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RETURNS TO EDUCATION
The Case of Fertility

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Abstract. The purpose of this research is to observe the impact of the individual and aggregate-level education on the fertility rate in Pakistan. In this study, two specifications are used to quantify the impact of women's schooling on the aggregate fertility rate. In the first specification, the proportion of literate (formal schooling) married women is used irrespective of the level of educational attainments, while in the other specification, two alternative variables are used; first, the proportion of married women in a district, who have education below the secondary level, and second, those who have obtained secondary or higher education. The majority of the estimates are statistically significant and show the expected relationship with the fertility rate. The estimated coefficients of the macro fertility model establish a case for higher education for women to achieve a noticeable reduction in the fertility rate. Moreover, the impact of the general level of education of a district, after controlling for the level of economic development, appears an important element in the fertility response model.

I. INTRODUCTION

Since Malthus' time, population growth has been a key determinant in the analysis of poverty within a country and/or a region. One way to study the behavior of population growth is by understanding the determinants of fertility rates. The comprehension of these determinants could then be used for guidance in the formulation of socio-economic policies for effective poverty alleviation.

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Kravdal (2000) explained that although women's education has been one of the most thoroughly studied determinants of fertility, the research in this area is still far from being exhausted. For example, several causal links seem plausible in light of existing empirical evidence, but we have inadequate knowledge about their relative importance.

A review of the existing literature on fertility determinants shows a striking commonality in one aspect: most of the work done so far estimates the determinants of fertility using a micro-data approach. That is, the source of information is the household or, in several cases, the women. The explanation for this commonality is quite straightforward. Since the economic theories of fertility assume that parents have the number of children they do because in actual fact they desire approximately that number, given certain costs, it can be perfectly understood why studies use data on households to estimate fertility determinants.

Another important, and not so widely recognized challenge, is to find out whether education at the aggregate level has any effect on a woman's fertility above and beyond that of her own education. The possible importance of 'mass education' was discussed by Caldwell (1980) many years ago, and has been touched upon in a review by Cleland and Jejeebhoy (1996); however, little empirical evidence has so far been accumulated. Recently, Kravdal (2000) empirically searched for aggregate-level effects of education on fertility using data on Zimbabwe and found some evidence of the effects of district education on women's fertility.

Conceptually, in addition to the effects of women's education, there may be a 'spill-over' from other people's education through, for example, social learning. Uneducated women who live in societies where a large proportion are literate, or where the average educational level is high, may have a fertility different from that of uneducated women elsewhere. Also the better-educated may be influenced by the educational distribution in the community. If aggregate education has, on the whole, a substantial reducing effect, fertility will decline more sharply in response to an increase in women's education than as suggested by the estimates of individual-level effects.

So far, we have focused on variables that might reasonably be expected to influence fertility but not be influenced by it. Examples of variables which stand in a relation of mutual interdependence with fertility (or are jointly determined) are infant mortality and female labour force participation. There are good reasons for infant mortality to affect fertility. Parents may have more children than they ultimately desire in anticipation of losing some (socalled 'hoarding' behavior). They may also replace lost children. At the same time, high fertility itself is likely to raise infant mortality, due to both biological and behavioural reasons.[1] Likewise, higher female labour force participation may both lead to and result from lower fertility.[2]

This research, therefore, quantifies the effects of education on fertility using aggregate data of Pakistan at the district level.[3] It includes both aggregate district education level and percentage education level of married women in a fertility model, along with other variables that are determinants of fertility.

The paper is organized as follows. Fertility behavior at the aggregate level is modeled in section II. This section also provides the definition of the variables used in this study and data sources. Results are presented in section III, while the last section provides the conclusions of the paper.

