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CENTER DISCUSSION PAPER NO. 541

POPULATION PROGRAMS: MEASURING THEIR IMPACT ON FERTILITY
AND THE PERSONAL DISTRIBUTION OF THEIR EFFECTS

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Abstract

Population Programs: Measuring Their Impact on Fertility and the Personal Distribution of Their Effects

Evaluating population programs involves statistically inferring how the interregional variation in subsidized family planning activity (or other program intervention) is related to fertility, holding constant for an array of initial endowments, prices, wages, and environmental factors that are determined independently of parents and are likely to exert an exogenous influence on desired and actual fertility. This paper illustrates how most family planning evaluation schemes are flawed because they focus analysis on measured contraceptive use rather than on the final fertility outcome. Furthermore, the choice of environmental determinants of fertility, other than the local activity of the family planning program, are rarely conceptualized as including only exogenous conditions influencing the reproductive goals and behavior of couples. Review of evidence from the early years of the Taiwan family planning program illustrates many of the issues discussed at the outset of the paper.

**Population Programs: Measuring Their Impact on Fertility
and The Personal Distribution of Their Effects***

1. Introduction

In much of the world, money and scarce organizational talent are being used to help reduce fertility. This paper explores some of the issues involved in evaluating voluntary family planning programs that seek to achieve a reduction in fertility by extending (i) information about birth control, (ii) services to adopt methods of birth control, and (iii) contraceptive supplies to continue using these methods. Evaluation of population policies involves dealing with three questions: (1) for a given level of effort, which of the possible program designs is preferable? (2) who benefits from the program? and (3) what level of effort is warranted, given the program's effectiveness and the distribution of its benefits?

This paper outlines approaches for answering only the first two questions and illustrates their application. Answering these first questions provides the framework needed to consider the third. But it is difficult to assign a comprehensive monetary benefit to the achievement of the objective of a family planning program--averting an unwanted birth--just as it is difficult to evaluate in strictly monetary terms most other social welfare programs. Consequently, this paper focuses on measuring the cost-effectiveness of programs and the distribution of that effect, and leaves to others the controversial task of assessing the cost-benefit ratio of a family planning program (National Research Council, 1986).

2. Evaluation Based on Intermediate Objectives

Initially, family planning advocates assumed that if information about

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modern means of birth control were made available throughout a society, a program should be regarded as a success. Increased knowledge of birth control within a population is undoubtedly one intermediate measure of program success. But controversy arose as to how knowledge should be measured, and whether it was not necessary for people to use their additional knowledge to control demonstrably their fertility in order to claim program success.^{1/}

The second generation of family planning program evaluation measured the services delivered by these programs--the number of pills dispensed, IUD's (intrauterine device) inserted, injections given, sterilization operations performed, and traditional contraceptives, such as condoms and foam, given away or sold at concessionary prices. To sum these diverse services, commensurate measures were computed in terms of births prevented by each type of service.^{2/} Although this was a step forward, and continues to be a basis for managing the operation of most family planning programs, as illustrated in the next section, these methods based on service statistics are sensitive on many unverified assumptions, and hence are subject to an unacceptably wide margin of error. For example, those who adopt a method of birth control within a family planning program are likely to be influenced by several sources of self-selection which could bias conventional estimates of the program's impact on fertility. On the biological side, one expects more fecund couples to have births more readily and to therefore exceed average levels of desired fertility at an earlier age and be motivated to adopt more effective means of birth control. Thus, one would tend to understate the effectiveness of a birth control method, if one were to compare the fertility of the program adopter with that of an average couple. This form of selection bias in estimating the use effectiveness of birth control due to heterogeneity in fecundity has been clearly documented in the US and Malaysia (Rosenzweig and Schultz, 1985, 1987).

The motivation of the program adopter to regulate their fertility may stem not only from variation in fecundity, but also from unexplained variation in desired fertility. Consequently, heterogeneity in preferences will also lead to a self-selection bias in the composition of program acceptors. In either case, the program adopter is more likely than the average couple to search out a method privately and use it relatively effectively had there been no public family planning program. The intensity of motivation, because it is not "held constant" in such comparisons, will tend to overstate the net effectiveness of the program. In other words, the program services substitute in part for birth control methods that would otherwise have been obtained from the private marketplace. The number of additional births averted by the program is, in this case, less than the full contraceptive effectiveness of the methods adopted and supplied within the program.

To assess the magnitude of this substitution of public for private sector services, more elaborate case-control matching studies are sometimes designed. Their objective is to compare the subsequent fertility of a group of women (or couples) accepting some form of birth control in the program with a control group who has not entered the program, matched by such characteristics as age, education, number of births, and time since last birth (Chang and Chow, 1969). Though undoubtedly an improvement over evaluation based on program services alone, the matching case-control approach is costly, time consuming, and is not free of motivational bias, whether it arises from variation in fecundity (supply) or desired fertility (demand).

Finally, programs probably contribute to the general availability of information about family planning, and thereby influence the reproductive behavior of some couples to obtain improved methods of birth control from sources outside of the program. On this score, the matching methodology, even

if it were purged of the self selection bias (Heckman, 1979, 1987), would understate the family planning program's effect on fertility, because of the spillover due to information diffusion. There is no simple way to assess how these various sources of bias balance out in each specific instance.^{3/}

3. Evaluation Based on Fertility Effects

The only way to avoid these unresolved problems of translating the adoption of family planning services into births prevented is to analyze directly the program's final objective--fertility. Reduction of birth rates is thus the least uncertain criteria by which to evaluate a family planning program. Nonetheless, there are also problems of measurement and comparative analysis with this approach.

First, a family planning program may assist parents in switching from one to another means of birth control, leaving birth rates potentially unchanged. For example, before a program is initiated, many couples may resort to coitus interruptus, continence, marital dissolution, frigidity, and induced abortion to avert unwanted births, while after a program has been initiated couples may instead acquire and use modern techniques of birth control. The program objective, narrowly defined, may not have been advanced, yet clearly there has been a private and social gain. This benefit is neglected here.

Second, parents may benefit from a program by learning of new methods of birth control without necessarily putting them to use immediately. Since family planning is largely avoiding unwanted births after having achieved the number of children desired (not spacing births), young parents upon learning about the availability of more reliable means of birth control may not seek to reduce their current birth rate. On the contrary, young parents may even

concentrate their child rearing in their younger years, as was common in many industrially advanced countries after the Second World War, because they knew how reliably to avoid additional pregnancies later in their lives. Although a family planning program could reduce the completed cohort fertility of today's younger woman, it might also shorten early birth intervals and increase birth rates for young women. Without the time to construct and analyze the preferable longitudinal cohort data that permits program evaluation to focus on long-run impact on completed fertility, reproductive behavior of women of different ages should be analyzed carefully. Evidence of different short-run program effects on different age cohorts should, therefore, be interpreted cautiously, for birth rate changes among younger women may be a result of offsetting changes in the length of birth intervals and the total number of children these women will eventually bear.^{4/}

Regardless of these weaknesses, the capacity of a family planning program to reduce birth rates appears to be the most satisfactory single criteria of program success. But a simple objective does not make evaluation simple. Only by statistical inference can the relationship between program inputs and birth rates be established, and statistical inference depends on the availability of data and the realism of working assumptions. The modeling problem of population program evaluation reduces to one of discovering the exogenous factors that explain variation in individual or aggregate fertility in the absence of the family planning program, and measuring variation in these factors and program activity across the population. The independence of these two factors is not always satisfied in reality, and thus the need to control for environmental influences on fertility in order to evaluate the effect of family planning program activity.

