percentage points when

**Table 18**

**Percentage Point Increase(+) or Decrease(-) in Allocation of \$200 Million Investment to Countries in Designated SS-PI Cell From Case in Which Intra-Country Population Distribution Is Not Used to Case in Which It Is, with 12, 7, and 6 Strategy Analyses, Average Ratings**

<u>Program Implementation</u>	<u>Social Setting</u>			<u>Total</u>
	<u>High</u>	<u>Middle</u>	<u>Low</u>	
<u>Full List of Strategies</u>				
Strong	-14	-20	+2	-32
Moderate	-9	+12	+15	+18
Weak	+9	+5	+1	+15
Total	-14	-3	+18	
<u>Seven Independent Strategies</u>				
Strong	-11	-27	-2	-40
Moderate	-6	+11	+21	+26
Weak	+7	+4	+2	+13
Total	-10	-12	+21	
<u>Six Available Strategies</u>				
Strong	-11	-20	-1	-32
Moderate	-11	+10	+18	+17
Weak	+8	+5	+2	+15
Total	-14	-5	+19	

intra-country population dispersion is considered in this manner, and to countries with low SS by 18-21 points.

The reallocations by cell are presented in Table 19,<sup>16</sup> where the percentage allocation of funds to countries in the nine designated cells is shown both for the allocations ignoring the redistribution of population and for those in which the redistribution was included. As this table shows, these reallocations favor the Lower SS and Lower PI categories (as we have described above) and are similar for all the regroupings of strategies.

The procedure based on dispersed intra-country population also yields estimates of per capita funding for the 9 SS-PI categories of countries, and indeed for individual countries. Table 20 presents the average per capita funding allocations for countries classified by SS-PI category. The per capita figures naturally range widely by SS and PI, but are essentially invariant over the 3 groupings of strategies: from about \$1.00 per capita in the High SS-Strong PI category to a few cents per capita in the Low SS-Weak PI category. Finally, Table 21 presents the estimated allocations of the \$200 million budget to illustrative countries in the various SS-PI categories, by the method of population redistribution described above.<sup>17</sup>

It should be emphasized that these estimates are to be interpreted with care. While they do reflect the respondents' judgments concerning the effectiveness of fertility reduction expenditures on various strategies in various social settings and under various program implementations, and while they are relatively stable in response to alternative aggregations of ratings and strategies (e.g., average vs. individual, independent vs. available) they also incorporate our own judgments on diminishing returns patterns, the intra-country distribution of population, even on the assignment of countries to the 9 SS-PI categories. Fundamentally, of course, they rest on the panel's judgments in a double sense: first, the similarity between such judgments and the fact, if knowable; and second, beyond that, the judgments as themselves the stuff of policy decisions.

Table 19

Percentage Allocations of \$200 Million Investment to SS and FI Categories  
 for Original Allocations and for Redistributed Populations,  
 For 12, 7, and 6 Strategy Analyses, Average Ratings

SS	FI	Original Allocations*			Allocation by Population Redistribution		
		All 12 Strategies	7 Independent Strategies	6 Available Strategies	All 12 Strategies	7 Independent Strategies	6 Available Strategies
H	S	48%	41%	41%	34%	30%	30%
H	M	20	16	21	12	10	11
H	W	6	5	9	15	13	17
M	S	20	27	20			
M	M	6	6	7	17	17	16
M	W		1		5	5	5
L	S		4	3	2	2	2
L	M		1		15	22	18
L	W				1	2	2
Total		100%	101%	101%	101%	101%	101%

\*From Tables 4, 6, and 8.

Table 20

Average Per Capita Allocations to Countries with Various  
Social Settings and Program Implementation Capability; in US cents

<u>Program Implementation</u>	<u>Social Setting</u>		
	<u>High</u>	<u>Middle</u>	<u>Low</u>
<u>Full List of Strategies</u>			
Strong	110	-	12
Moderate	48	21	4
Weak	13	5	0
<u>Seven Independent Strategies</u>			
Strong	97	-	17
Moderate	41	22	6
Weak	11	5	1
<u>Six Available Strategies</u>			
Strong	95	-	13
Moderate	45	21	5
Weak	15	5	1

**Table 21**

**Range of Allocations of Funds to Illustrative Countries in  
the Various SS-PI Categories, 3 Sets of Strategies, Average Rating  
(in millions of dollars)**

Program Implementation	Social Setting		
	High	Middle	Low
<b>Strong</b>	<b>South Korea \$32-37</b>		<b>Vietnam D.R. \$3-4</b>
<b>Moderate</b>	<b>Colombia \$11-12</b>	<b>Philippines \$9-10</b>	<b>India \$25-35</b>
<b>Weak</b>	<b>Mexico \$7-8</b>	<b>Egypt \$2</b>	<b>Bangladesh \$0.3-0.7</b>

Now it is clear that actual budget allocation can be, and is, based on considerations other than efficient fertility reduction, including political factors, expected changes in SS and especially in PI because of changed national leadership, appraisals of start-up needs and on-going self-sustaining efforts, and perhaps most importantly, evaluations of the need or urgency of fertility reduction (e.g., Bangladesh vs. South Korea). Efficiency of outcome, in itself, is one criterion for investment but not the only one.

Comparison with Actual Expenditures

This is readily seen in a brief comparison with the actual current distribution of donor funding for this purpose (Table 22).

Table 22  
Percentage of External Population Assistance, 1975,  
to Developing Countries

<u>Program Implementation</u>	<u>Social Setting</u>			<u>Total</u>
	<u>High</u>	<u>Middle</u>	<u>Low</u>	
Strong	11%	0%	-%	11%
Moderate	8	15	15	38
Weak	7	6	38	51
Total	26%	21%	53%	100%

Source: OECD, Development Centre, "Aide aux Programmes Demographiques en 1975," June 1977, Table 4.

Comparison with Tables 15 and 18 shows a substantial disparity with population size: somewhat more to upper SS, substantially more to the two extreme cells (the most successful in the upper right cell, the most needy in the lower right).<sup>18</sup>

Similar comparisons are available between the actual allocations (in 1975) and the allocations based on panel judgments in this analysis. For example, there is a sharp difference in per capital allocations (Table 23, compared to Table 20) and in illustrative country allocations (Table 24, compared to Table 21).

In interpreting these results in connection with donor agency funding decisions, one point stands out—the panel's estimates of fertility reduction effectiveness by social setting and program implementation do not closely correspond with the current allocation. If fertility reduction is the immediate objective, our analysis indicates that funds would flow largely to the "haves" relative to the "have-nots" according to the effectiveness ratings of the respondents, whereas in the real world the actual funding decisions reverse this emphasis. Thus a perception of "need" or "urgency" leads to a trade-off of some reduction in total births world-wide for a smaller reduction concentrated in nations which, on other than sheer efficiency grounds, strongly need to limit births.

