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THE ECONOMIC ASPECTS OF SLOWING POPULATION GROWTH

Introduction

The past decade of planned economic development has been a disappointing experience for many aspiring peoples and their governments. National domestic production in most Less Developed Countries (L.D.C.s) has grown faster than population by only one or two percentage points annually. It is no wonder that the United States will now grant technical assistance to reduce births on request, that half a dozen countries have incorporated contraception in their development programmes and that the Catholic Church is reconsidering its position on certain birth-control methods other than "rhythm."

Why High Birth-Rates Matter

Reasoned economic concern over high birth-rates in L.D.C.s--usually 40 per thousand a year and higher--has little to do with theories of optimum and static population size. First, high birth-rates cause a natural rate of population increase that is almost too fast to maintain per capita output in some countries. Second, high birth-rates mean a high ratio of dependent children, unable to produce but always consuming.

(1) With crude birth-rates continuing at 40 plus per thousand a year, and crude death-rates continuing to fall, many nations' population at present rates of natural increase will double every 25 to 35 years. Perhaps the employed labour force can double as fast. But natural resources cannot increase by definition. And many poor countries cannot save and invest enough yearly to double their stock of capital in, say, 30 years. Therefore, unless innovations increase final output to factor input rates rather more rapidly than now seems the case, aggregate output per capita may barely increase. Most of these countries cannot both have natural increases in population of from 2 to 3% annually and increases in per capita income of 3% a year or better. Even in

the most advanced nation, there is an inverse relation between annual rate of increase in population and in output per head.

(2) The fraction of population under 15 years of age is highly dependent on age-specific birth-rates, and increases with it. Very approximately indeed, and the interactions are complicated, a country with crude birth-rates of 40 per thousand a year could have as high as 40% of its population under 15 years of age. This percentage might be as low as 20 for a country with an annual crude birth-rate of 20 per thousand. Children under 15 are not significant producers, but only consumers. Lower birth-rates, reducing the relative burden of infant dependency, would "release" consumption to others. Additionally, depending on private saving propensities and government fiscal policies, perhaps a third of such released consumption could be diverted into useful investment.

Both these ideas are expanded below. Thus, the present discounted value of released consumption--several times the per capita income in many countries--provides the bases for several estimates of the economic worth of preventing a birth. And examination of the relative growth rates of output and population leads to the startling conclusion that resources used to retard population growth can contribute perhaps a hundred times more to higher incomes per head than resources used to accelerate output growth.

Superior Effectiveness of Investment in Reducing Births

Output per head (V/P) can be increased by investing resources in making the output numerator larger or the population denominator smaller than they would otherwise be in, say, 1975.

Suppose \$0-5 million worth of resources are invested every year in industrial plants to raise national output. The rate of return on these investments is 15% a year. After 10 years \$5-0 million has been invested, and the annual output increase (ΔV) attributable to it is \$0-75 million a year.

Perhaps national output (V) at the start in 1965 was $500 million. Then the proportionate change in yearly national output ($\Delta V/V$) due to this $5-0 million investment is 0-0015.

Now suppose $0-5 million of resources--but medical and contraceptive resources this time--are invested each year in a birth-reduction programme that stresses the use of intra-uterine devices (I.U.D.s). The cost per participant each year is about $1, so there are 500,000 participants on an average each year during the 1965-75 time period. And perhaps the live births fertility of a typical woman participant is 0-15 infants a year. Thus, the reduction in births (P) over 10 years is 0-75 million infants. Perhaps national population at the start in 1965 was 5-0 millions. Then the proportionate change in national population ($\Delta P/P$) due to this investment is 0-15.

If $5-0 million over 10 years gives a $\Delta P/P$ of 0-15 when used to retard population growth, and a $\Delta V/V$ of 0-0015 when invested to accelerate output growth, the superior effectiveness ratio of birth reduction over output expansion ($V \Delta P/P \Delta V$) is 100 times.

