WPS1045

Policy Research

WORKING PAPERS

Women in Development

Population and Human Resources
Department
The World Bank
November 1992
WPS 1045

# Social Gains from Female Education

## A Cross-National Study

Kalanidhi Subbarao
and
Laura Raney

Female secondary education, family planning, and health programs all reduce fertility and infant mortality — but the effect of female secondary education appears to be particularly strong.

Policy Research

WORKING PAPERS

Women In Development

WPS 1045

This paper is a product of the Women in Development Divis on, Population and Human Resources Department. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Maria Abundo, room S2-270, extension 36820 (November 1992, 50 pages).

Subbarao and Raney explore the strength of female secondary education relative to, and in combination with family planning and health programs in reducing fertility and infant mortality. They find that family planning and health programs do influence fertility and mortality, but that the impact of expanding female secondary enrollments appears to be much greater, especially in countries with low female secondary enrollment. Fertility and infant mortality are more elastic with respect to female secondary education than to family planning and health programs. Their simulations suggest:

• Doubling female secondary school enrollment (from 19 to 38 percent) in 1975 would have reduced the total fertility rate in 1985 from 5.3 to 3.9. Doubling the "family planning service score" (from 25 to 50 percent) in 1982 would have reduced the total fertility rate only from 5.5 to 5.0.

• Doubling female secondary school enrollment in 1975 from 19 to 38 percent would have reduced the infant mortality rate from 81 to 38. Halving the ratio of population per physician would have reduced the infant mortality rate only from 85 to 81. Doubling per capita GDP from $650 to $1,300 would have reduced the infant mortality rate only from 98 to 92.

• Doubling female secondary school enrollment (from 19 to 38 percent) in 1975 would have lowered the number of births by 29 percent of the 1985 number. Doubling family planning services would have reduced it by 3.5 percent.

• Doubling female secondary school enrollment would have reduced infant deaths by 64 percent. Halving the ratio of population per physician would have reduced it only by 2.5 percent. Doubling per capita GDP has no effect on reducing infant deaths, all other factors being constant.

Female education affects desired family size by raising the opportunity cost of a woman's time in economic activities, increasing demand for family planning, and promoting more effective contraceptive use.

# SOCIAL GAINS FROM FEMALE EDUCATION:

# A CROSS-NATIONAL STUDY

**K. Subbarao and Laura Raney**

**PHRWD**

## Table of Contents



## Tables



## Appendices

SUMMARY

i. Female education increases the value of women's time in economic activities by raising labor productivity and wages (with a consequential rise in household incomes and a reduction in poverty). Female education also produces social gains, by improving health (the woman's own health and the health of her children), increasing child schooling, and reducing fertility. This paper is concerned with the estimation of these social gains from female education. The paper examines the role of female education (measured by gross enrollment rates at the secondary level) relative to, and or/in combination with, some health and family planning services that influence fertility and infant mortality. It uses reduced-form estimation of the total fertility rate (TFR) and infant mortality rate (IMR). The paper presents cross-country regressions based on data drawn from 72 developing countries. The results from these cross-country regressions should be interpreted cautiously as they may not be representative of a particular country's experience and reflect the usual problems of relying on national averages. Moreover, the aggregate measures of education, health, and family planning available to us provide little information on the specific kinds or quality of services. However, the results are broadly consistent with evidence using household data sets (see e.g. an overview by Schultz 1989, an overview by Cochrane et al 1980, and studies by Gertler and Molineaux 1972; Rosenzweig and Schultz 1987; and Schultz 1988, 1990).

ii. The analysis in this paper generally shows that female secondary education, family planning, and health programs all affect fertility and mortality, and the effect of female secondary education appears to be very strong. Moreover, our results suggest that family planning will reduce fertility more when combined with female education, especially in countries that now have low female secondary enrollment levels. The elasticities of fertility and infant mortality with respect to female education substantially exceed those with respect to family planning and health programs when the elasticities are estimated with appropriate controls. Simulations in the paper were based on our equation using gross enrollment rates for secondary education from 1975, which we consider a more plausible

scenario than with 1970 enrollment rates. In this equation, family planning is significant when interacted with female secondary education. Thus, the effect of family planning should be evaluated with reference to specific education levels. The simulations suggest that a doubling of female secondary enrollments (from the mean of 19 percent to 38 percent) in 1975 would have reduced the total fertility rate (TFR) in 1985 from 5.3 to 3.9, whereas a doubling of the "family planning service score" (from 25 percent to 50 percent) in 1982 would have reduced the TFR in 1985 from 5.5 to 5.0. The implications of female secondary education for reducing the infant mortality rate (IMR) are also striking. A doubling of female secondary enrollments in 1975 from the mean of 19 percent to 38 percent would have reduced the IMR from 81 to 38, whereas halving the ratio of population per physician would have reduced the IMR from 85 to 81. A doubling of GDP per capita from $650 to the median level of $1300 would have reduced IMR from 98 to 92.

iii. Simulations were also done to compare the differences in the quantitative magnitudes of the gains (in terms of births and deaths averted) from female secondary education with the gains from expansion of family planning and some health program efforts to reduce fertility and infant mortality. Doubling female secondary school enrollments from 19 percent to 38 percent in 1975, keeping all other variables (including family planning services) constant at their mean values, would have lowered the number of births by 29 percent compared to the actual number in 1985. By contrast, doubling family planning services, holding female secondary enrollment constant at the mean, would have reduced the number of births by 3.5 percent. Simulations show that the gains from female education are also striking in terms of deaths averted. While doubling secondary female education reduces infant deaths by 64 percent, halving the ratio of population per physician reduces the number of infant deaths by 2.5 percent, whereas a doubling of GDP per capita from $ 650 to the median level of $ 1300 would have no effect on reducing infant deaths, keeping all other factors constant.

iv. Female education influences fertility and mortality through many pathways. For example, education affects desired family size by enhancing the opportunity cost of a woman's time in economic activities relative to child-bearing and by changing her aspirations, thus building demand for family planning services. Maternal education promotes child health which in turn affects desired family size. Education also promotes more effective contraceptive use and more willingness to use modern contraceptive methods -- which is, we believe, why we find that education and family planning interact in our TFR equation. Exploring these pathways is important from a policy perspective. Yet the limitations of data and estimation methods prevent us from attempting a detailed analysis of the relative importance of the various pathways. A limited attempt was made to examine the determinants of desired family size for a small sample of 37 countries for which data were available. After controlling for other key factors (such as the level of economic development of a country), female secondary education retains its high statistical significance. However, "desired family size" is a subjective concept, so most researchers rely more on estimates of TFRs observed directly. Among the determinants of contraceptive use, female secondary education and the family planning service score are each highly significant.

v. The research findings suggest that it would be valuable to study further the costs and benefits associated with education, health, and family planning programs. Data limitations prevented us from doing so, but any comparison of the benefits of female education and health and family planning services should take cognizance of the multiple benefits from both. Timing should also be considered. The female education route to reduce fertility or infant mortality needs 10-15 years to bring tangible results. While family planning can in principle have a shorter run impact, expanding either health or family planning programs in countries with poor administrative structures is difficult and also takes time. As of 1982, only two countries, China and Indonesia, had been able to reach a family planning service score of 78, whereas as many as 14 developing countries reached female secondary enrollment levels of

40 percent in 1975, and this number rose to 28 in 1988. Notwithstanding massive investment, India took over 40 years to build a good family planning delivery system in 5 of 21 states.

vi. Future research could usefully ask how the marginal gains from female education, family planning, and health programs at different stages of development compare with marginal costs, once cost data become available for female secondary schooling and for health and family planning program interventions for different countries. Research should then address appropriate phasing of different combinations of education, health, and family planning programs. In so doing, much more information should be developed on different specific kinds of education, health and family planning services that might be made available, so that more precise program strategies can be developed.

# SOCIAL GAINS FROM FEMALE EDUCATION: A CROSS-NATIONAL STUDY

**K. Subbarao and Laura Raney**[1]

## 1. Introduction

1.1 Female education increases the value of women's time in economic activities by raising labor productivity and wages (with a consequential rise in household incomes and a reduction in poverty). Female education also produces social gains, by improving health (the woman's own health and the health of her children), increasing child schooling, and reducing fertility. This paper is concerned with the estimation of these social gains from secondary female education (measured as gross enrollment rates). That female education contributes to lower fertility and infant and child mortality is well-known. However, the extent to which female education interacts with health and family planning programs and policies is less well-known. This paper examines the role of secondary female education relative to, and/or in combination with, health and family planning programs and policies that reduce fertility and infant mortality. To the extent the data permit, the paper also explores some of the routes through which female education lowers fertility and mortality, for instance by reducing desired family size or by promoting more effective use of available services for contraception. The paper is based on cross-country data from 72 developing countries (accounting for over 95 percent of the population of developing countries), drawn from the World Bank and other data sources. The period of investigation is 1970-85. The analysis generally shows that female secondary education, family planning, and health programs all affect fertility and mortality, and the effect of female secondary education appears to be very strong. Moreover, our results suggest that family planning will reduce fertility more when combined with female

[1] Acknowledgements: For excellent advice and contributions at all stages in the preparation of this study, we are grateful to Barbara Herz. Comments from participants of a PHR workshop where preliminary results of this study were presented were very helpful. We also wish to thank Randy Bulatao, Susan Cochrane, Dennis de Tray, Elizabeth King, Frances Plunkett, Lant Pritchett, Agnes Quisumbing, Martin Ravallion, Guilherme Sedlacek, and Roger Slade, for comments and suggestions. Of course responsibility for the present paper is ours.

education, especially in countries that now have low female secondary enrollment levels. The elasticities of fertility and infant mortality with respect to female education substantially exceed those with respect to family planning and health programs when the elasticities are estimated with appropriate controls. The results from these cross-country regressions should be interpreted cautiously as they may not be representative of a particular country's experience and reflect the usual problems of relying on national averages. Although endogeneity of services may be less of a problem in cross-country data, using cross-country data imposes a common structure on the econometric relationship between the variables. However, the results are broadly similar to a number of micro studies (e.g. see Schultz 1989 for a review) and with another cross-country study, Mauldin and Ross (1991) which found that the direct effect of family planning effort is less than the total (direct and indirect effects) of socio-economic factors (including education).

1.2 The paper is organized as follows. The basic analytical framework and the models to be tested are described in Section 2. Definitions, data sources, and limitations are discussed briefly in Section 3. The results from cross-country equations are discussed in Section 4. Some policy simulations are attempted in Section 5. Last, the concluding section draws some inferences for policy.

## 2. Analytical Framework and the Reduced Form Equations

### A. Analytical Framework

2.1 For most couples, achieving a pregnancy does not require a deliberate decision, but avoiding a pregnancy does. Following Herz (1984), this section outlines a structural framework focusing on the factors determining the number of children parents want and their ability to limit births to that number, with particular reference to the role of female education in influencing parental decisions and abilities.

2.2 The total fertility rate (TFR) -- the number of children that would be born to a woman if she lives to the end of her childbearing years and bears children at each age in accordance with the prevailing age-specific fertility rates -- comprises the number of children parents want (desired family size, or DFS) plus unintended births (which depend on parents' ability to achieve desired family size). In economic terms, DFS thus represents the demand for children by parents. DFS depends mainly on female education, male education, the insurance value of children, and the demand for female labor in the wage labor market, which may be reflected in the country's level of development (and proxied by the per capita GDP). DFS also reflects the chances for child survival.

2.3 Child survival depends in turn on the mother's education and on other factors such as access to safe drinking water, access to health services including immunization and curative care for common childhood diseases, and access to family planning (which promotes healthier spacing of births).

2.4 Of course, parents may have more or fewer children than they desire. This paper focuses on the more usual case where couples could have more children than they desire if they took no steps to limit pregnancy. The ability to achieve desired family size depends on the availability of family planning services, but also on other factors such as the age at marriage or union, duration of breastfeeding, and the scope for abortion.

2.5 These structural relationships suggest many pathways through which female education and family planning services affect fertility. Education, especially of the mother, works through wage and productivity effects on the opportunity cost of the mother's time and thus affects desired family size. It also improves the chances of child survival and so indirectly affects desired family size. Finally, education builds ability as well as willingness to use the available modern methods of contraception effectively and thus helps people achieve their desired family size. Family planning services enable couples more readily to achieve (lower) desired family size and over time may influence desired family size itself by affecting infant deaths (and perhaps also social norms).

2.6 From a policy perspective, it would be valuable to know more about the relative importance of the many pathways through which female education and family planning program services influence fertility. But such a structural model is extremely difficult to estimate because of data and econometric limitations. First and most important, DFS cannot be observed objectively. It is essentially an opinion, and people's responses may be influenced by the number of children they already have. Many a couple may be reluctant to say they did not want the children they already have. Second, country-level data sources are often not suitable for comparison as the type of canvassing and questions asked of the respondents do not always match. Therefore, most analysts feel much more comfortable banking on objectively observed fertility. Moreover, the task of estimating a structural model with cross-national data is even more difficult because the (admittedly unsatisfactory) data on DFS is available only for a small set of 37 countries which have had World Fertility Surveys. Finally, even if more satisfactory data on DFS were available for a wider sample of countries, it is difficult to find identifying exogenous variables, especially in cross-national data sets, that permit distinguishing the influences on desired family size, child survival, and ability to achieve desired family size. Female education clearly affects all three. Many analysts therefore rely on reduced form estimation of the TFR, as do we. Thus, we can determine the net impact of female secondary education and other exogenous variables but not precise pathways.

2.7 The conceptual underpinnings for the analysis of infant mortality (IMR) are more straightforward. Infant mortality is influenced by female education, male education, and access to services that affect mortality such as immunization; safe drinking water; trained birth attendants, nurses or physicians; and family planning services that promote better spacing of births. As in the case of the TFR, female education influences infant mortality through better use of available facilities and the parents', especially the mother's, knowledge of hygiene, sanitation, and health care. But as in the case of the TFR, we rely on a reduced form that shows the net impact of female secondary education and other exogenous variables without specifying pathways.

## B. Reduced Form Equations and the Estimation Procedures

2.8 Our reduced form equations derive their logic from the structural relationships outlined in the preceding paragraphs. Following Schultz (1990), the structural relationships can be expressed so that the TFR and IMR depend only on exogenous explanatory variables including education, health services, and family planning programs as well as personal and household characteristics that affect fertility and mortality. In specifying our reduced forms, we have tried to be careful to use as explanatory variables only those that are exogenous in a fairly strict sense, i.e. they affect, but are not the result of household decisions.