There are many exogenous constraints that influence fertility in any particular setting:

$$F_i = F(X_i, W_i, P_i, B_i, I_i, e_{1i}) \quad (1)$$

where F_i represents the fertility of the i^{th} couple, X_i are their economic and social resource constraints such as land and labor, W_i a vector of wage rates that men, women and children receive for labor in their community, P_i a vector of prices that they can exchange their income for goods, including privately supplied methods of birth control, B_i is their exogenous biological reproductive capacity or fecundity, I_i is the family planning program intervention activity in their community, expressed in terms of expenditures per potential recipient of services, such as reproductive aged women 15 to 49, and e_{1i} represents an error that includes omitted variables that are assumed independent of those included, such as preferences, errors in measurement, and approximations of functional form.

The crucial working hypothesis is that sample variation in family planning activity, I_i , is not systematically allocated across types of communities in such a way as to be correlated with the residual error e_{1i} . Nonrandom allocation of program activity might arise in two circumstances. Family planning activity may be promoted in, say, poor communities that lack private medical services. Alternatively, individuals with unusually strong preferences for a small family size and who are hence particularly motivated to control their fertility may tend to migrate to regions better served by family planning programs, because they demand these services. The latter possibility can, I suspect, be neglected, because family planning services are a sufficiently small share of expenditures to have only a minor effect on the direction of migration. The former possibility could be important, but would depend on the particular country, legislative mandate, and program implementation.^{6/}

Several determinants of fertility are stressed most frequently in the literature on the economic determinants of fertility (Schultz, 1976): (1) household wealth and (2) community income earning opportunities of the males (both are positive factors on fertility in most traditional, predominantly rural societies), (3) community wage opportunities available to women for work and their education (both negative factors), (4) wage opportunities in the community or the marginal product in the household of unskilled child labor (positive), (5) environmental conditions in the community that contribute to a higher level of child mortality (positive), (6) higher return in the community to child schooling and availability of schools that contribute to a higher enrollment rate among children^{7/} (negative), and (7) the local cost of birth control outside the family planning program (positive). Good measures for all seven of these constraints that would seem appropriate to a comprehensive economic model of fertility are not generally found in any studies. Data limitations permit researchers to control for only a few proxies for these constraints. At issue is whether the omitted factors are likely to be correlated with the local level of public family planning activity.

To facilitate evaluation, the resources expended in the family planning program should be recorded at the community level, valuing each input at its opportunity value elsewhere in the national economy. Aspects or activities of the program that operate through different instruments and can be reasonably combined in different proportions should be costed out separately in the program. This is particularly useful for human resources where doctors are aided by less skilled paramedical technicians and field workers, whose talents are less scarce than those of the doctor, and may be substituted within certain limits for those of the doctor. Alternative outreach efforts and promotional expenditure schemes may also be segregated and analyzed separately to help

determine what mix of publicity, outreach, and field staff yields a desired effect on the birth rate at least cost.

Though there is surprisingly little empirical evidence to suggest the scope for economies and diseconomies of scale in the provision of family planning services, some general propositions seem defensible.^{8/} Activities for which one input is fixed, in this case the population who might potentially use the family planning services, will experience eventually diminishing returns to this variable input, namely, the intensity of family planning expenditures. There may also be initially a segment of increasing returns, as information diffusion snowballs. In a country such as Taiwan, that I shall later analyze, diminishing returns undoubtedly occurred between 1960 and 1980, a period during which total fertility rates (or the sum of age specific birth rates) declined from almost 6 to little more than 2 children, and virtually everyone became acquainted with and practiced modern means of birth control. In modeling the inputs of family planning activity, therefore, it is realistic to fit a nonlinear function that may distinguish changing returns to scale of activity.

The program may also have a persisting effect on the contraceptive knowledge in a community. This knowledge, once acquired, only slowly "depreciates" as new generations of parents replace old. Thus all past program inputs should be considered as possible determinants (with diminishing weights) of the target population's current knowledge of birth control methods. Empirical studies have not yet explored these issues in great detail, however. In the first years of the Taiwan program examined here, the cumulative sum of past local activity explained fertility nearly as well as including all previous years as separate regressors, suggesting depreciation of "knowledge" is not yet very important (Schultz, 1971a, 1973).

The temporal specification of program evaluation studies is complicated by the uncertainty of conception and pregnancy wastage. Adopting today a more effective method of birth control should exhibit an effect on birth rates approximately nine months later. But the effect should increase until about 18 months or the most frequent interval between the resumption of menses and the next birth for a population practicing no birth control (e.g. Bongaarts and Potter, 1983). This distributed lag relationship should vary for birth rates of women of different ages (Schultz, 1971a, b), because fecundity and hence interbirth intervals vary in noncontracepting populations by age. It is anticipated, therefore, that the lag between a change in an economic constraint or program variable and fertility will differ according to the age of a woman. Most constraint and even program variables tend to be smoothly trended (for example, wage and schooling differentials across communities) and provide relatively little information for estimating these distributed lag structures. The exception is child mortality, where epidemics can cause unusual, partially exogenous, fluctuations from year to year, and from region to region. One to four year distributed lag relationships between child mortality and the birth rate of women of different ages can be clearly discerned in the published regional data for Taiwan. A three year discrete lag is adopted here (Schultz, 1971a).

As data become available on a cross section of communities over time, the time series variation within communities can also be analyzed. Eventually cross sections and time series are pooled under various statistical assumptions about the errors in the fertility determining equation (Schultz, 1973). The results reported here are based only on the cross sectional estimates, though time series and even cohort measures of fertility for Taiwan can be shown to confirm the cross sectional patterns observed in the first few years of the program.

4. Interaction Effects and the Distribution of Program Effects

A number of hypotheses relate to the mechanisms promoting the decline in fertility during economic development and the way family planning programs influence fertility. They often can be explored or tested by estimating interactions among the environmental constraint variables and the program input variables. For example, when one input to a family planning program is increased, the marginal productivity of other program inputs may be changed. They might increase if they are complements and decrease if they are substitutes. In the case of Taiwan, two classes of field workers were supported by the program: Village Health Education Nurses (VHEN) and Prepregnancy Health Workers (PPHW). The former were already involved in a community health and development program and worked part time for the family planning program, while the latter were recruited for and paid entirely by the family planning program. Since their tasks were not very different in reaching out to communities to inform women of contraceptive opportunities in the clinics, it could be hypothesized that the interaction effect between the specific worker input variables would be positive on the birthrate. Specifically, in a linear approximation of the fertility equation:

$$F_i = a_1 + a_2X_i + a_3I_{1i} + a_4I_{2i} + a_5I_{1i}I_{2i} + e_{2i} \quad (2)$$

where all nonprogram constraints are combined in the X_i vector, and I_1 and I_2 refer to the two field workers. The independent effect of the fieldworkers is expected to be negative, $a_3, a_4 < 0$, and the effect of the product of their work activity is hypothesized to be positive, $a_5 > 0$.

A lesson learned over the last two decades by family planning managers in different countries is that the success of family planning depends heavily on

the underlying changes in the economic and social environment which motivate couples to "demand" fewer births. There is no reason to expect "excess demand" for contraception, for which the program is a response, to be equally strong in all segments of the population. Moreover, statistics generated within programs on adoption of services may not reflect accurately these demands, if substitution from the private market to the public program is greater in some strata of the society than in others. For example, rural-agricultural regions might continue to value many children for their unskilled labor on family farms and not be motivated to use nontraditional forms of birth control. Not only would these agricultural regions exhibit higher fertility, the interaction of proportion in agriculture and family planning activity would be in this case positive.