This ratio of superiority varies proportionately with assumed rates of fertility of women practising contraception (f), and inversely both with returns to capital (r) and with cost of programme per participant. Table I gives examples. It is staggering to encounter such ratios when comparing different economic policies.

TABLE I

Superior Effectiveness Ratio ($\Delta VP/P\Delta V$)
(Sensitivity to f and r)

r \ f	0-10	0-15	0-20	0-25
0-20	50	75	100	125
0-15	67	100	133	167
0-10	100	150	200	250

It does not follow, though, that conventional development investments

(e.g., power dams and cement plants) should be terminated in favour of birth-reduction programmes. At most, these latter programmes could never usefully cost more than perhaps 1/25 of the formers' budgets. And, in free societies, the State can only use resources to slow population growth to the extent that adults want fewer children, and so voluntarily participate in birth-reduction programmes.

Value of Preventing a Birth

What is the "worth" of preventing a birth from the viewpoint of a government that is seeking to increase outputs disposable in future to those alive today? What does a typical infant ultimately cost its society, in this sense, measured at time of birth? What does it mean to "prevent a birth"?

Fifteen-Year Estimates

Not many Heads of Government look beyond 15 years. Any birth prevented between 1965 and 1980 affects consumption immediately, but cannot affect output significantly during that time. Everyone who can become 15 years old during this period is born already.

The present discounted value of the consumption "released" if a country does not have 1,000 infants forn this year, representative as regards sex and other attributes, can be estimated after a fashion. It is necessary to assume survival expectancies through each year. Typical consumption values by age are needed. And there must be agreement on a discount rate that reflects time preferences and capital productivity in the country.

For a country with a per capita income, V/P, of $100 yearly, from which 10% is saved, the present value of preventing a birth in the sense of released consumption over 15 years is $280 at an interest rate of 15%. At 10% it is $384. And at 20% it is $212.

Such estimates scale approximately with V/P, from $100 up to $500 perhaps, so in a country with an output per head of $250 annually these "worths" for

10%, 15% and 20% would roughly be $960, $700 and $530, respectively.

Total Life Estimates

Theoretically, the present discounted value of typical infants' consumption (negative) and production (positive) after 15 years should be included. Roughly, in a "V/P equals 100" country a typical undiscounted net surplus during 15-55 years of age is perhaps no more than $840. Practically, at 15% return, the present value of this $840 is an insignificant $17 at date of birth. This gives a net $263 at 15% for a country with a V/P of $100. Accordingly, very generally stated, the "worth" of preventing a birth in a typical L.D.C. is about 2-6 times the output per head.

Meaning of Prevention and Postponement

What does it mean to "prevent a birth"?

The above "worths" are the values to society of "permanently" preventing a birth some woman would definitely have otherwise had this year. The probability of the birth this year must be 1·0 without contraception and 0·0 with birth control. Moreover, whatever the probabilities had been of her giving birth next year and in future years, these must remain unchanged. This is an extreme case, admittedly rather unrealistic, and estimates of the "worth of prevention" made on this basis are not directly relevant to birth-reduction programmes. However, this case needs to be calculated initially, because other important "estimates of worth" are derived from it.

Most realistic probably is the case of birth postponement. This calculation depends on the fertility rate of exposed and fertile women considering only "pregnable" women, and excluding those who are already pregnant or have not resumed menses following childbirth. Perhaps this rate (f) is 0·25 for such women in their twenties. Effective contraceptive practice during a year, assuming the value of f in immediately following years is not altered, then "prevents" 0·25 of an infant during the current year. Thus, if the value of

"permanently" preventing a birth is $260 the value of postponing it one year is 0-25 of $260, or $65. This value declines as women age and f falls. Such a calculation of the yearly postponement worth of contraception is especially significant in primitive societies, where women take no precaution against conception at any time.