Two further points seem worth mentioning in this connection: First, accepting the reliability of the panel judgments, the analysis highlights just how far present allocations deviate from those that would be undertaken if only efficiency in aggregate reduction in births were the sole criterion. This deviation indicates the importance actually assigned to general development goals, urgency considerations, social objectives, or political pressures in the formation of budget allocations. In short, cost-benefit return, though often called for, is not really wanted in its raw form. Second, related to this point, if donor agencies could make concerns for urgency or need explicit and weight them relative to the fertility reduction objective, and if such

Table 23

Actual Per Capita Allocations to Countries with  
Various Social Settings and Program Implementation; in U.S. Cents

<u>Program Implementation</u>	<u>Social Setting</u>		
	<u>High</u>	<u>Middle</u>	<u>Low</u>
Strong	29	29	5
Moderate	0	14	5
Weak	1-	30	11

Table 24

Actual Allocations to Illustrative Countries, 1975

<u>Program Implementation</u>	<u>Social Setting</u>		
	<u>High</u>	<u>Middle</u>	<u>Low</u>
Strong	South Korea \$4.4		Vietnam AR \$0.2
Moderate	Colombia \$7.5	Philippines \$7.7	India \$14.2
Weak	Mexico \$5.4	Egypt \$3.1	Bangladesh \$20.0

variables could be quantified, the analytic framework developed here could be used to extract efficient allocations in the face of multiple objectives.<sup>19</sup>

This study has attempted to apply the principles of economic analysis to the problem of resource allocation in the population field, in particular the allocation of available fertility reduction funds by the international donor agencies. It is based on the assumption that a primary (though not the ultimate) objective of investments in this area is fertility reduction in developing countries. Because of the unavailability of data of several types, it has had to be an exploratory exercise: arbitrary in the designated interventions and the selected experts, based on judgments in the absence of direct empirical data, using assumptions about the shape of diminishing return curves and population distribution, and employing available classifications of social settings and program implementations.<sup>20</sup>

Nevertheless, asking and trying to answer the question of optimal resource allocation in the population field is important, particularly in the post-Bucharest period of policy debate. We consider that the analytic techniques taken over from economics are appropriate to this issue, that the panel's responses accurately reflect what is known about the birth reduction potential of various strategies in various settings, and that the estimates based on these responses have substantive interest and validity in themselves. We would again note the exploratory nature of this effort and the potential for expanding it in several directions--number of respondents, better specification of strategies and interactions between them, better estimates of diminishing returns patterns, the incorporation of objectives other than fertility reduction, and the application to specific countries where local data and close knowledge should provide better foundations for such analyses.

However, in our view this effort, however primitive, is a useful first step insofar as it emphasizes that the debate over the proper policies for fertility reduction must take into account effectiveness per unit of investment

along with other considerations. It is not helpful, often it is less than helpful, simply to assert as a policy recommendation that increased popular education or improved health or higher standard of living or more women's liberation would reduce fertility without appreciating the relative effectiveness per dollar of expenditure on such efforts, not to mention the programmatic means to effect them.

The following summarizes some of the main results of our analysis:

With regard to intervention strategy

- ◇ The supply options receive the highest effectiveness ratings, particularly the family planning programs augmented with sterilization, abortion, or a new method. Incentives and information campaigns received the lowest ratings. Traditional family planning programs fall in between.
- ◇ Social setting and program implementation make for substantial differences in such ratings: the better the setting and the stronger the program implementation, the more effectiveness.
- ◇ There is substantial difference of opinion within the panel with respect to strategic interventions (though not much for SS or PI), and especially for the major perceived alternatives to family planning programs, i.e., determinants and "pressure"/sanctions. There is considerably more agreement on the tried than on the proposed.
- ◇ Five distinctive profiles of effectiveness ratings were identified within this panel of respondents.

With regard to resource allocation

- ◇ The better social settings and the stronger program implementations would consistently be allocated the lion's share of the resources, regardless of analytic procedures or strategic list.
- ◇ The allocation ratios to supply/demand options range from about 3:1 to 1:1 depending upon the interventions included and the analytic procedures. Traditional family planning programs, as now commonly pursued in developing countries, would receive only a small fraction of available resources if the augmented versions were available, since the latter tend to be the most favored interventions. The "harder" measures of community "pressure" and official sanctions would receive a substantial share of resources, again if feasible; and determinants, incentives, and information campaigns would be allocated relatively little. If the allocations were limited to what we term the independent or the available lists, the SS and PI allocations would remain essentially the same, traditional FP programs would receive somewhat more and the augmented somewhat less though still substantial amounts, determinants would receive significantly more only in one allocational case, and "pressure"/sanctions would

remain substantial where available for choice. Finally, when we come down to what is currently available as strategic interventions in most developing countries, in the panel's average judgment the FP efforts should get fully 86% of the funding.

- <> The allocations are sensitive to the procedure of averaging the several responses, whether through a single mean of the ratings (quite concentrated) or through a summation of the individual allocations (less concentrated).
- <> The different clusters of respondents ("strategic profiles") naturally favor "their own" allocations by strategy. But beyond that, family planning programs are the only intervention which would receive any substantial allocation from all schools of thought; each of the others would receive zero or close to it from the other profiles. Essentially, there are three patterns of allocations among the clusters: to determinants and family planning, to family planning interventions, to "pressure"/sanctions and family planning. And, although there is considerable range in their allocations to SS and PI, the higher levels would consistently receive more.
- <> From the respondents' ratings, allocations of funding would flow far more to the have than the have-not countries. That is affected by our process of intra-country population distributions, in which case increased allocations are made to low SS and lesser PI. Nevertheless, substantial disparity still remains, from about \$1 per capita to 1 cent.

These results echo the familiar dilemma of public policy for welfare ends: what is most effective seems to be least feasible! According to the respondents, if fertility reduction is the goal, resources would be better allocated to the augmented family planning programs (including abortion, a new method, sterilization) than to the traditional, but except for India (itself now doubtful) and a few other countries, sterilization is not fully included in such programs, abortion is far less so, and a new method is neither available nor soon in prospect. Beyond family planning, the stronger measures of building community "pressure" or applying sanctions would work, in the panel's judgment, but they are generally unacceptable: the cure is considered worse than the disease--which is only to say that, quite properly, other impacts besides fertility reduction are taken into account in policy determination. Although the respondents recognize that changing the so-called structural determinants of fertility reduction could be successful, these options were given lower ratings because of their cost per birth avoided. Finally, the

greatest reduction in fertility would be obtained with heavy allocations to better settings and stronger programs (where the need is less and the populations small); and places of low social settings and weak program implementation, where most of the people are, would receive only trivial allocations if based on fertility reduction effectiveness alone. Benefit-cost evaluation extended to cover objectives in addition to fertility reduction, or to take into account some consideration of "need," or to apply to a local situation internally, would be most helpful in this regard.