The opposite situation might occur if agricultural mechanization were under way and the migration out of agriculture encourages parents to restrict abruptly their fertility and invest more in their children's schooling in order for these children to qualify for city jobs. Since it is common for rural communities to be poorly served by the private modern medical system, and thus rural residents may have a particularly hard time evaluating alternative modern means of birth control and adopting family planning in a timely fashion. The reproductive response to local family planning activity under this scenario might be stronger in rural-agricultural regions than in urban areas, leading to a negative effect of the interaction of the proportion in agriculture and program variables as they impact on fertility.

Another hypothesis that can be tested with individual data postulates that education of the adopter and extension activity that facilitates adoption are "substitutes." More educated women are able to understand, locate, and adopt modern contraception at less psychic and monetary cost when they want to

control their fertility than are less educated women. The family planning program provides an information service that is particularly valuable therefore to the least educated women who otherwise have the most unwanted births during a period of development leading to declining fertility. If this pattern of excess demand for contraceptive information exists in the population, then the independent effects of education and program activity will be negative, but the effect of their interaction will be positive. The program's role of diffusing information functions as a substitute for the innovative, information processing advantages that education provides to women.

Empirical evidence of interaction effects among the various variables entering into the fertility determining equation are useful for two purposes. The aggregate fertility reducing effect of a given budget of program expenditures can be increased by reallocating program expenditures toward those portions of the population that appear to have the strongest "excess demands" for program services, or in the last example the less educated women and couples. The second use of empirical evidence of interactions is to assign distinct welfare weights to different groups in the population who stand to benefit from the program. These distributional weights (e.g. progressive or regressive with respect to income) would be taken into account in addition to calculating more precisely the aggregate effectiveness of the program in reducing the birth rate.

In the prior example, suppose it was primarily the highly educated urban elite who had "excess demands" for family planning, and the program had to expend twice as much of its resources to avert a birth among the poor, less educated segments of the population. This evidence could lead to a more realistic appraisal of the costs of reaching the poor and disadvantaged within the currently designed program. It might lead to the adoption of new program

design, such as one that stressed outreach field workers for rural areas, rather than a clinic-based design that achieved its objectives efficiently for urban areas. Unless a public sector intervention program can be shown to serve more than a narrow urban elite, it would lose its claim to be a redistributive and progressive component of broadly based social welfare programs.

5. An Empirical Illustration: Taiwan 1965-69

This section summarizes evidence on the relationship between age standardized and age specific⁹/birth rates of women in Taiwan and household and community constraints that are expected to affect fertility. Among these constraints are the local levels of manpower committed to the national family planning program per woman 15 to 49. The data are for 361 administrative units of Taiwan in the years 1964 to 1968, the period during which the national family planning program was launched and was rapidly extended into every part of the island, except the aboriginal territories that are excluded from this analysis (Schultz, 1971a).

Four proxies for the economic and demographic characteristics of the population and its environment are held constant in an effort to evaluate more precisely the impact of the family planning program's local activity on birth rates. These four variables measure child mortality, child schooling, adult education, and the share of the labor force in agriculture. Although the latter two variables can be viewed as exogenous indicators of the resources and opportunities available to couples, the former two variables reflect not only local exogenous constraints on child survival and educational opportunities, but also the influence of parent allocations of resources to increase the likelihood of child survival and to augment their children's educational investments. Thus, the child mortality and child schooling variables are

endogenous variables that are jointly determined at the household level along with fertility.

These are two responses to such endogeneity of the environmental control variables. One is to seek instrumental variables that might reasonably be correlated with the endogenous control variables, and indeed influence the control variables, without being themselves choice variables for the couple or household. These instrumental variables might be regional public sector investments in health and education that influence the availability of child health and schooling services in a community, or climatic or environmental disease factors that exogenously influence the risk of contracting and succumbing to certain childhood diseases. The method of instrumental variables is then used to estimate the influence of family planning on fertility conditional on these identification exclusion restrictions, namely, that climate and public health and education expenditures do not directly determine fertility. Hausman (1979) type specification tests can then be performed to determine if one can confidently conclude from the data that the regional child mortality and schooling variables are indeed endogenous choice variables. Since specification tests of this form do not tend to be very discriminating, one is inclined to accept the null hypothesis that the choice variables are exogenous if suitable instruments are not available. Moreover, regional (aggregated or averaged) variables may appear exogenous, whereas when the unit of observation is disaggregated to the individual, the endogeneity of the same variable may be more evident, such as own child mortality in a couple's fertility equation.

A second possible response to the potential endogeneity of the control variables in the fertility equation is to suggest how their inclusion would probably bias the measured fertility effect of the family planning program. If the investments parents made in child health and education were undertaken as

though these activities substituted for the services of having additional children, then conditioning fertility on these endogenous choice variables will tend to bias down the estimated total effect of the family planning program.^{10/} Consequently, ordinary least squares (OLS) estimates of the family planning program's effect on fertility, controlling for child schooling and death rates, are lower bound estimates. Lacking satisfactory identifying instrumental variables in Taiwan, the OLS estimates reported here are therefore expected to be downward biased.

Table 1 summarizes linear OLS approximations for the total fertility rate equation, where the dependent fertility variable is normalized to unity for the regional age structure of women 15 to 49 (see notes to table for variable definitions). The national family planning program begun in 1964 may begin to influence fertility from 1965 onwards. Child mortality and child schooling rates are important predictors of fertility before the onset of the program in 1961 and 1963 (Schultz, 1971a, Table J-1) and thereafter. In all years, the four environmental control variables account for 37 to 58 percent of the cross sectional variance in this measure of fertility.

The linear effect on fertility of the two types of field workers in the program is statistically significant by 1965 and is again in 1966, with confidence levels in excess of 1 percent. But by 1967 and 1968 the point estimates of program's linear effects are smaller and are no longer statistically significant. To determine if the changes in returns to scale might account for the weakening of the linear association between program inputs and birth rates (as hypothetically illustrated in figure 1), a cubic function is fit to each worker input variable and again age standardized and age-specific birth rates are examined in the regression analysis. Sharply diminishing returns to scale of program activity is evident (reported in

Table 1

LINEAR REGRESSION ON AGE-NORMALIZED CRUDE BIRTH RATES
(beneath each regression coefficient is its t statistic)

Year of Dependent Variable	Constant Term	Child Death Adjustment (ratio)	Child Schooling (proportion)	Adult Education (proportion)	Agricultural Composition (proportion)	Family Planning Pro- gram Man Months (cumulative inputs to prior year)		R ²
						VHEN	PPHW	
1964	-.737 (4.36)	1.72 (10.8)	-.247 (5.32)	.0459 (0.55)	.0184 (0.58)			.404
1965	-.163 (1.39)	1.20 (11.0)	-.364 (6.37)	.149 (1.55)	.0248 (0.69)			.464
1965	.0256 (0.22)	1.04 (9.61)	-.365 (6.65)	.161 (1.75)	.0563 (1.62)	-.0967 (3.29)	-.0606 (5.02)	.509
1966	-.873 (5.10)	2.18 (13.3)	-.553 (10.0)	-.293 (3.32)	-.00856 (0.27)			.579
1966	-.633 (3.58)	1.99 (11.9)	-.569 (10.5)	-.295 (3.43)	.0106 (0.33)	-.0831 (4.52)	-.00882 (2.28)	.603
1967	-.831 (3.81)	2.01 (9.72)	-.505 (6.41)	-.0132 (0.11)	-.0570 (1.25)			.371
1967	-.776 (3.40)	1.98 (9.31)	-.513 (6.44)	-.0149 (0.12)	-.0562 (1.23)	-.0164 (0.92)	-.00138 (0.39)	.372
1968	-2.96 (9.96)	4.00 (14.1)	-.398 (6.33)	-.0289 (0.29)	.0318 (0.87)			.557
1968	-2.89 (9.15)	3.95 (13.4)	-.407 (6.36)	-.0300 (0.30)	.0320 (0.88)	-.0107 (0.89)	-.000855 (0.33)	.558

Source: Schultz (1971a) Table A-1.