Sterilisation is the only birth-control method where, assuming "faithful" wives, "probable" births are completely prevented. If a married man has a vasectomy the present discounted value of the probable future children his wife would otherwise have can be estimated. This in turn should be multiplied by the value of "permanently" preventing a birth. As estimated above, for a country where V/P is $100, this may be about $260. Then, taking some typical fertility rates, the present discounted value of a vasectomy is roughly $275 when the wife is 25 years old, $193 when she is 30 and $148 at 35 years.

The practical importance of these "worths" is that they form a basis for determining the maximum cost in resources a government can incur to postpone or "prevent" a birth. Thus, if three-fifths of all pregnancies result in live births the value of postponing a conception is three-fifths the value of postponing a birth. Specifically, if the value of postponing a birth one year is $65, Government should then use less than $39 worth of resources to prevent a pregnancy through birth-control measures.

Economic Cost of Reducing Births

The resource cost of reducing births is extraordinarily low relative to the apparent economic worth. Estimates of this cost vary, of course, depending on the mix of methods used. For a major national programme stressing a reasonable mix of methods, but with emphasis upon intra-uterine devices (I.U.D.s), over 5 years the annual cost per participant is under $1 and the cost per birth prevented during this half decade is probably $5.

Costs of Methods

Certain methods have a fixed "starting" cost for initial training, devices, etc., with very low or zero recurrent "operating" costs thereafter: examples are withdrawal, rhythm, diaphragm, I.U.D. and vasectomy. Other methods have low or zero "starting" costs but relatively high recurrent costs: examples are condoms, foam tablets and especially pills. Recurrent costs vary with frequency of coitus in the case of condoms and tablets, but not for contraceptive pills.

Table II, Column 1, estimates crudely the cost for each participant over

TABLE II

Hypothetical Costs and Effectiveness of Alternative Contraceptive Measures During a 5-Year Programme

	(1) Cost/ user 5 Yrs.	(2) Pregnancies prevented 5 Yrs.	(3) Cost each pregnancy prevented	(4) Cost each birth prevented	(5) Births prevented per $1 million,000	(6) "Acceptors" per $1 million,000
0.Zero control	0	0	0	--	--	--
1.Withdrawal	0-25	1-25	0-20	0-33	3,000	4,000
2.Rhythm	0-50	1-0	0-50	0-83	1,200	2,000
3.Condom	12-00	1-2	10-00	16-7	60	83
4.Foam tablet	12-00	1-0	12-00	20-00	50	83
5. Diaphragm	4-50	1-5	3-00	5-00	200	222
6.Pills	90-00	1-7	52-90	88-60	11	11
7.I.U.D.s	2-00	1-8	1-11	1-85	540	500
8.Vasectomy	3-00	1-9	1-57	2-62	381	333

N.B. These magnitudes are good at best to one significant digit. The variable costs assume about 50 exposures a year. No account is taken of possible deaths or reconsorting during the year. Two-fifths of all conceptions are assumed to result in early miscarriages, abortions or neo-natal deaths. No allowance is made for drop-outs.

5 years, depending upon method. It is assumed that both withdrawal and rhythm require some initial instruction (as noted above). The cost of pills is extremely high compared to other methods. The I.U.D. cost estimate assumes a single insertion and one recheck by a paramedic. The vasectomy cost per year varies inversely with the length of the period considered.

These estimates are of resource costs, assume that participants volunteer

without expensive propaganda campaigns, and are independent of whether Government or acceptor pays varying fractions of these costs.

Cost Effectiveness Comparisons

Within broad limits it is possible to make cost-effectiveness comparisons of alternative birth-control methods. Rough cost estimates (Col.1) must be compared with estimates of effectiveness (Col.2). Different methods can be ranked accordingly when the constraint is defined.

