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FERTILITY DECLINE IN FOUR ASIAN COUNTRIES: HOW IMPORTANT IS ECONOMIC DEVELOPMENT?

by

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Abstract: The purpose of this paper is to quantify the contribution of economic development to observed fertility decline, with specific reference to the recent experience of Indonesia, Japan, Korea, and Thailand. Economic development is conceived as including such factors as education, urbanization, and child mortality, in addition to income itself. The analysis proceeds in two stages. In the first, recent rates of fertility decline in the four countries are compared to those generated by a system of equations fitted to a cross-section of the world's nations as of 1970. Whereas the equation system provides a plausible account of fertility reduction on a world-wide average, it accounts for only one-third to one-half of that observed in the Asian countries under study. In the second stage of the study, fertility change is analyzed using survey data from Korea and Thailand. Although the results indicate a clear association between fertility decline and development factors, again, one-half to two-thirds of the fertility reduction must be attributed to something beyond economic development, even taken in its widest sense.

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FERTILITY DECLINE IN FOUR ASIAN COUNTRIES: HOW IMPORTANT IS ECONOMIC DEVELOPMENT?[1]

Population research has been preoccupied with estimating fertility trends and differentials; with developing models of fertility behavior; with carrying out surveys aimed at quantifying fertility histories, fertility intentions, attitudes toward contraception and attitudes towards children; and with estimating the factors responsible for fertility decline where it has occured and the factors impeding fertility decline where it has not. Most of this research has been directed toward documentation and explanation of fertility decline, and toward the development of successful population policies in countries that continue to experience rapid population growth.

It is possible to recount only a few of the research findings that have emerged over the last two decades. The impact on fertility of improved educational attainment, particularly of women, has been repeatedly documented in a wide variety of circumstances. With a very few exceptions, higher educational achievement is found to reduce fertility (Cochrane, 1979; Rosenzweig and Evenson, 1976; Michael, 1974). Urbanization appears to be closely related to fertility. Almost invariably, those residing in rural areas want and bear more children than those in the city. The more urbanized people become the fewer children they have. Reduction of child mortality leads to lower fertility, although neither enough to reduce the number of surviving children nor to slow the rate of population growth (Ben-Porath, 1976; Schultz, 1976: Preston, 1978; and Scrimshaw, 1978, Trussel and Olsen, 1983).

Other important research areas have proved less fruitful. The impact of increased income on fertility continues to be a bone of contention. Economic theorists contend that, when the effect is properly isolated, higher income will generally lead to more children (Becker, 1960; Becker and Lewis, 1973; Willis, 1973 and for an alternative view, Easterlin, et al, 1980). Although a number of studies have obtained indications of a positive income effect, many others have failed. In general, the direct effect of income on fertility appears to be small (Schultz, 1973, Simon, 1974).

The purpose of this paper is to present another attempt to quantify the contribution of economic development to observed fertility decline, with specific reference to the recent experience of Indonesia, Japan, Korea and Thailand. For purposes of this research, the term "economic development" is taken in its broadest sense to include the entire range of factors whose changes are concomitants of industrialization and rising income. These specifically include such factors as education, urbanization, child mortality, in addition to income itself.

The analysis proceeds in two stages. In the first, recent rates of fertility decline in the four countries under study are compared to those calculated from a standard development profile that is derived by simulation with a system of equations fitted to a cross-section of the world's nations

as of 1970. This model and its application to simulation of economic development and demographic change has been previously described in Suits and Mason (1978) and Mason and Suits (1982), and need not be repeated here. Several comparisons are made, each indicating that, whereas the standard profile provides a plausible account of fertility reduction on a world-wide average, it accounts for only one-third to one-half that observed in the Asian countries under study.

In the second stage of the study, the relationship of fertility to development is examined by analysis of survey data drawn from the World Fertility Survey in Korea, and from the Survey of Fertility in Thailand. Although the result is a clear indication of a significant association of fertility decline with reduction of child mortality, and with increased education, urbanization, and income, the most important finding is that, again, one-half to two-thirds of the fertility reduction recently experienced by these nations must be attributed to something beyond economic development, even taken in its widest sense.

Economic Development and Fertility: The Standard Profile

Five important factors can be identified as exerting a significant influence on the total fertility rate: child mortality, education, income, urbanization, and religion. Fitted to data from a cross-section of 69 nations as of 1970, the relationship of total fertility (TFR) to these factors is approximated by a statistical equation:

$$(1) \quad TFR_t = [1.5 + \exp(1.767 - 0.6762\, U/N_t - 0.6579\, AT123_t - 0.179\, GNP/N_t + 0.384\, ISLAM + 0.369\, SP)] \,/\, [0.75 + 0.25\, q5_t]$$

where q5 is the proportion of children who survive to age 5, U/N is the proportion of population living in urban areas, AT123 is the percent of adults with at least an elementary education, GNP/N is per capita GNP, and ISLAM and SP are variables that assume, respectively, the value 1 when the country is Islamic or Spanish/Portuguese speaking, and zero otherwise. The derivation of this equation and the procedure by which it was fitted to the data are presented in the appendix to this paper.

According to equation (1), greater educational attainment, a more urbanized population, higher per capita income, and increased child survival all contribute to lower fertility. Given an initial total fertility rate of 4.0 and a child survival rate of 0.88, a ten point increase in either the urbanization rate (U/N) or in the percentage with at least some primary school education (A123) tends to reduce fertility by 0.15 births per woman. A $100 increase in per capita GNP or an increase in child survival by 0.05 stimulates a reduction in fertility amounting to .05 births per woman. In Islamic and Spanish/Portuguese speaking countries, TFR averages about one more birth per woman than elsewhere.

When equation (1) (with ISLAM and SP set to zero) is combined with others that relate labor productivity, investment, education, urbanization, mortality, and other elements into a coherent system, the process of economic development over time can be simulated. The computer simulation of growth from a low-income, high-fertility, high-mortality society to one with high income, and low fertility and mortality is shown in Table 1. For ready reference in what follows, the pattern of simulated time series contained in the table is called the "standard development profile."

In the initial year of the simulation, the total fertility rate stands at 5.45 births per woman. By year 50 the TFR has declined to 4.0 and by year 100 to 2.4. As fertility declines along the standard profile, the magnitude of the individual contribution made by each of the factors in equation (1) varies with the level of fertility and the magnitude of change in the factor in question, both of which tend to vary with the level of development. More developed countries experience relatively large absolute increases in per capita GNP, but relatively small increases in educational attainment or in the urbanization ratio. Many less developed countries, on the other hand, experience rapid urbanization, substantial improvements in the proportion of their population with basic education, but small absolute increases in income.

This is illustrated in Table 2, which shows the decomposition of the decline in total fertility rate along the standard development profile. The change in fertility due to each factor is given for the decades, 10-20, 50-60, and 90-100. The contribution of each factor is estimated by holding all others at their levels as of the beginning of the decade and calculating from equation (1) the change in TFR that would be associated with the change in the factor in question as shown by the profile.

The early stages of the simulated fertility transition are dominated by increased educational attainment, which accounts for half of the decline. By year 50, the TFR has declined to 4 births per woman and increased education has lost its force as a fertility depressant. Over the decade 50-60, increased income and urbanization contribute equally to further fertility decline, and taken together, account for two-thirds of the total. Although increased child survival has its largest impact at this point, fertility declines by only .05 births as a result. By year 90, urbanization is played out as a driving force, leaving rising income as the sole important determinant of fertility decline.

Comparison of Simulation to World-Wide Trends in Fertility

Employing cross-section data based estimates to simulate trends in fertility is a precarious occupation at best. How does the simulated decline compare with actual experience? Figure 1 includes crude birth rates for the United States (1860-1940), England and Wales (1850s-1930s), and France (1830-1940) superimposed on the crude birth rate of the standard profile. The figure indicates substantial differences, but the observed speed of transition was close to that indicated by the profile. The crude

birth rate declined faster in the United States, somewhat more slowly in France, and in England and Wales at essentially the same pace as did the profile birth rate.

Of course, the Western experience took place in a considerably different environment from that faced by countries experiencing fertility decline, today. Recent trends in the crude birth rate for major developing regions of the world are compared in Table 3.

In East Asia (which includes Japan and Korea) and in Latin America the crude birth rate has declined substantially faster than along the standard profile. In South Asia (which includes Indonesia and Thailand), the decline has been equal to that of the profile, whereas there is no evidence of any fertility decline at all among African nations during the period cited. Thus, the standard profile stands as an adequate representation of the world-wide average. Fertility decline in a number of countries, however, has been substantially more rapid than represented by the standard profile. From a policy perspective, identifying the sources of fertility decline where it has been unusually rapid is of particular importance.

