DEMOGRAPHY© Volume 11, Number 4 November 1974

FERTILITY AND PER CAPITA INCOME: A COMMENT ON JANOWITZ'S RESULTS

Daniel B. Sults
Department of Economics, Michigan State University, East Lansing, Michigan 48823

In an excellent short study published recently in this journal, Janowitz (1973) examined statistical relationships among fertility, age composition and per capita income. Her main result was expressed in a regression equation

$$\log (15\text{-}64/N) = 5.36 - .281 \log GRR - .136 \log (GRR_{-10}/GRR) - .264 \log E, \quad (1)$$

where 15-64/N is the fraction of population of working age, GRR is gross reproduction rate, GRR_{-10} is GRR ten years previously, and E is life expectancy.

This note expands on the Janowitz article by pursuing two interesting implications that go beyond her conclusions. The first of these relates to the influence of trend changes in fertility and merely spells out explicitly what is already implicit in equation (1). In the second, equation (1) is combined with other equations from the article to arrive at an estimate of the economic value of programs to reduce fertility. Although the resulting estimate is necessarily crude and subject to qualifications that will be pointed out, it agrees quite closely with those arrived at by earlier researchers working from an entirely different point of view.

Trends in Fertility

Equation (1) embodies a long-run relationship between fertility and age composition that exists because GRR is fairly stable over time. That is, the real reason that the age composition observed today is related to current GRR is that today's GRR is a good index of fertility levels over a considerable past period. It is these past levels that are primarily responsible for today's age composition.

Janowitz noted this important fact and embodied it in the term GRR_{-10}/GRR of equation (1), but its implications are more readily appreciated if the equation is rewritten. Recalling that the log of a ratio is the difference of the logs, we can write $-.136 \log (GRR_{-10}/GRR) = -.136 \log GRR_{-10} + .136 \log GRR$. Substituting this into equation (1) and combining terms, we have the equivalent equation

$$\log (15\text{-}64/N) = 5.36 - .145 \log GRR - .136 \log GRR_{-10} - .264 \log E. \quad (2)$$

(Equations (1) and (2) are equivalent not only algebraically but also statistically. That is, if the original regression had been formulated as (2) in the first place, this is the result that would have been obtained.)

Equation (2) emphasizes the dependence of 15-64/N not only on recent fertility levels as represented by GRR but also on those of earlier years as embodied in GRR_{-10}. When fertility remains constant over time, $GRR = GRR_{-10}$, and equation (2) yields estimated age composition as $\log (15\text{-}64/N) = 5.36 - .281 \log GRR - .264 \log E$. When, however, fertility has been declining, GRR will be smaller than GRR_{-10}, and the same current level of GRR will be associated with a smaller value of 15-64/N because currently observed age composition is partly a heritage of past, higher levels of *GRR*. Likewise, when fertility is on a rising trend, the same current level of *GRR* will be associated with a higher value of 15-64/*N* inherited from past lower levels of *GRR*.

The point can be reenforced by yet another restatement of equation (1). If we represent the trend as an exponential growth rate of r per year, *GRR* observed in any year t can be represented as $GRR_t = GRR_0 e^{rt}$, where GRR_0 is *GRR* as of t years previously. In particular, $GRR = GRR_{-10} e^{10r}$. When this term is substituted into equation (1) we have

$$\log (15\text{-}64/N) = 5.36 - .281 \log GRR + 1.36r - .264 \log E. \quad (3)$$

(This is the form of the equation when natural logarithms are employed. When the logarithms are on base 10, the coefficient of r becomes 0.593, but the implication of any given r is, of course, exactly the same regardless of base.) Equation (3) has the advantage of making quite explicit the dependence of current age composition on both the level and the trend of *GRR*. Clearly, given currently observed *GRR*, the value of 15–64/*N* depends on r. When *GRR* is falling at a rate of one percent annually ($r = -.01$), the term in (3) subtracts .0136 from log (15-64/*N*), thus lowering 15-64/*N* by about 1.4 percent below the value to be expected if *GRR* had shown no trend and had always been at its current low level. Similarly, one percent per year growth in *GRR* leaves 15-64/*N* about 1.4 percent higher than would be expected with zero trend. Strictly, of course, r in (3) is defined as the average rate of change over the most recent decade and is not applicable to other periods without modification.

The Economic Value of Reduced Fertility

The second interesting corollary of the Janowitz results is their implication for the magnitude of economic benefits derivable from birth control. The question of how large an economic pay-off is likely to result from investment in fertility reduction has been explored by, among others, Enke (1966) and Zaidan (1971). In both cases, their procedure was to estimate economic gains primarily by the discounted value of net consumption saved during the first 15 years per birth prevented.

Equation (2) provides an entirely different approach to the question, for, since the fraction of population of working age (i.e., 15–64/*N*) is a key factor in determination of *GNP* per capita, any program to reduce *GRR* will tend to raise per capita *GNP*. To estimate the extent of this increase, we must complete the connection between fertility and *GNP* per capita. This is done by including two additional equations along with (2). Janowitz gives these two additional equations in the Appendix to her article, but for purposes of exposition slightly modified versions are used here.

The effect of age composition on production and income is represented by the identity:

$$\log (Y/N) = \log (15\text{-}64/N) + \log L + \log H + \log P, \quad (4)$$

where L is the labor-force participation rate (that is, the ratio of labor force to population of working age) and H is the average number of hours worked per worker per year. The last term, P, represents average output per worker-hour.