2.9 It is possible to estimate the determinants of fertility or mortality without bias with the OLS method when the function relating the (country-level) explanatory variables and dependent variable is correctly known, the explanatory variables are independent of each other, the variables are observed without error, and the error term is normally distributed with zero mean, has a constant variance, and is uncorrelated with the explanatory variables. But Schultz (1990) and Behrman (1990) discuss potential endogeneity between family planning or health programs and socio-economic variables, especially education levels, in countries where family planning or health program efforts may be focused on states/districts with higher levels of socio-economic development. Such endogeneity may be a less serious problem in cross-country analysis than in studies within a country. To test for endogeneity between socio-economic development and program effort at the cross-country level, we regressed an index of socio-economic development (WFS and UN 1987) on family planning services across countries, and found the correlation to be weak (R = .38). Such correlations with other socio-economic and human development indices were found to be even weaker.[2] In this paper, therefore, the possible endogeneity between program supply and socio-economic development is ignored.

2.10 Female Education and Total Fertility: The first equation presented in this study is intended to explain the total fertility rate (TFR) -- the number of children that would be born to a woman if she lives to the end of her childbearing years and bears children at each age in accordance with prevailing age-specific fertility rates. The hypothesis is that the TFR depends in a non-linear way on female and male secondary education (FED and MED) and in a linear way on per capita GDP (GDP), the rate of urbanization (URB), population per physician (PHYS), and the level of a family planning services score (SERV), and potential interaction between education and family planning services:

$$TFR = ao + a1FED + a2FED^2 + a3MED + a4MED^2 + a5GDP + a6URB + a7SERV + a8(FED*SERV) + a9PHYS + a10DAFR + a11DAS + a12DLAC + ei \quad (6)$$

[2] Mauldin and Ross (1991) found similar results.

where AFR, AS, and LAC stand for regional dummies for Africa, Asia and Latin America and the Caribbean.[3] The model does not separate the exact route through which education is influencing fertility (delay of marriage, contraceptive use, abortion, or breastfeeding or a reduction in child mortality), but summarizes the effects as they work themselves through an underlying structural model. The estimated equation is thus a reduced form equation with controls and interactions.[4]

2.11 Female Education and Infant Mortality: Numerous studies have examined the role of female education in determining mortality outcomes using cross-country data.[5] Much of the earlier literature using cross-country data did not consider any specific health program variable, though socio-economic variables have been thoroughly investigated and modelled. King and Hill (1991) did consider many program variables but did not treat interactions. In the present study, the IMR in 1985 is hypothesized to be inversely related to lagged female and male secondary enrollments (FED and MED), the rate of urbanization (URB), per capita GDP, and family planning services (SERV), and positively to population per physician (PHYS). Regional dummies were added to capture region-specific intercepts. The estimated model is as follows:

$$\begin{aligned} IMR = {} & ao + a1FED + a2FED^2 + a3MED + a4MED^2 + \\ & a5PHYS + a6URB + a7SERV + a8GDP + \\ & a9DUMAFR + a10DUMAS + a11DUMLAC + ei \qquad (7) \end{aligned}$$

[3] See the next section for definitions and exact specification of the variables.

[4] The under-five mortality rate also affects the TFR but is endogenous, since better educated women are more likely to have knowledge of preventive health care and to see medical attention for their children. Under-five mortality therefore does not enter this equation directly, but both female education and population per physician probably act in part through under-five mortality.

[5] See, for example, Preston (1980, 1985); Wheeler (1980); Mensch, Lentzner and Preston (1986), and King and Hill (1991). For thoughtful reviews of studies, see Cochrane, O'Hara and Leslie (1980, 1982), Behrman (1990) and Schultz (1992).

One program variable, "population per physician" (PHYS)", was considered.[6] The model captures the influence of the proximate determinants as well as female (and male) education without informing us about the precise route through which female education influences infant mortality outcomes; so it is again a reduced form equation.

2.12 To explore the routes through which female education affects fertility, data for a limited sample of countries where World Fertility Surveys were conducted were used to analyze the determinants of desired family size (DFS), and contraceptive prevalence (CP).

## 3. Definitions and Data Sources

3.1 The analysis is based on cross-country data for 72 developing countries compiled from various secondary sources. The sample consists of low and middle-income developing economies, according to the World Bank classification by income. We have deliberately excluded Eastern European countries for which data is scarce, Cuba and high-income countries such as Hong Kong, Saudi Arabia, Singapore and the United Arab Emirates as they are not strictly considered developing economies. The total sample of 72 countries represents the maximum number of countries for which data were available for the variables used in our analysis. Not all countries are included in all the equations and simulations owing to data gaps on certain specific variables. The approach we have taken is to maximize the number of observations in each equation; therefore the sample size varies across the equations. The countries,

[6] Our measure of health services is thus obviously inadequate. We wish we had had exogenous measures of the availability of other kinds of health care. Another health variable was available, namely percent of infants immunized. But it is potentially endogenous. It reflects the interaction of demand as well as availability since better educated women are more likely to bring their children to health centers to be immunized. We therefore did not include it in our main equations but did include it in an equation shown in Appendix Table 11. It would have been most interesting had we had data on access to immunization as distinct from use, since access would have been exogenous and thus could have shown the impact of making immunization available.

along with a summary of the variables and definitions, means and standard deviations, are listed in Appendix Tables 1 - 4. The total fertility rate is for 1985 (TFR) and represents the number of children that would be born to a woman if she lives to the end of her childbearing years and bears children at each age in accordance with prevailing age-specific fertility rates. The infant mortality rate (IMR), 1985, is defined as the number of infants who die before reaching one year of age per 1000 live births. Both the TFR and the IMR are taken from the World Bank's World Development Report, (WDR) 1987. Desired family size (DFS) is taken from the World Fertility Survey data from 1983 to 1988. It is based on the conventional method of measuring "preferred" family size and is available only for 37 countries from (Lightbourne, 1987). Contraceptive prevalence (CP) represents contraceptive use among currently married women for the latest available year ranging from 1982 to 1989, as assessed in 1988 from the United Nations in Levels and Trends of Contraceptive Use and the Population Division's 1989 database on contraceptive use found in the United Nations "Women's Indicators and Statistics Spreadsheet Database for Microcomputers" (WISTAT).

3.2 Gross secondary enrollment rates for males and females for 1970 and 1975 (MED, FED) are taken from UNESCO in the World Bank's Economic and Social Database (BESD). Gross Domestic Production (GDP) per capita, 1985 is corrected for purchasing power parity and is expressed in 1985 international prices from Summers and Heston (1991). The family planning services score (SERV), 1982 is based on part of a broader index developed originally by Mauldin and Lapham (1982) and updated by Mauldin and Ross (1991). The score used in this paper assesses the availability and strength of service and service-related family planning programs in developing countries (Ross et al. 1992).[7] The index reflects 13 separate measures of service and service-related activities, including community-based

[7] This index is one of the four components which make up the family planning program effort score in 1982 of Mauldin and Ross (1991). We have chosen this component to isolate a non-endogenous supply variable.

distribution, administrative structure and mass media for IE & C. Service (SERV) is the percent of the maximum score for each country. The actual values range from 0 to 78. Population per physician (PHYS), 1984 and the urban population as percent of total population, (URB) 1985 are from the WDR 1987.

3.3 In the simulations, the population of women of childbearing age in 1985 is taken from WISTAT. This measure, women aged 15-44, omits women in the 45-49 bracket because the data as presently organized and published (which is for ages 15-19, 20-24, 25-44 and 45-59) does not enable us to compute the number of women in this older cohort. The number of births in this age cohort, however, is quite small, and as such may not significantly understate the births and deaths simulated in section 5.

## 4. Results and Discussion

### A. Education, Family Planning Services, and Fertility

4.1 In the literature, several alternative specifications of education variables have been used. In the present study, female and male gross secondary school enrollment rates, lagged by approximately 10 and 15 years, were used, the inference being that the higher the enrollment rates in the (lagged) years, the higher the proportion of mothers (fathers) with secondary schooling in the year 1985, in each of the countries for which data on all the variables are available. Data limitations prevented looking at age cohorts separately.[8] Considering th ` high proportion of births (i.e. a high proportion of the life-time, realized total fertility rate) occurs before a woman reaches the age of 25-29, 15 and 10 year-lagged school

[8] A better approach which was not used in this paper for lack of data would be to use years of schooling completed (or estimates of same) which would take into account primary enrollment more effectively (see Schultz 1989).

enrollment (i.e. 1970 and 1975 enrollment levels) appeared the most appropriate; the results reported belong to these years.

4.2 We estimated the equations with both female and male secondary enrollments so as to capture the effect of female enrollments, controlling for male enrollments. We recognize that male and female education tend to be correlated and therefore tried female education separately (reported in Appendix Table 5). But we felt that relying only on female education might overstate its effect. This is, we recognize, a difficult judgement. We could see no strong theoretical case for simply relying on male education. We also estimated the equations with and without interaction between female education and family planning services. In each equation, non-linearity in the linkages between enrollments and fertility was tested with quadratic terms. The descriptive statistics are given in Appendix Table 3, and the results are presented in Table 1.

4.3 Irrespective of the model specification, female secondary school enrollment, lagged by either 10 or 15 years, is inversely related to fertility rate, and the coefficient is relatively large and highly significant. We evaluated the positive quadratic term and found that the turning point occurs at about 60 percent of gross secondary school enrollment in 1970 and 80 percent in 1975 -- a level which none of the countries in our sample had reached in either year. Male enrollment is not statistically significant. Family planning services is statistically significant by itself <u>only</u> in the equations <u>without</u> the interaction terms. Once interacted with female education, it is no longer independently statistically significant. Equation 4 in Table 1 (using 1975 education data) suggests that family planning works in conjunction with education (the interaction term is significant). This implies that the effect of family planning can only be evaluated with reference to specific levels of female secondary enrollment, as it differs depending on the enrollment level. It is well known that education promotes more willingness to use contraception and

**Table 1. Female Education, Family Planning Services, and Total Fertility Rate**

| Independent Variables | Dependent Variable, TFR, 1985 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) Without interaction, Sec. Sch. Enrollments 1970 | | (2) With interaction Sec. Sch. Enrollments 1970 | | (3) Without interaction Sec. Sch. Enrollments 1975 | | (4) With interaction Sec. Sch Enrollments 1975 | |
| | Coefficient | t-ratio | Coefficient | t-ratio | Coefficient | t-ratio | Coefficient | t-ratio |
| Constant | 7.322 | 15.801*** | 7.199 | 14.385*** | 7.137 | 14.453*** | 6.77 | 12.453*** |
| Female Secondary Gross Enrollment, 1970 | -0.187 | -3.723*** | -0.177 | -3.450*** | | | | |
| Female Secondary Gross Enrollment squared | 0.002 | 2.166** | 0.002 | 2.325** | | | | |
| Male Secondary Gross Enrollment, 1970 | 0.038 | 0.996 | 0.029 | 0.709 | | | | |
| Male Secondary Gross Enrollment squared | 0.0004 | 0.756 | 0.001 | 0.914 | | | | |
| Female Secondary Gross Enrollment, 1975 | | | | | -0.116 | -3.644*** | -0.100 | -3.079*** |
| Female Secondary Gross Enrollment squared | | | | | 0.001 | 1.496 | 0.001 | 1.939* |
| Male Secondary Gross Enrollment, 1975 | | | | | 0.027 | 1.088 | 0.010 | 0.272 |
| Male Secondary Gross Enrollment$^{2}$ | | | | | 0.003 | 0.775 | 0.001 | 1.395 |
| GDP per capita, 1985 | -0.0001 | -1.361 | -0.0002 | -1.490 | -0.0001 | -0.653 | -0.0001 | -0.726 |
| Family planning services, 1982 | -0.021 | -3.900*** | -0.014 | -1.251 | -0.024 | -4.603** | -0.010 | -0.695 |
| Fem. Sec. Enrollment and FP services | | | -0.0004 | -0.723 | | | -0.001 | -1.853* |
| Urban population as % of total population, 1985 | -0.010 | -1.040 | -0.100 | -0.871 | -0.009 | -0.963 | -0.006 | -0.613 |
| Population per physician, 1985 | -0.000004 | -0.576 | -0.000004 | -0.497 | -0.000001 | -0.101 | 0.000001 | 0.07 |
| Africa Regional Dummy | 0.229 | 0.741 | 0.282 | 0.835 | 0.302 | 0.931 | 0.515 | 1.392 |
| Asia Regional Dummy | -0.496 | -1.249 | -0.460 | -1.125 | -0.561 | -1.361 | -0.401 | -0.965 |
| LAC Regional Dummy | 0.879 | 2.244** | 0.821 | 2.147** | 0.373 | 1.198 | 0.282 | 0.886 |
| $R^2$ | .82 | | .82 | | .83 | | .84 | |
| n | 64 | | 64 | | 65 | | 65 | |

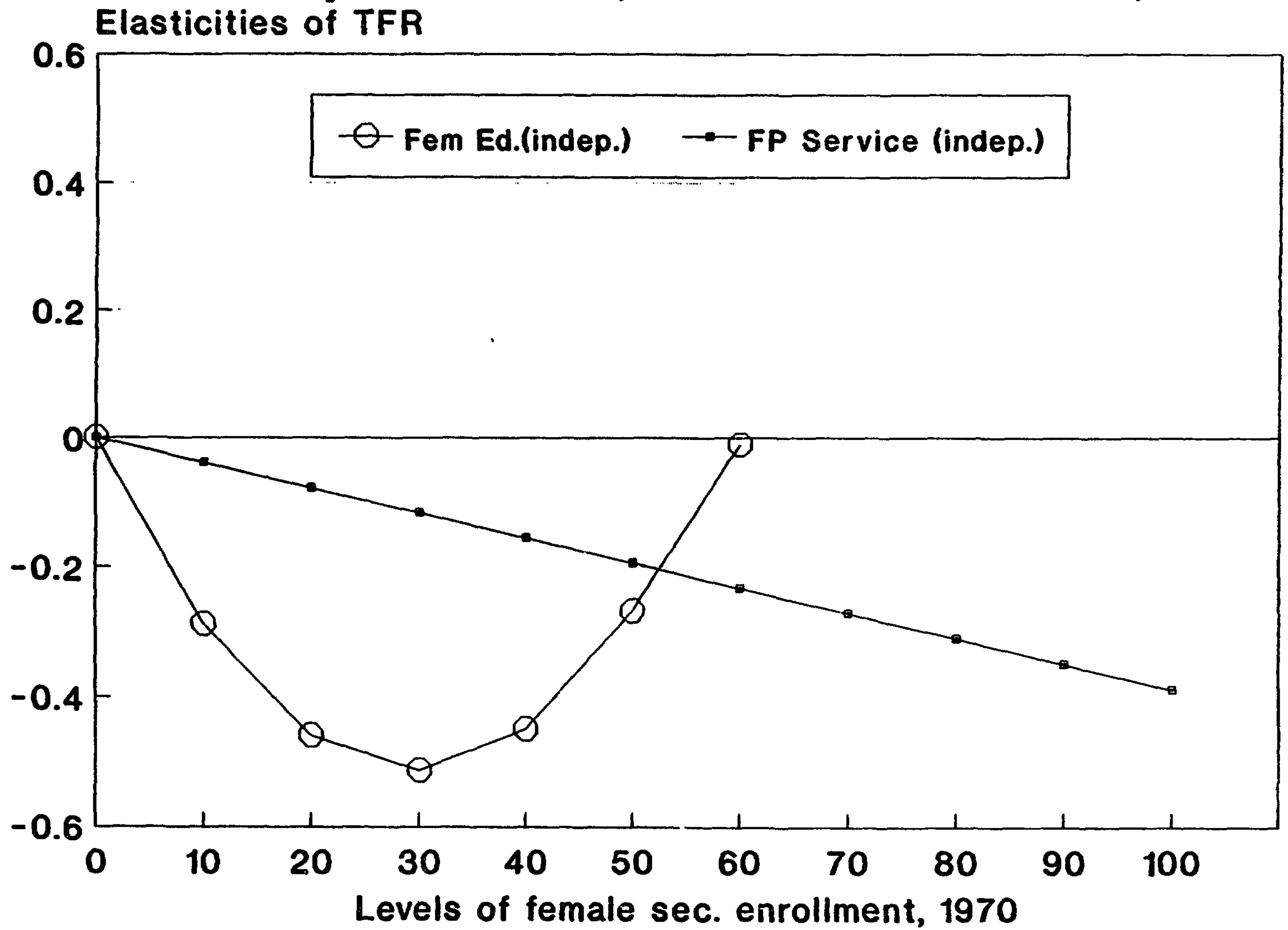
Absolute values of t-ratios, where *, **, and *** indicate significance levels of 10, 5, and 1 percent respectively.

more effective use. On the other hand, equation 2 in Table 1 (using 1970 education data) fails to confirm the interaction. What we can say definitely is that family planning does matter and may well interact with education, and the magnitude of the effect of female education remains large, even controlling for its interaction with family planning services. Controlling for education and family planning services, the GDP variable is significant in only one of the equations. In two equations the regional dummy for LAC is significant. On the whole, the results suggest that the total effect on fertility of female education combined with family planning services is substantial.