II. AGGREGATE FERTILITY MODEL AND DEFINITION OF VARIABLES

Economic theories of fertility assume that parents have the number of children they do because they desire approximately that number, given the costs of birth control. This demand for children, at a household level, is affected by many socio-economic factors such as the level of human capital of family members, family income and assets, and the experience of child mortality. By extension, fertility rates at aggregate level can be modeled as:

$$F = \alpha + \beta_i [SLE] + \gamma_i [MWE] + \delta_i [DC] + \kappa [IMR] + \lambda_i [PD] + \mu \qquad (1)$$

The dependent variable F denotes the fertility rate, which is taken here as the average number of children per married women (in the 15-45 age group) in a particular district. Aggregate-level effects of education on

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[1]High fertility is associated with short birth spacing, and with bearing children at relatively young or old ages, both of which increase the risk of infant mortality (*see* Wolpin, 1997, for a review of this literature). If high fertility is motivated by the desire for sons, it may go hand in hand with high mortality among unwanted girls. *See* Das Gupta (1987) for evidence of high mortality among higher birth-order girls in Punjab.

[2]The association between fertility and female labour force participation in India is discussed in Murthi *et al.* (1995).

[3]Census Commission of Pakistan does not issue the census data at micro level at Pakistan level. That is why, we use aggregate approach in this study to estimate our models.

fertility are represented by district School Life Expectancy (*SLE*).[4] The *SLEs,* described in detail later, are computed separately for males and females. *MWE* is a vector of educational attainments by married women and includes various levels of education. District characteristics are taken care of by *DC*, which is a matrix and is composed of three column vectors. First, Index of Economic Development (IED) is included to proxy the level of income and development of a district. Second, the health status of the district is incorporated, which is measured through first level health institutions (Rural Health Centre, Basic Health Unit, Sub-Health Centre, Mother Child Health Centre, Dispensaries, Reproductive Health Units and Mobile Health and Family Planning Units) per 1000 population.[5] It is hoped that these facilities would cause a decline in the fertility rate due to an increase in health and family planning consciousness. The third vector is the female labour force participation rate, which is also hypothesized to have an inverse relationship with the fertility rate. Infant Mortality Rate[6] (*IMR)* is measured by the number of children that died before turning one year old out of 1000 ever born alive. Micro-level studies on fertility behavior indicate a direct relationship between fertility and infant mortality and therefore, reflect the desire through replacement. *PD* is a vector of provincial dummy variables to capture the differences and dissimilarities in provinces regarding non-measurable environmental and locational aspects.

With the exception of the composite IED, all variables are constructed using Pakistan Population Census (1998) data. The computational detail of SLE and IED is provided in the following sub-sections, while the average values of the variables used in multivariate regression analysis are furnished in Table 1.

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[4]SLE is a flow variable and depicts the current enrollment situation in a district; therefore, it is preferred over adult literacy rate, which is a stock variable. In principle, it would be useful to distinguish between different levels of education, and to take into account the *quality* of education.

[5]The data for district health facilities is taken from Pakistan Health & Population Welfare Facilities Atlas, Planning and Development Division, Government of Pakistan (2000).

[6]As can be noted in equation (1), IMR is treated as an exogenous variable. One assumption could be that IMR is endogenously determined. This specification is also tested using Two-Stage-Least-Square technique. The results were not statistically sound, but the relationship between IMR and fertility were positive in both specifications.

TABLE 1

Variables Used in Macro Fertility Response Model [Average Level]

Variables	Overall	Provinces			
		Punjab	Sindh	NWFP	Balochistan
Fertility Rate	4.49	4.66	3.94	4.83	4.32
School Life Expectancy – Male (Years)	6.70	7.87	5.96	7.35	5.02
Literate Married Women (%)	14	23	13	10	6
Married Women – Below Secondary (%)	9	16	8	6	4
Married Women – Secondary or Higher (%)	4	6	5	4	2
Index of Economic Development (%)	32.67	38.05	38.69	26.84	27.32
Female Labour Force Participation (%)	2	2	3	1	2
District Health Status (Institutions per ‘000’ population)	0.12	0.08	0.06	0.12	0.24
Infant Mortality Rate*	140	126	185	90	178
Number of Districts	100	34	16	24	26

*Generally in demographic surveys, IMR is computed on the basis of 3 year averages. In the Population Census, data is only available for one year. Therefore, these estimates seem overestimated and are thus indicative.

