a1
9363024
PN-AAW-778
ISN=44908

RURAL ELECTRIFICATION AND FERTILITY CHANGE

October 1984

Sarah F. Harbison*

and

Warren C. Robinson**

* Population Analyst, U.S. Agency for International Development, Dhaka, Bangladesh.

** Professor of Economics and Associate Director, Population Issues Research Centre, The Pennsylvania State University, 22 Burrowes Building, University Park, PA, 16802, U.S.A.

Abstract

This paper addresses the possible linkage between the spread of electrification in rural areas and subsequent declines in human fertility. Evidence from nine studies in six countries is reviewed and compared. The conclusion from this review is that there is, in fact, some link and that the higher the level of rural electrification the higher is contraceptive prevalence and the lower the level of fertility. This link appears puzzling at first glance but the paper proposes a conceptual and theoretical framework for interpreting these results and fitting them into accepted theories of fertility. Finally some important policy implications are discussed and future directions for research indicated.

INTRODUCTION

This paper addresses the relationship between rural electrification, an important policy intervention, and subsequent decline in rural fertility. The possibility of such a linkage is not a new idea and seems to have an intuitive appeal. At an anecdotal level, the notion that "putting a light bulb in every rural bedroom in India" would cause a dramatic decline in fertility has been repeated so many times over the years that it is impossible to identify the original source. In the U.S. the New York Times published an amusing story suggesting a correlation between the first great blackout (power failure) in New York City and a rise in the number of births nine months later. Closer statistical analysis showed this to be purely a chance correlation but the story is still repeated (Udry, 1970).

Most recently there have been a growing number of solidly-based, empirical studies showing a link between electrification and fertility. Typically these studies show that in a multivariate analysis of the determinants or factors associated with variation in fertility, rural electrification emerges as a significant and negatively-related independent variable.

This growing evidence is puzzling since major theories of fertility offer no explicit reason for expecting such a link and no satisfactory interpretation of the link even after it has been demonstrated. This is the point of departure of the present paper. We will: (1) review the growing body of studies which show a link between rural electrification and fertility; (2) suggest an analytical framework for interpretation of these results in a way which is consistent with the "proximate determinants" framework for fertility analysis; and (3) review the policy implications and suggest some unresolved issues and possible directions for future research.

I. EMPIRICAL STUDIES

Nine studies have been reviewed which examine the relationship between rural electrification and fertility. The studies are diverse with respect to area studied, duration of study and methodology used. Nevertheless the studies find an undeniably strong effect of electrification on fertility, even when a large number of variables is included in the analysis. In order to provide as accurate picture as possible, these studies are described in detail, and quotations are included from the original studies.

(A) Herrin's Study of Misamis Oriental

On the Northern Coast of Mindinao Island, 10 out of 24 municipalities had been electrified by 1975 (Herrin, 1979). This large-scale electrification effort in a very rural, relatively inaccessible and undeveloped area, began in 1971. It quickly became clear that fertility was falling rapidly in those areas affected by electricity, and detailed studies of this apparent relationship were undertaken. The research focussed on "the social economic and demographic changes associated with rural electrification" (p. 70). A very short, exploratory study was conducted in 1975, examining "who used electricity, for what purposes, and how users benefitted." A more detailed 12-month follow-up study was conducted in 1977 to help "identify specific mechanisms through which electrification affected a wide range of concerns, including income employment, health, productivity, education and population growth." Intensive interviews were conducted with three groups including: (1) administrators/supervisors of both public and private establishments such as firms, educational and service institutions, and large farms; (2) employees of such institutions; (3) married couples. The study covered both electrified and non-electrified areas. As noted, data on fertility were also available

from the earlier but still on-going demographic data collection effort. In the area most affected by the electrification project (West Misamis Oriental), the Crude Birth Rate declined from 46 to 30 between 1971 and 1975. The non-electrified area showed a smaller decline, from a CBR of 41 to one of 36 during the same period. Similarly, contraceptive prevalence rose to about 33 percent in the electrified areas, as compared to 21 percent in the non-electrified areas. Detailed follow-up surveys found that electrification has a substantial impact on community level services and also on general well-being and development. Production, income, employment (both in agriculture and industry), and health, education and social services were judged to have improved due to electrification.