4.4 To get a better idea of the magnitude of the effects of female education and family planning services on total fertility, elasticities were computed. Figure 1 shows the values of elasticities of the TFR (1985) with respect to female secondary enrollments (1970) (controlling for male enrollments), and with respect to family planning services (1982) at different levels of female secondary enrollments and family planning service scores. These were computed from equation 1, Table 1. The elasticity of TFR with respect to female education has a "U" shape, suggesting that the effect of female secondary enrollment on fertility is high initially until it reaches a threshold level of and then tapers off. The elasticity of fertility with respect to female education is very high for female enrollments from 0 to 40 percent -- a range in which all but 4 of the sample countries fall. Female secondary enrollment has the greatest negative effect on fertility at around 30 percent enrollment; the mean of female secondary enrollment in the 1970 sample is 13 percent. Family planning services undoubtedly reduce the fertility rate,[9] but the magnitudes of the elasticities of the TFR with respect to family planning services are small.

[9] In this equation, since it does not have an interaction term, we can estimate the independent effect of family planning services.

## Figure 1: Elasticities of TFR 1985, with respect to Female Secondary Enrollments, 1970 and FP Services, 1982




Note: Elasticities computed from eq.1 Table 1, holding all other variables constant at their mean value. (Means: Female Sec. Enroll. (1970), 13%, Family Planning Service Score (1982), 24%, TFR (1985), 5.4).

Only at the maximum possible score of the index (100) does the elasticity of fertility with respect to family planning services reach that of female education at 30 percent enrollment rate.[10] Yet the highest score of family planning service any country in 1982 was 78.

4.5 We use the equation with female secondary enrollments for 1975 in subsequent simulations of the effects of increasing female education and family planning services on TFR[11]. When female secondary enrollments lagged by 10 years (1975 enrollments) were interacted with family planning services, the interaction term is significant (see equation 4, Table 1). From this equation, the elasticities of the TFR with respect to the total effect of female secondary education family planning services were computed at different levels of enrollments and service scores. These are shown in Figure 2. At 20 percent enrollment level, the elasticity of the TFR with respect to the total effect of female education is three times higher than that of family planning services. Clearly, in countries with currently low female secondary enrollments, an expansion of female education, in combination with even a low family planning service score, can bring fertility down substantially.

4.6 Simulations show that a doubling of female secondary enrollments (from the mean of 19 percent to 38 percent) in 1975 holding all other variables constant at their mean values, would have reduced the TFR in 1985 from 5.3 to 3.9, whereas a doubling of family planning service score[12] (from the mean of 25 percent to 50 percent), again holding other variables constant, would have reduced the TFR in 1985 from 5.5 to 5.0. These illustrative scenarios are suggestive of the powerful influence of

---

[10] See Appendix Table 6 for actual values of the elasticities.

[11] We found the 1970 equation to yield unrealistic declines in TFR as a resut of increasing female secondary enrollments by one percent, e.g. a reduction of close to 0.2 or a fifth of a child, in comparison to a tenth of a child in the 1975 equation.

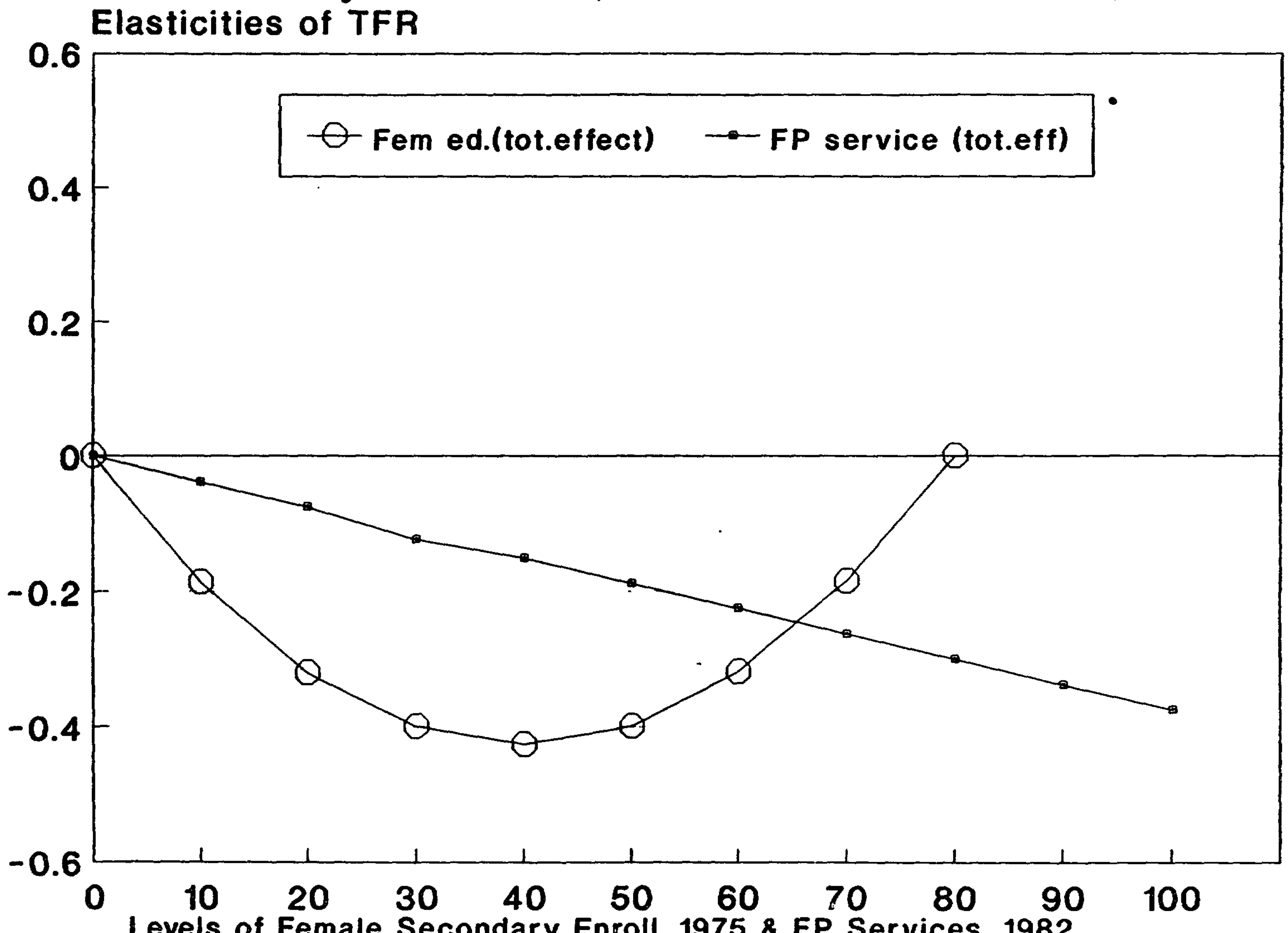
[12] The independent effect of family planning services cannot be estimated from this equation as the variable is non-significant. The effect of family planning services can only be evaluated with reference to specific levels of female enrollment.

female education in fertility reduction.

4.7 The extent to which female education, interacting with the mean level of family planning services, reduces fertility can also be seen from the predicted values of total fertility rate, also derived from equation 4, Table 1. Figure 3 presents the predicted values of total fertility rate in 1985 for varying levels of female enrollments in 1975 and family planning services in 1982. The fertility rate falls steadily with increases in female secondary enrollments. The rate of decline in fertility appears steep initially, but tapers off after female enrollment levels reach 40 percent. Family planning services also reduce fertility but by a slower rate. Even with the maximum family planning service score of 100 (quadruple the mean of 25 percent in 1982), fertility does not reach the same level as with 40 percent female secondary enrollment. It would appear that mere expansion of family planning services by itself affects fertility much less than if it were accompanied by expansion of female secondary enrollment.[13]

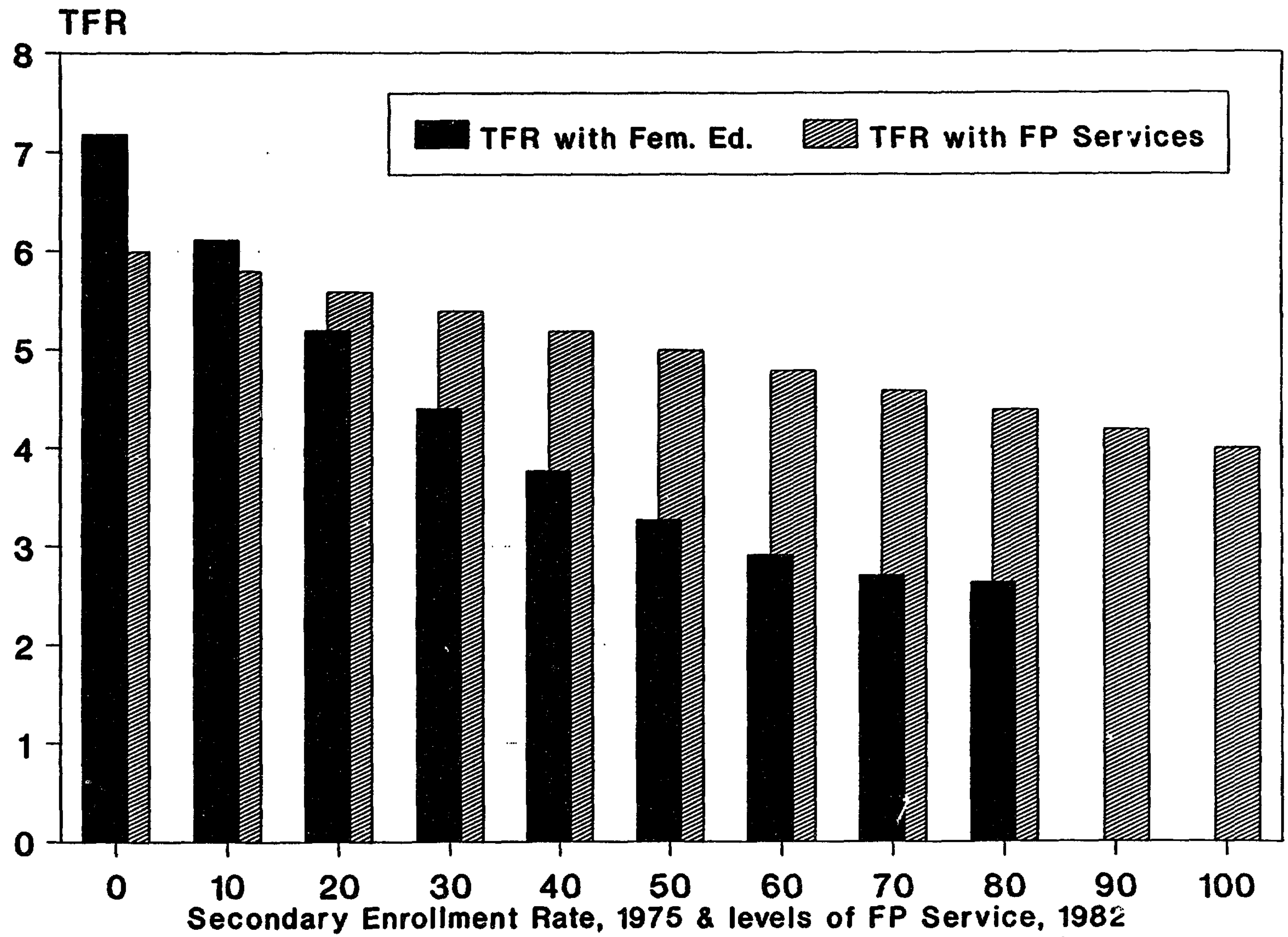
[13] Several micro-level studies based in household data sets have reached similar conclusions. For example, one recent careful study based on Indonesian household-level data set confirms the small contribution of family planning program efforts to fertility decline (P. Gertler and J. Molineaux, 1992). In this study, the authors show that over the period 1982-87, the combined educational and economic impacts, working through increases in contraceptive use, accounted for 87 per cent of fertility decline over the period. By contrast, measures of family planning program inputs were responsible for only 4 to 8 per cent of the decline. Of course, this study uses a fixed effects model which relates changes during 1982-86 in family planning inputs and socio-economic variables to changes in contraceptive use and fertility. Since family planning was already quite well established in 1982, these results may reflect this context.

## Figure 2: Elasticities of TFR with respect to Female Secondary Education, 1975 and FP Services, 1982




Note: Elasticities computed from eq.4 Table 1, holding all other variables constant at their mean value. (Means: Female Sec. Enroll. (1975), 19% Family Planning Service Score (1982), 25% TFR 5.3)

# Figure 3: Predicted TFR, 1985 for Different Levels of Female Education & FP Services




Note: calculated from Table 1, holding all other variables constant at their mean value.
(Means: Female Sec. Enroll. (1975), 19.1%, Family Planning Service Score (1982), 25%, TFR (1985) 5.3).