SCHOOL LIFE EXPECTANCY (SLE)

According to the World Education Report (UNESCO, 1995), the SLE is defined as “the number of year of schooling which the child can expect to receive in the future, assuming that the probability of his or her being enrolled in school at any particular future age is equal to the current enrollment ratio for that age.” Taking the reference age-range to be 5-24, SLE for *ith* district may be expressed as:

$$SLE_i = \sum_{i=5}^{24} E_{ij}$$

where E_{ij} is the enrollment rate at age j in district i. Thus, SLE expresses in a compact form the enrollment position for the district over the 19-year schooling cycle. As Ram (1999) pointed out, the advantage of SLEs is that they are based on enrollment rates in the standard age-range for schooling, and the difficulty of combining enrollment rates for three conventional levels is avoided.

Student population in different age-cohorts is taken from the Population Census (1998). For this exercise, SLEs are computed separately for males, females and combined enrollments.

INDEX OF ECONOMIC DEVELOPMENT (IED)

The index is constructed along the lines proposed by Filmer and Pritchett (1999) through the use of the Principal Component Analysis (PCA) on the given below indicators. The PCA searches for the linear combinations of the variables selected that account for the maximum possible variance in the data. The exercise was undertaken on the full sample and factor scores of principal components were used to construct the index of economic development.

As National Accounts do not report Gross Domestic Product at the district level, the district's economic development is represented by a composite development index. Various attributes or indicators have been integrated to develop a composite Index of Economic Development.[7] These indicators measure the economic potential and achieved levels of income and wealth; extent of mechanization and modernization of agriculture; housing quality and access to basic residential services; and the development of transport and communication network. A brief description of individual indicators is given below.

[7]Diverse sources are used to gather data for the above indicators. Major sources include; District Census Reports (1998), Provincial Census Reports (1998), Agriculture Statistics of Pakistan (1998-99), Provincial Development Statistics, Crop Area Production (1997-98), Census of Manufacturing Industries (1995-96). Further, to fulfill the missing gaps or for updating various information, unpublished data is obtained from the provincial Bureaus of Statistics, State Bank of Pakistan and the Ministry of Agriculture.

Household income and wealth is the most discussed welfare attribute in literature. Direct income data at provincial or district levels is not available; therefore various proxies are used to estimate the income and wealth position of a district. For the rural economy, *cash value of agricultural produce per rural person* and *livestock per rural capita* are used. All major and minor crops are considered to estimate the district's cash value from agriculture. This indicator is based on the aggregation of 43 crops, including fruits and vegetables. Different types of livestock have been aggregated by assigning weights as recommended by the FAO (Pasha and Hassan, 1982) to reflect the capital value of various animals and poultry. For the urban part of a district, *per capita value added in large-scale manufacturing* is used to proxy the level of urban income. Value added by the small-scale component could not be included due to the lack of data. On the assumption that there may be a direct link between the number of bank branches in a district and the volume of bank deposits, *number of bank branches per capita* is used as a crude measure of the district's wealth. *Per capita car ownership* is also used to proxy the district's income and wealth in the urban areas. This variable is calculated on the bases of overall Pakistan (both rural and urban areas are included).

Modernization of agriculture is another area of development which has direct or indirect effects on the prosperity and standard of living of the rural population. To capture the process of mechanization in agriculture, *tractors per 1000 acres of cropped area* is used. *Consumption of fertilizer per 100 acres of cropped area* is also used as an indicator of modernization in agriculture. In addition, *irrigated area per 100 acres of cropped area* is used to capture the access to canal irrigation systems and tube-wells.

Shelter is one of the basic needs, and housing conditions are one of the key determinants of the quality of life. For IED, the *proportion of households using electricity, gas and inside piped water connections* is used. The quality of housing stock is represented by the *proportion of houses with cemented outer walls and RCC/RBC roofing*. *Rooms per persons* is used to proxy adequate housing in a district.