In a 1979 follow-up to the original Misamis Oriental study Herrin and Te (1982) collected household-level data from 800 households in 20 rural barangueys (villages), ten in the Western zone which had been electrified for nearly nine years and ten in the Eastern zone which had been electrified for only slightly under one year. The sample of villages was stratified by geographic zone - coastal versus inland - to "reflect possible community-level variations in socioeconomic characteristics and access to development inputs" (p. 19). In each village 40 households were selected randomly and data collected included: fertility history of eligible women; farm and nonfarm production practices; household income and expenditures; community-level social, economic and demographic characteristics. Analysis of the demographic impact of electrification was further limited to those households containing a once-married female aged 15 to 49, who had been pregnant once or more (including currently), was still menstruating and living with her husband. This reduced the final sample to 468 women, 259 in the West and 209 in the East.

The results supported the earlier findings. Looking at a comparison of the two zones, the women in Western (electrified) zone had 5.3 births per married female, while those in the Eastern (non-electrified) zone had 6.6. Current use of family planning was similarly higher in the West than in the East (58 percent and 50 percent) and current use of a modern method was twice as high in the West as in the East (28 percent and 14 percent).

The authors also did a regression analysis using several measures of fertility and contraceptive practice as the dependent variable and a battery of independent variables including individual and village characteristics and dummy variables for the presence of electricity in the village and also in the household. The household electrification variable was negatively and significantly related to fertility (standardized beta coefficient - 0.386, significant at the .01 level) in the last five years and only slightly less so to fertility in the last two years. Household electrification was not, however, significantly related to the current practice of family planning. Desire for additional children as a dependent variable also showed no significant relationship with electrification.

Interestingly, the village-level electrification variable was not significantly related to fertility but was to current contraceptive practice (standardized beta coefficient of -0.124, significant the .10 level). For use of modern methods the relationship was even stronger (beta coefficient - 0.242, significant at the .01 level). This effect remained even after other locational factors which might affect access to family planning services were controlled for. This difference in the impact of the household-level and village-level electrification variables suggests a somewhat more complex causal mechanism, involving direct and indirect paths or other intermediate variables. But, this "preliminary report" did not attempt a more detailed analysis.

(B) The World Bank India Study

In this analysis of data from 16 states of India, the impact of socio-economic variables and family planning program inputs on program outputs (acceptor rate and user rate) and on fertility (crude birth rate) was evaluated using multivariate regression techniques (World Bank, 1974). The study reported that "...electricity consumption per capita could explain as much as 61 percent of the interstate variation in user rates; the best that (any other) variable could accomplish was less than 50 percent of the variance" (p. 156).

The analysis did not reveal per capita electricity use as a significant independent variable in the step-wise regression explaining the inter-state variation in birth rates. Yet electricity was correlated significantly with urbanization which was one of the significant independent variables explaining birth rates. It also showed a high, negative association (just below the significance level) with the death rate. This suggests an interaction among electricity, urbanization and the death rate which could potentially be broken down into direct and indirect effects using a path analytic model.

Electrification was also correlated significantly with an index of overall state development level, with income per capita and with literacy. But, it showed no significant relationship with the program-related variables or health-related variables such as doctors or hospital beds per capita.

(C) The First Northeast Thailand Study

This study, undertaken as part of the Population Council Microlevel Studies Program on Fertility-Development Interactions under the auspices of USAID, aimed at evaluating the impact of electrification on fertility (Peknan, 1982). Approximately 300 households in each of two rural Thai villages, one with electricity and one without, were the subject of the study. Except for

the presence or absence of electricity, the villages were highly similar. Married women between the ages of 15 and 44 living in the study villages comprised the sample. Data were collected on economic variables such as occupation, land holding, housing conditions, and household assets; on social variables including time use, utilization of mass media (radio and TV but also newspapers), travel outside the village, and expectations regarding childrens' education; and on contraceptive practice, desired family size, cumulative fertility and fertility in the recent past (1976-79).