Comparison of the Standard Profile with Recent Experience in Indonesia, Japan, Korea and Thailand

Equation (1) is fitted to 1970 data, and when evaluated at levels of the variables observed that year in Indonesia, Japan, Korea, and Thailand, provides reasonable estimates of the fertility actually observed in those countries. Table 4 includes data on observed fertility, that predicted by equation (1), and the difference between the two for each country. The total fertility rates of the year nearest 1970 for Indonesia and Korea were 0.2 to 0.3 births per woman higher than would be expected from their respective levels of socioeconomic development.[2] Fertility rates of Japanese and Thai women, on the other hand, were about half a child less than the level predicted. All in all, the profile conforms closely to the fertility levels observed in these countries at that time.

When we turn from the levels shown in Table 4 to the rates of change contained in Table 5, however, agreement is not nearly so close. All four countries experienced faster fertility decline than that exhibited by the development profile, and, with the exception of Indonesia, the differences are substantial.

In contrast to the standard development profile, which requires thirty years for fertility to decline by one birth per woman, the total fertility rate in Korea from 1960 to 1980 and in Japan from 1947 to 1960 declined at the rate of one birth every five years. In Thailand, the rate of decline was one birth every six years. Even in the case of Indonesia, recently available evidence suggests rapid decline since 1976.

That fertility has declined unusually rapidly in Japan, Korea, and Thailand is widely appreciated by those familiar with the demographic experience there. Considerably less well understood is why they have experienced such rapid change. Two sets of causes can be distinguished. First, to some extent the rapid decline in Asian fertility has been merely the reflection of the extraordinary rate of economic development observed there since World War II. Secondly, and in addition, forces governing fertility in these countries differ to some extent from those that operate in the rest of the world. That is, fertility in the four Asian countries declined more rapidly than would have been expected, even after account has been taken of their exceptional rate of economic progress.

Table 6 includes data that provide one way of separating the two effects. For each nation, figures show total fertility rate as observed in recent years, and the rates calculated from Equation (1) above, given urbanization, education, per capita income, and child mortality as of the same years. The rate of decline in the calculated values represents the contribution of economic growth to fertility reduction. The difference between this and the observed rate of decline constitutes a measure of the contribution of special, country-specific, factors to the rate of reduction of fertility. The contribution of economic growth is, in turn, decomposed into a typical rate of decline of .03 per year, exhibited along the development profile, and a residual attributable to the very rapid rate of economic development observed in the Asian countries.

As seen in the table, economic development accounts for 25 to 100 percent of observed rates of decline in fertility, and except in the case of Thailand, from 33 to 67 percent of this can be associated with economic development rates above average. But, with the exception of Indonesia, up to 1976, this still leaves a substantial component of the decline in fertility associated with special factors, not taken into account in the standard profile.

The role of these special factors is clearly depicted in Figure 2, where observed total fertility rates are plotted on the vertical axis against calculated values on the horizontal. If observed changes in total fertility arose only from things related to economic development, the path shown for each nation would parallel the diagonal line (corresponding to situations where calculated and observed fertility rates are equal.) Plainly, fertility in Japan, Korea, and Thailand have declined more steeply than could be accounted for by rapid social and economic development. Of special interest, however, is the situation in Japan after 1960. By this date, Japanese fertility had declined to the replacement rate, and subsequent reduction was slower than would have been expected from its continued economic growth.

Fertility Relationships from Household Data

Up to this point, all analysis has been in terms of aggregative data. For Korea and Thailand, however, the relationship of fertility to education, income, urbanization, and child mortality can be further explored with data

from surveys of ever-married women. The results substantially agree with the aggregative analysis in demonstrating both the basic importance of economic development in fertility decline and the existence of unidentified elements in the process.

For Korea, data are available from the Korean World Fertility Survey (WFS) sample of 4050 ever-married women. Thai data come from the Survey of Fertility in Thailand (SOFT) conducted by the National Statistical Office of Thailand and the Institute for Population Studies, Chulalongkorn University under the auspices of the World Fertility Survey. In the survey, approximately 5000 ever-married women aged 15 to 49 were interviewed in 1975 and detailed information about their demographic histories obtained. Analysis here is limited to women aged 20 and above at the time of the survey who responded to all relevant questions. The greatest attrition from the sample was due to non-response to the household income question (almost 25% of the respondents). The childbearing experiences of a total of 3516 women is subject to analysis.

Each survey reports the number of children born during the five preceding years to each ever-married woman in respondent households, together with information on her age, child-mortality history, income, and place of residence. These data form the basis for an estimate of marital fertility rates and their relationship to household characteristics observed in the survey. To complete the analysis, marital fertility rates are converted to total fertility by reference to the age-specific probability that a woman has been married.

Marital Fertility

For each woman in the sample, marital fertility is defined as the number of children she has borne per year of marriage during the five years preceding the date of the survey multiplied by five. For women who had been first married five years or more before the survey date, the result is simply the number of children born to her during the preceding five-year period. For women first married less than five years, marital fertility becomes the number of births divided by number of years since marriage, all multiplied by five.

Educational attainment is measured in Thailand as the proportion of parents (either 0, 0.5 or 1.0) with at least four years of schooling. This constitutes the first half of elementary school and, until the educational system was recently changed, was the mandatory (though far from universal) level of education in Thailand. In Korea, primary school education is nearly universal among childbearing women, so education is measured by two variables: the proportion of parents with at least some secondary school education; and the proportion of parents with at least some college education.

Child mortality is estimated for each women as the proportion of children born to her more than five years preceding the interview who failed to live to their fifth birthday. Child mortality could not be estimated for

women who had borne no children more than five years preceding the interview. For such women, child mortality was estimated by a predicted value based on individual socioeconomic and demographic characteristics. Table 7 includes sample means of each variable by location of household and by age of woman two and a half years prior to the survey; i.e., the midpoint of the interval for which fertility is estimated.

The tabulation indicates that, as expected, marital fertility declines steadily with age, and tends to be lower among urban than among rural women. Little else, however, can be discerned. The natural correlation of income, child mortality, and education with age obscures the relationship of these factors to fertility.

To disentangle this correlation among characteristics, their relationship to marital fertility is explored. First, women of the same age and residence are grouped together. Second, fertility is measured for each woman as the proportion by which her own marital fertility deviates from that of the group to which she belongs, and her income, education, and child mortality are similarly measured by arithmetic deviations from their respective group means.

For example, as shown in Table 7, an urban woman aged 20 to 24 is associated with a group whose mean marital fertility is 1.94. If her individual fertility is 3, she is (3 - 1.94)/1.94 = .546, or 54.6 percent above the mean of the group. Similarly, if her income is 35, this is measured as 35 - 49.3 = -14.3.[3] Similar calculations are made for child mortality and education.[4]

The relationship of marital fertility is then estimated as a regression in the form

$$(2)\quad (f_{ij} - \bar{f}_j)/\bar{f}_j = (a_0 + a_1A + a_2A^2)(y_{ij} - \bar{y}_j) + (b_0 + b_1A + b_2A^2)(e_{ij} - \bar{e}_j) + (c_0 + c_1A + c_2A^2)(q_{ij} - \bar{q}_j)$$

where f is marital fertility, y is income, e is education, and q is the rate of child mortality. The subscripts refer to the attribute of the ith woman in the jth age-urbanization group. The coefficients in (2) vary with age of woman. Preliminary experimentation showed that the coefficients were unaffected by urbanization and no allowance was made for variation on this account. The statistical result is given in Table 8. (For a detailed explanation of statistical procedures and results, see Appendix.)

It is easier to understand the relationship when values of the coefficients are examined at selected ages as in Table 9. The results can be seen to parallel the macroeconomic findings. Age-specific marital fertility rates tend to fall with rising income and, in Thailand, with increasing elementary education. The Korean data reveal an interesting

"inverted U" shape in the response of marital fertility to secondary and college education. It is the wife's education that lies behind this puzzling phenomenon. The higher marital fertility of educated Korean women occurs partly because women with more education tend to marry at a later age and hence, on average, have been married fewer years than less educated women in the same age cohort. This tends to place them in the high-fertility period of married life. This is not the entire explanation, however, for even among Korean women of equal marriage duration, educated women still show somewhat higher fertility than their less educated counterparts.

The coefficient of child mortality in the equation is an estimate of the replacement effect and implies that one-quarter of all children who die before age five are replaced through higher fertility in Korea. A very similar result is obtained for Thailand.