Three indicators have been included to portray the level of development of the transport and communication sector in a district. Roads and the transportation network have a significant impact on socialization and modernization. Therefore, *metalled road mileage per 100 square miles of geographical area* of a district is included in the index. With regard to the availability of transport vehicles, a summary measure, *passenger load carrying capacity,* is included. Different vehicles are aggregated assigning weights as recommended in Pasha and Hassan (1982). *Number of telephone connections per 1000 persons* is also used to observe the distribution of this important indicator of the standard of living.[8]

III. RESULTS

Tables 2 and 3 provide Ordinary Least Square (OLS) estimates of the macro fertility model.[9] All regressions are statistically significant. Adjusted R^2 is 0.45, pointing at a good fit of the model. The majority of the estimates are statistically significant and show the expected relationship with the fertility rate. The proxy used to represent district health facilities[10] depicts an inverse relationship with the fertility rate, but is not statistically significant; this indicates low coverage, and less effective health and reproductive health facilities. Improvement in health facilities can produce better result to control fertility and infant mortality rate.

The followings sections provide some comments regarding the relationship between fertility and the core variables: economic development, aggregate-level education and individual-level education.

ECONOMIC CONDITIONS AND FERTILITY

The relationship between economic conditions and fertility, at best remains unclear. Once children can be regarded as a special type of commodity, in the economic parlance, a feasible relationship between income and fertility is not difficult to visualize. A rise in income is likely to be associated with higher fertility. The rationale behind this positive income-fertility

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[8]See detailed methodology, Jamal and Khan (2005).

[9]To econometrically evaluate the model specification, an important statistical test (White, 1980) is applied. Basically it consists of taking the residuals from the model to be tested, and regressing the squares of these residuals on the (unduplicated) squares and cross-products of the model regressors. Then, under the null hypothesis, test statistic (nR^2) is distributed as a chi-square with degree of freedom equal to the number of regressors in the test regression.

White's test for the joint null hypothesis of no-specification-error and homoskedasticity is not rejected at the 5 percent level for any regression. Therefore, the model used appears econometrically reasonable and theoretically close to what is feasible.

[10]Other health related variables such as per capita hospital bed availability, per capita availability of doctors, access to safe drinking water, proportion of children who have completed vaccination, are also tried in the macro fertility response model, but none of these appeared statistically significant.

relationship is that, holding everything else constant, higher income implies greater resources available to support a large family; in accordance, if children are assumed to be consumer durables with a positive income elasticity, higher income will lead to the consumption of more children (Becker, 1960). But the value or utility of children has not been invariant over time and space. With a rise in income, a greater concern for the quality of children rather than their quantity may become the dominant concern. And since quality children usually require greater investment than return, a rise in income might in fact lead to a reduction in fertility. Furthermore, a majority of the later studies tend to support this negative association.

TABLE 2

Regression Result [Version 1]
Dependent Variable: Total Fertility Rate

Variables	Coefficients	Std. Error	t-Statistic	Prob.
Index of Economic Development	–0.068	0.031	–2.23	0.03
Index of Economic Development ^2	0.002	0.001	2.66	0.01
Index of Economic Development ^3	–1.02E-05	4.25E-06	–2.40	0.02
School Life Expectancy – Male	0.106	0.036	2.90	0.01
Literate Married Women	–2.527	0.813	–3.11	0.00
Female Labour Force Participation	–5.807	3.931	–1.48	0.14
Infant Mortality Rate	0.001	0.001	1.76	0.08
District Health Status	–1.163	0.670	–1.74	0.09
Proportion of Urban Population	–0.011	0.005	–2.13	0.04
(Constant)	5.126	0.481	10.66	0.00
R-squared	0.57	F-statistic		9.44
Adjusted R-squared	0.51	D-W Statistics		1.99

NOTE: Prob. reflects the level of significance.

This empirical investigation suggests a cubic relationship between fertility and the level of economic development. At very low levels of development, an inverse relationship exists perhaps due to high costs of children. The positive relationship, at the medium level of development, between standard of living or economic development and fertility is evident from the estimated macro model. This suggests more demand for children as income rises. Quite understandably, the relationship is negative at the highest level of development. The phenomenon supports the findings of fertility studies at the micro level.