The results highlight a dilemma of public policy toward fertility reduction: Should efforts be concentrated on making acceptable policies more efficient, or on making efficient policies more acceptable? And in a sense, that raises the allocation question to a higher level, namely, the perceived value of the end which national policy must set against the monetary and the non-monetary costs of the means. For as we have noted before, fertility reduction is neither the first priority nor the final value of the public good.

#### NOTES

<sup>1</sup>Dorothy Nortman and Ellen Hofstatter, "Population and Family Planning Programs: A Factbook," Reports on Population/Family Planning, 8th ed., October 1976, Table 5, p. 20.

<sup>2</sup>Halvor Gille, "Recent Trends in International Population Assistance," Fourth Bellagio Population Conference, June 1977, Table 1.

<sup>3</sup>For a further discussion of such benefits and costs, see Robert Haveman, "Benefit-Cost Analysis and Family Planning Programs," Population and Development Review, Vol. 2., No. 1, March 1976.

<sup>4</sup>In this connection, note this judgment:

"President Johnson was persuaded to insert in one of his speeches a statement that one dollar spent on the reduction of fertility in a high-fertility population was better than 20 dollars devoted to general development. Professor Etienne van de Walle, of the University of Pennsylvania, says this statement is wrong. What is true is that 20 dollars spent on development are more effective if one of them is devoted to a population program," Ansley J. Coale, "Population Growth and Economic Development: The Case of Mexico," Foreign Affairs, January 1978, p. 429.

The current allocation to population is now about 40 cents per 20 dollars to development, according to Gille, op. cit.

<sup>5</sup>An index of social setting based on a similar concept but developed for a different purpose is found in Ronald Freedman and Bernard Berelson, "The Record of Family Planning Programs," Studies in Family Planning, January 1976. A more extensive analysis based on 7 socioeconomic factors (literacy, school enrollment, life expectancy, infant mortality, non-agricultural, labor force, GNP, and urbanization) but with similar outcome is contained in W. Parker Mauldin and Bernard Berelson, "Conditions of Fertility Decline in Developing Countries, 1965-1975," Studies in Family Planning, May 1978.

<sup>6</sup>This variable, also described in Freedman and Berelson, op. cit., is operationalized in Robert J. Larham and W. Parker Mauldin, "National Family Planning Programs: Review and Evaluation," Studies in Family Planning, March 1972.

<sup>7</sup>Fifteen were received on the first round. On the second round one additional response was received, five respondents reconfirmed their initial ratings, three made slight changes, and three made moderate changes. In view of the relatively small shifts made in response to our second request, we use here the 12 responses to the second round plus the additional four from the first round (on the assumption that non-response to the second round indicated satisfaction with the initial ratings). We would emphasize that our aggregate findings are sensitive to the implicit "sampling weights" accorded to the various perspectives held by our group of respondents. Hence, another group of respondents, of equal size and with equal reputation and knowledge, might yield a pattern of ratings quite different than those we have obtained. We judge, however, that the sample of respondents we have chosen is quite representative of the population of experts (somehow defined) and that our results would not differ markedly from results taken from this entire population.

<sup>8</sup>There are very few reversals in the ratings by individual respondents. For each strategy row there exist 12 possible comparisons of a rating on a lower to a higher category (6 for SS, 6 for PI), or 144 for the matrix. There are thus 2256 among our total responses--i.e., 144 times 16 respondents (or 2304) minus 48 for 4 omitted rows on one response. Of them, only 71 or 3 percent are reversals, in which a lower SS (in 66 cases) or PI (in 5 cases) gets a higher rating than a higher SS or PI. They appear among seven of the 16 respondents, and mainly with regard to strategies 6, 8, and 9 and to the judgment that a Strong effort in a Middle setting would achieve more than in a High setting.

<sup>9</sup>The anchor value of 7, on which of course no range was possible, is omitted from these calculations.

<sup>10</sup>Gille, op. cit., Table 1. Gille reports (p. 11) that in 1975 "about 48% of the total resources available for population assistance supported family planning programs," to which should be added "a substantial part" of the allocations for "multi-sector activities" (20% of the total) and "some" of communication and education; plus in our view a good part of the nearly 10% devoted to "biomedical research including contraceptive development." So two-thirds to three-fourths of the total seems a fair estimate of the amount allocated to direct interventions in the sense used here--hence, \$200 million.

<sup>11</sup>In both we assume that the respondents would not change their relative ratings if presented with the selected set in place of the full set.

<sup>12</sup>Only the family planning cluster allocates any budget to the Low SS category, and only the determinants strategy allocates any budget to the Weak PI category.

<sup>13</sup>This allocation of countries is based on Mauldin and Berelson, *op. cit.* The 4x4 classification there was reduced to our 3x3 by combining Lower Middle and Low on SS and combining Weak and None on PI, for both of which there is empirical justification in that report.

<sup>14</sup>This diversity is taken into account in two analyses of the impact of family planning programs among Indian states: Bernard Berelson, "An Evaluation of the Effects of Population Control Programmes," in H. B. Parry, ed., Population and Its Problems: A Plain Man's Guide, Clarendon Press, 1974, pp. 156-158; and K. S. Srikantan, The Family Planning Program in the Socio-economic Context, Population Council, 1977, Chapter 4.

<sup>15</sup>The new allocation of funding was done by assigning the designated proportion of each country's population to the indicated cell, computing its funding allocation by the rating for that cell, and then re-aggregating the total funding for the country back into the category of its original assignment. In this way the dollar amount per country is allocated among its various SS and PI groupings on the basis of the assumed population distributions. Note that in this process some population fractions are assigned to the empty cell in the actual tabulation (Middle/Strong), allocated funding on that rating, and then aggregated back into the base cell of their countries. The percentage distributions vary for the three kinds of cells because of differing numbers of adjacent cells to which population could be allocated. (Each redistribution of population does not affect the allocations to strategies of intervention, only to the country categories.)

<sup>16</sup>Note that in the last three columns of Table 19, no allocation would be made to Middle SS-Strong PI category, as no countries actually fall in that category.