Marriage and Age-Specific Fertility Rates

The final step in the analysis of the survey data is to take account of the proportion of women at each age who have ever been married. Examination of the survey data revealed no systematic relationship between income at the date of the survey and the age of the wife at first marriage. Moreover, child mortality is expected to exert its influence largely through its effect on marital fertility and to have little or no bearing on age at first marriage. For this reason, the probability that a woman becomes first married by a given age is approximated as a function of her education and urbanization.[5] The result is shown in Table 10.

Each line of the table applies to a given age. The first column shows the average probability for all women of that age, irrespective of residence or education. The remaining columns give the deviations from the average probability associated with residence and education. For example, in Korea, the average probability that a woman marries before age 20 is .333, but among urban women with college education, the probability is .333+.029-.130= .232.

In Korea, first marriage is heavily concentrated between the ages of 20 and 30. Only 33 percent of women are married before age 20, and only 1.3 percent are married for the first time after age 30. Within these limits, however, age of first marriage is significantly influenced by education and, to a lesser extent, by urbanization. Korean women with more than primary education have substantially lower probability of marriage before 25, but education infrequently delays marriage beyond 30. There is also a small, but statistically significant, probability of earlier marriage by women residing in urban areas.

Age at first marriage varies more widely among Thai women. Although they are slightly more likely than Koreans to be married by age 20, almost 10 percent marry for the first time after age 30. The effect of residence and education on age of marriage is about the same among Thai as among Korean women, except that the estimated probability of early marriage is higher by a slight margin among rural Thai women than among urban dwellers.

Total Fertility Rate

Age-specific total fertility rates can now be estimated from the cross-section data as:

(3) $ASFR = M(a,y,u,e,q) \times P(a,e,u)$

where $M(a,y,u,e,q)$ is the age specific marital fertility rate of women aged a, with income y, urbanization u, eoucation e, and child mortality q, and $P(a,e,u)$ is the proportion of women ageo a, education e, and urbanization u who have ever been married. When age-specific fertility rates are summed over all ages, the result is the total fertility rate of women with the remaining characteristics.

Results of applying equation (3) to women in households w .h selected characteristics is shown in Tables 11A and 11B. Under each heading in the tables, age-specific fertility rates are shown as calculated for women from households that differ only in the indicated way. For example, the first three rows in each table show age-specific rates for urban women with average child mortality experience in households where both spouses have primary education. In the first of these, household income is taken at only twenty-five percent of the mean for the age-urbanization group. In the second row, income is taken at the mean, and in the third row, income is taken as two and a half times the mean. Comparison of the resulting calculated values shows the effect of income differences, all other things held constant. In similar fashion, other rows of the tables permit examination of the difference among households with different educational attainment, residence, or child mortality experience.

As can be seen, fertility, especially that of older women, declines with rising income. In Korea, the ten-fold increase in income from a level 25 percent of the group mean to one 2.5 times the mean is associated with a 4 percent drop in total fertility rate, but among women 35 to 39, the rate declines by 17 percent, and by 30 percent among women 45 to 49. In Thailand, the corresponding decline in total fertility rate is 18 percent, and again it is greater at older ages.

The greater apparent response of fertility to income in Thailand is not entirely a real phenomenon, but stems, at least in part, from the difference in the measurement of income in the two surveys. Whereas we examine the relationship of husband's income to fertility in Korea, the Thai sample reported only total household income, and this is used in the analysis. Thus, the apparent difference in response of fertility to income consists partly of the bias arising because a working wife, by virtue of her employment, not only has lower fertility than other wives, but also adds to the total earnings of the household. This "double-counting" of the wife's status accounts for some of the difference between income elasticity of the fertility response as estimated from the two samples.

In both Korea and Thailand, total fertility of better-educated households is significantly lower than that of the less well-educated. In

Korea, education beyond primary school is associated with fertility rates about 10 percent lower than in households with primary-school education only. Households with college educated spouses, however, display somewhat higher fertility than those with only secondary education, although this is still lower than those with only primary education. In Thailand, the total fertility rate in households where both spouses have at least primary education is a third lower than that among households in which neither spouse has attained that level of schooling.

Comparison with Equation (1)

Although Tables 11A and 11B on the one hand and equation (1) on the other are derived from greatly different methods applied to greatly different data sources, they agree in confirming the response of fertility to changes in income, education, urbanization, and child mortality. It is now interesting to compare the rates of fertility decline implied by the two sets of results. This can be done by comparing the total fertility rates contained in Tables 11A and 11B with those calculated under similar circumstances from equation (1)

Although equation (1) lends itself only crudely to the purpose, the following expedient yields estimated total fertility rates roughly comparable to those included in Tables 10A and 10B. The total fertility rate of urban Korean women from households with primary education and with income equal to the average of their age group was estimated by evaluating equation (1) at the level of GNP per capita observed in Korea in 1975 (the date of the survey), with U/N set to 1 (to make the result consistent with urban women), and with A123 set to 1 (to make the result consistent with both spouses having a primary education.) Child mortality was set at the level observed in Korea in 1975.

The result, shown in Table 12, is a total fertility rate of 4.15, remarkably close to the 4.41 estimated from equation (3) under comparable conditions. To examine the influence of income, additional calculations are made with equation (1), with income set at 25 percent of the observed Korean level, and again with income raised to 2.5 times the observed level, all other conditions being kept fixed. The result is a calculated total fertility rate of 4.32 at the lower income level and 3.86 at the higher.

In similar fashion, the estimated fertility difference between urban and rural women is explored by comparing rates calculated at mean GNP per capita when U/N is set to 1, with those calculated when U/N is set to 0, all other conditions the same.

Similar calculations are made with equation (1) to compare with total fertility rates of Thai women, except that to compare with women in families where neither spouse has a primary education, the value of A123 in equation (1) is set to 0. The resulting calculations produce total fertility rates that are about a third higher than comparable rates based on equation (3).

Given the radically different procedures and sets of data that underlie the two sets of estimates in Table 11, there is no reason to expect the levels of the two sets of estimates to agree closely. Interest attaches, rather, to the way the estimates respond to differences in conditions. The 10-fold increase in income from 25 percent of mean to 2.5 times mean is associated with a 4 percent decline in Korean fertility as estimated from equation (3), half that predicted by equation (1). Although it is partly an expression of the estimation bias referred to earlier, the results for Thailand are nearly the reverse. The 18 percent fertility reduction as estimated from equation (3) is almost double that obtained from equation (1).

The Korean equations do not lend themselves to comparison of the effect of rising education, but according to both equations (1) and (3), total fertility of Thai women in families where both spouses have had a primary education is about 35 percent lower than those in which neither spouse has had primary education.

Finally, in both nations, the influence of urbanization is much greater as measured by equation (3) than by equation (1). Estimates from equation (3) show total fertility rates 10 percent lower among urban than among rural Korean women, and about 30 percent lower among corresponding groups of Thai women. This compares with differences of about 5 percent as calculated from equation (1).

In summary, the data in Table 12 show that when the response of fertility to family income, urbanization, education, and child mortality is analysed with widely different data and statistical procedures, the results are qualitatively the same, but different degrees of response are implied. It remains to compare both results to recently observed fertility decline in Korea and Thailand to determine how much can be attributed to economic development and how much must be laid at the door of non-economic causes.

Equations (1) and (3) can be employed in another way to explore whether and to what extent the rapid fertility decline observed in Korea and Thailand is a reflection of factors other than economic development. Table 13 includes three sets of estimates of total fertility rate. The first row for each country contains published estimates for 1970-75 and 1955-60. The second row contains estimates based on marital fertility rates and their relationship to economic development. For 1970-75, these are obtained from age-specific marital fertility rates shown in Table 7 multiplied by the proportion of women at each age who have ever been married. Urban and rural total fertility rates, derived from the resulting age-specific fertility rates, are averaged on the basis of percent of population urbanized to produce the total fertility rates shown. For 1970-75, these rates are legitimate estimates of actual total fertility, and any difference from the corresponding estimate in the first row arises solely from differences in estimating procedure and is unrelated to causal factors.

The second-row figures for 1955-60, however, are obtained from marital fertility rates calculated from equation (2) on the basis of data for the respective nations as of 1955-60. These are converted to total fertility

rates by reference to percent of ever-married women found at each age and place of residence in 1955-60. Since, by calculation, the resulting 1955-60 estimates of marital fertility bear the same relationship to income, education, and child mortality as had those of 1970-75, any difference between the two figures reflects the influence of these factors alone. Thus the difference between the rate of fertility decline shown by the first row and that shown by the second is a measure of the extent to which factors other than economic development have played a role in fertility reduction.