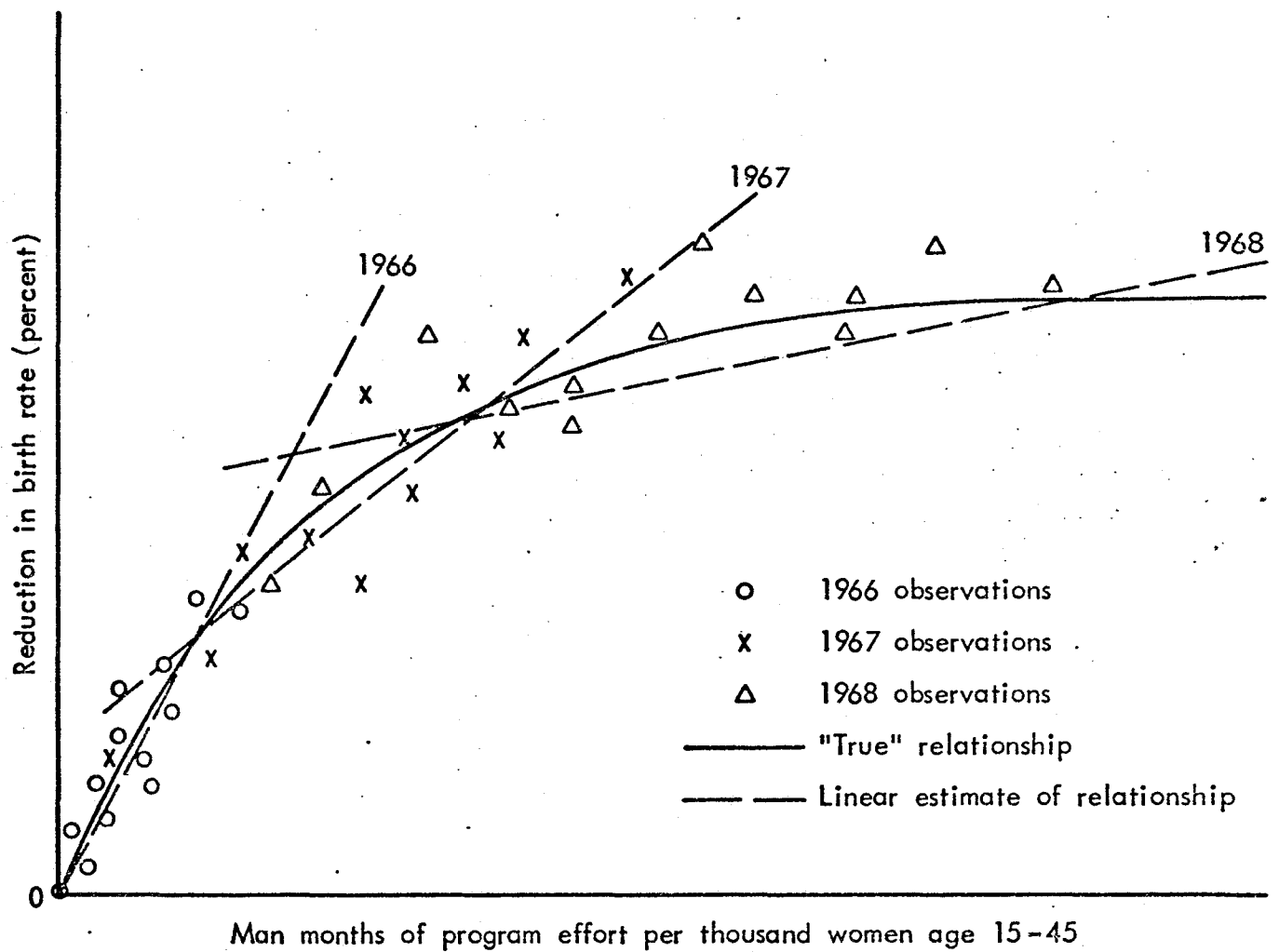


Fig.1 -- Postulated explanation of regression results

Schultz, 1971a), particularly by 1967 and 1968. Interactions between the worker input variables are also significantly positive, as anticipated above.

Part of the explanation for the weakening linear relationship between program inputs and the level of age standardized birth rates is due to the differential effects of the program on women of different ages. Program inputs are most notably associated to lower birth rates among women over age 30 in this early stage of the program. Table 2 summarizes these patterns for various ages and years, based on the cubic specification. Because the program effects are now nonlinear, both the average effect (total effect divided by average level of inputs used) and marginal effect (evaluated at the sample average input levels) are reported. The overall marginal effect of one more man month of PPHW personnel per 1000 women aged 15-49 diminishes from 1965 to 1967 from -.93 to -.13 whereas the parallel decline for VHEN is from -1.69 to -.81. Diminishing returns to scale is clearly evident.

Figure 2 plots the estimated effectiveness of the two classes of field workers on lowering 1966 birth rates. Knowledge of these schedules is limited, however, to the range of sample observations, and the sample mean level of VHEN was only one sixth that of PPHW in 1966, or .28 man months versus 1.6, respectively. At the lower average levels of employment of VHEN in the program, they appear to be substantially more effective than the PPHW, so far as they reduce birth rates at the margin. Since the cost of training and employment in the program were not dissimilar, this analysis of program cost-effectiveness suggests that hiring more VHEN relative to PPHW was justified on efficiency grounds. The marginal effectiveness schedule of the field personnel remained relatively constant over time as cumulative program inputs increased rapidly. Additional portions in the program effectiveness function were therefore traced out to the right over time as plotted in Figure 3 for the birth rate of one age group--women age 35 to 39.