<sup>17</sup>Note that, because these figures are based on the specified intra-country population redistributions, they are not simply the average per capita allocation in the cell to which the country is assigned times the population of that country. Similar allocations have been done for each country.

<sup>18</sup>Actually, the disparity by strategy is not great, if only the available ones are considered (e.g., as shown in Table 10). According to a recent review, about three-fourths of external assistance goes to family planning efforts in one form or another (K. Kanagaratnam, "Approaches to the Population Problem . . .," World Bank, October 1978).

<sup>19</sup>At one point in our study, we considered "weighting" effectiveness estimates by need. We did not do so for two reasons: 1) Such a step would complicate an already complicated analysis and would best be left to further research; and 2) we had no particular confidence in the possible measures of urgency or need that we considered.

<sup>20</sup>In the course of this analysis we tried a variety of procedures. If we were to redo the analysis, we would probably use simpler, and we think preferable, procedures with regard to diminishing returns (say 3 curves in place of the present 5) and to the redistribution of population (with 50%, 40%, and 30% stationary in the 3 kinds of cells). Moreover, we tried various ways of identifying the clusters of respondents by strategic profiles before settling on the one presented.

## APPENDICES

Appendix A: The Requests to Respondents

Appendix B: The Supplementary Form

Appendix C: Strategic Profiles for Individual Respondents

Appendix D: Procedures for Specifying Diminishing Returns Patterns

APPENDIX A

The Requests to Respondents

To:

Date: January 5, 1977

From: Bernard Berelson

I am writing to ask for your help on a project I am undertaking with Professor Robert Haveman of the University of Wisconsin, an economist experienced in cost-benefit analysis of public policy issues. He and I are investigating resource allocation to achieve fertility reduction in developing countries; and in the absence of firm data on the effectiveness of different interventions to reduce fertility under various conditions, we are seeking judgments from highly informed and qualified students of the matter like yourself.

We would like your help in filling in the attached matrix of 108 cells: 12 strategies by 3 levels of social setting by 3 degrees of program implementation, capability, and commitment. The strategies refer to general policies for governmental intervention to reduce fertility, and the 12 strategies listed in the matrix are compressed from Exhibit A, attached, as keyed. By social setting we mean essentially the index used in Freedman & Berelson's "The Record of Family Planning Programs," that is, an index of infant mortality, female enrollment in school, and per capita income by which developing countries are classified as High (e.g., Taiwan or Chile), Middle (e.g., Thailand or Colombia) and Low (e.g., India or Bangladesh). By program implementation we mean administrative commitment and feasibility to implement fertility reduction measures of various kinds in a particular setting, again trichotomized into Strong, Moderate, and Weak, roughly along the lines of the Freedman & Berelson notion of "Program Effort." (Note that program implementation refers to each of the 12 strategies, and not only to implementation of family planning programs.)

Thus, attempts to reduce fertility can be pursued by 12 different strategies of intervention in developing countries of High, Middle, or Low social setting and under conditions of Strong, Moderate, or Weak implementation, feasibility and commitment—all as shown in the attached table.

What we would like is your professional judgment on the relative effectiveness of the 108 strategy-social setting-implementation combinations in the matrix, given the same investment of funds.

As you can see, we have entered one effectiveness rating in that table—the middle value in the top row. This was done in order to anchor the ratings. Hence, each of your judgments of relative effectiveness should be made in comparison with that number, given the same amount of resources. That is, if a given amount would yield 7 units of fertility reduction in the anchor cell, how much would it yield in every other cell? Hence, a combination which you think might be a little more effective than the combination with the filled-in rating might be assigned a 9; and one that is significantly more effective might be given a rating of, say, 15.

In short, we are asking you to fill out the table according to the following instructions:

Assume that the only objective is to reduce fertility. Each of the 108 options in the table represents a way in which donor agencies could allocate a given amount of money (realistically estimated) in order to achieve such reduction. Assume a scale from 0 to 20 taken to express the possible range of effectiveness in fertility reduction per amount expended. The filled-in cell is given a value of 7 on that scale. Using that as the anchor point, indicate the value which you believe each of the cells should be assigned—that is, try to make the deviation of the scores from the anchor value of 7, up or down, reflect your judgment of the relative effectiveness of the other options relative to that particular option. In other words, if a given amount of funds allocated to strategy 1 in middle-level social settings and with a moderate degree of program implementation is given a rating of 7, what rating would you assign to the other combinations, from 0 to 20? Please use whole integers with no decimals or fractions.

We are asking a number of knowledgeable people to respond to this same set of instructions. However, if you are not able to complete the task because of some ambiguity or incompleteness in the instructions, or because of a need

to clarify something, please do not hesitate to be in touch with me. If you feel that some explanatory notes should accompany your completed matrix, please feel free to add them. (I enclose 2 copies of the matrix so that one can be used for your preliminary estimation and/or your files.)

We do hope that you will be able to cooperate with us in this way. We have a computer-based analytic program that requires this sort of information, and we shall of course be glad to show you the completed report when it is ready. You are being asked to cooperate in your individual capacity, and your ratings will not be individually identified.

Finally, we do hope you can return this to me within two weeks at the above address. As an expression of gratitude, I enclose an honorarium provided by the Population Council. Many thanks for your help.

MATRIX TO BE COMPLETED

Social Setting	High			Middle			Low		
	Strong	Mod.	Weak	Strong	Mod.	Weak	Strong	Mod.	Weak
<u>Program Implementation</u>									
<u>Strategies of Intervention</u>									
<u>Supply</u>									
1. Public sector, current methods (A1, A5-9)					7				
2. ...plus Sterilization (A2)									
3. ...plus Abortion (A3)									
4. ...plus New method (B)									
5. Private sector distribution (A4)									
<u>Demand</u>									
6. Determinants (C)									
7. Information (D)									
8. Incentives (E1-4, E6)									
9. ...Money (E5)									
10. Community "pressure" (F)									
11. Sanctions (G1-2)									
12. ...limits on family size (G3)									

## EXHIBIT A

### Means of Fertility Intervention

#### To Affect Supply

A. Improve the access to modern means of fertility control, both quantitatively (to more people) and qualitatively (with better services), through

1. Traditional family planning programs, in various forms and with currently available contraceptives (pill, IUD, condom)

Provision of information, supplies, and services for voluntary fertility control via modern contraception and various delivery systems; many examples operating today

2. ...plus sterilization

...and adding sterilization, male and/or female, on an equivalent basis, e.g., as in India

3. ...plus abortion

...and adding induced abortion on an equivalent basis, e.g., as in China

4. Community-based/commercial distribution of current contraceptives

...emphasizing contraceptive distribution through local agents for profit, e.g., as in Colombia

5. Sterilization camps

...concentrating communal facilities and promotion for vasectomy, as in the Indian experience in Ernakulum and Gujarat

6. Postpartum arrangements

...systematically providing information and services in connection with institutionalized delivery, e.g., as in the FC program in 138 hospitals in 21 countries

7. Integration into maternal and child health programs

...organized as integral part of MCH, e.g., as in Taylor-Berelson efforts in Philippines, Turkey, and Nigeria

8. Integration into general health programs

...organized as integral part of total health infra-structure, e.g., as in Naranjwal or Etimesgut

9. Integration into community development programs

...organized as part of rural improvement and community development, e.g., as in Gandhigram

B. Improve the product, i.e., the acceptability, continuity, and/or effectiveness of new means of fertility control—e.g., a vaccine

Research programs directed toward that end now underway in both private and public sectors, e.g., drug companies, WHO Expanded Programme and ICCR.