The third row for each country indicates the total fertility rate obtained when equation (1) is evaluated at the income, urbanization, education, and child mortality observed for the country as of the years in question. Again, since the two estimates in this row involve the same relationship to economic development, any differences between them constitute a measure of the influence of development factors acting alone.

Despite the great differences in data and methodology involved, remarkable agreement among the several sets of estimates are shown in the table. The three estimates of the Korean total fertility rate for 1970-75 agree more closely than the range of error in the data, but there is somewhat greater dispersion among Thai estimates for the same period. All three rows for each nation indicate declining fertility over the fifteen-year interval, but the Korean rate of decline observed in the KIFP estimates is two to three times that of either of the other two. In Thailand, the rate of decline in fertility observed in estimates derived from adjusted registered births is roughly triple that indicated by either of the other estimates.

The close agreement in rates of decline in fertility shown by equation (3) (WFS and SOFT data) and those shown by equation (1) (world cross-section data) confirms the extent to which economic development alone contributed to the observed decline. Comparison with the rate of decline as actually observed indicates that only one-half to one-third of the reduction can be attributed to economic development. The remainder must be attributed to other factors, including those specific to the countries and the time period involved.

Non-economic Factors in Fertility Reduction

For those who have extensively studied fertility change in countries such as Thailand, Korea, and Japan, neither the remarkable decline in fertility of these countries nor its weak relationship to socioeconomic change can be of any surprise. The Thai family planning and fertility experience is most recently recounted by Rosenfield, et al., 1982 and Peerasit, Aphichat and Knodel, 1982, while Knodel and Nibhon, 1978 have offered a number of hypotheses which might explain the rapid pace of Thai fertility decline, stressing the possible contribution of family planning programs, the importance of modernization, and the facilitating or inhibiting role played by cultural factors.

A recent report on Korea (Cho, et al., 1983) summarizes current evidence on fertility determinants by saying: "...economic and social development may be a fundamental cause of fertility transition. However, the family planning program has expedited the process. Cultural factors, [such as] the absence of barriers to ready acceptance of abortion and sterilization, cultural homogeneity in ethnicity, language, and religious tradition, and geographic and political unity, have contributed to rapid fertility transition. The characteristics in turn promote social integration in the form of efficient communication and shared values, norms, and institutions." Similarly, rapid fertility decline in Japan has been attributed to population policy, the passage of the National Eugenics Law in 1948 (Mosk, 1977), facilitated by cultural factors such as those cited above (Yamamura and Hanley, 1975).

A common thread of much of these discussions is the view that social and economic development underlies fertility decline but the timing and pace of decline are strongly influenced by diffusion processes that are imperfectly understood but bound up in the interaction between population policy and cultural factors (Knodel, 1977; Freedman, 1979; Retherford and Palmore, 1983). The evidence presented here, then, re-emphasizes the importance of continued research on diffusion processes and family planning.

To some extent, however, rapid fertility decline is surely attributable to increased "secularization" of society in both East and West. The power of religious beliefs to affect a wide spectrum of human attitudes and behavior including child-bearing can hardly be overlooked. Although total fertility rates in Islam and in the countries that are traditionally conservative Catholic are significantly higher than the world average, there has been important liberalization of attitudes, especially among the latter, on such matters as birth control and divorce.

On the other hand, cogent arguments have been made that change in the family and the roles of its members is responsible for rapid fertility decline. Caldwell (1976), in particular, points to "Westernization," which has proceeded largely independently of social and economic development, as the motivating force in the nucleation of families and the decline in the value of children and family size. Ben-Porath (1980) and Willis (1982), in contrast, point to changes in the family institution more closely linked to social and economic development. If both secularization of society and the altered role of the family are, in fact, only very long run results of the development process, we would expect to find them captured by the standard profile, which is based on relationships fitted to nations at all levels of development and, hence, embodies long run secular factors. (On the other hand, some of these processes would not be captured in the micro analysis carried out.)

It is beyond our purpose to debate this issue here. Suffice it to say that basic development factors are demonstrable contributors to fertility decline. Countries that have enjoyed rapid social and economic development have, as a consequence, also experienced faster decline in fertility. The particularly rapid fertility reduction experienced by Korea, Thailand, and Japan, however, are in large part due to non-development factors.

APPENDIX

Derivation of Equation (1)

Child mortality is introduced into the fertility relationship by defining TFR*, the total fertility rate that would result if childbearing women could achieve their desired completed family size with no losses due to child mortality. TFR* is the aggregate level counterpart of desired completed family size and is determined by factors such as education, income and urban-rural residence. Observed TFR exceeds TFR* because women bear additional children to compensate for child mortality. When the average number of child deaths experienced per woman during her childbearing years is designated by M_t, and where r is the replacement rate:

(A1) $$TFR_t = TFR^*_t + r\, M_t$$

If the replacement rate were one, all children who died would be replaced, and observed TFR would exceed TFR* by the child mortality rate. All women would complete a family of the desired size. If the replacement rate were zero, TFR would equal TFR* and completed family size would be short of desired by the number of child deaths, M.

The number of child deaths equals the number of children born times the probability that a child dies before age five. Equivalently, when q_5 is the probability that a child survives to age 5, $M_t = (1 - q_{5t})\, TFR_t$. Substituting for M_t in equation (A1) and rearranging terms, desired completed family size is given by:

(A2) $$TFR^*_t = TFR_t\, [(1-r) + r\, q_{5t}]$$

The effect of education, income, and urbanization on TFR* (and indirectly on TFR) is estimated using a truncated logistic with a minimum of 1.5:

(A3) $$\ln[TFR^*_t - 1.5] = b_0 + b_1\, U/N_t + b_2\, AT123_t + b_3\, GNP/N_t$$

Where U/N_t = proportion of the population residing in urban areas, $AT123_t$ = the proportion of the adult population with at least primary education, and GNP/N_t = per capita gross national product in thousands of 1973 U.S. dollars.

Substituting for TFR^*_t and rearranging terms, the total fertility rate is given by:

(A4) $$TFR_t = [1.5 + e\,(b_0 + b_1\, U/N_t + b_2\, AT123_t + b_3\, GNP/N_t)]/[(1-r) + r\, q_{5t}]$$

Estimation of the Relationship

The parameters of equation (A4) are estimated in the following way. Survey data for a number of countries including Indonesia, Korea and Thailand yield a consistent estimate of about 0.25 for replacement rates, a value near those estimated elsewhere for other countries. Using this value, TFR* can be calculated from observed TFR, and the remaining parameters of equation (A3) can be estimated directly.

As is frequently the case, however, multicollinearity interferes with the estimating procedure. To circumvent this problem, additional data are employed from a small number of countries for whom fertility rates for rural households are given separately from the total. For these nations, we can define RTFR* as the rural counterpart of TFR*, and when U/N is set equal to zero, equation (A3) implies:

(A5) $\ln[RTFR^*_t - 1.5] = b_0 + b_2\ ED123_t + b_3\ GNP/N_t$

Subtracting equation (5) from equation (3) and rearranging terms yields an alternative estimate for b_1 based on differences between total and rural fertility:

(A6) $b_1 = [\ln(TFR^*_t - 1.5) - \ln(RTFR^*_t - 1.5)] / U/N_t$

This procedure yields an estimate for b_1 equal to -0.676. (The estimate employs data from Liberia, Panama, Malaysia, Pakistan, Austria, Bulgaria, Cuba, Dominican Republic, El Salvador, Korea and Israel.)

Substituting back into equation (A3) and rearranging terms, we obtain estimates of the remaining coefficients and their associated standard errors (in parentheses):

(A7) $$\ln TFR^*_t - 1.5) + 0.6762\ U/N_t = \underset{(0.094)}{1.767} - \underset{(0.214)}{0.6579}\ AT123_t$$

$$- \underset{(0.040)}{0.179}\ GNP/N_t + \underset{(0.123)}{0.384}\ ISLAM + \underset{(0.122)}{0.369}\ SP$$

$$N = 77 \qquad R^2 = 0.725$$

ISLAM takes a value of one for Islamic countries and a value of zero otherwise.

SP takes a value of one for Spanish-Portugeuse countries and a value of zero otherwise.