But it is not only true that fertility affects income per capita via equations (2) and (4), it is also true that per capita income, in turn, influences fertility. We represent this "feedback" effect by the equation

$$\log GRR = 1.00 - .28 \log (Y/N) + \log A. \quad (5)$$

Equation (5) is the Janowitz regression with the term log A added to it. The factor A is a dummy "shift variable" used to represent the effect of investment in fertility change. In the absence of such a program, $A = 1$ ($\log A = 0$), and GRR depends only on per capita income. An investment in birth control education and technology that reduces GRR by ten percent, income given, is represented by a ten percent reduction in the value of A (i.e., $A = .9$). Similarly, a program to increase fertility that would result in a ten percent rise in GRR, income given, would be represented by a ten percent increase in A ($A = 1.1$). In other words, A is merely a means of keeping track of the effect of fertility modification as it works its way through the feedback of the economic system.

To measure the gains from birth control, substitute equation (5) into (2) and substitute the result into (4). Solving for log (Y/N), we then find

$$\log (Y/N) = 5.44 - .150 \log A - .142 \log GRR_{-10} - .275 \log E + 1.04 \log L + 1.04 \log H + 1.04 \log P. \quad (6)$$

Equation (6) means that any program of birth control that produced an initial ten percent reduction in fertility (i.e., any program that reduced A by ten percent) would raise annual per capita income by 1.5 percent. Taking \$100 per capita as typical of less developed countries, such a program would tend to raise per capita income by about \$1.50 via its impact on age composition, other things equal. (It is interesting to note how little of this result is generated by feedback via equation (5). According to (2), a ten percent reduction in fertility would raise 15-64/N by 1.45 percent, and according to (4) this translates directly into a 1.45 percent increase in Y/N. Thus GNP per capita rises by \$1.45 without reference to equation (5). Economic feedback generates only an additional \$.05 per capita.)

To make this result comparable with earlier estimates, it can be translated into economic return per birth prevented. This can be done by reference to the crude birth rate, which ranges around 40 per thousand of population in nations of the sort under consideration. A ten percent reduction in fertility, then, would be roughly equivalent to preventing four births per thousand of population, or .004 births per capita. Dividing this figure into the prospective gain of \$1.50 per capita, we obtain an estimate of \$375 as the value of preventing a birth. This result falls well within the range of values presented by others. Thus Zaidan (1971) estimated the value of a birth prevented in Egypt as the equivalent of \$327 to \$941, depending on assumptions and discount rate employed. Enke (1966) produced estimates for a nation with \$100 per capita that ranged from \$212 to \$384.

In view of the roughness of our estimates, it is perhaps presumptuous to attempt further reconciliation, but a few remarks are in order. In the first place, \$375 clearly understates the full effect of fertility reduction, even in terms of our method. For reasons set forth above, initial impacts of fertility reduction will be held down by the continuing influence of past higher fertility. As GRR_{-10} declines with the passage of time, per capita income will rise still further, and in the long run the value of reduced fertility should approach \$730 per birth prevented, almost double the original Enke estimate. On the other hand, it is unlikely that changes in age composition would immediately yield gains as high as even the \$375 of our estimate. Rather, we might expect an immediate pay-off considerably lower than this but rising in about ten years to the full \$730 per birth prevented. It is not evident how such a varying pay-off could be evaluated, but it does seem clear that earlier estimates of the value of birth control—large as they appeared to be at the time—were, if anything, remarkably conservative.

As a second qualification, it should be observed that our estimate was derived by neglecting any accompanying changes in labor-force participation rates, annual hours of work, or labor productivity, but these tend to change along with fertility and income. On the one hand, reduced fertility not only raises the fraction of population of working age, but also makes it possible for more women to take jobs outside the home. As a result, the effect of declining fertility on age composition is reenforced by rising labor-force participation among women. On the other hand, rising income tends to promote greater leisure, particularly in the form of fewer hours worked per worker each year. In addition, greater leisure permits increased education, while higher income contributes to increased capital formation, both of which raise labor productivity.

Some indication of the interaction among these factors can be had from U. S. experience between 1890 and 1970. Over this period, the fraction of population aged 15 to 64 rose from .61 to .63, accompanied by a rise in labor-force participation rates from .52 to .61. At the same time, however, average annual number of hours worked per worker declined 30 percent, with the net result that annual worker-hours available per capita in 1970 were 15 percent lower than they had been 80 years earlier. The simultaneous rise in real output per worker-hour, of course, more than offset the decline in available worker-hours and left us with real per capita incomes that were more than four times 1890 levels.

In other words, the economic value of reduced fertility involves much more complex relationships than the simple model used here. Nevertheless, it is interesting that the crude estimates reached are of the same general magnitude as those arrived at by other means.

References

Enke, Stephen. 1966. The Economic Aspects of Slowing Population Growth. Economic Journal 76:44–56.

Janowitz, Barbara. 1973. The Effects of Demographic Factors on Age Composition and the Implications for Per Capita Income. Demography 10:507–515.

Zaidan, George C. 1971. The Costs and Benefits of Family Planning Programs. World Bank Staff Occasional Papers, No. 12. Baltimore; Johns Hopkins Press.