Exhibit A (Continued)

or implant, a side-effect-free IUD, a safer or more convenient pill (once a month), a nonsurgical termination of pregnancy...a currently unknown "ideal" contraceptive

To Affect Demand

C. Promote basic socioeconomic determinants of fertility, or the most likely presumed determinants ("thresholds"), singly or together

1. General development: modernization, Westernization, social change, sociocultural transformation...away from the traditional (high fertility) society

Reliance on social change, modernization, development, social-structural transformation, "new international economic order" to reduce fertility rates "automatically" in the process

2. Popular education: e.g., toward 6 to 8 years of schooling for all

...with special reference to extending popular education, particularly for girls, as a necessary pre-condition to fertility reduction, e.g., Rich

3. Infant-child mortality: e.g., toward a rate of 50 or below

...with special reference to reducing infant and child mortality as a necessary pre-condition, e.g., Heer

4. Income: e.g., toward \$500 per capita or, better, \$800 (and perhaps more equitable income distribution)

...with special reference to poverty reduction, particularly at the bottom of the income pyramid, as a necessary pre-condition, e.g., Kocher

5. Industrialization: e.g., toward one-third or less of the labor force in agriculture

...with special reference to industrial development, and its consequences for family, kinship, modern attitudes, etc.

6. Women's status: toward liberation from traditional child-bearing and -rearing, through education and employment

...with special reference to emancipation of women from traditional status, particularly via education and moneyed employment, e.g., sewing factories in Egypt

7. Urbanization: toward 25% living in large cities (100,000+)

...with special reference to urban development, with its implications for housing, diminished economic value of children, etc.

D. Inform, educate, propagandize: persuade people to lower fertility through messages, arguments, appeals, reasons

Exhibit A (Continued)

- |   |  |
|---|--|
| 1. ...via mass media (radio, TV, newspapers, posters)   | Provision of energetic propaganda for smaller families, e.g., as in South Korea, Singapore, China                                    |
| 2. ...via person-to-person communication, individually (e.g., door-to-door field work) or collectively (e.g., group meetings including special interest groups) | ...the same through personal contact, including via residential or occupational communities, e.g., as in Isfahan, Sialkot            |
| 3. ...via formal school system ("population education")   | Incorporation of population materials into primary and secondary school curricula, for long-term effect, e.g., as in the Philippines |

E. Manipulate incentives/disincentives

- |   |   |                         |
|---|---|-------------------------|
| 1. Housing and job opportunities  | Adjustment of incentives/disincentives, in money or in kind, in antinatalist direction, e.g., as in Singapore, Taiwan, India Tea estates and vasectomy camps; development of obligation by the state for provision of welfare to the aged, in order to reduce need for children (sons) for that purpose |                         |
| 2. Maternity costs, leaves, etc.  |   |                         |
| 3. Child allowances, educational fees, etc.   |   | to individuals/families |
| 4. Social security system   |   |                         |
| 5. Money, gifts   |   |                         |
| 6. Communal incentives (e.g., schools, roads, water supply) for collective fertility performance at appropriate level | Provision of communal benefits in return for specified fertility behavior, e.g., as proposed by Kangas  |                         |

F. Manage community change and "pressure," to develop an antinatalist community consensus, typically guided by the political apparatus, via

- |   |  |
|---|--|
| 1. Youth corps, or equivalent work program, to break traditional bonds away from the home community | Proposals for collective employment and instruction of young people, both male and female, away from home ties, in order to delay marriage and modernize attitudes and information |
| 2. Community "pressures" organized to discourage the Nth child                                      | Organized and systematic efforts to develop community consensus in antinatalist direction, e.g., as reportedly in China, Ranpur district in Bangladesh, McNicoll                   |

Exhibit A (Continued)

G. Impose legal sanctions, via

1. Increase in age at marriage      Increase in minimum age of marriage for women, to at least 18 and preferably beyond, e.g., as in China, Tunisia, now in India
  
2. Restriction on out-migration from villages      Limitations in mobility, such that villages cannot export local unemployment to cities but must face up to support of their own excess reproduction, e.g., as in China
  
3. Direct limitation on family size      Governmental imposition of a limit to child-bearing, e.g., as in proposals by Davis, Boulding, Hardin, Ehrlich and in recent tendencies reported in India and China

### Follow-up Request

TO: The Panel

FROM: Bernard Berelson

DATE: 15 June 1977

This is a follow-up to the inquiry addressed to you by Bob Haveman and me on January 5, unfortunately delayed by my intervening illness. We received responses from almost all of our initial panel and are most grateful for your collaboration. In the process of responding, many of you raised good questions about the procedures, and Bob and I are eager not only to keep you informed as promised but also to pursue the matter further, with the hope of your cooperation one more time.

In responding to the original matrix, a number of you raised queries that we would like to clarify, so that all ratings will be made on as similar a basis as possible. Your major concerns were three-fold:

What time period is to be considered when judging effectiveness in fertility reduction?

What magnitude of investment is envisaged?

What magnitude of fertility reduction is represented by the anchor value of 7 in the middle of the top row?

Our responses are as follows:

We envisage a time period of about 15-20 years for the impact in fertility reduction.

The donor community's total investment in population these years averages about \$250 million a year, or about 10-15 cents per capita for the population of the developing world (ex China). We ask that you keep in mind some realistic proportion of that amount--say, 10% or \$25 million a year--in estimating your effectiveness rating for each cell. The

question is: what is the effectiveness in fertility reduction of allocating the same amount to each cell, taken one at a time?