Substituting the estimated parameters back into equation (A4) yields the estimated relationship between the total fertility rate and all of the independent variables:

$$\text{(A8)} \quad TFR_t = [1.5 + \exp(1.767 - 0.6762\ U/N_t - 0.6579\ AT123_t - 0.179\ GNP/N_t + 0.384\ ISLAM + 0.369\ SP)] / [0.75 + 0.25\ q5_t]$$

Estimation of Fertility Relationships from Survey Data

Since women who had never married were excluded from the surveys, direct estimation of age-specific fertility rates are not possible. Instead, we estimate births per ever-married woman, or what we shall refer to as marital fertility rates. A marital fertility rate is calculated for each woman as the number of children born per five years of marriage over the previous five years. For women first married more than five years ago, the dependent variable is number of children born in the last five years. For women first married less than five years, marital fertility is the number of children born divided by the number of years since first marriage. This yields a measure of fertility at the household level that most closely corresponds to births per ever-married women over the five years preceding the survey.

The household variable most comparable to per capita GNP is household income per household member, but this variable is inappropriate for analyzing fertility at the micro level, because it introduces substantial simultaneity bias. To a lesser extent the use of household income suffers from the same problem, but no satisfactory alternative is available for Thailand. Husband's income is available for the Korean sample and is employed in the estimation.

Functional Form

The relationship of marital fertility rates to other characteristics of the woman is approximated by a linear regression of the percentage deviation of each woman's fertility from that of all women of her age and residence on the deviations of the independent variables from their respective group means. The general functional form is:

$$\text{(A9)} \quad [f_i - \bar{f}_i]/\bar{f}_i = b_1\ [x_i - \bar{x}_i]$$

where:

f_i is the marital fertility rate of woman i

$\bar{f}_i$ is the mean fertility rate of women belonging to the same five year age group and residence (urban or rural) group of woman i.

x_i is any independent variable

$\bar{x}_i$ is the mean value of x_i for women belonging to the same five year age group and residence group as woman i.

To simplify exposition, the equations above include only one independent variable. The equations to be estimated include, of course, three variables: income, education and child mortality.

This particular functional form is used for several reasons. First, it directly controls for systematic variation in marital fertility by mother's age and place of residence. In developing countries, mother's education, household income, and many other determinants of fertility are closely related to age of mother and residence. The standardization procedure adopted here minimizes confounding the effects of variables such as income and education with those of age or urbanization. In the estimation of equation (A9), the effect of x is obtained solely from variation within age-residence groups and not by variation across groups.

A second advantage of this procedure is that it minimizes the problems associated with errors of measurement in income and child mortality. The appropriate income variable should be "permanent" or lifetime income. Current income, which is all that is available, bears a distorted relationship to marital fertility because relatively young couples are not only in prime child-bearing ages, but also earn incomes generally below their life-time average. A spurious relationship between income and fertility can be avoided by restricting analysis to deviations from age group means. Likewise child mortality is frequently under-reported by older women and a biased estimate of the effect of child mortality on fertility can be avoided by analysis of deviations.

A third advantage of this specification is that the approximated relationship between marital fertility and the independent variables can be easily adapted to the aggregate level. The coefficient, b_1, represents the percentage change in marital fertility due to a change in x. The analogous aggregative specification is:

(A10) $$\ln [f_{t+1} / f_t] = b_1 [x_{t+1} - x_t]$$

Whence:

(A11) $$f_{t+1} = f_t \, e^{b_1 [x_{t+1} - x_t]}$$

Given an estimate of b_1, predicting fertility in the aggregate is a relatively simple task.

Equation (A2) can, in principal, be estimated separately for each age residence group, but preliminary analysis yields no significant differences by residence, so urban and rural women are pooled in estimating the regression. In most countries, however, marital fertility is observed to become increasingly concentrated among women of prime childbearing age as fertility declines. This would not occur if all age groups were proportionally affected, so coefficients are allowed to vary by age of woman.

Estimation Procedures and Results

As it stands, equation (A2) is inappropriate for estimation, because of severe heteroskedasticity associated with mothers' age. This problem is easily avoided by transforming (A2) to:

$$f_i = \bar{f}_i + b_1 [x_i - \bar{x}_i] \bar{f}_i. \quad \text{(A12)}$$

Estimated coefficients and their standard errors are provided in Table A1.

Two sets of regressions are reported. The first excludes the age interaction terms to provide estimates of the "average" impact of the independent variables for all age groups taken together. The second contains age interactions to allow the coefficients to vary with age of woman.

Age of Marriage

The influence of development factors on the timing of marriage is represented by the function m(a,e,u), which gives the proportion of women with education e and urbanization u that marry for the first time by age a. Child mortality is not included in the function because it operates almost exclusively on marital fertility and has little, if anything, to do with the age at which women marry. A woman's income or earning potential at the time marriage is under consideration probably exerts some influence on the likelihood of marriage, but such earnings figures are unavailable in the survey. Preliminary analysis produced no evidence that income reported at the time of the survey bares any systematic relationship to the timing of the marriage, which had generally occurred many years earlier.

Estimation Procedures and Results

Given a survey restricted to married women, with the date of marriage of each, the proportion of women married for the first time by age a can be estimated as follows: Define D_i as a dummy variable that takes the value $D_i = 1$ if woman i was ever-married at age a and $D_i = 0$ otherwise. The proportion of women married at age a is then expressed by:

$$Di = b0 + b1\ Urban_i + b2\ Ed_i + u_i \quad \text{(A13)}$$

A number of well-known problems associated with the estimation of dichotomous dependent variables rules out the application of ordinary least squares to equation (A13). An even more serious problem results from truncation bias associated with exclusion from the data of women who have not yet married.

Suppose we were to estimate the proportion of women married by age 20. We would obviously not include in the analysis data for respondents under age 20 because, by definition, all such women in the sample had married before they were 20 years old. Moreover, 73 percent of respondents 20 to 24

were also women who had married by age 20. By comparison, fewer than 60% of respondents over the age of 30 married before the age of 20. These differences derive entirely from the sampling design.

Let M(x) be the number of women who marry at age x. The ratio of women married by age a to those who eventually marry, m(a), is given by:

(A14) $$m(a) = \sum_{x=0}^{a} M(x) \Big/ \sum_{x=0}^{50} M(x)$$

Let P a y be the ratio of women married by age x given that they are ever-married by age y, where y a. Then,

(A15) $$P\{a|y\} = \sum_{x=0}^{a} M(x) \Big/ \sum_{x=0}^{y} M(x)$$

Expanding equation (A15):

A16) $$P\{a|y\} = \left[\sum_{x=0}^{a} M(x) \Big/ \sum_{x=0}^{50} M(x)\right] \Big/ \left[\sum_{x=0}^{y} M(x) \Big/ \sum_{x=0}^{50} M(x)\right]$$

(A17) $$P\{a|y\} = m(a) / m(y)$$

Rearranging terms, the desired measure of marriage, m(a), is given by:

(A18) $$m(a) = P\{a|y\}\ m(y)$$

Of all women who eventually marry, the proportion who marry by age a equals the proportion of women who marry by age a given that they marry by age y times the ratio of women who marry by age y to those who eventually marry.

The model employed below is very simple. Namely, the probability of marriage by age a is approximated as a linear function of the proportion of the partners (0, .5 or 1.0) with at least primary school education, and a dummy variable that equals one if the wife currently resides in an urban area. (Although a logistic or similarly constrained function is typically used for probability functions so as to avoid out-of-range predictions, this is often unnecessary when the independent variables are categorical, as is the case here.)

(A19) $$m_i[a] = b_0(a) + b_1(a)\ Ed_i + b_2(a)\ Urban_i + e_i$$

and as above:

(A20) $$m_i[a] = P_i[a|y]\ m_i[y] \qquad y > a$$

Where for estimation purposes $P_i[a|y]$ is replaced by its dummy variable counterpart:

$D_i[a|y] = 1$ if woman i currently aged y was married by age x

$= 0$ if woman i currently aged y was not married by age x

Although $m_i[y]$ is not observable it can be approximated from the experience of women older than age y; i.e.,

(A21) $m_i[a] = P_i[a\ y]\hat{m}_i[y] = b_0(a) + b_1(a)\ Ed_i + b_2(a)\ Urban_i + e_i$

$\hat{m}_i(y) = \hat{b}_0(y) + \hat{b}_1(y)\ Ed_i + \hat{b}_2(y)\ URBAN_i,\ y > a.$

Initial estimates are obtained by restricting the sample to older ages at which m[y] is relatively constant and close to one. Preliminary analysis of the Thai data indicated that m[y], for $y > 35$, was not significantly related to education or urbanization; i.e., $m[y] = b_0[y]$ for $y > 35$, and the relationship to age is approximated by a logistic:

(A22) $\hat{m}(y) = 1 - \exp\ (4.0556 - 0.2465\ y) \qquad y \geq 35$

A final estimate of m[35] and preliminary estimate of m[30] are obtained, again from the sample of women over age thirty-five at the time of the survey using the adjustment factor given by equation (A22):

(A23) $m[35] = D[35|y]\ \hat{m}[y] = b_0(35) + b_1(35)\ Ed + b_2(35)\ URBAN$

$m[30] = D[30|y]\ \hat{m}[y] = b_1(30) + b_1(30)\ Ed + b_2(30)\ Urban$

where $D[35|y]$ and $D[30|y]$ are dummy variables equal to one if respondent was married by her 35th and 30th birthdays, respectively.