Comparing the electrified village with the non-electrified village, the study concluded that thus far electricity has not lead to major changes in economic or social behavior. The single exception is TV viewing. Although relatively few households (20) own a TV set, the impact extends to the village as a whole because neighbors and friends frequently come to watch..

Contraceptive practice is significantly higher in the electrified village (62 percent) than in the village without electricity (51 percent). This is true at all levels of economic status. Similarly, cumulative fertility is 3.12 in the electrified village and 3.52 in the non-electrified village. A comparison of recent past fertility presents the same picture. During the period 1976-79, in the electrified village there were .643 births per married woman aged 15-44, while in the non-electrified village the rate was .825. These differences exist among both users and nonusers of contraception.

The study then examines these fertility differences using analysis of variance and multiple classification procedures. The analysis of variance found"... two main effects (on fertility) - expectation of childrens education having a .05 level of significance and electricity having a .001 level of significance." The MCA found that "electricity has brought about differences in fertility between the two (villages) more clearly than expectation of childrens education has."

The conclusion of the study is that "rural electrification is a major development input that has a significant unintended effect on fertility reduction" (p. 47).

(D) The Contraceptive Diffusion Study in Thailand

This large scale study investigated the link electrification and fertility as part of a larger study of the impact of contraceptive availability on contraceptive usage in rural Thailand (Chayovan et al, 1984). The study used data collected from 64 villages which were selected because they were covered in one or more of three earlier demographic surveys conducted by the Institute of Population Studies at Chulalunkorn University in Bangkok. These studies included the rural component of two rounds of the National Longitudinal Study of Social, Economic and Demographic Change (LS1 and LS2) in 1969 and 1972 and the National Survey of Fertility, Mortality and Family Planning (NS) in 1979. The authors point out that:

> "Since the National Family Planning Program was only established on a national level after the time of LS1, analysis in the present paper is limited to LS2 and NS. For cross-sectional analysis, this means that information is available for a total of 38 LS2 villages and 51 NS villages. This corresponds to 886 individuals currently married women aged 15-44 for LS2 and 1270 such women for NS. When analysis of change is conducted between the two surveys, information for a total of 28 villages common to LS2 and NS can be analyzed. For some purposes, however, the total sample of 64 villages can be used, for example when we wish to examine relationships or parameters on the village level which do not require information from any of the three individual-level surveys themselves. While not representative of all rural Thai villages in a strict statistical sense, it is probably a reasonable cross-section of most of rural Thailand" (p. 9).

Two sets of analyses were carried out: "The village level analysis employed as independent variables measures of accessibility and other aspects of village structure, such as distance to schools and presence of electricity ... The multi-level model... combined a framework for the individual-level

determinants of contraceptive use with measures of accessibility and other aspects of the social context hypothesized to affect individual behavior..." (pp. 10-11).

The village-level simple correlation analysis found that there was "a strong positive relationship between contraceptive use and the extent to which a village was electrified. Villages in which more than half the houses had electricity had the highest prevalence while those without electricity had the lowest" (p. 28). In 1979, the correlation coefficient was .48. Multivariate analysis found that the pattern of increasing contraceptive use with electricity remained even after controlling for accessibility.

The authors of this study were evidently a bit troubled by this finding. They were seeking to establish the influence of accessibility but instead stumbled across the electrification variable. In particular, the fact that electrification has occurred in less than 10 years prior to their survey seemed to them to rule out its having any real effect on fertility.

Thus, they probed further.

"The high correlation between the average village-level use of contraception... and the level of electrification... suggests that factors be identified which are common to high accessibility and use as well as the likelihood of electrification" (p. 32). Using path-analytic regression analysis, no possible combination of indirect paths, or interactions with other variables could remove the electrification-contraceptive use effect. In other words: "the correlation between use in 1979 and electricity cannot be reproduced on the basis of common background factors alone. A direct path from electricity to use... is required to capture adequately the observed correlation" (p. 34).