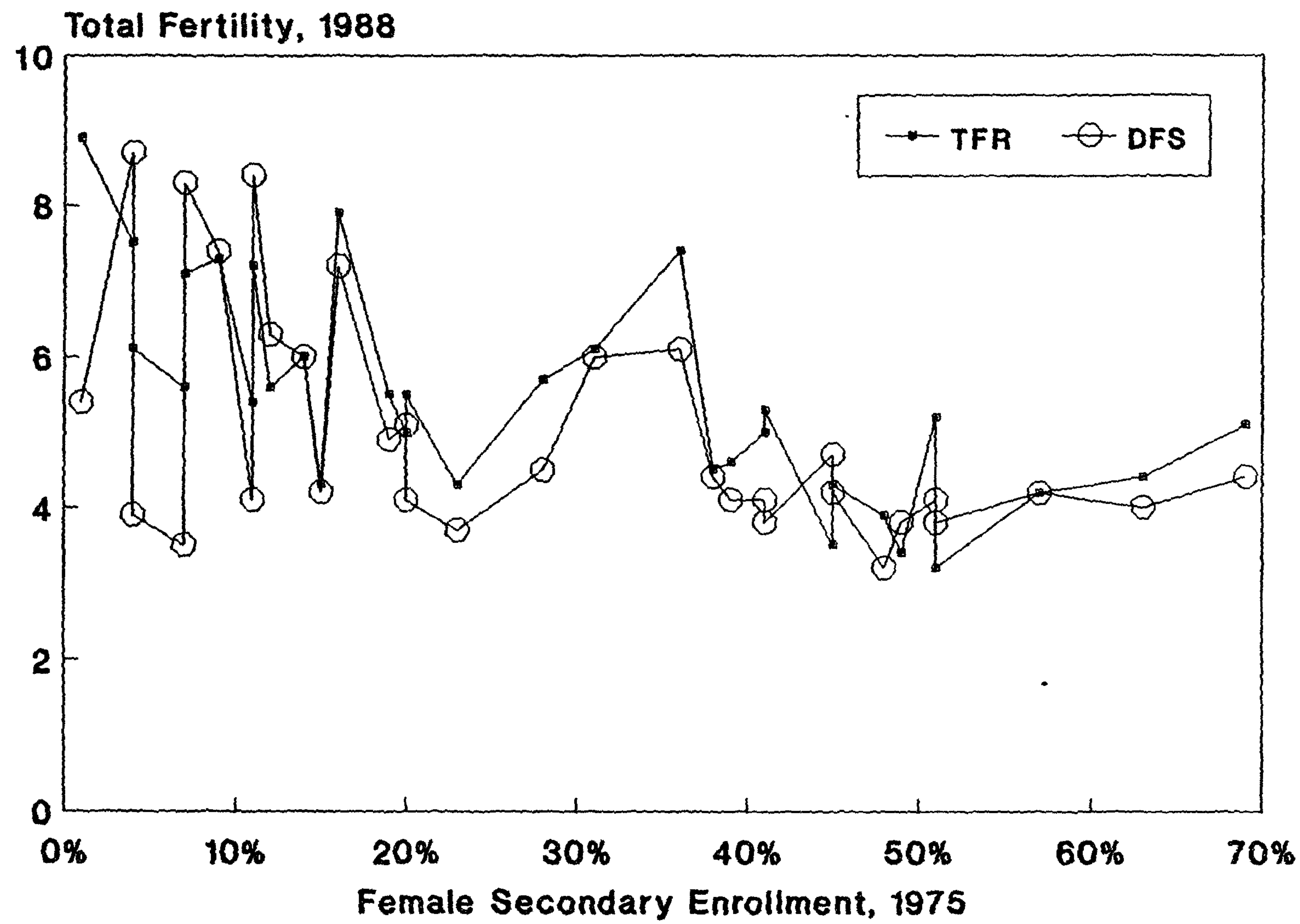
B. Female Education, Desired Family Size and Contraceptive Prevalence

4.8 Female education affects fertility in several ways, but we consider two ways: it reduces the desired family size, and it promotes contraceptive use. There are important empirical problems in mapping out these effects. For example, desired fertility could fall for a variety of reasons of which female education is one. Similarly, contraceptive prevalence could increase due to many factors. There are (unknown) time lags in each effect. There are, of course, serious data and measurement problems, as discussed in para 2.6 above. For example, desired family size is available from WFS surveys only for 37 countries, may not be exactly comparable across countries, and reflects subjective judgments. These limitations must be taken into consideration when interpreting the results.

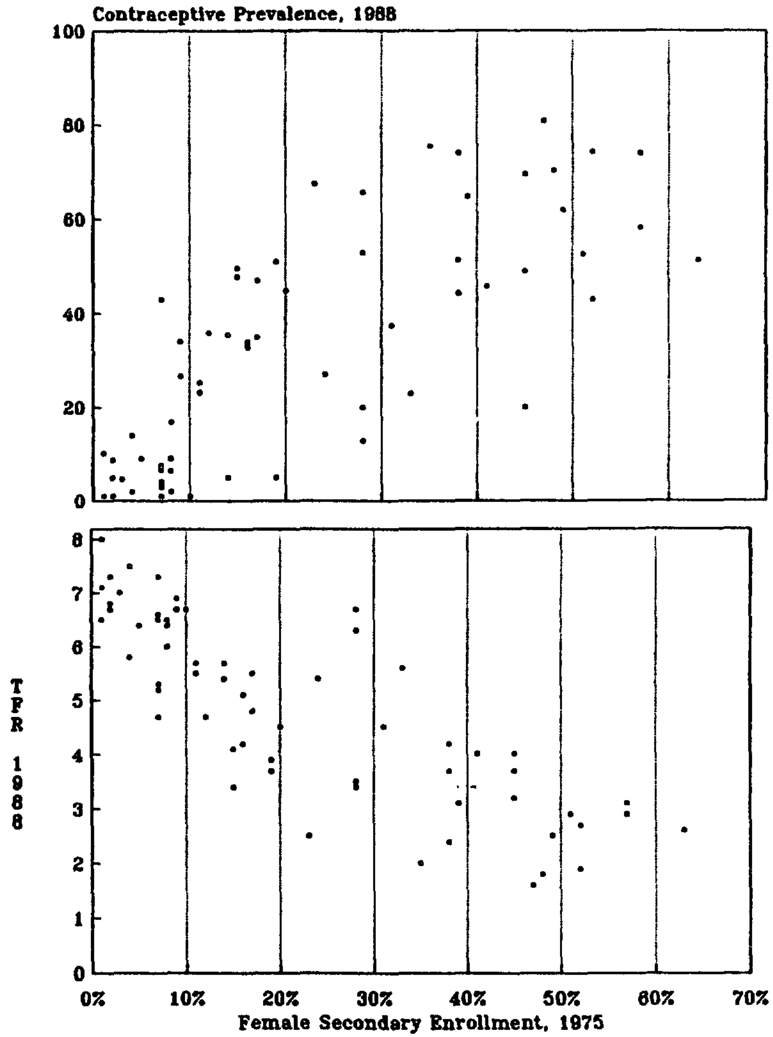
4.9 Data from World Fertility Surveys shown in Figure 4 depict the total (actual) fertility and desired fertility for a sample of 37 countries in 1988, along with the country's female secondary enrollment rate in 1975. Above a female secondary enrollment of about 40 percent, actual and desired fertility rates begin to converge, indicating that women with more education are better able to reach their desired fertility. In Figure 5 contraceptive prevalence, total fertility and female secondary school enrollments are plotted. As expected, contraceptive prevalence increases and total fertility decreases with higher levels of female education.

4.10 The results on DFS and CP were obtained from two regressions with desired family size (DFS) and with contraceptive prevalence (CP) as the dependent variables; the estimated equations are presented in Tables 2 and 3 and show the role of female secondary education relative to other factors.

## Figure 4: Total and Desired Fertility



## Figure 5: Female Secondary Enrollment, Contraceptive Prevalence and TFR, 1988



The independent variables include male and female secondary enrollments, GDP per capita, and regional dummies, and family planning services in the CP equation. The equations were also estimated allowing female secondary enrollments to enter separately. In both DFS and CP equations, the coefficient of female secondary school enrollments is highly significant with the expected signs for the linear term and the quadratic term; the turning point occurs only at a high (40 percent) level of female secondary enrollment.[14] While the male education variable is not significant, GDP per capita is highly significant in both DFS and CP equations. Ceteris paribus, a rise in GDP per capita leads to a higher desired family size up to a threshold level reflecting the positive income effect on fertility, but beyond a threshold level increases in GDP lead to a fall in desired family size; the quadratic terms for GDP are highly significant with a negative sign. The impact of an increase of GDP per capita on contraceptive prevalence (CP) is also non-linear; it leads to a rise in CP initially, but after a threshold income level, it has a negative impact on CP. Family planning services are highly significant and has positive impact on CP.

4.11 The elasticities of contraceptive prevalence with respect to secondary school enrollment, GDP per capita, and access to family planning services are shown in Figure 6. The elasticity with respect to education has an inverted "U" shape, peaking again at 30 percent enrollment with an elasticity of 0.33. However, it is worth stressing that the family planning service score is an extremely important determinant of contraceptive prevalence. The service component has a strong positive upward slope, and at a score level of 20, reaches the same contraceptive prevalence level as for 10 percent female enrollment.[15]

---

[14] When female secondary enrollments were entered without male enrollments (see Appendix Table 7) female secondary enrollments still retain their high statistical significance.

[15] The actual values of these elasticities are given in Appendix Table 8.

**Table 2. Female Education, GDP per capita and Desired Family Size**

| Independent Variables | Dependent Variable, DFS, 1988 | |
|---|---|---|
| Constant | 3.404 | 3.817*** |
| Female Secondary Gross Enrollment, 1975 | -0.109 | -2.781*** |
| Female Secondary Gross Enrollment$^2$ | 0.001 | 2.579*** |
| Male Secondary Gross Enrollment, 1975 | 0.018 | 0.320 |
| Male Secondary Gross Enrollment$^2$ | 0.00001 | 0.125 |
| GDP per capita, 1988 | 0.001 | 2.381** |
| GDP per capita$^2$ | -0.0000001 | -2.162** |
| Africa Regional Dummy | 3.181 | 7.301*** |
| Asia Regional Dummy | -0.147 | -0.361 |
| LAC Regional Dummy | 0.392 | 0.865 |
| Adjusted $R^2$ | .74 | |
| n= | 32 | |

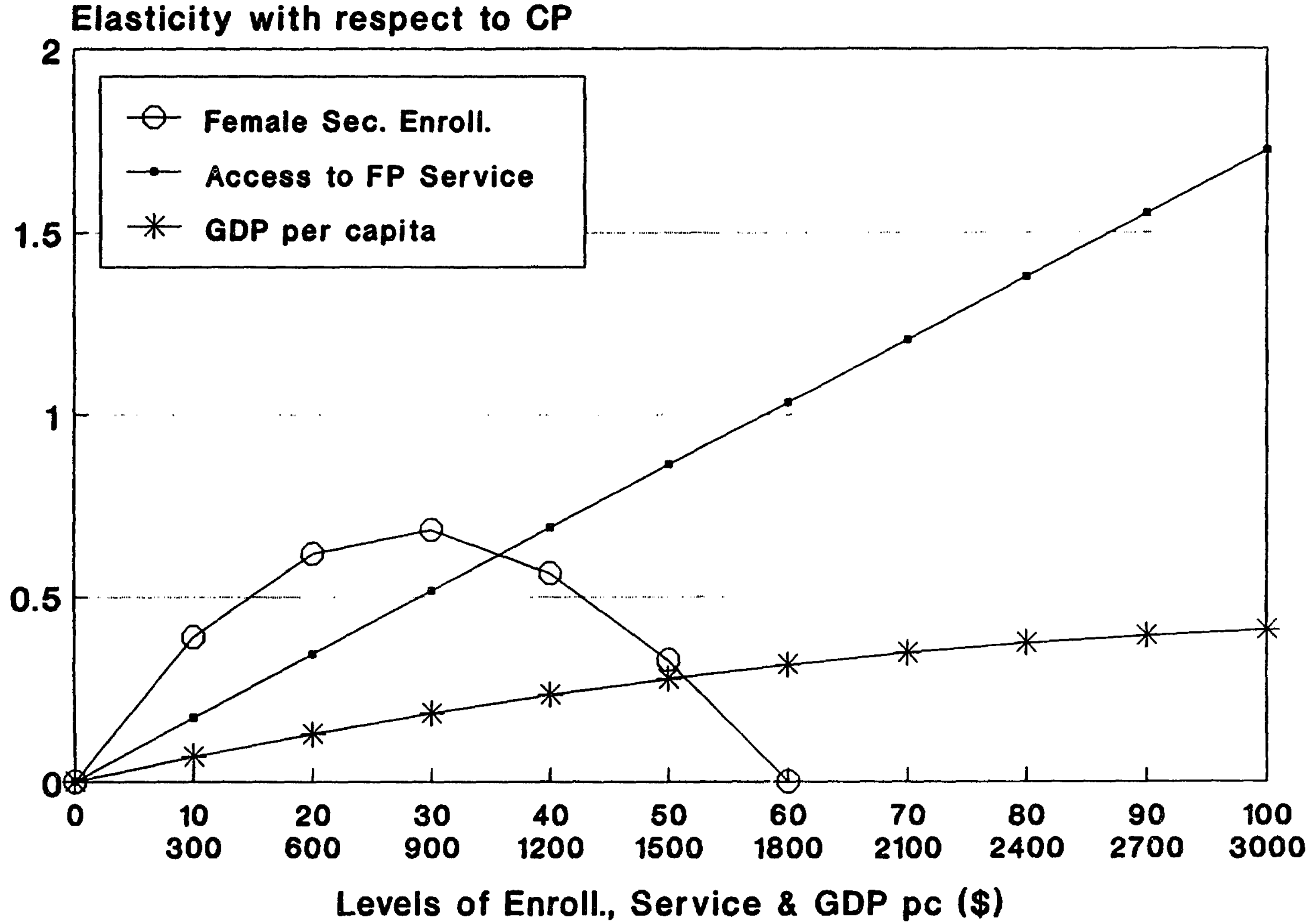
Absolute values of t-ratios, where *, **, and *** indicate significance levels of 10, 5, and 1 percent respectively.