It is now possible to obtain a final estimate of m[30] and a preliminary estimate of m[25] enlarging the sample to include all women over thirty at the time of the interview. The adjustment factor for women over age 35 is still given by equation (A22). For $30 < y < 35$, $\hat{m}[y]$ is obtained by linear interpolation between $\hat{m}[35]$ and $\hat{m}[30]$. We continue, in like fashion, estimating the probability of marriage at younger ages, enlarging the sample size as we proceed. Similiar procedures were employed in the case of Korea.

Analysis, similiar to that in any standard econometric textbook, shows that estimating the dummy-type dependent variable using OLS produces heteroskedastic disturbances. Consequently, weighted least-squares procedures were employed in the final estimation stage.

Since the survey data from which m(a) is derived excludes women who never marry, a final step is needed to complete the analysis. Let k be the proportion of women who eventually marry (that is, 1 - k is the proportion of women who remain unmarried throughout their lives.) The proportion of

all women of education e, urbanization u who marry for the first time before age a is then km(a,e,u), where m(a,e,u) is the function derived from the survey of married women.

Estimates of k for women who have passed the marrying years are available from other sources. In Korea, 99.7% of all women aged 40-44 and 99.8% of all women 45-49 in 1975 were ever-married. (Source: Economic Planning Board, 1975 Population and Housing Census Report, 1977.) While in Thailand, 96.1% of all women aged 40-44 and 96.9% of all women aged 45-49 in 1975 were ever-married. Predicted trends in the TFR reported above are based on the assumption that these percentages will not change substantially in response to changes in development factors.

Table A1. Estimated Marital Fertility Equations for Thailand and Korea.

Variable	Thailand		Korea	
Income	-.000131 (.00005)	.00228 (.00109)	-.00039 (.00027)	-.00351 (.00936)
X Age		-.000155 (.000080)		.00305 (.00066)
X Age^2		.00000217 (.00000140)		-.00000658 (.0000115)
Education 1	-.118 (.051)	-1.299 (.990)	.0804 (.0277)	-1.23 (.794)
X Age		.103 (.0731)		.0903 (.0589)
X Age^2		-.00214 (.00131)		-.00150 (.00108)
Education 2		.2307 (.0493)		-2.264 (1.58)
X Age				.169 (.112)
X Age2				-.00279 (.00197)
Mortality	.210 (.056)	-.888 (1.102)	.242 (.066)	-.987 (2.49)
X Age		.0752 (.0819)		.0752 (.168)
X Age^2		-.00119 (.00147)		-.00111 (.00280)

NOTES

1. We gratefully acknowledge the cooperation of the United Nations Fund for Population Activities in carrying out this research. We received considerable help from our colleagues including Lee-Jay Cho, Griffith Feeney, Sung-Yeal Koo, Toshio Kuroda, Hiro Ogawa, Nipon Poapongsakorn, Robert Retherford, and Hananto Sigit. In addition, Gayle Uechi, Nimfa Mendoza, and Sung-Chul Chung provided invaluable technical assistance.

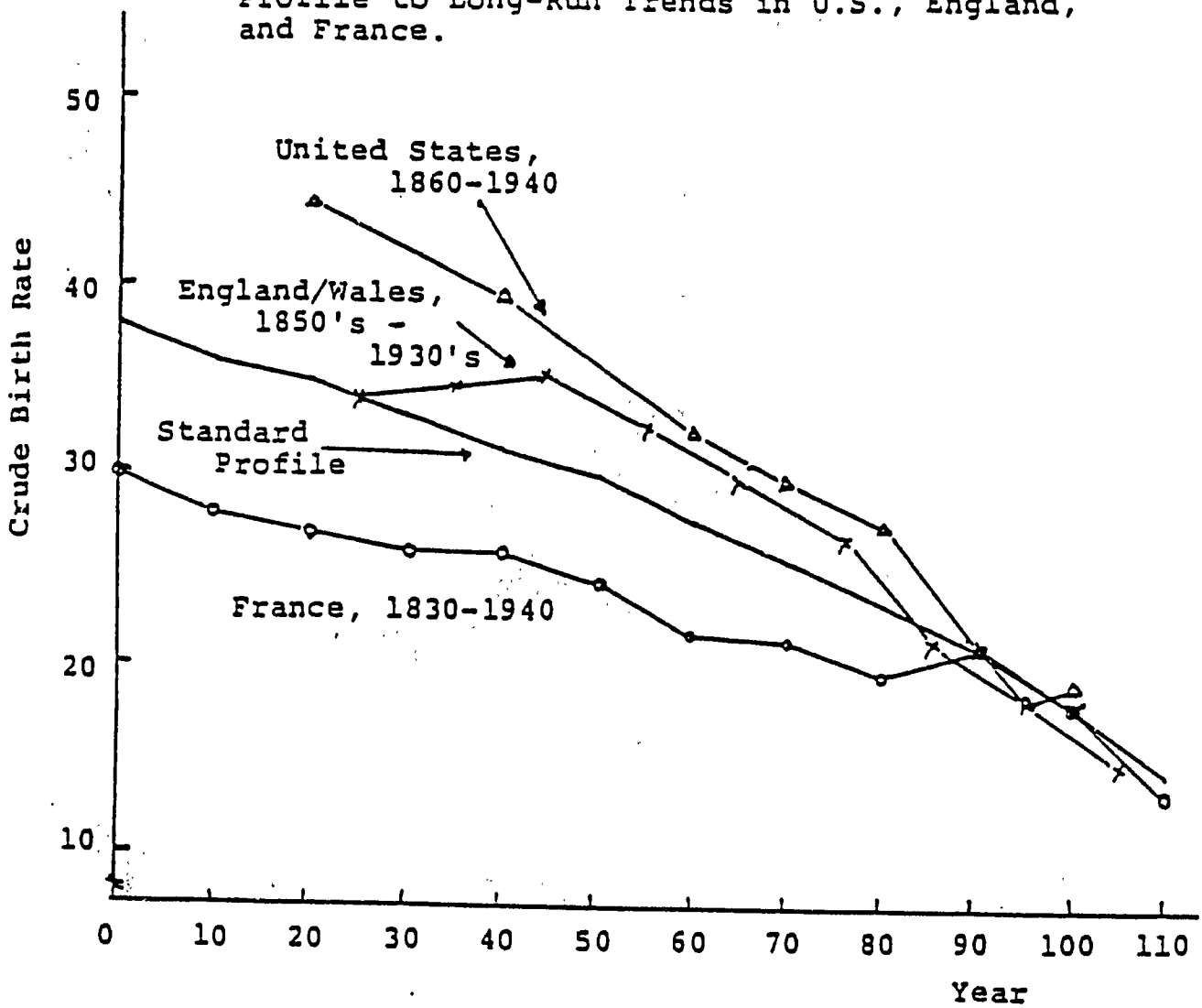
2. Results for Indonesia are based on the Non-Islamic variant of the fertility equations. Setting Islam to one results in substantial over-prediction of the TFR and the mean age at childbearing. Although Indonesia is an Islamic nation, its cultural heritage is quite distinct from the Islamic nations of the Middle East and North Africa.

3. To eliminate the potential bias that might result from the higher income and lower fertility of those households with working wives, husband's income was used as the appropriate measure of household income in Korea. Data on husband's income was unavailable in the Thai survey, and household income was employed in Thailand in default of a better measure.

4. The survey of Thai women indicates only whether individuals have had at least primary education; since primary education is virtually universal in Korea, the survey indicates whether they have attained at least secondary education or have attended college. Education of the household is measured as the proportion of spouses who have attained at least the indicated level of schooling. For example, in a Thai household where only one spouse has had at least primary schooling, the value of the education variable eij is .5. In Korea, each household is associated with two educational variables: the proportion of spouses who have at least some secondary school; and the proportion who have attended college.

5. The statistical processing of the data required to estimate the probability of first marriage by a given age from a survey of ever-married women presents a number of interesting technical problems that are relegated to the appendix of this article.