A distinction must be made between the idealised effectiveness and the operational effectiveness of different methods. Some methods that are effective if a couple practices them faithfully as instructed, and notably rhythm, are relatively ineffective where sustained motivation, dependable supply sources or household utilities are lacking. Failure rates for any of the traditional methods seem to behigher with poor Asian villagers than with educated and prosperous Westerners. This is not at all true of I.U.D.s and vasectomies, however. Otherwise, lacking good data from primitive cultures, the estimates of Col. 2 can be little more than intelligent guesses for these methods.

The 5-year costs of Col. 1, divided by the 5-year effectiveness (pregnancies prevented) estimates of Col. 2 give the 5-year costs per pregnancy prevented of Col. 3. These are multiplied by 1-67, allowing for miscarriages, abortions, stillbirths and fatalities shortly after birth, to give the 5-year costs per birth prevented of Col. 4.

Withdrawal, one of the least effective methods biologically, has supposedly the highest effectiveness per unit cost, because it can be readily explained and involves no purchases or medical treatment. The contraceptive pill, among the most effective methods physiologically, is the worst from an economic viewpoint. As these cost-effectiveness ratios tentatively vary by a factor of 250 times between the most and least costly, and perhaps by a factor

of 20 even between rhythm and condom, the choice of a method to stress is important.

<u>What is the Best Method?</u>

What is the best method depends upon whether the effective constraint of a birth-reduction programme is budget or participants. Suppose, for example, that the costs and effectiveness of the various methods are again as set out in Table II. Also assume that the maximum potential "acceptors" in a country is 10 million cohabiting women or men.

If acceptors are not the constraint, i.e., the budget is the limitation, the "best" method is that which prevents the most pregnancies per unit cost. Suppose only $1 million is available over 5 years. According to Table II, Col. 5, withdrawal is then preferable to all other methods, because 3 million births (5 million pregnancies) are prevented. And the 4 million actual participants shown in Col. 6 are less than the potential of 10 million.

However, if the budget exceeds $2-5 million over 5 years in this instance the effective constraint will be participants and not funds. Given 10 million actual rather than potential acceptors regardless of method, for each alternative budget over $2-5 million there is a "best" method that maximises births prevented. However, at successively higher budgets above $2-5 million the best method in each case will have a lower effectiveness to cost ratio. Hence the truly best method is that associated with the best budget. And the best of all budgets is that which equates the cost and worth of preventing births at the margin.

Fig. 1 explains this optimisation. The vertical axis gives expected pregnancies and the horizontal axis expected costs over 5 years. The scatter points represent the data of Cols. 1 and 2 of Table II. Noteworthy is the envelope of efficient methods, linking points representing Zero Control, Withdrawal, I.U.D. and Vasectomy. The inefficient methods, with higher costs or more expected

pregnancies, are Rhythm, Diaphragm, Condoms and Tablets, while the Pill is so costly it cannot be plotted. Considering efficient points, in cost-effectiveness terms, Method 7 (I.U.D.) is inferior to Method 1 (Withdrawal) and Method