**Table 3. Female Education, GDP per capita and Contraceptive Prevalence**

| Independent Variables | Dependent Variable, CP, 1988 | |
|---|---|---|
| | Coefficient | t-ratio |
| Constant | -8.166 | -1.572 |
| Female Secondary Gross Enrollment, 1975 | 1.437 | 2.683*** |
| Female Secondary Gross Enrollment$^2$ | -0.012 | -1.924* |
| Male Secondary Gross Enrollment, 1975 | -0.040 | -0.093 |
| Male Secondary Gross Enrollment$^2$ | -0.005 | -0.970 |
| GDP per capita 1988 | -0.007 | -3.107*** |
| GDP per capita$^2$ | -0.000001 | -2.655*** |
| Family planning services 1982 | 0.526 | 7.701*** |
| Africa Regional Dummy | -0.525 | -0.150 |
| Asia Regional Dummy | -5.351 | -1.451 |
| LAC Regional Dummy | -3.738 | -0.817 |
| $R^2$ | .83 | |
| n | 61 | |

Absolute values of t-ratios, where *, **, and *** indicate significance levels of 10, 5, and 1 percent respectively.

## Figure 6: Elasticities of Contraceptive Prevalence with respect to Female Enrollments, 1975, FP Services & GDP pc




**Note: Elasticities computed from eq. 1 Table 3, holding all other variables constant at their mean values.**

**(Means: Fem. Sec. Enroll., (1975) 20.4%, Access to Services (1982) 28%, GDP per capita (1988) $2324, CP 30.5)**

4.12 Controlling for female education, the elasticity of CP with respect to GDP per capita is smaller. It could be argued that progress in contraceptive prevalence may occur quickly (without timelags) as GDP per capita grows, whereas the female education route would require "waiting". But this argument may be more hypothetical than real. Consider a typical, poor country with per capita GDP under $ 300 and a female secondary enrollment rate of 10 percent. If this country wants to promote contraceptive prevalence by 1 percent in 1985, it would involve an increment of female secondary school enrollment of 2.4 percent in 1975 and a wait of 10 years. That country might in theory raise GDP per capita and achieve the same objective more quickly, say in one year, without any time lag. However, to do this, the country would need annual GDP per capita growth of 14 percent, which is not usually feasible. A per capita GDP growth of this magnitude was achieved by few countries during the entire decade of the 1980s, especially in Sub Saharan Africa.[16] Thus, while "waiting time" may seem a disadvantage in the female education route to fertility reduction, the income route may also not be quick. Building a sound institutional and administrative framework for effective family planning programs also needs time.

4.13 Does provision of family planning services appear more attractive in financial terms, relative to female education? Unfortunately due to the absence of precise estimates of costs of secondary education across the world, we are unable to compare the cost of education alternatives. The differences in unit costs of education as well as family planning program services can be expected to vary substantially across continents. Family planning program services probably generally cost considerably less per capita than secondary female education does. However, benefit/cost comparisons, once cost data become available, must be done with great care to ensure that the multiple benefits from both female

[16] See World Bank (1989), Sustainable Growth with Equity: Sub-Saharan Africa.

education and family planning are duly accounted for. Future research should focus on careful comparisons of costs and benefits of alternatives, including the time needed to place the required administrative apparatus to achieve tangible results.

C. Female Education, Access to Medical Care, and Child Health

4.14 The results relating to the determinants of infant mortality are presented in Table 4. One public program variable is considered: population per physician. Of course, this measure of health programs affecting the IMR is highly inadequate (as we acknowledge in footnote 6). We considered using additional variables, namely access to safe drinking water and the percentage of infants immunized, but were unable to use the former due to lack of reliable data, and the later due to its endogeneity and the lack of a good instrumenting variable to measure access rather than use.

4.15 Female secondary enrollments again are highly significant. The quadratic terms are positive but not statistically significant. Male education is not statistically significant for either 1970 or 1975 enrollments[17]. The health program effort variable, population per physician, is highly statistically significant in all equations. GDP per capita is also significant with the expected negative sign. Family planning services is negative and statistically significant only in the equation with 1975 enrollments, while the urban variable is positive and significant in the 1970 equation only. The LAC regional dummy is significant in the 1975 equation. Thus, even after controlling for income and the program variable, female secondary education is clearly a prime factor in reducing the IMR.

[17] Appendix Table 10 presents the results when female education alone is entered into the equation.

4.16 The elasticities of the IMR with respect to female enrollments in 1975, population per physician and GDP per capita have been computed from Table 4 and are shown in Figures 7a and 7b. The direction of the results was similar for the 1970 equations, thus only the results with 1975 enrollments are presented here. The elasticity of IMR with respect to female secondary enrollment sharply rises to -0.92 at an enrollment level of 40 percent; whereas the elasticity of IMR with respect to GDP per capita is low at -0.21 even at a per capita GDP level of $1800.[18] The elasticity of IMR with respect to population per physician is positive and decreases as the ratio decreases. It reaches 0.06 percent when the ratio of population per physician is halved (from the mean). For a typical, poor country with a GDP per capita of $300, a female secondary enrollment rate of 10 percent, and physician for every 15,000 people, let us consider alternative approaches to reducing infant deaths. A doubling of female enrollments (from 10 percent to 20 percent) would bring down the IMR from 105 to 78, whereas a doubling of GDP per capita would reduce IMR from 102 to 99. Halving the ratio of population per physician would reduce the IMR from 85 to 81. These illustrative scenarios suggest the powerful influence of mother's education in the prevention of infant deaths.

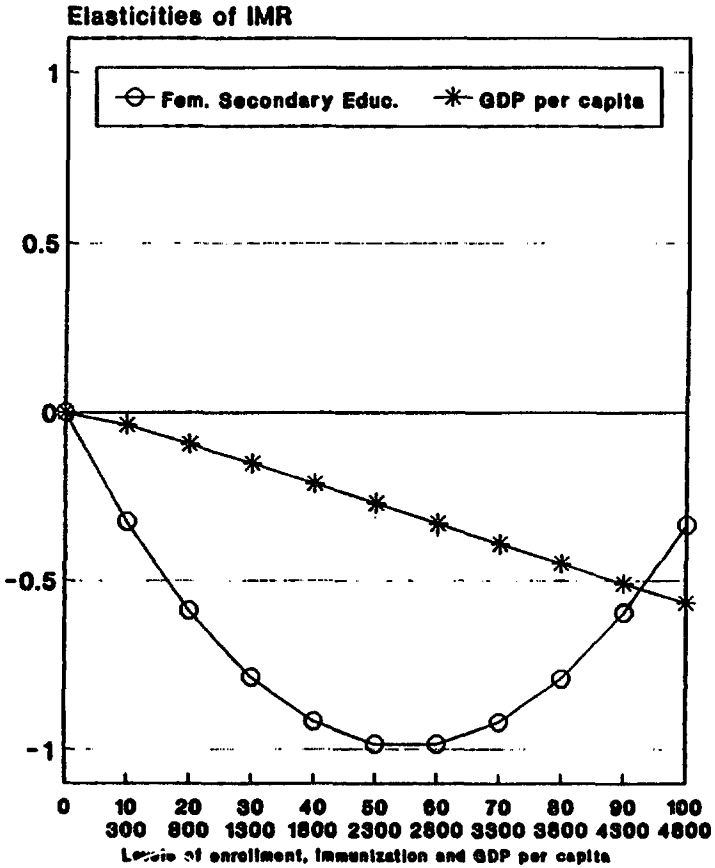
[18] The actual values of these elasticities are given in Appendix Table 9.

**Table 4. Infant Mortality (1985), Female Education and Program Variables**

| Independent Variables | Dependent Variable, IMR 1985 | | | |
|---|---|---|---|---|
| | (1) Enrollments 1970 | | (2) Enrollments 1975 | |
| | Coefficient | t-ratio | Coefficient | t-ratio |
| Constant | 85.246 | 7.474*** | 98.849 | 7.561*** |
| Female Secondary Gross Enrollment Rate, 1970 | -3.309 | -2.373** | | |
| Female Secondary Gross Enrollment Rate squared | 0.020 | 0.946 | | |
| Male Secondary Gross Enrollment Rate, 1970 | 1.609 | 1.718 | | |
| Male Secondary Gross Enrollment Rate squared | -0.01 | -0.494 | | |
| Female Secondary Gross Enrollment Rate, 1975 | | | -3.055 | -3.720*** |
| Female Secondary Gross Enrollment Rate squared | | | 0.014 | 1.237 |
| Male Secondary Gross Enrollment Rate, 1975 | | | 0.710 | 1.113 |
| Male Secondary Gross Enrollment Rate squared | | | 0.01 | 0.910 |
| Family planning services | 1.049 | 1.047 | -0.187 | -1.682* |
| Population per physician, 1984 | 0.001 | 2.433** | 0.001 | 3.795*** |
| Urban population as % of total population | 0.660 | 1.681* | 0.389 | 1.571 |
| GDP per capita, 1985 | -0.018 | -2.466** | -0.010 | -3.872*** |
| Africa Regional Dummy | 8.540 | 0.604 | 10.470 | 1.532 |
| Asia Regional Dummy | 3.252 | 0.229 | 9.299 | 1.118 |
| LAC Regional Dummy | 20.611 | 1.080 | 19.094 | 2.315** |
| Adjusted $R^2$ | .75 | | .73 | |
| n= | 64 | | 65 | |

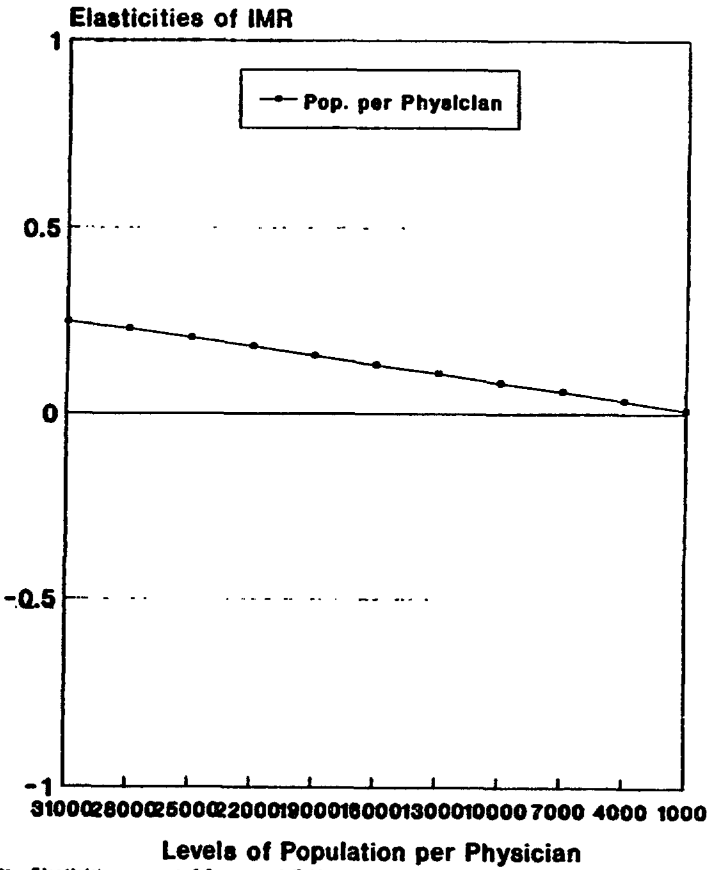
Absolute values of t-ratios, where *, **, and *** indicate significance levels of 10, 5, and 1 percent respectively.

## Figure 7a: Elasticities of IMR, 1985 with respect to Female Secondary Enrollment, 1975 & GDP, 1985




Note: Elasticities computed from eq. 2 Table 4, holding all other variables constant at their mean value.
(Means: Fem. Sec. Enroll. (1975), 19%, GDP per capita (1985), $1070, IMR (1985), 80.

## Figure 7b: Elasticities of IMR, 1985 with respect to Population per Physician, 1984



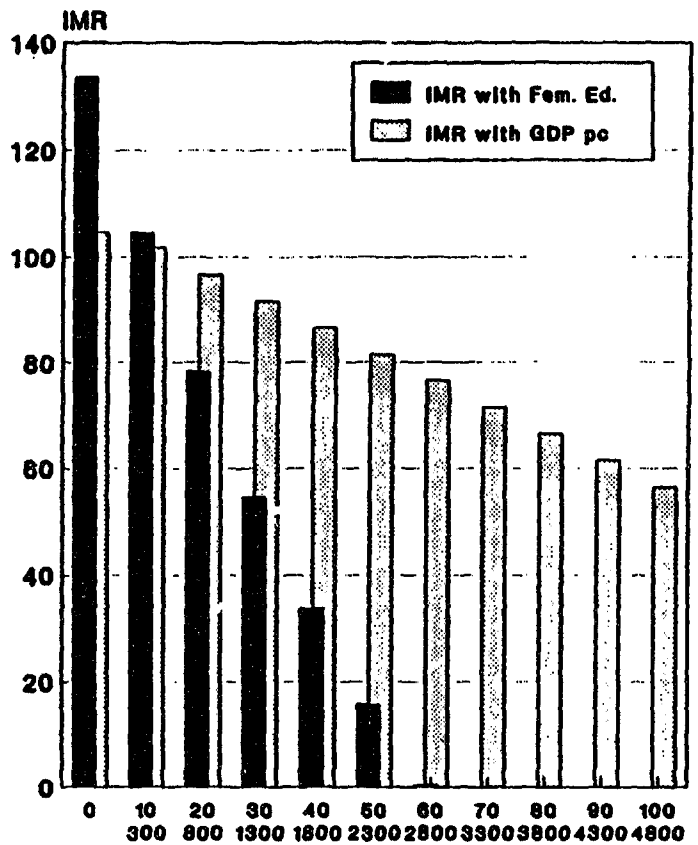

Note: Elasticities computed from eq. 2 Table 4, holding all other variables constant at their mean value.
(Means: Population per Physician (1984), 11861, IMR (1985) 86.

4.17 To examine the above scenarios more clearly, the response of the IMR to female education relative to population per physician and GDP per capita is shown in Figures 8a and 8b, which give the predicted values of the IMR for different levels of female secondary enrollments, holding all other variables constant at their mean level. The IMR falls steadily until female secondary enrollment reaches 50 percent. Also as expected, a rise in GDP per capita leads to a fall in IMR, ceteris paribus, with a slightly steeper slope than for population per physician. However, a GDP level of $4800 -- a clearly implausible proposition for many developing countries even within a decade -- would be needed to reach the level of IMR obtained with 30 percent female secondary enrollments. The IMR falls after halving the ratio of population per physician (again keeping all other variables, including female secondary enrollments constant at their mean level), but at a much lower pace compared to female enrollments. Thus, for developing countries, female education appears to be a powerful way to reduce infant deaths.

4.18 The combined effect of fertility reduction and improvement in infant survival from increasing female enrollments can be seen from the predicted values of each plotted in Figure 9.[19] The reduction in fertility and improvement in infant survival are striking. The simulation shows that with increasing levels of female secondary enrollment in 1985, not only does the number of births per woman fall, but the proportion of infants who survive rises. Doubling the mean level of female education from 19 percent to 38 percent, holding all other variables constant at their mean values, would reduce the TFR from 5.3 to 3.9. Similarly, the proportion of infants surviving increases as the IMR falls from 81 to 38.