TABLE 3

Regression Result [Version 2]
Dependent Variable: Total Fertility Rate

Variables	Coefficients	Std. Error	t-Statistic	Prob.
Index of Economic Development	–0.0563	0.0313	–1.80	0.08
Index of Economic Development ^2	0.0015	0.0007	2.11	0.04
Index of Economic Development ^3	–0.00001	0.0000047	–1.79	0.08
School Life Expectancy – Male	0.1142	0.0348	3.28	0.00
Married Women (Below Secondary)[11]	–2.9447	0.6950	–4.24	0.00
Married Women (Secondary or higher)	–7.9414	4.7273	–1.68	0.10
Female Labour Force Participation	0.0009	0.0005	1.86	0.07
Infant Mortality Rate	–0.8598	0.6794	–1.27	0.21
District Health Status	–0.0091	0.0047	–1.93	0.06
Proportion of Urban Population	–0.0563	0.0313	–1.80	0.08
(Constant)	5.1345	0.4811	10.67	0.00
R-squared	0.51	F-statistic		7.49
Adjusted R-squared	0.44	D-W Statistics		2.02

NOTE: Prob. reflects the level of significance.

EDUCATION AND FERTILITY

There are several plausible reasons why women with some secondary education for example, usually display a lower fertility rate than the uneducated. To summarize very briefly, and without professing to produce a complete list of mechanisms, fertility desires are thought to have been influenced by the individual woman's education because of the following reasons:

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[11]Married women (Below Secondary) variable consists of all married women age 15-49 who could not complete secondary education.

(1) the high opportunity costs of childbearing involved in some types of work that may be offered to the better-educated woman,

(2) the cash expenses and children's reduced contribution to domestic and agricultural work as a result of children's schooling, which tends to be encouraged by the educated mother (quality vs. quantity of children),

(3) the reduced need for children as old age security,

(4) the higher prevalence of nuclear families, which may reduce fertility partly because childbearing costs are high due to the absence of economies of scale,

(5) stronger preferences for consumer goods or other sources of satisfaction, and

(6) a lower infant and child mortality, influencing desires through replacement (Kravdal, 2000).

One reason why education may operate through these channels is that schooling makes the woman able to read and write, increases her knowledge about the outside world, and provides her with certain practical and theoretical skills that enhances her productivity. In addition, a woman's position relative to a man may be involved. While their 'economic autonomy', 'physical autonomy' and 'decision-making autonomy' (Jeheebhoy, 1995) are likely to depend to a large extent on community norms and institutional structures, there may also be individual variations determined by individual factors. If she has an education, she may, for example, be allowed by the family to work outside. This will add to the effect of her literacy and skills, and possibly reduce fertility desire (Kravdal, 2000).