The multi-level analysis, using individual characteristics as well as the village-level background variables, also showed a clear electrification effect. The authors state that "after adding a dichotomous variable for the presence or absence of electricity in the village... the effect... varies with age group. Among younger women this community characteristic is not significant but among older women there is a strong association between the level of contraceptive use and the presence of electricity in the village" (pp. 50-51). In summary, the study concluded that electrification is at least as important as accessibility in explaining contraceptive usage.

(E) The Second Northeastern Thailand Study

A random sample of 4,986 households was drawn from villages in 16 provinces of Northeastern Thailand (Piampiti, 1984). There were 2,490 electrified households and 2,496 non-electrified households. Every fifth household was also subject of a more intensive time-use interview. Two basic questionnaires were used, one for the husband centering around economic activities, and the other for the wife dealing with fertility behavior. household activities and time-use patterns (in one of five cases). The field work was done in May, June and July 1981.

There was a shift towards a greater non-agricultural employment and occupational pattern electrified villages. This was true for both men and women. It was primarily through increased involvement of women in trade and crafts that a positive effect on income was felt.

The difference in fertility, as measured by children ever born, between electrified and non-electrified villages as very slight - 4.7 and 4.9 respectively. Sixty-nine percent of the women in the electrified villages reported ever-use of contraception whereas only 62 of the non-electrified

group did. Ideal family size was 3.5 and 3.7 for electrified and non-electrified villages respectively. The authors then used path-analytic regression analysis to establish two significant causal paths. "The first is through male occupation and family planning and the second is through male occupation, desired family size and family planning. Although the paths between occupation and income, and occupation and breast feeding are significant, income shows no significant relationship with family planning, desired family size or breast-feeding; and breast-feeding shows no significant relationship with fertility" (p. 15).

"In... the analysis for females, the effect of use of electricity on female participation in non-agricultural occupation is also positive. However, the relationship between women's occupation and practice of family planning is not significant. But, on another path, women's occupation affects desire family size which in turn exerts... (an) effect upon practice of family planning" (p. 17).

Overall, the authors state that their study supports the hypothesis that fertility is affected by the availability of electrification chiefly through changes in the occupational-employment structure and hence through changes in norms of family size and the practice of family planning.

(F) The Korean Farm Study

A household study in Korea (Yul and Kim, 1984) has investigated the hypothesis that "individual fertility behavior is affected not only by an individual's personal attributes and the economic characteristics of the household but also by community factors" (p. 2). Among the community factors included is the use of electricity.

The data used to test this hypothesis were drawn from a special survey of farm households undertaken by the Korean Rural Economics Institute in November and December, 1980. The survey was a stratified probability sample of a larger annual survey of farm households undertaken by the Ministry of Agriculture. The Government sample consists of 3,375 households in 225 villages, and the KREI sub-sample consists of 1,422 households in 96 villages. Of these, 1,136 were successfully interviewed. A fairly wide range of demographic characteristics, socio-economic data, fertility and family planning behavior, and a numerous community-level variables collected.

The effect if length of time over which the village had been electrified (using dummy variables so that 1957-1973 - 0, and 1974-79 = 1) showed no significant effect on average number of children even born or recent (1970-80) fertility. (Virtually all Korean villages in 1980 had electricity and hence no real control group was available.) In general, all the community-level variables were weakly related to fertility and family planning practice, explaining only 4 percent of the variation in ideal family size and only 2 percent for children-ever-born in multiple regression analysis. The measure of length of time electrified was correlated with other community-level variables and also with some individual socio-economic characteristics so it is possible that an indirect effect was exerted. However, no path-analytical decomposition of the regression results was attempted by the authors.

(G) U.S. Farm Fertility at the State Level, 1940-1970

This study was concerned with the causes of the rapid decline in U.S. rural farm fertility which occurred in the period 1940 to 1970 (Lee, 1981). Although both rural and urban fertility in the U.S. had fallen almost

continuously since 1800, the relative levels remained almost unchanged up to 1940. That is, in 1800 the urban fertility ratio was 64 percent of the rural ratio and in 1940 it was 58 percent.