Table 2

MARGINAL AND TOTAL EFFECT OF FIELD WORKERS ON BIRTH RATES IN TAIWAN, 1965-1968^a
(percent change)

Year/Type of Worker	Age-Specific Birth Rates							Overall Age-Specific Effect	Age-Standardized Crude Birth Rate Effect
	15-19	20-24	25-29	30-34	35-39	40-44	45-49		
<u>1965</u>									
PPHW-Marginal	-3.53	-.55	-.28	-.82	-2.48	-2.85	-.68	-.93	-1.00
Total	-21.21	-2.56	-1.72	-5.75	-13.87	-16.29	-1.67	-5.43	-5.75
VHEN-Marginal	-6.82	-.79	.22	-2.29	-4.99	-6.67	-8.79	-1.69	-1.62
Total	-10.57	-1.18	.47	-4.25	-8.68	-12.37	-14.97	-2.86	-2.72
<u>1966</u>									
PPHW-Marginal	-.48	.01	-.13	-.36	-.80	-.84	-.58	-.24	-.26
Total	-20.80	-2.90	-2.10	-5.57	-19.17	-26.68	-11.57	-6.49	-6.79
VHEN-Marginal	-3.88	-.50	-.28	-1.86	-4.54	-5.90	-6.74	-1.44	-1.54
Total	-12.59	-1.24	-.61	-6.11	-16.61	-19.91	-20.65	-4.64	-5.03
<u>1967</u>									
PPHW-Marginal	-.32	-.04	.05	-.26	-.50	-.91	-1.10	-.13	-.13
Total	-24.34	-4.20	1.06	-12.04	-27.12	-43.60	-71.49	-8.46	-8.88
VHEN-Marginal	-3.15	-.28	.28	-1.00	-2.88	-5.16	-8.75	-.81	-.79
Total	-16.70	-1.73	1.17	-5.48	-18.30	-28.89	-40.09	-4.75	-4.40
<u>1968</u>									
PPHW-Marginal	-.03	.04	.02	-.15	-.40	-.43	-.62	-.05	-.06
Total	-16.20	-1.15	5.58	-4.65	-25.74	-38.27	-57.73	-3.55	-4.84
VHEN-Marginal	-.16	.22	.06	.05	-.95	-.90	-1.85	-.02	-.14
Total	1.28	2.77	.26	1.57	-3.18	-3.82	-5.32	.90	.35

NOTE: ^aThe marginal effectiveness is the percentage reduction in the age-specific birth rate associated with the employment of an additional tenth of a man month of field personnel per thousand women of childbearing age evaluated at the sample mean program input (Schultz 1971b).

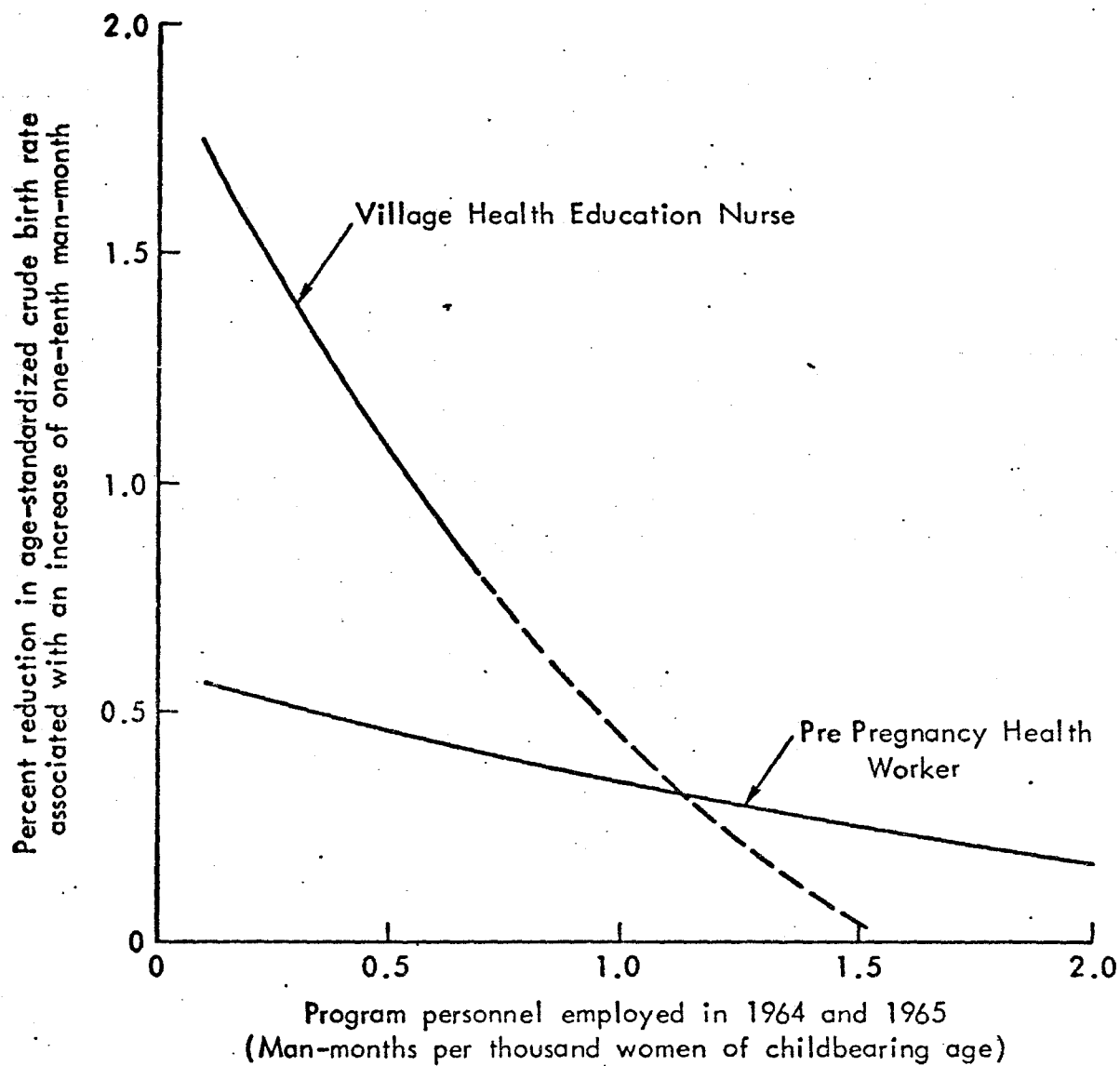
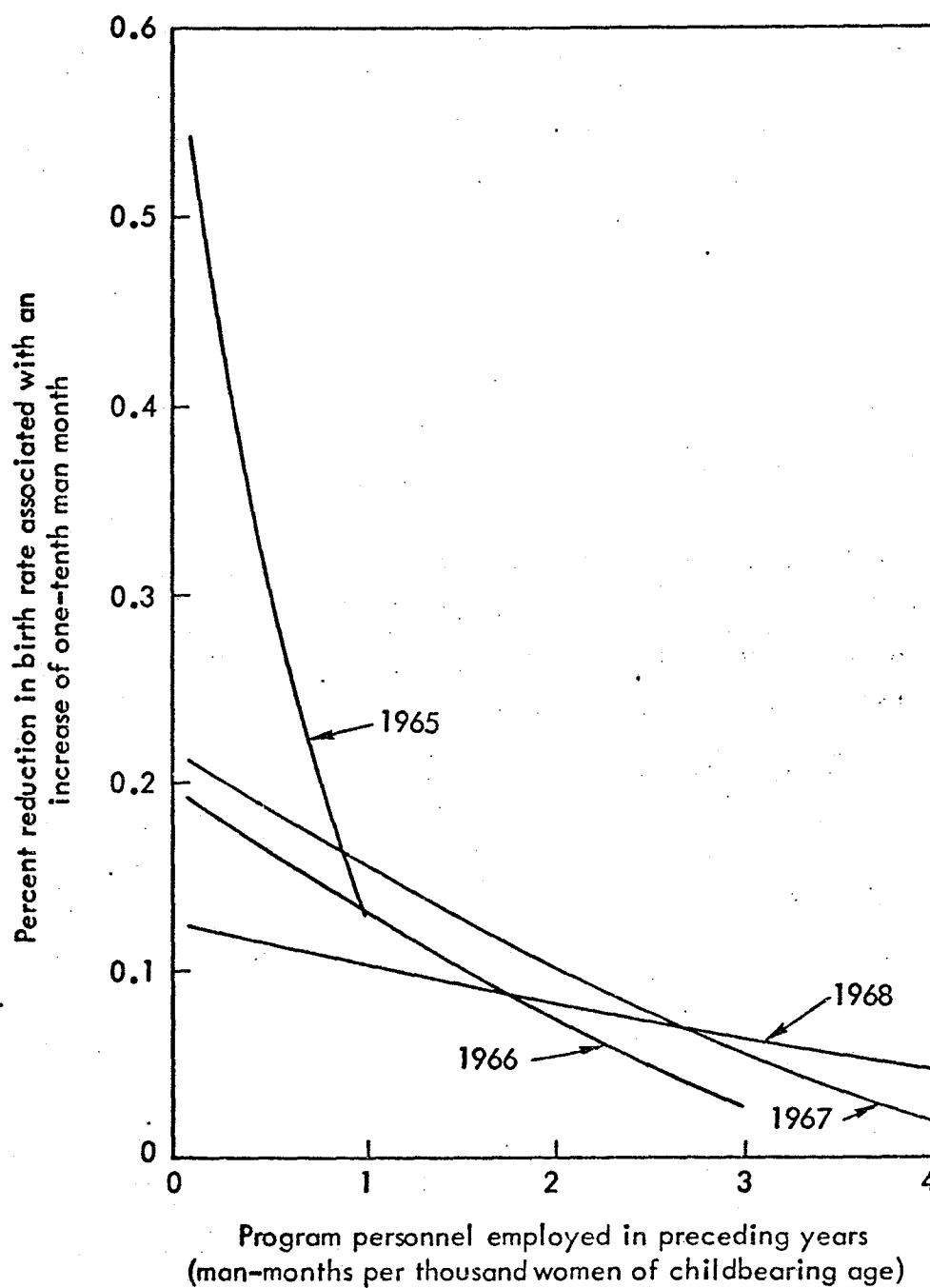