The anchor value is double the estimated fertility reduction for that cell in the indicated time period, in points off the crude birth rate. That is, the 7 reflects the judgment that investment in strategy 1 in a middle social setting and with moderate program implementation could take 3.5 points off the CBR in that period. (We doubled the figure from 3.5 to 7 in order to eliminate decimals for easier calculation.) Hence the meaning of your rating in any particular cell is that the investment would reduce the CBR by half your rating (up to a limit of 10 points, though you can add a rating beyond 20 if you wish, or a negative number for that matter).

In addition, there were a couple of specific queries raised in your responses. (1) Does strategy 3 include strategy 2 or not? Yes, it does. But strategy 4 does not include either 2 or 3, only strategy 1. (2) Can investments properly refer to strategies 10-12? Yes, because some funding is necessary in order to administer and "enforce" such efforts, at least as part of larger administrative budgets. And (3) Can the determinants of strategy 6 be considered individually as well as collectively, i.e., popular education or income or women's status...? Yes, they can.

Finally, one of you suggested another approach that we wish to pursue on the Supplementary Form, having to do with the preferred allocation of the present resources and of a major increment thereto—not only to the direct Strategies of Intervention as on the matrix but to various other means of population support as well, as now being utilized by the donor community.

So this memorandum is not simply a report but also a request for further assistance. In our review of the initial responses it is clear to us that not everyone responded to the same set of considerations—as the above questions indicate. On the basis of our clarifications, would you be willing to review

your scores and submit a revised version to us on one of the enclosed blank forms? This would give us a more standardized response for our further analysis. Your ratings may or may not change much from the initial set, but at least we would then have a series responding more nearly to the same set of instructions. The general instructions at the top of page 3 of the January 5 memo still hold.

In addition, we solicit your cooperation in filling out the Supplementary Form for the first time.

For this purpose, enclosed are:

- (1) The original instructions of January 5, 1977 with two more blank forms (one for your files).
- (2) A copy of your own filled-in matrix in response thereto.
- (3) The averaged matrix from all respondents for your comparative information, and the range of scores per cell.
- (4) Two copies of the Supplementary Form (one for your files).

We are sure that the task will be much easier for you this second time around and we hope that you are sufficiently interested in the potential outcome to be willing to help us again in this way. Our preliminary analysis of the first round is most interesting and in our judgment fully warrants this additional effort.

We'd like to have your responses--the revised matrix and the Supplementary Form--by July 10 if at all possible, or soon thereafter. My personal thanks for your help.

## APPENDIX B

### The Supplementary Form

At the suggestion of one of the respondents, we prepared a form which went directly to the question of expenditure allocation. In the second round of inquiry we employed this form and asked each respondent the following:

Given the objective of fertility reduction in developing countries . . . , how should the current donor resources of about \$250 million a year be allocated over the next five years, with realistic consideration of absorptive capacity?

Given the same objective, how should an increment of \$50 million a year be allocated over that time period?

The form included all categories of "population assistance," not only the direct interventions aimed at fertility reduction analyzed in the study, but other efforts to support population work, including training, institutional development, data collection, and research. The average responses to the questions are shown in Table B-1 (based on 13 responses).

As for the current total investment, family planning programs in various forms are allocated nearly one-half the funding. Information, incentives, community "pressure," and sanctions—strategies 7-12 in the original list—are allocated a total of 11 percent.

The allocation pattern for an increment of 20 percent in population funding is substantially different. The percentage allocated to family planning programs is reduced by about half, and the "saved" amount is allocated primarily to population research in social science fields, to biomedical work, and to socioeconomic determinants. Overall, the "other efforts" receive 37 percent of the increment, relative to 31 percent of the base budget.

It is not possible to precisely compare these recommendations with current allocations in the field because of differences in classification. However,

TABLE B-1

Average Percentage Allocations of Total and Incremental Population Budget, 13 Respondents

	<u>Most desirable allocation of current investment by donor community (\$250 million/year), by percentage</u>	<u>Most desirable allocation of an incremental \$50 million/year, by percentage</u>
<u>Direct Interventions</u>		
(1) Family planning programs, in various forms	43%	20%
(2) Bio-medical search for better technology of fertility control	9	16
(3) Promotion of socio-economic determinants of fertility (e.g., popular education, women's status, income growth, etc.)	6	10
(4) Special information/education campaigns in population	5	6
(5) Special incentive/disincentive efforts	3	4
(6) Community change in social norms toward childbearing	3	6
(7) Legal sanctions affecting fertility	0	1
<u>Other Efforts</u>		
(8) Development of trained personnel in population field	7	6
(9) Institution-building in population field (local centers, institutes, academic departments, etc.) for training and research, including population policy units in government planning boards, etc.	11	13

**TABLE B-1 (Cont.)**

	<u>Most desirable allocation of current investment by donor community (\$250 million/year), by percentage</u>	<u>Most desirable allocation of an incremental \$50 million/year, by percentage</u>
<b><u>Other Efforts (cont.)</u></b>		
(10) Demographic data collection (census, vital registration systems, surveys, etc.)	7%	4%
(11) Population research in social science fields, oriented to better policy analysis	6	14
(12) Other (specify)	0	0
TOTAL	100%	100%

some rough comparability can be achieved. The current allocation by the standard categories used by international agencies for 1973-1975 is:

Basic population data	7%
Population dynamics	6
Population policy	2
Family planning	54
Information & education	7
Biomedical	6
Multisector & unallocated	15
	<hr/>
	100%

Source: OECD, Assistance to Population Programmes, 1973-75.

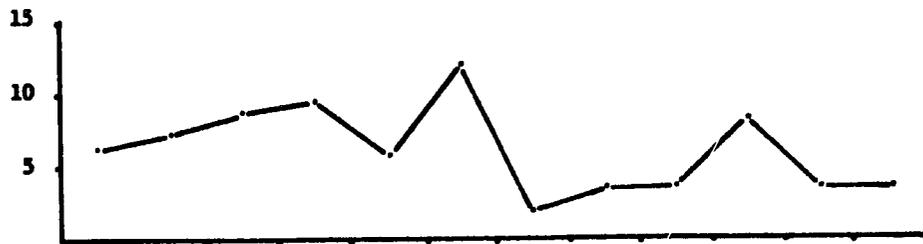
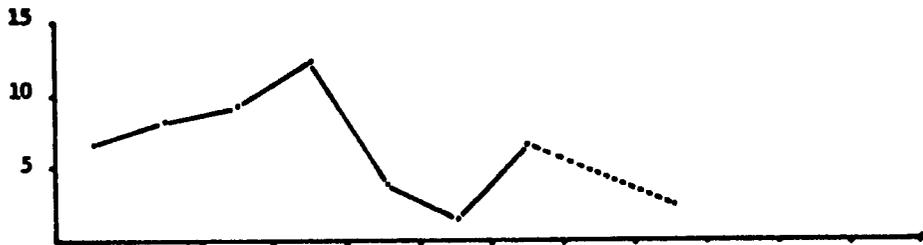
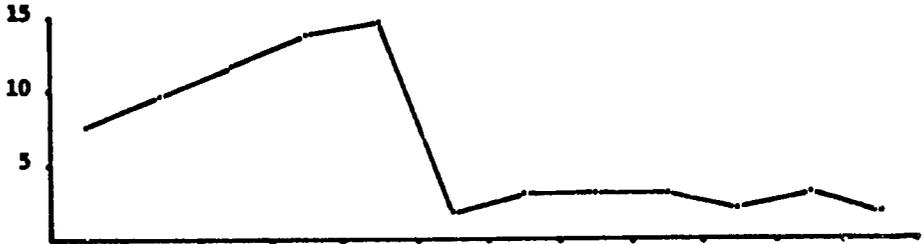
The recommended allocations for the total funding are relatively close to these actual figures, where comparable. The main discrepancy is in the family planning category, where the discrepancy is over 10 percentage points. Comparison of these actual allocations with the incremental responses again reveals some sharp differences: much less family planning and much more biomedical and social science research are preferred by the panel.