Figure 1. Crude Birth Rate: Comparison of Standard Profile to Long-Run Trends in U.S., England, and France.



Sources: B.R. Mitchell, European Historical Statistics, 1750-1970 (Columbia University Press, New York) 1975; U.S. Department of Commerce, Bureau of the Census, Historical Statistics of the United States, Pt. 1, Washington, D.C., 1975. E.A. Wrigley, Population and History (McGraw-Hill Book Co, New York) 1975.

Figure 2. Comparison of Calculated and Observed TFR's.

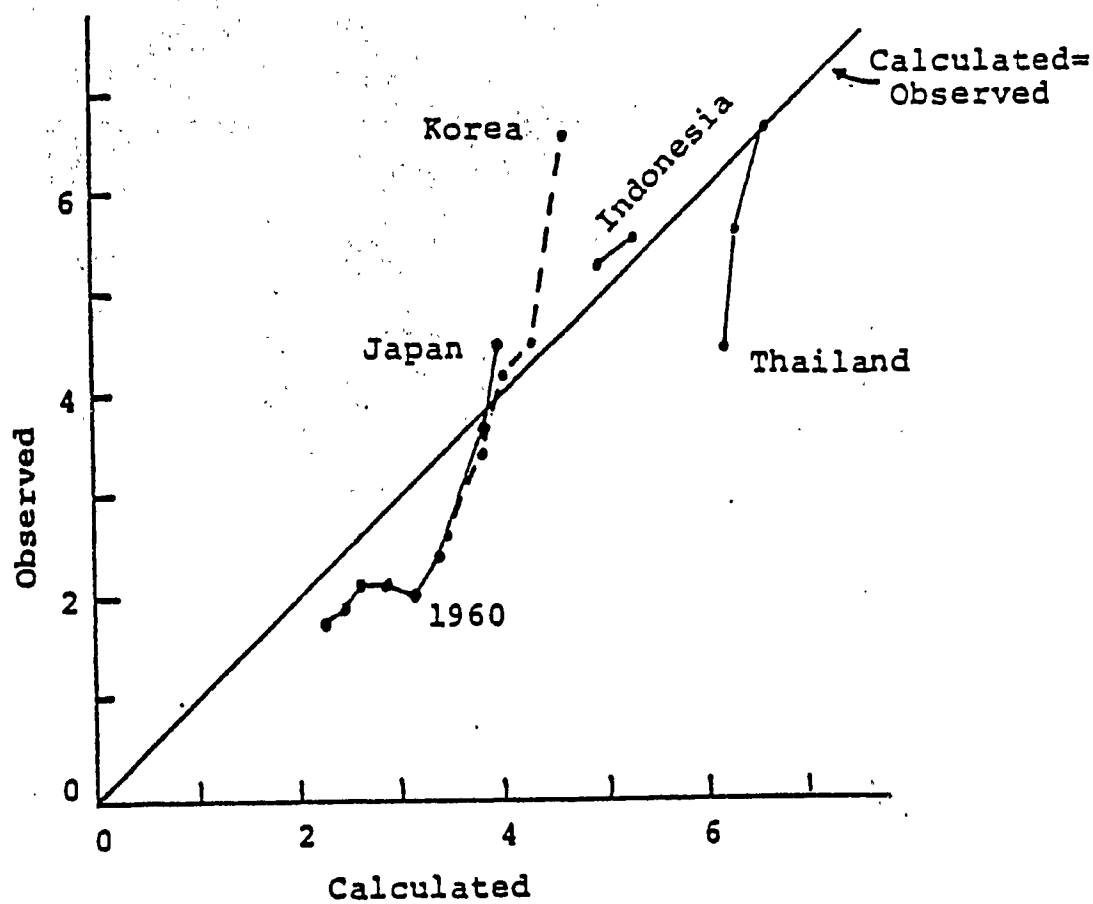


Table 1. Profile of Development

Year	Economic Factors				Demographic Factors				
	GNP/N	GCF/GNP	LF Part		Farm	TFR	Eo	RNI	POP
			Male	Female					
0	100	0.204	0.734	0.361	0.751	5.45	41.3	15.9	100
10	143	0.189	0.734	0.362	0.741	4.96	44.4	16.4	117
20	202	0.190	0.731	0.367	0.716	4.70	47.3	17.3	138
30	282	0.190	0.731	0.369	0.683	4.47	49.8	17.1	164
40	395	0.195	0.725	0.369	0.640	4.26	52.4	16.9	195
50	561	0.203	0.722	0.371	0.581	4.01	57.4	17.8	231
60	797	0.209	0.716	0.370	0.504	3.73	65.4	19.0	277
70	1149	0.223	0.705	0.368	0.409	3.45	68.3	17.8	335
80	1745	0.243	0.695	0.368	0.293	3.13	69.3	15.6	398
90	2786	0.260	0.684	0.367	0.175	2.75	70.7	13.2	462
100	4729	0.284	0.680	0.374	0.129	2.35	72.8	10.3	524

Year	Enrollment Ratios			Educational Attainment				
	First	Second	Third	None	First	Second	Third	Weight
0	0.786	0.245	0.017	0.361	0.489	0.139	0.011	1.33
10	0.827	0.323	0.022	0.318	0.501	0.168	0.013	1.40
20	0.854	0.378	0.025	0.249	0.505	0.229	0.017	1.44
30	0.877	0.436	0.028	0.195	0.483	0.301	0.021	1.48
40	0.899	0.499	0.032	0.155	0.445	0.376	0.024	1.51
50	0.935	0.584	0.036	0.125	0.394	0.453	0.028	1.54
60	0.989	0.698	0.041	0.102	0.333	0.533	0.032	1.57
70	0.990	0.806	0.048	0.084	0.256	0.623	0.037	1.59
80	0.990	0.946	0.058	0.064	0.178	0.716	0.042	1.62
90	0.990	0.990	0.073	0.044	0.114	0.792	0.050	1.65
100	0.990	0.990	0.097	0.030	0.065	0.847	0.058	1.67

Table 2. Determinants of Fertility Decline

Year	Initial Fertility	Change in Fertility	Due to			
			Urbanization	Education	Income	Survival
10-20	5.01	0.30	0.05	0.17	0.04	0.04
50-60	4.00	0.26	0.09	0.04	0.09	0.05
90-100	2.81	0.38	0.02	0.01	0.35	0.01

Table 3. Trends in the Crude Birth Rate: Major Regions and the Standard Development Profile

Place	Years				Total Change
	1955-59	1960-64	1965-70	1970-75	
Africa	46	47	46	46	0
Latin America	43	41	39	36	7
East Asia	39	33	31	26	13
South Asia	44	42	44	41	3
Profile	38	37	36	35	3

Sources for Regional Data: United Nations, Demographic Yearbook, various issues. Profile values are for years 0 to 15.

Table 4. Actual and Predicted Fertility for Indonesia, Thailand, Korea and Japan.

Country	Actual TFR	Predicted TFR	Difference
Indonesia			
1971	5.47	5.23	0.24
1976	5.24	4.97	0.27
Thailand			
1961	6.6	6.6	0.0
1965	6.8	---	---
1970	5.6	6.3	-0.7
1975	4.4	6.2	-1.8
Korea			
1960	6.54	4.60	1.94
1965	4.59	4.36	0.23
1970	4.27	4.04	0.23
1975	3.22	3.78	-0.56
1980	2.80	3.54	-0.74
Japan			
1947	4.54	3.94	0.60
1950	3.65	3.72	-0.07
1955	2.37	3.36	-0.99
1960	2.00	3.14	-1.44
1965	2.14	2.91	-0.77
1970	2.14	2.59	-0.45
1975	1.91	2.46	-0.55
1980	1.74	2.32	-0.58

Table 5. Decline in TFR for Indonesia, Thailand, Japan, Korea, and the Development Profile.

Country	Years of Observation	Fertility Decline Total	Fertility Decline Per Year	Years for One Birth Decline
Indonesia	1971-1976	0.20	0.04	25
Thailand	1961-1975	2.20	0.16	6
Korea	1960-1980	3.74	0.19	5
Japan	1947-1980	2.80	0.08	12
	1947-1960	2.54	0.20	5
Profile	0-100	3.05	0.03	30
	0-50	1.45	0.03	30
	50-100	1.60	0.03	30

Table 6. The Importance of Rapid Development for Fertility Decline in Indonesia, Japan, Korea and Thailand

Date	TFR Actual	TFR Eqn. 1	Average Annual Rate of Decline Actual	Average Annual Rate of Decline Eqn. 1	Decline Associated with: Normal growth	Decline Associated with: Rapid growth	Decline Associated with: Special factors
Indonesia							
1971	5.47	5.23					
1976	5.24	4.97	.046	.052	.030	.022	-.006
Japan							
1947	4.54	3.94					
				(changes 1947 - 1960)			
1960	2.00	3.14	.195	.062	.030	.032	.133
				(changes 1960 - 1980)			
1980	1.74	2.32	.013	.041	.030	.011	-.028
Korea							
1960	6.54	4.60					
1980	2.80	3.54	.187	.053	.030	.023	.134
Thailand							
1961	6.60	6.60[a]					
1975	4.40	6.20	.157	.027	.030	-.003	.130

[a]value for 1960.