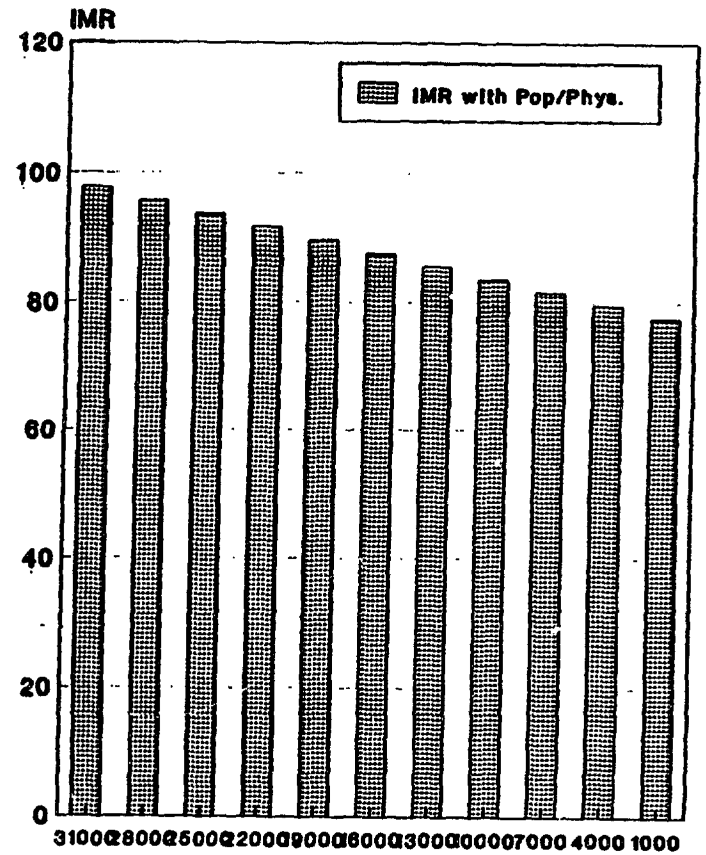
[19] Infant survival rate computed as 1-(IMR/1000) multiplied by TFR.

**Figure 8a: Predicted IMR, 1985 for different levels of Female Secondary Enrollment, 1975, & GDP pc, 1985**



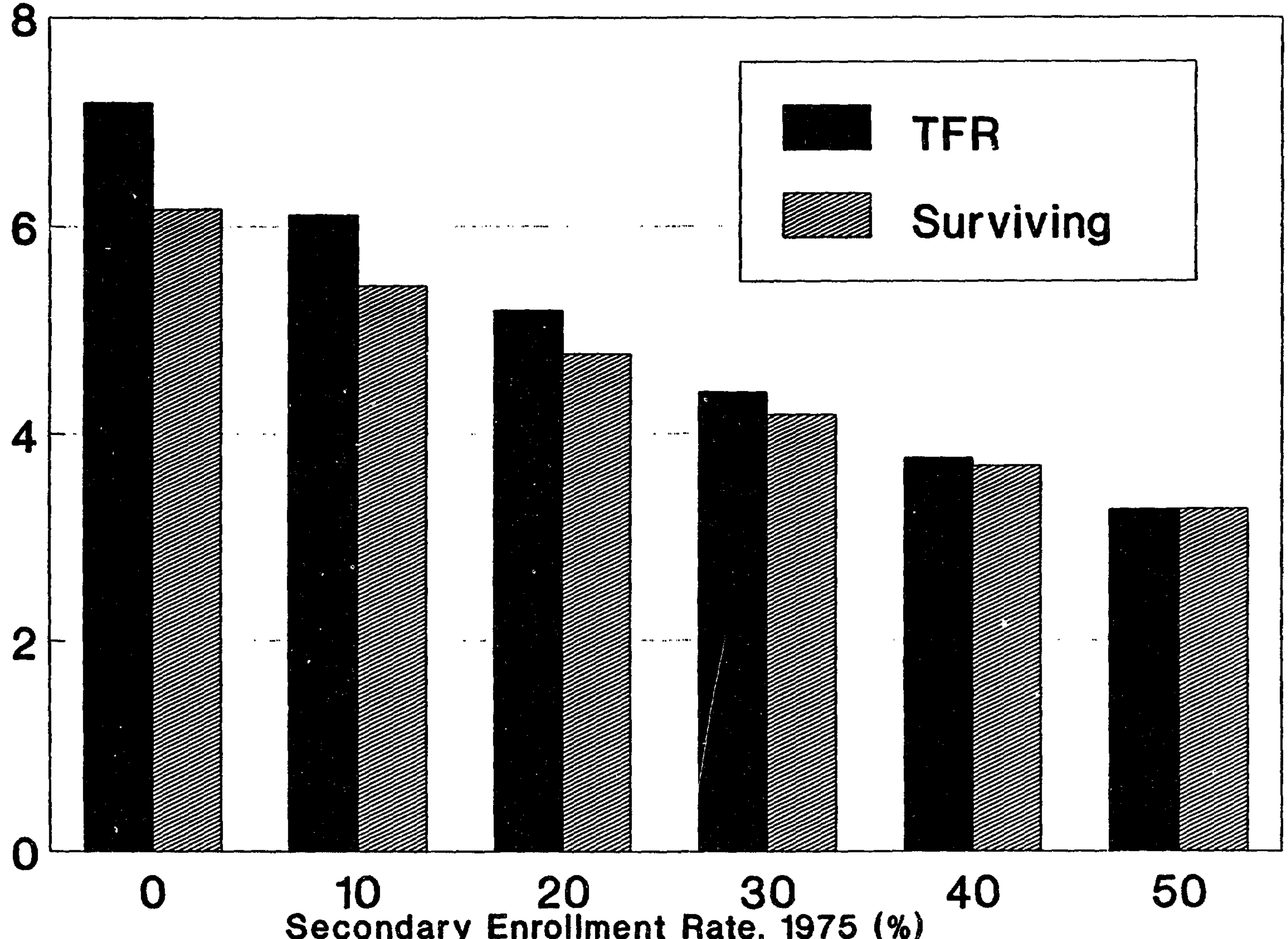

Note: calculated from eq. 2 Table 4, holding all other variables constant at their mean value.
Means: Female Secondary Enrollment (197[illegible]), 19%, GDP per capita (1985), [illegible].

**Figure 8b: Predicted IMR, 1985 for different levels of Population per Physician, 1984**




Note: calculated from eq. 2 Table 4, holding all other
Means: Population per Physician (1984), [illegible], IMR (1985)

Figure 9: Predicted TFR and Infant Survival Rates at different levels of Female Secondary Enrollment in 1975




Note: Simulated from equations 4 & 2 in Tables 1 & 4
(holding all other variables constant at their mean value.)

## 5. Quantifying the Gains in Fertility and Mortality Reduction: Some Simulations

5.1 The econometric estimates obtained from cross-country analysis can be used to simulate what the impact in the 1980s would have been had the female secondary school enrollment rate been double its actual its average in 1975, keeping all other variables (including health and family planning services) constant at their mean values. The impact of doubling (and trebling) the family planning services index was also simulated. The results (shown in Table 5) are striking. For a sample of 65 low and middle income developing countries (including China) which account for 93 percent of the population of developing countries, doubling female secondary enrollment from the mean of 19 percent to 38 percent in 1975, keeping all other variables (including family planning services) constant at their mean values, would have reduced the number of births by 29 percent compared to the actual in 1985[20]. By contrast, doubling the family planning services score, without raising female enrollments, would have reduced the number of births by only 3.5 percent. Results comparable to a doubling of female secondary school enrollments cannot be obtained even by a <u>trebling</u> of the family planning services score (see column 9 and 10, Table 5). Of the developing countries, only two have been able to reach a service level of 75 (China and Indonesia have scores of 78), whereas as many as 14 developing countries, some of which with relatively low per capita GDP such as Sri Lanka and Indonesia, reached 40 percent female secondary enrollment level in 1975, and this number rose to 28 in 1988. The highest gains (in terms of births averted as percent of actual) from female education occur in the countries of South Asia and Sub Saharan Africa.

---

[20] Calculated using the predicted values of TFR and actual female population of childbearing age (15-44) in the sample countries for 1985.

**Table 5. Gains in Births Averted through Female Education and Family Planning Program Services: Simulation Results[1]**
**Births per year, 1985 (millions)**

| | Raising Female Secondary Enrollments | | | | | Raising Family Planning Services | | | |
|---|---|---|---|---|---|---|---|---|---|
| Countries[2]<br>(1) | Actual<br>(2) | Remarks<br>(3) | Simulated<br>(4) | Births Averted<br>(5) | Col. 5 as % of col. 2<br>(6) | Remarks<br>(7) | Simulated<br>(8) | Births Averted<br>(9) | Col. 9 as % of col. 2<br>(10) |
| Low and Middle Income (n=65)[3] | 102.5 | Scenario 1: if female gross enrollment rates in 1975 were doubled to 38% from 19% (actual).[4] | 72.9 | 29.6 | 29 | Scenario 1[a]<br>Scenario 2[b] | 98.9<br>93.4 | 3.6<br>9.1 | 3.5<br>8.9 |
| Low Income (n=31)[5] | 81.2 | | 55.6 | 25.6 | 32 | Scenario 1[a]<br>Scenario 2[b] | 79.6<br>77.1 | 1.6<br>4.1 | 2.0<br>5.0 |
| Sub-Saharan Africa (n=26)[6] | 17.4 | | 11.3 | 6.1 | 35 | Scenario 1[a]<br>Scenario 2[b] | 16.2<br>15.5 | 1.2<br>1.9 | 6.9<br>11.0 |
| South Asia (n=5)[7] | 33.9 | | 17.7 | 16.2 | 48 | Scenario 1[a]<br>Scenario 2[b] | 33.7<br>31.9 | 0.2<br>2.0 | 0.6<br>5.9 |

1/ These simulations are based on equation 4 in Table 1.
2/ According to World Bank classification.
3/ These 65 countries represent 76% of the world's population and 93 of the LDC population, including China.
4/ Keeping all other variables constant at their mean values.
5/ These 31 countries represent 61% of the world's population and 97% of the low-income LDC population, including China.
6/ These 26 countries are: Benin, Botswana, Burkina Faso, Burundi, Central African Republic, Cote d'Ivoire, Ethiopia, Ghana, Guinea, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritius, Mozambique, Niger, Nigeria, Rwanda, Sierra Leone, Somalia, Sudan, Tanzania, Togo, Uganda, Zaire, Zambia, and Zimbabwe. They represent 8.7% of the world's population and 94% of SSA's population.
7/ These 5 countries are: Bangladesh, Nepal, India, Pakistan, and Sri Lanka. They represent 23.1% of the world's population and 96% of South Asia's population.

a/ Scenario 1: if family planning service index score in 1982 were doubled to 50%, from 25% (actual) (see footnote 4).
b/ Scenario 2: if family planning service index score in 1982 were tripled to 75%, from 25% (actual) (see footnote 4).

5.2 Table 6 shows similar simulations for gains in the reduction of infant deaths. Doubling female secondary school enrollments has a dramatic impact on infant deaths averted, reducing them by 64 percent for the sample of developing countries as a whole. The gains in terms of deaths averted are again highest in South Asia and Sub Saharan Africa. Reduction of the ratio of population per physician results in prevention of infant deaths, but to a much smaller extent (2.5 percent), while an increase in GDP per capita from $650 to the median level in the sample of $1300 has no effect on infant deaths.

5.3 The simulations show the virtue of expanding education as well as health and family planning services to reduce fertility and promote child health. Just expanding female education itself would have a significant impact. However, combining female education with health and family planning services would have the greatest impact on the reduction of births and infant deaths. At the same time, the simulations suggest that exclusive reliance on health and family planning program efforts, without expanding female education, will not affect the TFR and IMR substantially, especially in very poor countries with a low female secondary education base. Female education is thus a powerful force for health and family planning in the developing world.

**Table 6. Gains in Infant Deaths Averted through Female Education versus Health Services and GDP per capita change: Simulation Results[1/]**
**Infant Deaths per year, 1985 (millions)**

| Countries[2/] (1) | Actual (2) | Remarks (3) | Simulated (4) | Averted (5) | Col. 5 as % of Col. 2 (6) | Remarks (7) | Simulated (8) | Averted (9) | Col. 9 as % of Col. 2 (10) | Remarks (11) | Simulated (12) | Averted (13) | Col. 3 as % of Col. 2 (14) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Low & middle income (n=65)[3/] | 8.0 | The scenario if female gross enrollment in 1975 were doubled from 19% (actual) to 38%.[4/] | 2.9 | 5.1 | 64 | Scenario halving the ratio of population per physician in 1984 from 11,851 (mean) to 5926.[4/] | 7.8 | 0.2 | 2.5 | Scenario raising GDP per capita level from $650 in 1985 to the median of $1300.[4/] | 8.0 | 0 | 0 |
| Low income (n=31)[5/] | 6.8 | | 2.3 | 4.5 | 66 | | 6.6 | 0.2 | 2.9 | | 6.8 | 0 | 0 |
| Sub-Saharan Africa (n=26)[6/] | 2.1 | | 0.4 | 1.7 | 81 | | 1.9 | 0.2 | 9.5 | | 2.0 | 0.1 | 4.8 |
| South Asia (n=5)[7/] | 3.2 | | 0.7 | 2.5 | 78 | | 3.2 | 0 | 0 | | 3.2 | 0 | 0 |

1/ These simulations are based on equation 2 in Table 4.
2/ According to World Bank classification.
3/ These 65 countries represent 76% of the world's population and 93 of the LDC population, including China.
4/ Keeping all other variables constant at their mean values.
5/ These 31 countries represent 61% of the world's population and 97% of the low-income LDC population, including China.
6/ These 26 countries are: Benin, Botswana, Burkina Faso, Burundi, Central African Republic, Cote d'Ivoire, Ethiopia, Ghana, Guinea, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritius, Mozambique, Niger, Nigeria, Rwanda, Sierra Leone, Somalia, Sudan, Tanzania, Togo, Uganda, Zaire, Zambia, and Zimbabwe. They represent 8.7% of the world's population and 94% of SSA's population.
7/ These 5 countries are: Bangladesh, Nepal, India, Pakistan, and Sri Lanka. They represent 23.1% of the world's population and 96.3% of South Asia's population.