Finally, how do these estimates relate to the average ratings in the matrix? Both sets of responses emphasize the importance of the family planning approach, especially the importance of new technology. In the response on the Supplementary Form, however, respondents appear to attribute rather severe diminishing returns to the direct family planning approach. While this strategy should continue to receive the bulk of current expenditures, incremental expenditures should be concentrated on approaches and strategies with a longer perspective.

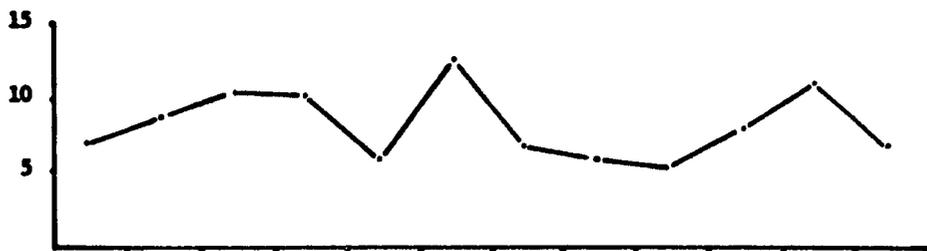
APPENDIX C

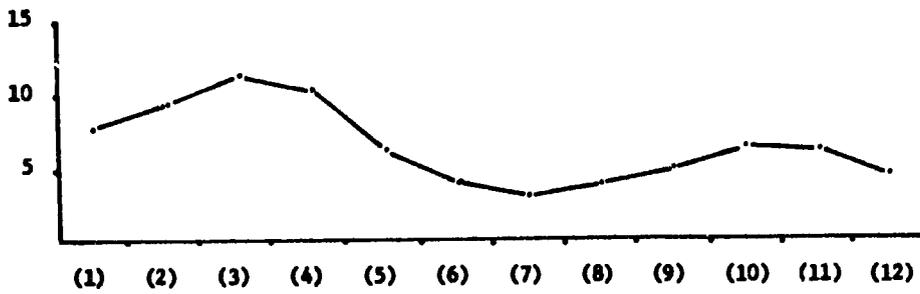
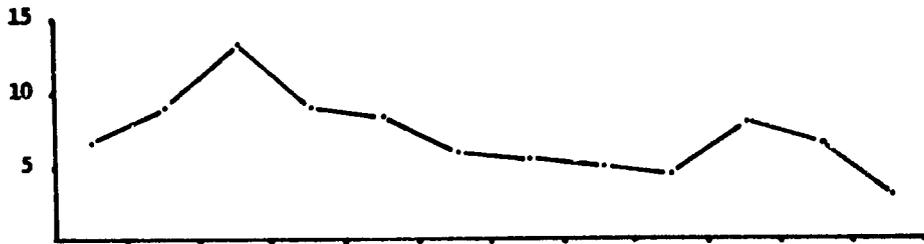
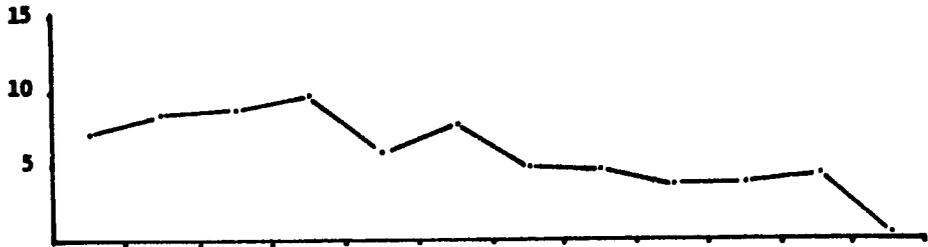
Strategic Profiles for 16 Individual Respondents

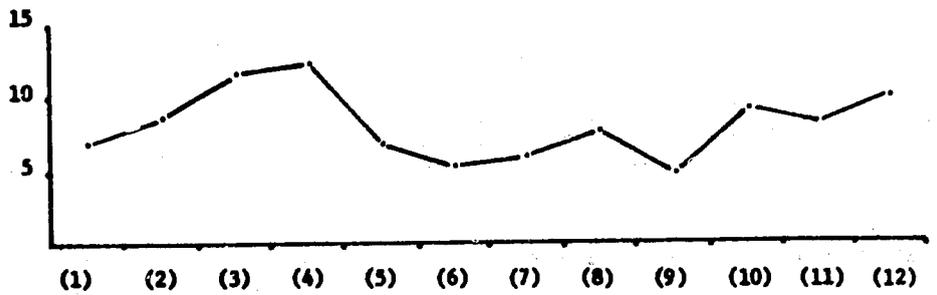
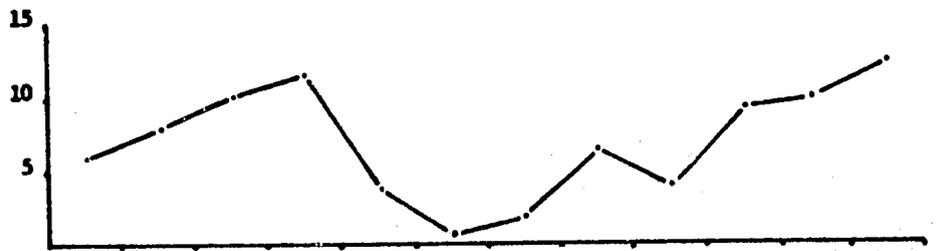
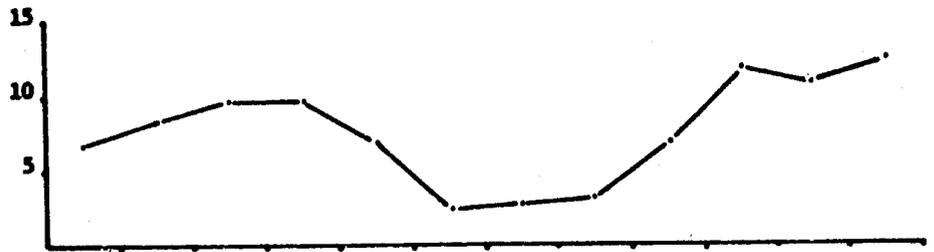
(Effectiveness ratings on a scale from 0 to 20)