Table 7. Mean Values of Variables.

Korea

Age	Husband's Income Urban	Husband's Income Rural	Child Mortality Urban	Child Mortality Rural	Secondary Education Urban	Secondary Education Rural	College Education Urban	College Education Rural	Marital Fertility Urban	Marital Fertility Rural
15-19	38.89	27.85	---	---	.53886	.26405	.061	.001	2.15	1.97
20-24	49.43	32.13	.085	.060	.57767	.35921	.068	.025	1.94	2.04
25-27	53.14	34.17	.072	.075	.50057	.30788	.142	.053	1.67	1.67
30-34	55.56	34.42	.050	.075	.43562	.23425	.170	.025	.97	1.19
35-39	56.76	35.16	.071	.097	.35922	.15678	.157	.040	.31	.68
40-44	64.62	34.96	.102	.140	.24844	.11015	.162	.048	.09	.34

Thailand

Age	Household Income Urban	Household Income Rural	Child Mortality Urban	Child Mortality Rural	Primary Education Urban	Primary Education Rural	Marital Fertility Urban	Marital Fertility Rural
20-24	244.93	146.15	.042	.078	.390	.073	1.6186	1.7552
25-29	349.80	126.87	.050	.118	.384	.097	1.5016	1.4988
30-34	334.05	132.17	.063	.108	.403	.059	.9140	1.1993
35-39	258.80	148.11	.080	.108	.239	.033	.5028	.9742
40-44	293.26	157.46	.106	.131	.253	.040	.4404	.6908
45-49	388.66	181.20	.085	.140	.303	.067	.2105	.2397

Table 8. Coefficients of Equation (2)

	Thailand	Korea
Income	.00228	-.00351
x Age	-.00155	.000305
x Age^2	2.17×10^{-6}	-6.58×10^{-6}
Education 1	1.299	-1.23
x Age	.103	.0903
x Age^2	-.00214	-.0015
Education 2	----	-2.264
x Age	----	.169
x Age^2	----	-.0015
Child Mortality	-.888	-.987
x Age	.0752	.0752
x Age^2	-.00119	-.00111

Table 9. Coefficients of Equation (2) by Age of Woman

Age	Husband's Income	Child Mortality	Secondary Education	College Education
Korea				
15 - 19	-.19D-03	-.8D-02	-0.11	-.17
20 - 24	.2D-04	.15	.04	.12
25 - 29	-.1D-03	.25	.11	.26
30 - 34	-.55D-03	.29	.12	.27
35 - 39	-.13D-02	.28	.05	.13
40 - 45	-.24D-02	.21	-.10	-.14
Thailand				
15 - 19	.2D-03	.064	-.15	
20 - 24	-.1D-03	.20	-.06	
25 - 29	-.3D-03	.28	-.08	
30 - 34	-.5D-03	.30	-.21	
35 - 39	-.5D-03	.26	-.45	
40 - 45	-.2D-03	.16	-.79	

Table 10. Probability of First Marriage before Indicated Age as a Function of Place of Residence and Level of Education of Woman

		Deviation from Average Associated with:				
		Residence		Level of Education		
Age	All Women	Urban	Rural	Primary	Secondary	College
Korea						
20	.333	.029	-.029	.290	-.160	-.130
25	.849	.013	-.013	.126	-.012	-.115
30	.987	-.0017	.0017	.009	-.009	.000
Thailand						
15	.045	-.006	.006	.021	-.021	
20	.356	-.030	.030	.190	-.190	
25	.744	-.015	.015	.124	-.124	
30	.880	-.005	.005	.060	-.060	
35	.958	-.012	.012	-.002	.002	

Source: Regression coefficients fitted to samples of ever-married women, multiplied by .998 (Korea) or .969 (Thailand) to adjust for the proportion of women who never marry at all.

Table 11A. Age-specific Fertility Rates as Calculated from Equation (3) Under Specified Conditions, Korea*

	15-19	20-24	25-29	30-34	35-39	40-44	45-49	TFR
Income =								
.25 x mean	.12	1.54	1.51	.89	.31	.10	---	4.47
mean	.11	1.54	1.50	.87	.30	.09	---	4.41
2.5 x mean	.11	1.54	1.49	.83	.26	.07	---	4.30
Urbanization								
Urban	.11	1.54	1.50	.87	.30	.09	---	4.41
Rural	.10	1.14	1.45	1.13	.67	.34	---	4.83
Education-Both spouses have:								
Primary Ed.	.11	1.54	1.50	.87	.30	.09	---	4.41
Secondary	.10	1.03	1.55	.97	.31	.08	---	4.04
College	.10	1.03	1.69	1.12	.34	.08	---	4.36
Child Mortality								
mean	.11	1.54	1.50	.87	.30	.09	---	4.41
.01 below	.11	1.53	1.50	.87	.30	.09	---	4.40

*Except as indicated, all rates are calculated for urban women in households with average income and child mortality for age-urbanization group, and where neither spouse has more than primary education.

Table 11B. Age-Specific Fertility Rates as Calculated from Equation (3) Under Specified Conditions, Thailand.*

	15-19	20-24	25-29	30-34	35-39	40-44	45-49	TFR
Income =								
.25 x mean	.43	1.15	1.49	1.04	.57	.54	.26	5.48
mean	.43	1.13	1.38	.93	.52	.50	.25	5.14
2.5 x mean	.44	1.09	1.17	.72	.43	.43	.23	4.51
Urbanization								
Urban	.43	1.13	1.38	.93	.52	.50	.25	5.14
Rural	.59	1.31	1.41	1.25	1.04	.80	.29	6.69
Education								
Low	.43	1.13	1.38	.93	.52	.50	.25	5.14
High	.10	.59	1.03	.73	.41	.33	.15	3.34
Child Mortality								
Mean	.43	1.13	1.38	.93	.52	.50	.25	5.14
.01 below	.43	1.13	1.38	.93	.52	.50	.25	5.14

*Except as indicated, figures apply to urban women in households with mean income, and where neither spouse has had an elementary education.

Table 12. Response of Total Fertility Rates to Changes in Selected Conditions: As Estimated from Survey Equation (3), and from World Cross-Section Equation (1)*

	Korea		Thailand	
	Equation(3)	Equation(1)	Equation(3)	Equation(1)
Income =				
.25 x group mean	4.47	4.32	5.48	7.07
equal to group mean	4.41	4.16	5.14	6.84
2.5 x group mean	4.30	3.86	4.51	6.41
Education				
Both spouses have:				
less than primary	---	6.62	5.14	6.84
primary education	4.41			
secondary	4.04	4.16	3.34	4.29
college education	4.36			
Urbanization				
Urban	4.41	4.16	5.14	6.84
Rural	4.83	4.34	6.69	7.21

*Except as noted, "equation (3)" values were calculated for urban women with average income for their age class and where both spouses have low educational attainment (primary education in Korea, less than primary education in Thailand.) Equation (1) values were calculated with mean GNP per capita and child mortality as of 1975. The urbanization ratio was set to 1, corresponding to urban women, and A123 was set to 1 for Korea, corresponding to a situation where both spouses have primary education, and to 0 for Thailand, corresponding to a situation where neither spouse has a primary education.

Table 13. Comparison of Changes in Total Fertility Rate in Korea and Thailand as Estimated by Different Procedures, 1955-50 to 1970-75.

	1970 - 75	1955 - 60	Average Annual Rate of Change
Korea			
KIFP	3.9	6.3	-.16
WFS	4.1	4.9[a]	-.064
Eqn. (1)	3.9[b]	5.2[c]	-.086
Thailand			
Composite Est.	5.0	6.6[d]	-.140
SOFT	5.6	6.0[a]	-.032
Eqn. (1)	6.2[b]	6.6[c]	-.027

[a]Back projection based on marital fertility equations derived from WFS data (Korea) or SOFT data (Thailand).

[b]1975

[c]1960

[d]1961

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