## 6. Implications for Policy and Concluding Remarks

6.1 This paper explored the strength of female secondary enrollment relative to, and/or in combination with some health and family planning program efforts to reduce fertility and infant mortality in the developing world. The relative strength of these strategies seems to vary at different levels of socio-economic development, suggesting the need for careful consideration of priorities especially in countries with low female secondary enrollments. The equation with 1975 enrollment rates suggests that effect of family planning services should be evaluated with reference to specific levels of female enrollments. The elasticity of the total fertility rate with respect to female secondary enrollments is consistently higher than for family planning services, ceteris paribus. Thus expansion in female education reduces fertility substantially and even more when family planning services accompany it. For example, a doubling of female secondary enrollments in 1975 from the mean of 19 percent to 38 percent would have reduced the fertility rate from 5.3 to 3.9, whereas a doubling of family planning services in 1982 from the mean of 25 to 50 would have reduced the total fertility rate from 5.5 to 5.0. In countries where the female secondary education base is low, this research suggests that the expansion of female secondary education may be the best single policy lever for achieving substantial reductions in fertility. However, couples who desire smaller families certainly ought to have good family planning options at hand, and improvements in family planning may encourage more couples to opt for contraception.

6.2 With respect to infant mortality, public programs with reduction in the ratio of population per physician coverage do reduce infant deaths independently of female education. However, the elasticities of the IMR with respect to female secondary enrollments are always greater than with reduction in the ratio of population per physician coverage or GDP per capita. Our simulations show that the reduction in IMR from expansion of female enrollments is striking. For example, in a typical poor country with a GDP per capita of $300, female secondary enrollment of 10 percent, and a physician for every 12,000 people, a doubling of female education in 1975 would have reduced the IMR in 1985 from 105 to 78; in comparison, a halving of the ratio of population per physician would have lowered the IMR from 85 to 81, and a doubling of GDP per capita would have lowered the IMR from 102 to 99. When the results are translated into deaths averted, the magnitude of reductions in deaths obtained from small increments in female education swamp the reduction in IMR obtained from even massive direct programs; for example, while doubling female enrollment rate reduces infant deaths by 64 percent, halving the ratio of population per physician reduces infant deaths by 2.5 percent. Of course, our measure of health programs is very imperfect and doubtless understates the impact of health care. But it is reasonably clear that expanding female education is a powerful option for many developing countries.

6.3 The simulations attempted in this paper show that the gains from female education in terms of births averted are also striking. For example, doubling female secondary school enrollments from their mean level in 1975, keeping all other variables (including family planning services) constant at their mean values, would have lowered births by 29 percent compared to the actual number in 1985. Doubling the family planning service score, keeping all other variables constant at their mean values, would have reduced births by 3.5 percent. The gains from expansion of female secondary schooling are largest in South Asia and Sub-Saharan Africa where the female enrollment rates were among the lowest in the world in 1975. Since then there has been progress; yet even as of 1989, 25 out of 27 countries with female enrollment rates of less than 20 percent are in Sub Saharan Africa and South Asia.

6.4 The broad conclusion of this study is that family planning and health programs do reduce fertility and mortality, but the impact of expanding female secondary enrollments appears to be even greater, especially in countries with low female secondary enrollment; the gains are, of course, greatest when female education is combined with health and family planning programs.

**References**

Behrman, J.R. 1990. "The Action of Human Resources and Poverty on One Another: What We Have Yet to Learn," LSMS Working Paper, No. 74. Washington, D.C.: World Bank.

Cochrane, S. 1988. "The Effects of Education, Health, and Social Security on Fertility in Developing Countries, World Bank Staff Working Paper No. 93. Washington, D.C.: World Bank.

Cochrane, S. and D.K. Guilkey. 1992. "Fertility Intentions and Access to Services as Constraints on Contraceptive Use in Columbia," mimeo, World Bank.

Cochrane, S., O'Hara, D. and J. Leslie 1980. "The Effects of Education on Health," World Bank Staff Working Papers, No. 405. Washington, D.C.: World Bank.

—. 1982. "Parental Education and Child Health: Intracountry Evidence." Health Policy and Education, 2 (March), 213-250.

Herz, Barbara K. 1984. "Official Development Assistance for Population Activities: A Review." World Bank Staff Working Paper No. 688, Population and Development Series, No. 13. Washington, DC World Bank.

King. E.M. and M.A. Hill. 1991. eds. Women's Education in Developing Countries: Barriers, Benefits and Policy. Johns Hopkins University Press.

Lapham, R.J. and W.P. Mauldin. 1972. "National Family Planning Programs: Reviews and Evaluation." Studies in Family Planning 3:3, 29-52.

Lightbourne, R.E. 1987. "Reproductive Preferences and Behaviour" in Cleland, J., Scott, C. and D. Whitelegge. eds. 1987. The World Fertility Survey - An Assessment. Oxford University Press.

Mauldin, W.P. and J.A. Ross. 1991. "Family Planning Programs: Efforts and Results, 1982-89." Studies in Family Planning, 22:6 (Nov./Dec.), 350-367.

Mensch, B., Lentzner, H. and S. Preston. 1986. Socio-Economic Differentials in Child Mortality in Developing Counties. New York: United Nations.

Preston, S.H. 1980. "Causes and Consequences of Mortality in Less Developed Countries During the Twentieth Century," in Population and Economic Change in Developing Countries, R. Easterlin, ed. New York: National Bureau of Economic Research, 289-360.

—. 1985. "Mortality and Development Revisited," Population Bulletin of the United Nations, No. 18. New York: United Nations.

Rosenzweig, Mark R. and T.P. Schultz. 1987. "Fertility and Investments in Human Capital: Estimates of the Consequences of Imperfect Fertility Control in Malaysia," Journal of Econometrics 36 (1-2): 163-184.

Ross, J.A., Mauldin, W.P., Green, S.R. and E.R. Cooke. 1992. Family Planning and Child Survival Programs as Assessed in 1991. New York: The Population Council.

Schultz, T.P. 1988. "The Relationship Between Local Family Planning Expenditures and Fertility in Thailand, 1976-1981," paper presented at the Baltimore, MD Annual Meetings of the Population Association of America, March 1989.

----. 1989 "Returns to Women's Education." PHRWD Working Paper No. 001. Washington, DC: World Bank.

----. 1990. "Assessing Family Planning Cost-Effectiveness: Applicability of Individual Demand-Program Supply Framework," mimeo, Economics Department, Yale University.

----. 1992. "Investments in the Schooling and Health of Women and Men: Quantities and Returns," paper presented at the Conference on Women's Human Capital and Development, Bellagio, Italy, May 18-22, 1992.

Summers, R. and A. Heston. 1991. "The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950-1988," The Quarterly Journal of Economics, CVI:2 (May), 327-368.

UNDP. 1990. Human Development Report 1990. New York: United Nations.

United Nations. 1991. "Levels and Trends of Contraceptive Use," in "United Nations Women's Indicators and Statistics Spreadsheet Database for Microcomputers" (WISTAT), Version 2. New York: United Nations.

Wheeler, D. 1980. "Female Education, Family Planning, Income and Population: A Long-Run Econometric Simulation Model," in N. Birdsall, ed. "The Effects of Family Planning Programs on Fertility in the Developing World," World Bank Staff Working Papers No. 677, Population and Development Series No. 2, 116-206. Washington, DC: The World Bank.

World Bank. 1989. Sustainable Growth with Equity: Sub-Saharan Africa. Washington, D.C.: World Bank.

World Bank. 1990. World Development Report. Washington, D.C.: World Bank.

World Bank. 1992. Social Indicators of Development (STARS).

World Bank Economic and Social Database (BESD).

World Fertility Survey and United Nations, Department of International Economics and Social Affairs. 1987. Fertility Behaviour in the Context of Development - Evidence from the World Fertility Survey. Population Studies Series No. 100. New York: United Nations.

# Appendices

**Table A1. List of Sample Countries**

| Sample n = 72 | | |
|---|---|---|
| Low Income<br>n = 37 | Lower Middle Income<br>n = 27 | Upper Middle Income<br>n = 8 |
| Afghanistan1/2/ | Bolivia2/ | Algeria |
| Bangladesh1/ | Botswana | Brazil |
| Benin | Cameroon1/2/ | Iran, Islamic Rep. |
| Burkina Faso | Chile | Iraq |
| Burma | Colombia | Korea, Rep. of |
| Burundi | Costa Rica | Panama |
| Central African Rep. | Cote d'Ivoire | Trinidad and Tobago |
| Chad2/ | Ecuador | Venezuela |
| China1/ | Egypt, Arab Rep. | |
| Ethiopia | El Salvador | |
| Ghana | Guatemala | |
| Guinea | Honduras | |
| Haiti1/ | Jamaica | |
| India | Malaysia | |
| Indonesia | Mauritius | |
| Kenya | Mexico | |
| Lesotho | Morocco | |
| Liberia | Papua New Guinea | |
| Malawi1/ | Paraguay | |
| Madagascar | Peru | |
| Mali | Senegal2/ | |
| Mauritania2/ | Syrian Arab Rep. | |
| Mozambique1/ | Thailand | |
| Nepal | Tunisia | |
| Niger | Turkey | |
| Nigeria2/ | Yemen Arab Republic1/2/ | |
| Pakistan | Zimbabwe | |
| Rwanda | | |
| Sierra Leone | | |
| Somalia | | |
| Sri Lanka | | |
| Sudan | | |
| Tanzania | | |
| Togo | | |
| Uganda | | |
| Zaire | | |
| Zambia | | |

Note: Not all countries were used in all the equations and simulations owing to gaps in the data on certain specific variables as shown below:
1/ Not used in the TFR or IMR equations with 1970 enrollments (n=64).
2/ Not used in the TFR or IMR equations with 1975 enrollments (n=65).

**Table A2. Variables and Definitions**

| Variable | Definition |
|---|---|
| TFR85 | Total fertility rate, 1985, representing the number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children at each age in according with prevailing age-specific fertility rates. |
| IMR85 | Infant mortality rate, 1985, defined as the number of infants who die before reaching one year of age, per 1000 live births. |
| FED70<br>MED70<br>FED75<br>MED75 | Gross secondary enrollment rates for females and males, 1970 and 1975 (1988 was used in the contraceptive prevalence equation). |
| GDP | Gross domestic product per capita, 1985, purchasing power parity adjusted. 1988 used in equation for contraceptive prevalence and desired family size. |
| PHYS | Population per physician, 1984 (latest year available). The number includes medical assistants as well as registered practitioners. |
| URB | Urban population, as a percent of total population, 1985. |
| CP | Contraceptive Prevalence 1988, represents contraceptive use among currently married women for the latest available year (range 1983-89) |
| SERV | Percent of the maximum service score that a country has, from the service component of Family Program Effort, 1982 (Mauldin and Ross 1991, and Ross et al. 1992). It includes community-based distribution, social marketing, home-visiting workers, etc. |
| DFS | Desired Family Size, 1983-88, measures "preferred" family size (WFS). |
| DUMAFR<br>DUMAS<br>DUMLAC | Dummy Regional Variables representing Africa, Asia and LAC. |

**Table A3. TFR Equations - Means of Standard Deviations**

| Variables | Mean | Std. Dev. | Mean | Std. Dev. |
|---|---|---|---|---|
| TFR85 | 5.40 | 1.52 | 5.35 | 1.57 |
| FemSec70 | 13.38 | 12.71 | | |
| MalSec70 | 20.34 | 13.74 | | |
| FemSec75 | | | 18.87 | 16.55 |
| MalSec75 | | | 26.74 | 17.05 |
| GDP PC85 | 2124.30 | 1588.0 | 2114.5 | 1585.7 |
| Service 82 | 23.77 | 20.6 | 25.48 | 21.7 |
| Urban 85 | 37.00 | 19.62 | 35.79 | 20.0 |
| Pop Phy 84 | 12053.00 | 15313.0 | 11851.0 | 15213.0 |
| Dummy Africa | 0.47 | 0.50 | 0.45 | 0.50 |
| Dummy Asia | 0.16 | 0.36 | 0.18 | 0.39 |
| Dummy LAC | 0.25 | 0.44 | 0.25 | 0.43 |
| n= | 64 | | 65 | |

**Table A4. IMR Equations - Means of Standard Deviations**

| Variables | Mean | Std. Dev. | Mean | Std. Dev. |
|---|---|---|---|---|
| IMR85 | 84.38 | 40.55 | 84.83 | 41.8 |
| FemSec70 | 13.38 | 12.71 | | |
| MalSec70 | 20.34 | 13.74 | | |
| FemSec75 | | | 18.87 | 16.55 |
| MalSec75 | | | 26.74 | 17.05 |
| Pop Phy 84 | 12053 | 15313 | 11851 | 15213 |
| Urban 85 | 37.0 | 19.62 | 35.79 | 20.0 |
| GDP PC85 | 1985.5 | 1523.3 | 1976.2 | 1520.9 |
| Service 82 | 23.77 | 20.6 | 25.48 | 21.72 |
| Dummy Africa | 0.47 | 0.50 | 0.45 | 0.50 |
| Dummy Asia | 0.16 | 0.37 | 0.18 | 0.39 |
| Dummy LAC | 0.25 | 0.44 | 0.25 | 0.43 |
| n= | 64 | | 65 | |

**Table A5. Education, Family Planning Services, and Total Fertility Rate**

| Independent Variables | Dependent Variable, TFR, 1985 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Without interaction (1) | | With interaction (2) | | Without interaction (3) | | With interaction (4) | |
| | 1970 | | | | 1975 | | | |
| | Coefficient | t-ratio | Coefficient | t-ratio | Coefficient | t-ratio | Coefficient | t-ratio |
| Constant | 7.678 | 13.125*** | 7.303 | 12.399*** | 7.324 | 6.549*** | 6.597 | 4.886*** |
| Female Secondary Gross Enrollment, 1970 | -0.084 | -3.804*** | -0.167 | -3.532*** | | | | |
| Female Secondary Gross Enrollment^2 | 0.001 | 2.083** | 0.002 | 2.242** | | | | |
| Female Secondary Gross Enrollment, 1975 | | | | | -0.055 | -2.092*** | -0.050 | -1.801*** |
| Female Secondary Gross Enrollment^2 | | | | | 0.0002 | 0.596** | 0.001 | 1.253 |
| GDP per capita, 1985 | -0.0002 | -1.414 | -0.0002 | -1.389 | -0.0001 | -0.621 | -0.0001 | -0.270 |
| Family planning service | -0.023 | -2.949*** | -0.014 | -1.007 | -0.022 | -1.381 | -0.0001 | -0.004 |
| Fem. Sec. Enrollment FP services | | | -0.0004 | -0.624 | | | -0.001 | -1.680* |
| Urban population as % of total population | -0.005 | -0.502 | -0.005 | -0.492 | -0.002 | -0.185 | -0.002 | -0.222 |
| Under 5 mortality rate, 1985 | 0.001 | 0.117 | 0.003 | 0.200 | 0.007 | 0.170 | 0.018 | 0.385 |
| Africa Regional Dummy | -0.347 | -1.001 | -0.290 | -0.806 | -0.146 | -0.388 | 0.057 | 0.142 |
| Asia Regional Dummy | -0.850 | -1.879* | -0.852 | -1.856* | -0.815 | -1.127 | -0.866 | -1.126 |
| LAC Regional Dummy | -0.285 | -0.920 | -0.323 | -1.010 | -0.495 | -1.502 | -0.574 | -1.627 |
| $R^2$ | .79 | | .78 | | .79 | | .76 | |
| n | 64 | | 64 | | 65 | | 65 | |

Absolute values of t-ratios, where *, **, and *** indicate significance levels of 10, 5, and 1 percent respectively.