Figure 2 -- Marginal effectiveness of program personnel
in reducing 1966 age standardized birth rate.

Source: Schultz (1971b).



Source: Table E-1

Fig. 3 -Marginal effectiveness of PPHW in reducing birth rates among women aged 35 to 39

Source: Schultz (1971b).

When each input has diminishing marginal productivity, a basic rule of economics is that costs per unit of output are minimized by selecting the mix of inputs at which the marginal value products of all inputs are equalized. In other words, the family planning program manager should be searching for a situation where the last dollar spent on any input yields the same decline in birth rates. But Table 2 and Figure 2 suggest that VHEN fieldworkers were at the margin more productive than PPHW workers. The output of the program, or the fertility reduction attributable to the family planning budget that was largely expended on these field staff, might have been substantially increased at no increase in program budget if the VHEN had been expanded and PPHW reduced correspondingly. The Taiwan program shifted its emphasis instead toward relying more heavily on PPHW and phasing the multipurpose VHEN out of the program. This may have represented a costly departure from the optimal staff structure. Why did it occur?

The principal measure of "success" in the Taiwan Family Planning Program was the number of women who locally accepted an IUD. Bonus payments were awarded to PPHW workers on the basis of acceptor quota achievements and the number of referrals she received from women accepting an IUD. Because the VHEN spent half their time on other health and education projects in the community, they did not receive the same incentive payments. The sources of information available to program managements on the accomplishments and effectiveness of both field personnel must have suggested to management that the program operated at approximately constant returns to scale as it grew in size and that the PPHW^{11/} was a more effective field worker than was the VHEN. Evidence later indicated that referral information became increasingly inflated and biased in favor of the PPHW, probably because of the quota incentives were only paid to the PPHW and only if one among many possible techniques of birth

control was adopted.^{12/} It can be speculated that the decision made to increase program employment of PPHWs (and decrease program employment of VHENS) was made with access only to the referral information from the first few years of program operation. The sharply contrasting image of the relative effectiveness of field staff emerges here only when a broader indicator of program "success" is adopted--namely, the program's contribution to reducing the actual birth rate.

6. Distribution of Program Effects

In the case of Taiwan, my evaluation of the family planning program relied on published data in the form of regional aggregated birth rates, which do not permit the researcher to interact individual characteristics of the couple collected from a random household survey or census with the local levels of program activity. However, more limited regional interactions of environmental and averaged individual variables suggest that the Taiwan family planning program was distinctly more effective in reducing birth rates in (1) predominantly agricultural regions, (2) regions that exhibited low child mortality, and (3) regions that had a high proportion of children already in school (Schultz, 1971a).

An analysis of a Colombian Census sample from 1973 and municipality data suggests that the education of the woman interacted with the municipal level of family planning activity has a positive effect on children ever born, while both variables exert the anticipated negative direct effect on children ever born (Rosenzweig and Schultz, 1982). This interaction effect is statistically significant, however, only among urban women between the ages of 25 to 34 who stood a substantial chance of benefiting from the national program that had been initiated in Colombia in 1967 when ASCOFAME began to coordinate family

planning services in the 350 government health centers. Before that date, only Profamilia clinics operated in the major cities. The number of hospital beds and clinics per capita in the municipality, another source of family planning information, also exert a significant negative effect on children ever born in Colombia among women aged 20 to 44. These medical inputs are also distinctly less effective in reducing fertility among the more educated women, who I expect to have an advantage in independently evaluating and adopting modern methods of birth control. Further analysis of the interaction of family planning programs and individual characteristics of couples as they impact on fertility is an important topic for population policy research. Oddly, it is not discussed in recent surveys of the field (Lapham and Simmons, 1987).

7. Policy Conclusions and Their Limitations

In such an important area as population policy, it is disconcerting that different approaches to evaluating family planning interventions can yield different conclusions with regard to the overall impact of the program, changes in returns to the scale of program activity, and the relative effectiveness of various classes of workers. More economic and demographic research is needed to confirm the reasons for why these differences in policy conclusions occur. Recent global reviews of the state of knowledge about the effectiveness of family planning do not refer to these ambiguities of evaluation methodologies or to the policy problems they imply (Lapham and Simmons, 1987). Some regional analyses of family planning, however, do explore the limitations of current evaluation methods (Palmore, 1987).

Analysis of intermediate outcomes in a family planning program, such as the number of IUD acceptors served, may not accurately reflect the impact of the program on birth rates, especially as in the Taiwanese case, where various

workers received different incentives for disseminating this intermediate output. There is an urgent need to arrive at a consensus on what social and economic factors beyond the family's control influence importantly family size, and therefore substantially help to account for differences in fertility. When agreement is reached on this set of behavioral determinants of fertility, it should be possible to assess more reliably the contribution of population programs to the reduction in fertility. However, program evaluation based on the study of fertility rather than only on the distribution of family planning services, requires a year or two more lead time to draw policy conclusions. Some short-run policy decisions will have to be made more quickly, and consequently analyses of service statistics within a program are an appropriate component of any program management system.

Day-to-day information on the functioning of a family planning program should be drawn from unbiased and broadly based sources of data to improve policy making. Operational guidelines deduced from studies of service statistics should then approximately coincide with those that will be eventually derived from parallel long-term studies of the program's impact on fertility. Incentives built into the organizational structure of a population program should be aligned to motivate staff to improve the birth control options available to the population. This involves informing them of the relative effectiveness of various methods, the risks associated with their use, and where these methods may be obtained. Initial emphasis on a single contraceptive method, such as the IUD in Taiwan or vasectomy in India, as the principal basis for record keeping, program evaluation, and field staff remuneration, may excessively discount the importance of other effective and widely used means of birth control. Provision of all forms of birth control should be monitored through prevalence surveys, whether users are served within or outside of the public sector program.