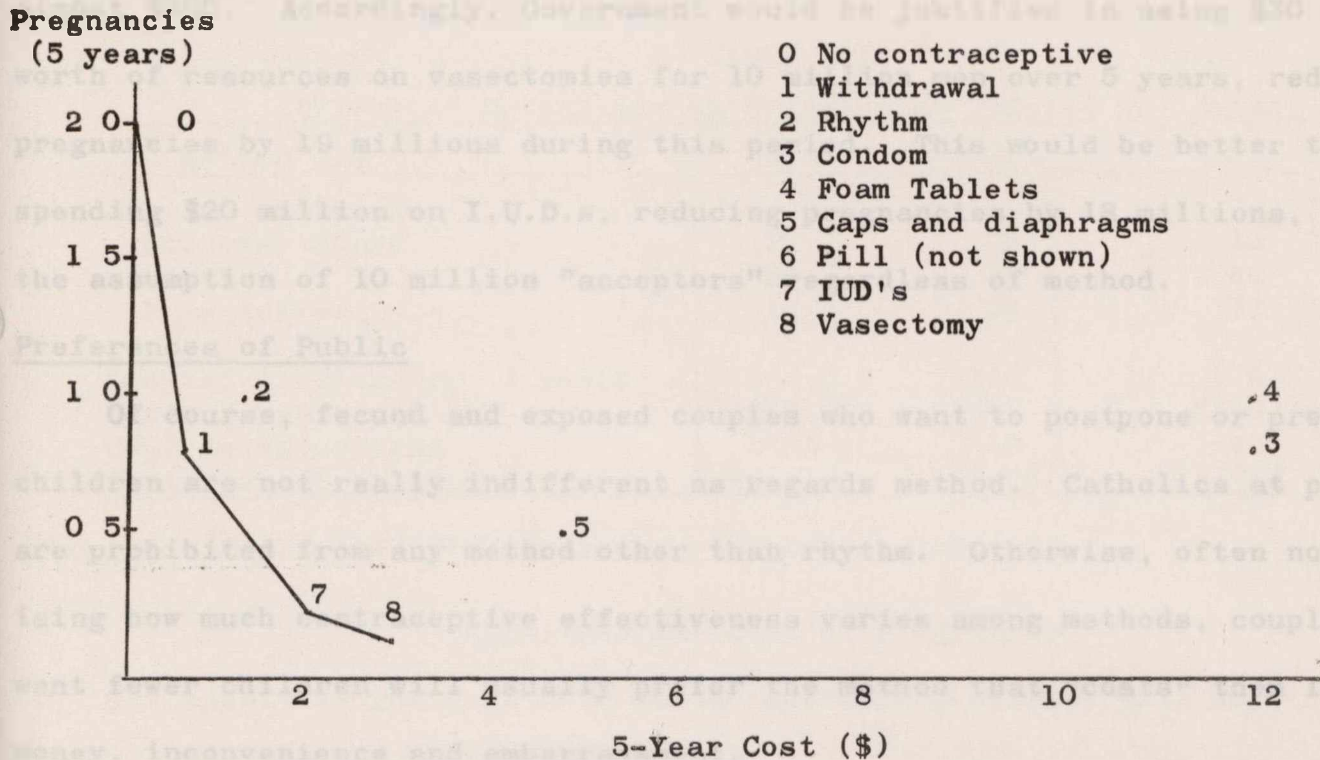

Fig. 1. Hypothetical Pregnancy Reductions and Costs Associated with Different Contraceptive Methods per Acceptor (5-year Programme).

Source: Table II.

8 (Vasectomy) is in turn inferior to Method 7, as indicated by the slopes of imaginary rays from the zero point (of no contraceptives) to these scatter points.

But which method is best in marginal terms?

A shift to I.U.D.s from Withdrawal means an extra cost of $1-75 per acceptor, and an extra pregnancy prevention of 0-55 over 5 years, for a marginal cost per pregnancy prevented of $3-17. Adoption of vasectomy, instead of I.U.D., means an extra cost of $1 per participant and an extra 0-1 pregnancy prevented, for a marginal cost of $10. The question is whether $3-17 or $10 best reflects the economic worth of preventing a pregnancy, in the sense of at least postponing it for an average period of 5 years?

Considering even a low-income country with a V/P of $100 a year, where the value of preventing a birth permanently is around $250 to $300, the worth of postponing a pregnancy among participants for 5 years on an average is worth almost $200. Accordingly, Government would be justified in using $30 million worth of resources on vasectomies for 10 million men over 5 years, reducing pregnancies by 19 millions during this period. This would be better than spending $20 million on I.U.D.s, reducing pregnancies by 18 millions, given the assumption of 10 million "acceptors" regardless of method.

<u>Preferences of Public</u>

Of course, fecund and exposed couples who want to postpone or prevent children are not really indifferent as regards method. Catholics at present are prohibited from any method other than rhythm. Otherwise, often not realising how much contraceptive effectiveness varies among methods, couples who want fewer children will usually prefer the method that "costs" them least in money, inconvenience and embarrassment.