FEMALE LABOUR FORCE AND FERTILITY

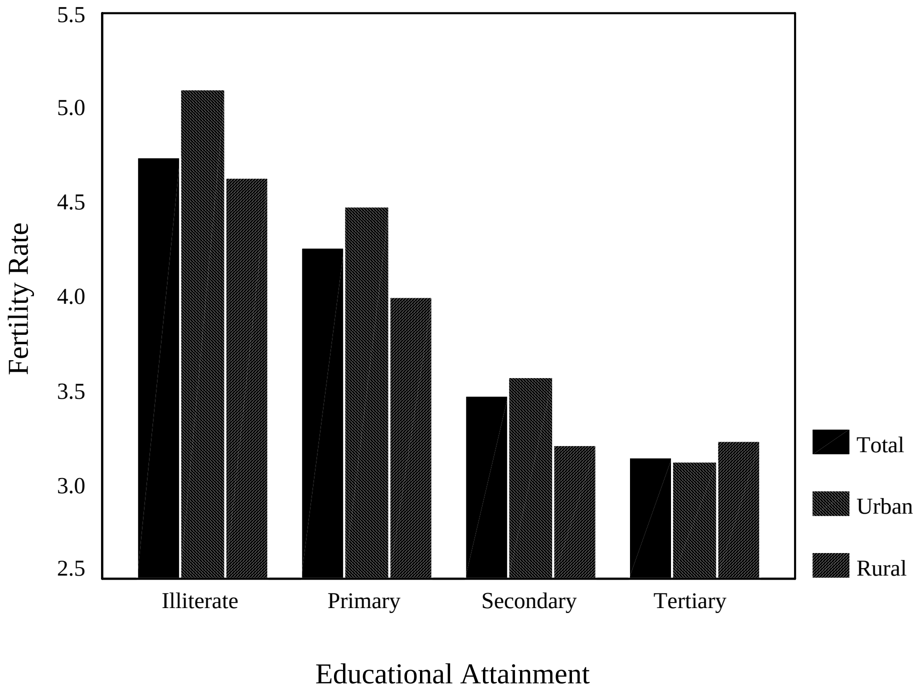
Female labour force participation portrays a negative relationship with the fertility rate, but the coefficients are statistically not significant. This result confirms the recent literature on relationship between female labour force and fertility in developing countries (Hill, 1983, 1989; Tiefenthaler, 1994). The literature shows that in particular, self-employment can allow women to generate income while simultaneously taking care of their children and other household responsibilities. Even within wage employment, public sector employment often involves shorter hours and the presence of child care facilities that makes it more compatible with child rearing. Other factors also affecting the relationship between women's employment and fertility, such as the socio-cultural and macro economic contexts in specific areas, are more identified.

INFANT MORTALITY AND FERTILITY

The coefficient of Infant Mortality Rate, in all regression confirms a direct relationship with the fertility rate. However, the marginal effect seems very small. Aside from reflecting various household characteristics (such as maternal education and income), childhood mortality is likely to be associated with the quality of the household's environment, including its access to safe drinking water (*see*, for example, Rosenzweig and Wolpin, 1982).

FIGURE 1

Fertility Rate and Educational Attainment of Married Women



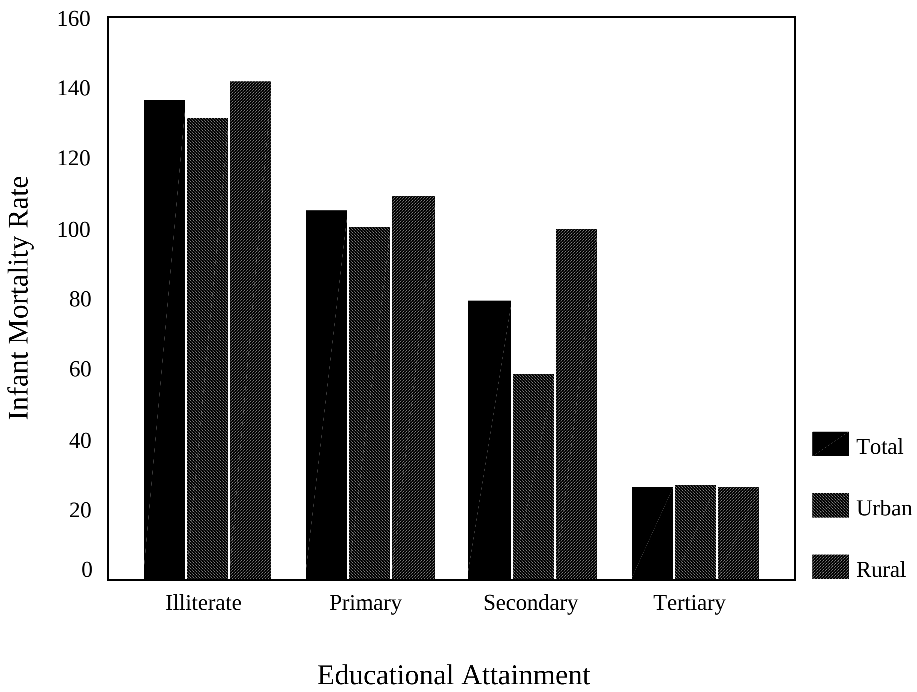
Source: Pakistan Population Census, 1998

Figure 1 portrays an obvious relationship between fertility and the educational attainment of married women. One important observation emerges. Although the educational attainment below secondary level reduces fertility, the impact is not so pronounced as in the case of higher education. This observation provides a strong rationale for higher education for women.