A problem with policy inferences based on nonexperimental data on social behavior is that the relationship between program activities, I_i , and birth rates, F_i , denoted in equation (1) may not measure only the cause-and-effect relationship, because I_i and e_{1i} could be correlated. Even when a careful investigation manages to hold constant major economic developments that influence parent desired fertility, the geographical distribution of program activity may still parallel some factors that are neglected in the evaluation design, or people may migrate in response to the differential availability of program services. If these underlying mechanisms are themselves responsible for variation in birth rates, a portion of the interregional variation in birth rates may be spuriously attributed to the regional level of program activity.

It would be advisable, therefore, that the mix of program activities incorporate some randomness to facilitate evaluation of different program components on fertility. For example, the same total expenditures per capita could be allocated to each region or community, but the decision where and when to build and staff schools, or health clinics, or family planning facilities, or protected water supplies, would be independent of other potentially confounding community characteristics. Eventually, of course, all communities would want and receive all facilities, but in the interim this mode of advanced planning of social welfare programs would permit straightforward evaluation of the effects of each program on fertility, as well as how each program influences other related outcomes and decisions of families and individuals regarding marriage, labor force participation, school attendance rates, child health migration, and private savings, etc. (Schultz, 1971b).

One untested explanation for the sharply diminishing returns to scale of the Taiwan family planning program may be the rapid diffusion of knowledge and practice of modern birth control within the mobile and closely integrated

island of Taiwan. The impact of the program's activity could initially be distinguished within the 361 small administrative units of Taiwan. But with a few years time, the diffusion of information and even services may have rapidly spilled over beyond these local units of observation. In a larger, more heterogeneous, less mobile population, with a smaller scale of program activity, regional differentials in program impact on fertility might have persisted for a much longer period than they did in Taiwan.

8. Summary

The problems of evaluating population programs are not easily resolved; indirect inferences cannot be avoided at one stage or another, for there are unobserved links in the complex chain of events that relate policy instruments to human behavior and policy objectives. The link between the distribution of family planning services and the resultant decline in births must be subjected to a variety of indirect statistical verifications, if population programs are to be confidently evaluated.

The approach reviewed here observes births directly and controls for the major fertility determinants that are assumed to be exogenous to a couple when it makes its life plans as to the number of children it desires and the amount it wants to invest in each child's health and education. Unbiased estimates of the average, and more important, the marginal effects of program activities on birth rates can then be inferred from these data. The inferences for policy drawn from this methodology can differ from those derived from other widely used demographic approaches to family planning evaluation. The Taiwan Family Planning Program appears to have had an initial impact on the birth rate in 1965 and 1966 that is larger than previously estimated, but the program is also subject to sharply diminishing returns as field staff activities accumulated over time. Although this analysis does not indicate precisely why the

program's impact was so substantial or transitory, it may have been due to the initial innovative effect of birth control information disseminated by the program's field staff; it was clearly not entirely a direct consequence of the acceptance of the particular contraceptive device (IUD) that the program decided to emphasize initially.

Strong evidence is found in Taiwan for the importance of the constraints and opportunities of the parents' environment (e.g. schooling rates and child mortality) in accounting for regional differences in birth rates. Without changes in the family environment it is doubtful whether the family planning program would have reduced birth rates as substantially as it did. In some countries, promoting the changes that bring about the increased demand for family planning can be as important and cost effective as responding to this demand with a well structured, carefully evaluated supply of family planning services. In other words, it may be less costly to lower birth rates by working on demand oriented variables that lower the benefits of more children and increase the costs of childrearing, than to supply more family planning services which lower the cost of birth control and thereby raise the cost of additional children. Priorities in allocating expenditures in the public sector among health, child nutrition, education, and family planning programs should be guided by cost effectiveness criteria, and may, therefore, appropriately differ from country to country and from time to time, as the preconditions for effective policy evolve. Very few countries with the per capita income of Taiwan in 1965 had invested as heavily in public health and education; these policies are presumably responsible for a large share of Taiwan's notable decline in child mortality and its rapid rise in school enrollment during the 1950s and 1960s and set the stage for the highly effective family planning intervention in the 1960s and 1970s.

As family planning programs contribute to the reduction in the number of "unwanted" births due to ignorance and accident, it is becoming clear that there are ways by which governments can marginally influence the relative attractiveness to parents of having many versus few children. If it is deemed socially desirable, governments can indirectly influence the number of offspring parents want by changing the relative prices they confront as parents.

Three major opportunities for policy to affect reproductive motivations may be distinguished. The first strengthens the child's position in the family by rewarding school attendance and inhibiting his or her early entry into the labor force. Parents are thus encouraged to invest more heavily in the future of each of their offspring. The second increases women's economic opportunities to perform jobs outside of the home that are competitive or incompatible with childrearing. The third reduces infant and child mortality and thereby reduces the number of births required to provide parents with their desired number of surviving offspring and also increases the returns to allied investments in the human capital of their children. These three routes should interact with each other, strengthening the incentive effects of each to reduce fertility.

To what extent can public policies change these prices that face the family and thereby foster changes in fertility? The final contribution of direct and indirect population policies still remains to be documented, and their side effects, both good and bad, have not been adequately assessed. This information is needed to enable society to make an intelligent choice of the policies that are most equitable in narrowing any identified divergence between private and social interests in having children (National Research Council, 1986).

To apply cost-effectiveness evaluation techniques to alternative policies that seek to change birth rates, whether by direct provision of birth control information and services in a voluntary family planning program or by indirect emphasis of policies that promote a smaller (or larger) family size, one needs a general theory and appreciation of the principal determinants of fertility.

The belief that parents are ignorant of, and indifferent to, all methods for controlling their fertility has justified in the past a heavy reliance on technological solutions to the population problem via investments in contraceptive technology. Although it is undoubtedly true that rapid population growth in the world today is in part a consequence of our unperfected methods of birth control, it is also true that this basic technological shortcoming is less important than it is often assumed. Fundamentally, the problem is social; parents want many more children than are now needed to replace themselves.^{13/} This is not to minimize the difficult task of bringing available birth control technology to all people and overcoming their social disadvantages as innovators and adopters of these modern techniques. Nonetheless, understanding the motivations for reproduction and the manner in which development policy impinges on actual behavior is crucial to the design of equitable and efficient policies to cope with population problems. This knowledge is essential if one is to disseminate new birth control techniques effectively and if one is to wisely choose supporting population policies that promote a better balance, if it is needed, between social and individual welfare objectives in the area of human reproduction.

Notes

*This paper (1971b) was originally presented at a conference coordinated by N. Keyfitz and L. Moses in 1970 in East-West Population Institute in Hawaii. Many of the issues originally discussed in this paper have not yet been resolved, and thus I have only slightly revised and updated the references. Many persons contributed to the original analysis of Taiwan data, including L.P. Chow, R. Freedman, A. Hermalin, S.A. Hoenack, S.C. Hsu, T.C. Hsu, R.R. Nelson, M. Nerlove, and T.H. Sun. I acknowledge thanks to them all.