Thus, Government may have one preference ranking of methods while couples wanting fewer children have differing ranking systems of their own. Politically, Government must usually offer all methods, but this need not preclude it from subsidising one method as against another. Were Government to insert I.U.D.s free, but charge the full price for contraceptive pills, for instance, few participants would use the latter.

The art for Government is only to discourage inefficient methods for which practitioners do not have a strong preference, while encouraging efficient methods for which those who want fewer children do not have a strong revulsion.

<u>Costs of Different Mixes of Methods</u>

The sensitivity of programme costs to different mixes of methods used is indicated by Table III. The increasing use of I.U.D.'s instead of foams by women, and of vasectomies instead of condoms by men, increases contraceptive

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effectiveness and reduces costs. There will hopefully be a gradual substitution of "once-for-all" methods, although requiring individual medical attention, in the place of devices that must be repeatedly supplied and depend for effective use on sustained motivation.

TABLE III

Effect of Method Mix on Pregnancies Reduced and Costs

Method Mix	A.	B.	C.
No. Acceptors, %			
Condoms--Foams	70	28	10
I.U.D.s	20	50	60
Vasectomies	10	22	30
Reduced pregnancies, 5 years	132	163	176
Cost, 5 years per 100	$910	$502	$330
Cost/acceptor/year	1-82	1-0	-66
Cost/reduced pregnancy	$6-90	$3-08	$1-88

Source: Costs and effectiveness are based on Table II.

Magnitude and Cost of Programmes

The magnitude and cost of a birth-reduction programme will depend, of course, upon goals established by Government. Japan halved its birth-rate in 10 years after the Second World War, from 34 to 17 per thousand annually, abortion being widely and openly used; but that nation cannot be considered typical of under-developed countries in Asia or elsewhere. A more probable contraceptive goal might be a one-third reduction in crude birth-rates during a decade.

Achievement of such a goal requires that about half the couples in the procreative age groups, couples over 25 years old being represented somewhat disproportionately, must be effectively practising one or other method of control at any one time.

A typical L.D.C. comprises about 16 men and 16 women per 100 population who are fecund and exposed. Some of these 16 women will not be pregnable in any month, because of pregnancy, or post-partem amenorrhoea. Another substantial fraction will be young couples who want their first boy or girl. If these women who cannot conceive or want to conceive are deducted, perhaps 8 women (or

their partners) per 100 population are "eligible" in any one month to practise birth control.

Realistically, there will be some rotation of participants among this group, so that perhaps 10% of the population are involved in any year. The cost per "acceptor" a year varies with the mix of contraceptive methods used, but with Mix B (see Table III) this is $1. It follows arithmetically that the cost of the national programme per head of population is 10 cents a year.

An annual cost of 10 cents per head means government budgets, assuming all the programme is financed through the State, that are typically about 1% of the economic development programmes in many L.D.C.s. Table IV gives selected examples. It is astounding to realise that resources having a value of 1% of all those used for development, assuming sufficient participants, could be as effective in raising per capita income as the other 99%.

TABLE IV

Estimated Annual Costs of Birth-reduction Programmes Relative to National Development Budgets for Ten Selected Countries

Country	Population, 000,000	Estimated cost family planning programme, 000,000 year, $	Total cost development programme, 000,000 year, $	Relative cost of programme to reduce births, %
Brazil	80	8-0	2,043	0-4
Colombia	16	1-6	334	0-5
India	470	47-0	3,921	1-2
Korea	28	2-8	105	2-7
Mexico	40	4-0	412	1-0
Nigeria	42	4-2	227	1-9
Pakistan	107	10-7	1,064	1-0
Taiwan	13	1-3	149	0-9
Tunisia	5	0-5	200	0-2
Turkey	30	3-0	538	0-4

Col. 1. 1964 estimates.
Col. 2. Population x 10 cents.
Col. 3. Includes United States assistance, country's own contribution and expenditures from other external aid sources expected in financial year 1965.
Col. 4. Col. 2 divided by Col. 3.