1/ 2-stage least squares using population per physician to instrument under 5 mortality rate.

2/ Female Secondary Enrollment used in (a) and (b); male enrollment used for (c).

**Table A6. Elasticities of TFR with respect to Female Secondary Enrollment and Family Planning Services at Different Levels of Enrollments, and Service**

| Levels of enrollment/ Levels of service score | Female Education (1970) | Family Planning Services (1970 education equation) | Female Education (1975) | Family Planning Services (1975 education equation) |
|---|---|---|---|---|
| Mean | -0.359 | -0.092 | -0.307 | -0.096 |
| 10 | -0.288 | -0.039 | -0.186 | -0.038 |
| 20 | -0.459 | -0.077 | -0.320 | -0.075 |
| 30 | -0.513 | -0.116 | -0.399 | -0.113 |
| 40 | -0.449 | -0.155 | -0.426 | -0.150 |
| 50 | -0.268 | -0.194 | -0.399 | -0.188 |
| 60 | -0.031 | -0.32 | -0.319 | -0.225 |
| 70 | 0.447 | -0.271 | -0.185 | -0.263 |
| 80 | 0.900 | -0.310 | 0.001 | -0.300 |
| 90 | 1.631 | -0.349 | 0.242 | -0.338 |
| 100 | 2.400 | -0.388 | 0.534 | -0.375 |

*Source*: Computed from equations 1 and 4 in Table 1.
Means: Female Secondary Enrollment Rate 1970: 13%, Family Planning Services 1982: 24%, IMR 84.4.
Means: Female Secondary Enrollment Rate 1975: 19% Family Planning Services 1982, 25%, IMR 84.8.

**Table A7. Female Education, GDP per capita, Desired Family Size, and Contraceptive Prevalence**

| | Dependent Variable, DFS, 1988 | | Dependent Variable, CP, 1988 | |
|---|---|---|---|---|
| | Coefficient | t-ratio | Coefficient | t-ratio |
| Constant | 4.092 | 7.285*** | -10.832 | -2.683*** |
| Female Secondary Gross Enrollment, 1975 | -0.070 | -3.483*** | 0.926 | 2.657*** |
| Female Secondary Gross Enrollment^2 | 0.001 | 2.704*** | -0.010 | -1.994** |
| Male Secondary Gross Enrollment, 1975 | | | | |
| Male Secondary Gross Enrollment^2 | | | | |
| GDP per capita 1988 | 0.001 | 2.005** | 0.008 | 3.169*** |
| GDP per capita^2 | -0.0000001 | -1.733* | -0.000001 | -2.615*** |
| Family planning services | | | 0.524 | 7.352*** |
| Africa Regional Dummy | 2.826 | 6.129*** | 2.798 | 0.728 |
| Asia Regional Dummy | -0.362 | -0.844 | -2.853 | -0.652 |
| LAC Regional Dummy | -0.022 | -0.046 | 2.846 | 0.583 |
| $R^2$ | .74 | | .82 | |
| n | 32 | | 61 | |

Absolute values of t-ratios, where *, **, and *** indicate significance levels of 10, 5, and 1 percent respectively.

**Table A8. Elasticities of Contraceptive Prevalence, with respect to Female Secondary School Enrollment Rate, Access to Family Planning Services, and GDP per capita, at Different Levels of Enrollment, Access and Income**

| Range SSE and Access Services= 0-100 | Female Secondary School Enrollment Rate in 1975 | Access to Family Planning Services, 1982 | Range GDP= 300-3000 | GDP per capita, 1988 |
|---|---|---|---|---|
| 10 | 0.239 | 0.172 | 300 | 0.075 |
| 20 | 0.349 | 0.343 | 600 | 0.143 |
| 30 | 0.330 | 0.515 | 900 | 0.205 |
| 40 | 0.182 | 0.687 | 1200 | 0.260 |
| 50 | -0.095 | 0.858 | 1500 | 0.308 |
| 60 | -0.500 | 1.030 | 1800 | 0.351 |
| 70 | -1.035 | 1.201 | 2100 | 0.387 |
| 80 | -1.699 | 1.373 | 2400 | 0.416 |
| 90 | -2.491 | 1.545 | 2700 | 0.439 |
| 100 | -3.413 | 1.717 | 3000 | 0.455 |

*Source*: Computed from Table 3.
(Means: Female Secondary Enrollment 1975:20.3%, Access to Services:28%, GDP per capita:$2324, andCP

**Table A9. Elasticities of IMR with respect to Female Secondary Enrollments, Population per Physician, and GDP at Different Levels of Enrollment, 1975**

| | Female Education | Population per Physician | | GDP per capita | |
|---|---|---|---|---|---|
| Enrollment levels | | Range 28.000-1.000 | | Range $300-$4800 | |
| Mean | -0.563 | Mean | 0.094 | Mean | -0.234 |
| 10 | -0.327 | 28,000 | 0.230 | 300 | -0.036 |
| 20 | -0.590 | 25,000 | 0.205 | 800 | -0.095 |
| 30 | -0.786 | 22,000 | 0.181 | 1300 | -0.154 |
| 40 | -0.918 | 19,000 | 0.156 | 1800 | -0.213 |
| 50 | -0.984 | 16,000 | 0.131 | 2300 | -0.272 |
| 60 | -0.985 | 13,000 | 0.107 | 2800 | -0.332 |
| 70 | -0.921 | 10,000 | 0.082 | 3300 | -0.391 |
| 80 | -0.792 | 7,000 | 0.058 | 3800 | -0.450 |
| 90 | -0.597 | 4,000 | 0.033 | 4300 | -0.509 |
| 100 | 0.337 | 1,000 | 0.008 | 4800 | -0.568 |

*Source*: Computed from equation2 in Table 4.
(Means: Female Gross Enrollment Rate 1975, 20%; Population per Physician 1984, 118511, GDP per capita 1985, $2042, IMR 84.8)

**Table A10. Education, Program Variables and Infant Mortality**

| Independent Variables | Dependent Variable, IMR85 | | | |
|---|---|---|---|---|
| | (1) | | (2) | |
| | Coefficient | t-ratio | Coefficient | t-ratio |
| Constant | 124.601 | 5.170** | 128.669 | 6.072*** |
| Female Secondary Gross Enrollment Rate, 1970 | -3.437 | -1.496 | -2.518 | -1.959* |
| Female Secondary Gross Enrollment Rate'2 | 0.029 | 0.886 | 0.018 | 1.144 |
| Female Secondary Gross Enrollment Rate, 1975 | | | -2.518 | -1.959* |
| Female Secondary Gross Enrollment Rate'2 | | | 0.018 | 1.144 |
| ontraceptive prevalence | 1.171 | 1.046 | 0.597 | 0.805 |
| Population per physician, 1984 | 0.001 | 2.549** | 0.001 | 2.447** |
| Urban population as % of total population | 0.833 | 2.109** | 0.681 | 2.137** |
| GDP per capita, 1985 | -0.019 | -2.525** | -0.014 | -2.681*** |
| Infants Immunized, 1987 | -0.559 | -1.851* | -0.376 | -1.644 |
| Africa Regional Dummy | -7.452 | -0.565 | -3.900 | -0.349 |
| Asia Regional Dummy | -8.202 | -0.540 | -9.187 | -0.661 |
| AC Regional Dummy | +3.263 | -1.001 | -13.291 | -1.141 |
| Adjusted $R^2$ | .55 | | .68 | |
| | 62 | | 63 | |

Absolute values of t-ratios, where *, ** and *** indicate significance levels of 10, 5, and 1 percent respectively.

**Table A11. Infant Mortality (1985), Female Education and Program Variables, including Immunization**

| Independent Variables | Dependent Variable, IMR 1985 | | | |
|---|---|---|---|---|
| | (1) Enrollments 1970 | | (2) Enrollments 1975 | |
| | Coefficient | t-ratio | Coefficient | t-ratio |
| Constant | 107.953 | 6.544*** | 119.842 | 6.344*** |
| Female Secondary Gross Enrollment Rate, 1970 | -3.151 | -2.142** | | |
| Female Secondary Gross Enrollment Rate squared | 0.020 | 0.894 | | |
| Male Secondary Gross Enrollment Rate, 1970 | 1.437 | 1.495 | | |
| Male Secondary Gross Enrollment Rate squared | -0.01 | -0.343 | | |
| Female Secondary Gross Enrollment Rate, 1975 | | | -2.853 | -3.380*** |
| Female Secondary Gross Enrollment Rate squared | | | 0.013 | 1.082 |
| Male Secondary Gross Enrollment Rate, 1975 | | | 0.329 | 0.518 |
| Male Secondary Gross Enrollment Rate squared | | | 0.012 | 1.408 |
| % Infants Immunized, 1987 | -0.297 | -1.981** | -0.249 | -1.663* |
| Family planning services | -0.123 | -0.992 | -0.098 | -0.788* |
| Population per physician, 1984 | 0.001 | 3.100** | 0.001 | 2.652*** |
| Urban population as % of total population | 0.359 | 1.473 | 0.312 | 1.257 |
| GDP per capita, 1985 | -0.011 | -4.016*** | -0.010 | -3.517*** |
| Africa Regional Dummy | 7.235 | 0.909 | 8.250 | 1.228 |
| Asia Regional Dummy | 2.715 | 0.275 | 1.875 | 0.186 |
| LAC Regional Dummy | 14.432 | 1.276 | 15.281 | 1.908* |
| Adjusted $R^2$ | .76 | | .78 | |
| n= | 64 | | 65 | |

Absolute values of t-ratios, where *, **, and *** indicate significance levels of 10, 5, and 1 percent respectively.

## Policy Research Working Paper Series

| | Title | Author | Date | Contact for paper |
|---|---|---|---|---|
| WPS1019 | How Effective are Directed Credit Policies in the United States? A Literature Survey | Anita M. Schwarz | November 1992 | M. Raggambi 37664 |
| WPS1020 | Another Look at Population and and Global Warming | Nancy Birdsall | November 1992 | S. Rothschild 37460 |
| WPS1021 | Measuring Welfare Changes from Commodity Price Stabilization in Small Open Economies | Jonathan R. Coleman<br>Chris Jones | November 1992 | D. Gustafson 33714 |
| WPS1022 | A New Approach to Evaluating Trade Policy | James E. Anderson<br>J. Peter Neary | November 1992 | M. T. Sanchez 33731 |
| WPS1023 | Tariff Index Theory | James E. Anderson | November 1992 | M. T. Sanchez 33731 |
| WPS1024 | An Exact Approach for Evaluating the Benefits from Technological Change | Will Martin<br>Julian M. Alston | November 1992 | D. Gustafson 33714 |
| WPS1025 | Openness and Economic Performance in Sub-Saharan Africa: Evidence from Time-Series Cross-Country Analysis | Kazi M. Matin | November 1992 | D. Ballantyne 38004 |
| WPS1026 | Financial Liberalization and Adjustment in Chile and New Zealand | Paul D. McNelis<br>Klaus Schmidt-Hebbel | November 1992 | A. Marañon 31450 |
| WPS1027 | Lessons from Bank Privatization in Mexico | Guillermo Barnes | November 1992 | W. Pitayatonakarn 37664 |
| WPS1028 | Socioeconomic and Ethnic Determinants of Grade Repetition in Bolivia and Guatemala | Harry Anthony Patrinos<br>George Psacharopoulos | November 1992 | L. Longo 39244 |
| WPS1029 | Controlling Tropical Deforestation: An Analysis of Alternative Policies | Robert T. Deacon | November 1992 | P. Pender 37851 |
| WPS1030 | Measuring the Effects of Urban Transportation Policies on the Environment: A Survey of Models | Alan J. Krupnick | November 1992 | P. Pender 37851 |
| WPS1031 | Measuring the Possibilities of Interfuel Substitution | Robert Bacon | November 1992 | P. Pender 37851 |
| WPS1032 | East Asia and Pacific Region, South Asia Region Population Projections, 1992-93 Edition | Eduard Bos<br>My T. Vu<br>Ann Levin | November 1992 | O. Nadora 31091 |

## Policy Research Working Paper Series

| | Title | Author | Date | Contact for paper |
|---|---|---|---|---|
| WPS1033 | Latin America and the Caribbean Region (and Northern America) Population Projections, 1992-93 Edition | My T. Vu<br>Eduard Bos<br>Ann Levin | November 1992 | O. Nadora<br>31091 |
| WPS1034 | Revising Financial Sector Policy in Transitional Socialist Economies: Will Universal Banks Prove Viable? | David H. Scott | November 1992 | K. Waelti<br>37664 |
| WPS1035 | How Import Protection Affects the Philippines' Motor Vehicle Industry | Wendy E. Takacs | November 1992 | D. Ballantyne<br>37947 |
| WPS1036 | Output Decline in Hungary and and Poland in 1990-91: Structural Change and Aggregate Shocks | Simon Commander<br>Fabrizio Coricelli | November 1992 | O. del Cid<br>35195 |
| WPS1037 | Vocational Secondary Schooling, Occupational Choice, and Earnings in Brazil | Ana-Maria Arriagada<br>Adrian Ziderman | November 1992 | C. Cristobal<br>33640 |
| WPS1038 | Determinants of Expatriate Workers' Remittances in North Africa and Europe | Ibrahim A. Elbadawi<br>Robert de Rezende Rocha | November 1992 | A. Marañon<br>31450 |
| WPS1039 | Education, Externalities, Fertility, and Economic Growth | Martin Weale | November 1992 | PHREE<br>33680 |
| WPS1040 | Lessons of Trade Liberalization in Latin America for Economies in Transition | Jaime de Melo<br>Sumana Dhar | November 1992 | D. Ballantyne<br>37947 |
| WPS1041 | Family Planning Success Stories in Bangladesh and India | Moni Nag | November 1992 | O. Nadora<br>31091 |
| WPS1042 | Family Planning Success in Two Cities in Zaire | Jane T. Bertrand<br>Judith E. Brown | November 1992 | O. Nadora<br>31091 |
| WPS1043 | Deriving Developing Country Repayment Capacity from the Market Prices of Sovereign Debt | Stijn Claessens<br>George Pennacchi | November 1992 | R. Vo<br>33722 |
| WPS1044 | Hospital Cost Functions for Developing Countries | Adam Wagstaff<br>Howard Barnum | November 1992 | O. Nadora<br>31091 |
| WPS1045 | Social Gains from Female Education: A Cross-National Study | Kalanidhi Subbarao<br>Laura Raney | November 1992 | M. Abundo<br>36820 |