1/The coordination and direction of family planning programs starting in the 1960s and spreading in the 1970s depended heavily on a world-wide battery of Knowledge Attitudes and Practices (KAP) household surveys. Participants in this survey work discovered that large numbers of persons "did not want more births" and yet "did not use or know about modern means of birth control." The conclusion was drawn that programs should improve knowledge, and thereby lead to increased practice of modern birth control, fewer unwanted births, and much lower fertility levels. Controversy continues to surround subjective measures of "unwanted births" (Berelson, 1971). Monitoring the prevalence of contraceptive use then became the central issue, and remains the basic management tool in family planning (Freedman and Takeshita, 1969; Lapham and Mauldin, 1985; Lapham and Simmons, 1987). The more difficult task of measuring the role of family planning in actually reducing fertility has not yet led to a consensus on suitable evaluation methods (Hermalin, 1975, Mauldin and Berelson, 1978; Palmore, 1987).

2/For example, calculations may be made on how long the IUD is likely to remain in place for the average woman served by the program and how effective they are in this period in preventing births (Potter, 1971). There are always differences in the clinical effectiveness rates and those achieved in a mass program. Moreover, the problem of self selection of users may add various forms of bias (Rosenzweig and Schultz, 1985, 1987), as discussed later.

3/There are also other problems with interpretation of service records for overall program evaluation. In many programs there are monetary incentives built into the administration scheme to motivate field workers and doctors to help the largest number of persons possible. Though this common procedure is complemented in the Taiwan program by appropriate safeguards to assure records are accurate, it seems nevertheless likely that these incentives will introduce some bias into service statistics. In other countries this bias may be large, in Pakistan for example, and thus sources of information collected independently of the program are essential to ascertain both program services rendered to the population and the effectiveness of those services in reducing birth rates.

4/In economic terms, I am concerned both with the stock and flow dimensions of fertility. Changes in desired stocks (completed fertility) are translated in complex ways into adjusted flows over time (birth rates of a cohort). Changes in the status and role of women in a society and their employment opportunities outside of the home may induce different patterns of adjustment in birth rates for the same change in desired completed fertility. A perceptive discussion of the changing patterns of fertility and its "tempo" in the US is set forth and analyzed by N.B. Ryder (1971). A different change in the tempo and timing of

births may be observed in some low income countries, where birth rates dropped rapidly in the 1960s and 1970s in such countries as Costa Rica and Colombia, and may be underway in parts of Africa today.

5/L.P. Chow (1968) states this conclusion forcefully in his early discussion of evaluation of the Taiwan Family Planning Program. "The fundamental question 'what would have been the fertility rate if there were no family planning program?' is an extremely difficult one to answer. No matter how primitive he may be, man seems to have the 'rationale' to adjust his numbers in accordance with the resources available, and the environment to which he is subjected. Those who do not want too many children probably would have fewer anyway, regardless of whether there is a large scale organized family planning program or not. This raises a skepticism toward the value of a family planning program. A family planning program, nevertheless, is justified because it should be able to accelerate the fertility decline."

6/The problem of self selective migration and program evaluation is formally modeled by Rosenzweig and Wolpin (1986) in the context of Colombia where immigration from rural areas to the suburban sampled area was substantial. They were unable, however, to deal with the effect of outmigration from their highly mobile population or treat fully the factors influencing the rates of immigration to their community.

7/To interpret the seemingly general association for the purposes of formulating policy, information is required on what determines interregional differences in school attendance rates. Is it the limited capacity of the school system or, in other words, the supply of schooling that is restricting

attendance? Or is it the reluctance of parents to send their children to receive basic education, and thus a lack of demand for schooling that determines the interregional variation in school attendance rates? I believe the more plausible assumption for Taiwan in the 1960s is that the capacity of the school system, particularly in rural areas, generally constrained the acceptance of students and accounted for much of the interregional variation in attendance rates. If this assumption is correct, and excess demand for schooling exists, a consequence of school expansion is likely to be a reduction in child labor force participation and a reduction in birth rates.

8/The only empirical evidence I have discovered that sheds some light on the returns to scale in the Taiwan family planning program are those compiled and analyzed by John A. Ross (1966) from the carefully designed Taichung experiment. The incommensurability of IUD insertions and the acceptances of traditional contraceptives led him to deal with both service outputs separately. No single satisfactory measure of program output is devised or related to births averted. With respect to IUD insertions, the lowest (of three) scale effort yielded much the lowest average cost per acceptor (\$4.83 compared with \$7.95). But when traditional contraceptive accepters were considered in the same light, the disadvantage of slightly higher cost per acceptor (\$4.22 versus \$5.03) may according to some people be offset by the increased rate of accepters (8.7 versus 13.7 percent of women aged 20-39). Yet even in this somewhat extreme case of equating traditional and IUD accepters, direct costs appear to double in order to secure an increase in the acceptor rate from 8.7 percent in the small scale program neighborhoods to 13.7 percent in the large scale program neighborhoods. Diminishing returns

to scale appear to be evident from the Taichung data Ross has studied, even though the measure of program output is regrettably limited to service statistics and not the program's final effect on fertility.

9/The age standardized birth rate is the sum of the local female age specific birth rates weighted by the region's total population share of the specific female age group, divided by the national crude birth rate. The mean of the age standardized birth rate is thus approximately one. The regional female age specific birth rates are also normalized to one by dividing them by the national age specific birth rate. See notes to Table 1 for other variable definitions in Taiwan.

10/For example, Rosenzweig and Schultz (1982) show that in Colombia family planning activity contributes to both a decline in fertility and a decline in child mortality. Thus, if child health and fertility are substitutes, then the inclusion of child mortality in the fertility equation is expected to reduce the partial regression coefficient on family planning activity. In Malaysia, Rosenzweig and Schultz (1987) again find evidence that an exogenous increase in their supply of births induce couples to educate their children less. This finding confirms that the Malaysian couples behave as though children and child schooling are substitutes, in which case the inclusion of child schooling in a fertility equation would bias down the estimated family planning program effect (i.e. an intervention that increases the implicit price of children by reducing the cost of avoiding an unwanted birth). Rosenzweig and Wolpin (1980) also use twins as an exogenous source of fertility variation to confirm that in a rural Indian sample parents react to a twin by reducing the schooling that they provide their other children. This is another indication that fertility and

child schooling are substitutes. Finally, the effects of local family planning, health, and educational programs on fertility and child mortality in India and the Philippines reported by Rosenzweig and Wolpin (1982) provide additional evidence for the patterns of cross price effects that are assumed here.

11/See, for example, Robinson's (1969) estimates suggested that the average cost of an IUD insertion did not rise markedly in the Taiwan program in the first several years of program expansion.

12/As the program developed, doctors and health station workers increasingly gave "credit" for referrals to the local PPHW, for they recognized that this assignment of credit would help the PPHW reach her quota (and earn her financial bonuses) while having no effect on the status of VHENS (Freedman and Takeshita, 1969, pp. 316-317). Because the bonus incentive payments were awarded to only one class of responsible personnel, these payments apparently introduced a bias in the referral information that was subsequently used in evaluating the program. For example, the PPHW referrals increased from 36 percent of the total in 1964 to 62 percent in 1968, whereas VHENS referrals fell from 7 to 3 percent in this period (Freedman and Takeshita, 1969, Table XIII-2, p. 317).

13/An interesting example of this point is provided by Zimbabwe. An excellently implemented family planning program in that country has recently managed to increase a prevalence rate of contraception use among women of childbearing age to one-third. But the level of total fertility rates has not yet begun to decrease noticeably from 6-8 children. Women report using modern birth control, but only to space births. They may be using these modern

techniques largely to replace more traditional ones, such as breastfeeding. Nonetheless, the problem, if there is one, is that the vast majority of women in Zimbabwe want more children (Bohene and Dow, 1987).

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