Using Resources and Bonuses to Increase Participation

None of the L.D.C.s currently have 8 women (or their partners) per 100 population practising effective birth control. The number is often not a tenth as large. Sooner or later, as government planners realise how great are the economic advantages to the nation of reducing births, there will be a greater willingness, however, to use resources for public education on contraception. The granting of bonuses to families that practise contraception effectively, or to men who volunteer for a vasectomy, will also become more widespread. It is important also to recognise, in making this choice between education and bonuses that the latter are transfer payments and have no opportunity production cost.

Resources for Education

Various surveys indicate that many simple peoples understand very little about why reproduction occurs and how it can be prevented. The most effective and recent methods of birth control--notably the I.U.D. but also vasectomy--are known but vaguely to a few. Some of this ignorance can be remedied by direct education in secondary schools, to men and women in the civil and military services, and indirectly through radio and movies. However, even if the cost per acceptor a year was thereby tripled the annual programme cost would typically be only 3% of all resources used for economic development in a country, and the superior effectiveness ratio could be around 33.

Bonuses to Participants

It is really much cheaper in terms of resources for Government to encourage participation through offering bonuses that are transfer payments. There is then a transfer of purchasing power from tax-payers to acceptors. Couples who limit births are rewarded by Government in the name of society for behaving more than others in conformity with the public interest.

Such bonuses can be large enough to be influential.

Thus, if the worth of postponing a pregnancy one year is about $39 in a

country where V/P is $100 (see p. 6) and the resource cost of a reasonable method mix is $1 per acceptor a year (see Table III), Government could afford to pay over $30 a year bonus to women who remain non-pregnant. Practically, each participating woman would have to register with a clinic and be superficially examined there each 17 weeks, receiving $10 on each visit if she did not miss her last examination and is again found to be not pregnant. How this woman remains non-pregnant is her own affair, but she might well ask for an I.U.D. at the clinic when registering there. And the $30 a year is to her the equivalent of 4 months' per capita consumption in her country.

Considerably higher bonuses could be granted to vasectomy volunteers, varying from $260 to $148 (see p. 6) in a country where per capita income is $100. This could be analogous to a bonus approaching $10,000 in the United States. While the fraction of eligible men who would volunteer as a result might not be high, so large a sum ensures that its availability will be publicised.

Government, representing all tax-payers, has an interest in making these bonuses less than the full reservation price to the economy. As acceptance of birth reductions became more widespread, these bonus rates could presumably be reduced, sharing more of the gain with society at large. If this shifting "supply" schedule of participants is relatively elastic, so that the ratio of marginal cost to average cost does not greatly exceed unity, a given budget for these payments will be more effective.

Other Financial Incentives

There are other ways in which Government can use funds to extend a birth-reduction programme that partly involve extra resources but also provide generous suppliers' surpluses.

It can offer private doctors generous fees for vasectomies and the insertion of I.U.D.s. It can offer generous fees to midwives and others who "intro-

duce" new acceptors to the clinics. And it can distribute condoms, etc., free to stores and midwives to retail at a generous profit margin.

All such arrangements increase the cost per acceptor, but they also increase the number of participants, and each extra couple reducing births means an extra net product for the economy.

Conclusions

The main conclusions are important for policy-makers. (1) If economic resources of given value were devoted to retarding population growth, rather than accelerating production growth, the former resources could be 100 or so times more effective in raising per capita incomes in many L.D.C.s. (2) An adequate birth-control programme in these countries might cost as little as 10 cents per capita yearly, equivalent to about 1% of the cost of current development programmes. (3) The possible use of bonuses to encourage family planning, whether paid in cash or kind, is obvious in countries where the "worth" of permanently preventing a birth is roughly twice the income per head. Economists can make a major contribution to economic development by refining and explaining such estimates for particular nations.

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