As the Census data do not provide information regarding infant mortality by the level of education of the mother, Figure 2 is plotted using the data from Pakistan Integrated Household Survey (PIHS). Similar trends are evident from this graph. However, the decline in infant mortality rate at the highest level of education, *i.e.*, 'tertiary', is much sharper than in the case of fertility. Particularly, in the rural context, this is the only education category that significantly affects the decrease in the infant mortality rate.

FIGURE 2

Infant Mortality Rate and Educational Attainment of Married Women



Source: PIHS data, 2001-2002

The above discussed graphs, albeit while indicating an important link between fertility and educational attainments of married women, do not control for other possible interactions which may affect the fertility rate. For instance, they do not control for the level of the district's development, available health facilities, female labour force participation, etc; therefore, a macro model (equation 1) of fertility at district level is estimated to quantify the net impact of aggregate district education level and percentage education level of married women on the reduction of the fertility rate.[12]

The improvements in male education may also negative impact on fertility. This study is also proved this hypothesis. However, the impact of male education on fertility is likely to be smaller than that of female education, because women bear the primary responsibility for child-rearing. It is also possible, in principle, for male education to matter more than female education, *e.g.* if fertility decisions are dominated by men. However, this does not seem to be the case in practice. Indeed, most of the studies that have investigated both effects support the hypothesis that female education has a greater impact on fertility than male education.

In this study, the sign of 'proportion of urban population' is negative and significant in Table 2. The role of urbanization has also been emphasized in the literature (*e.g.*, Schultz 1994). Urbanization is believed to reduce fertility because children are less likely to contribute to household production and more difficult to supervise in an urban setting. In so far as fertility decline is in part a 'diffusion process', it is also likely to proceed at an accelerated pace in urban areas, where people have greater exposure to electronic and print media as well as wider opportunities to observe and discuss the lifestyles of other social groups.

In this study, two specifications are used to quantify the impact of women's schooling on the aggregate fertility rate. In the first specification, the proportion of literate (formal schooling) married women is used irrespective of the level of educational attainments (Version 1), while in the other specification, two alternative variables are used; first, the proportion of married women in a district, who have education below the secondary level, and second, those who have obtained secondary or higher education (Version 2).

Results indicate significant impacts of education on women's fertility. The coefficient associated with 'Literate Married Women' is negative and is highly significant. But more importantly, the marginal effects of 'Married Women – Secondary or higher' is striking. The coefficient is approximately 4 times higher than that associated with the 'Married Women – Below

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[12]The Index of Economic Development represents the overall level of the district's development and it is not feasible to prepare separate development indices for rural and urban areas. Therefore, the analysis is restricted to total district fertility rate.

Secondary' category. These results clearly justify the case of higher education to women.

IV. CONCLUDING REMARKS

The main objective of this empirical investigation was to observe and quantify the impact of women's education on fertility using aggregate cross-section data for the districts of Pakistan. The objective is achieved by estimating a macro model of fertility with variables, School Life Expectancy at the district level, Education of Married Women, Index of Economic Development, District Health Status, Female Labour Force Participation, Infant Mortality Rate, and some locational and regional variables.

The fact that a women's education influences her fertility, and is usually negative, is firmly established in a macro scenario. The study also noticed the importance of higher education in reducing fertility. An additional fertility-depressing effect of the general educational level in the community, net of its aggregate determinants, is certainly not intuitively implausible either. However, such a spill-over effect from educational investments has yet to be well demonstrated empirically. In this study, negative but statistically insignificant effects of aggregate female education and positive impact of aggregate male education on fertility are found.

As a byproduct, the study also exhibited a weak relationship between health and reproductive health facilities and fertility rate in Pakistan. While positive but with low marginal effects, higher infant mortality rates also add to the aggregate fertility. The economic condition of the districts and fertility holds a cubic relationship. Fertility rates are negative with the low and high levels of development.

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