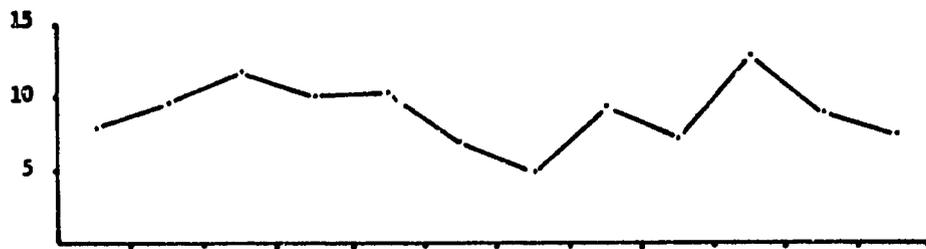
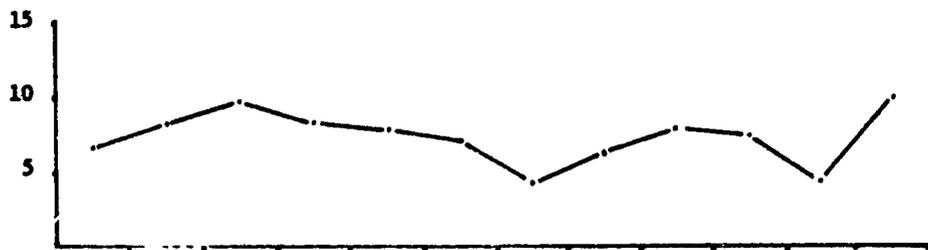


(1) Public Sector  
 (2) ...Plus Sterilization  
 (3) ...plus Abortion  
 (4) New method  
 (5) Private Sector  
 (6) Determinants  
 (7) Information  
 (8) Incentives  
 (9) ...heavy  
 (10) Community "pressure"  
 (11) Sanctions  
 (12) ...limits











## APPENDIX D

### Procedures for Specifying Diminishing Returns Patterns

A basic principle of economics is that additional expenditures in any specific program will, after some point, yield diminishing returns. This principle also applies to expenditures for fertility reduction. Indeed, the problem of allocating resources among competing activities exists primarily because of diminishing returns—as incremental expenditures are allocated to a superior activity, diminishing returns occur and marginal expenditures seeking the highest return must be allocated among alternative activities. To maximize productivity, expenditures must be allocated among alternatives so that, at the margin, the returns in each activity are equal.

Consistent with this principle, our procedure assumes that the marginal effectiveness of expenditures on any strategy in any SS-PI environment diminishes as the total amount spent on that option increases. We also assume that if no money is spent, effectiveness is zero. Take any combination—say, strategy 3, in a High Social Setting and with Moderate Program Implementation. If the effectiveness rating (E) for an expenditure of \$10 million on that combination is 10, \$20 million will have an effectiveness rating of more than 10 but less than 20, and so on. The question is: What patterns of diminishing returns should be employed?

In our analysis various patterns of diminishing returns were assigned to the strategies to reflect the judgment that the marginal effectiveness of money spent declines more rapidly for some of the strategies than for others. These patterns are assumed to be invariant over Social Setting and Program Implementation categories. The patterns employed in this approach are shown in Table D-1.

TABLE D-1

Diminishing Returns Patterns in the First Approach,  
Seven Selected Strategies

	<u>Expenditure Level (X)</u>			
	<u>\$0</u>	<u>\$10 million</u>	<u>\$20 million</u>	<u>\$30 million</u>
Strategy 1	0	E	1.6 E	2.0 E
Strategy 2-5	0	E	1.5 E	1.9 E
Strategy 6	0	E	1.9 E	2.7 E
Strategy 7-8	0	E	1.4 E	1.6 E
Strategy 9-12	0	E	1.75 E	2.4 E

For example, the diminishing returns pattern assigned to strategy 6 indicates that \$10 million, \$20 million, and \$30 million of expenditure in any SS-PI environment will yield effectiveness ratings of 10, 19, and 27 respectively.

In order to convert the above discrete specification of diminishing returns into a continuous one, a quadratic function of  $TE = aX^2 + bX + c$  is assumed as a representation of diminishing returns, where TE is the effectiveness rating for any level of expenditure (X).<sup>\*</sup> Ordinary least squares regressions were used to obtain the estimates of a, b, and c for each strategy. For example, for strategy 3, the regression equation was fit to the following four observations of X and TE: (\$0 million, 0), (\$10 million, 1.0 E), (\$20 million, 1.9 E), and (\$30 million, 2.7 E). The resulting equations are:

Strategy 1	$TE = -.0015 E X^2 + .112 E X$
Strategy 2-5	$TE = -.0016 E X^2 + .109 E X$
Strategy 6	$TE = -.0005 E X^2 + .105 E X$
Strategy 7-8	$TE = -.0021 E X^2 + .114 E X$
Strategy 9-12	$TE = -.0009 E X^2 + .107 E X$

<sup>\*</sup>The difference between E and TE should be noted. The former refers to the effectiveness rating at an expenditure level of \$10 million; the latter refers to estimated effectiveness ratings at various expenditure levels.

With this approach then, there is a total effectiveness equation which applies to each of the Strategy-SS PI combinations for each respondent, or each group of respondents. Because of the form of the equation describing total effectiveness, each function has an associated marginal effectiveness (ME) equation which is linear. That is, the marginal effectiveness relationship corresponding to  $TE = aX^2 + bX$  is  $\frac{TE}{X} = ME = -2aX + b$ . With the full family of marginal effectiveness equations--one for each Strategy-SS-PI combination -- the total budget (\$200 million in the case analyzed here) can be allocated optimally among the Strategy-SS-PI options. This is done by allocating the budget among the options such that the marginal effectiveness of money allocated to each options is identical and the amount of money so allocated sums to \$200 million.

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