Data employed were measures of fertility and various economic, social and technological factors drawn chiefly from the Census of Agriculture and Population for 1940, 1950, 1960 and 1970 plus other data where available. The unit of analysis was the state.

Among the technology variable employed in the regression analysis was percentage of farm households having electricity. This was consistently negatively (and in 3 of 4 regressions significantly) related to fertility. In other words, the variation in rural farm fertility was significantly related to the degree of rural electrification cross-sectionally. Over time the rise in the percent of households electrified was associated with declining rural farm fertility. The standardized beta coefficients of this relationship were: 1940 - 0.27; 1950 - 0.10; 1960 - 0.25; 1970 - 0.31; considering a single pooled regression equation for 1940, 2950, 1960 and 1970 yields - 0.34. As noted, all except 1950 are significant statistically.

(H) U.S. Farm Fertility on the County Level, 1930-1950

This study presented a causal model of the interaction of certain key farm-household characteristics, including electrification, with fertility during the period 1930-1950 (Cornwell and Robinson, 1983). The data were drawn from the decennial censuses of population, from the five-yearly agricultural censuses, from vital statistics, and from various other secondary data sources. Rural farm counties were the unit of analysis. Four hundred seventy-three counties were included in the sample.

"The sample... was selected in a three-step process designed to insure representation of rural, farm America. First, using the 1960 definition of metropolitan, this definition was applied to all counties outside of New England as they were characterized in 1920... New England counties were excluded because over 40 percent of farms were electrified by 1930... This (gave) an initial pool of 2,714 of non-metropolitan or "rural" counties. The second step consisted of drawing a sample of 600 counties from this pool, representative of counties within census divisions. The proportion of the 2,714 counties existing within each census division was determined and a stratified, random sample of these counties was drawn reflecting these proportions. Finally, this group of 600 counties was narrowed to 473 through selection of all counties which in 1930 had more than 40 percent of their land devoted to agriculture" (p. 9-10). A total of 17 independent variables, covering five "economic," two "structural," four "household" and six "contextual" were then analyzed with respect to their impact on fertility. Electrification was one of the two "structural"variables, bivariate (simple correlation) and multivariate (Ordinary Least Squares regression) analysis were undertaken of the relationship.

The descriptive statistics of the sample are interesting. In 1930 only 7 percent of the households in these rural-farm counties had electricity but by 1950 it had become 80 percent. The number of farms fell, average size rose, as did trucks and other mechanical equipment per farm and average value of crop output sold.

Considering simple (zero-order) correlations, electricity is strongly related to the measure of fertility. In 1930, the r is -.05; in 1940 - .46; in 1950 - .26; all these are significant at p = .001. Electrification was also, as would be expected, positively related to other independent variables

including literacy, women working outside agriculture, and value of farm output among others. These relationships tended to weaken over time from 1930 to 1950, as did the basic fertility-electrification link.

Multivariate (ordinary least squares) analysis for 1930, 1940 and 1950 was also undertaken. It was discovered that one striking regional variation existed in the data. Census Region 3, the South Atlantic, East South Central and West South Central Divisions (roughly the "deep" South) showed quite different characteristics from the other regions. Region 3 had higher fertility, lower income, small farm size and value of output and lower values for the various developmental indicators such as education. Region 3, particularly the early phase of the period, was quite clearly the "less-developed" area of rural-farm America.

Overall, the model explained fertility variation within the rural-farm county households rather well. The coefficient of determination (R^2) for the sample as a whole was .56 in 1930, .53 in 1940 and .51 in 1950. However, only in 1930 did electrification have a moderately strong negative beta coefficient with respect to fertility.

Looking only at Region 3, the under-developed area of rural America, the results change a bit. In Region 3 electricity has a consistently large negative beta coefficient with respect to fertility. The overall R^2 is not higher for Region 3 than the total sample but the relationships within the overall explanatory moded emerge more clearly. In 1930 electricity, possession of a telephone, and possession of a truck were the most powerful negative independent variables. In 1940 electricity and telephone were even more important (and significant statistically) and had been joined by level of education of the head of the household. The 1950 picture continues this same

pattern. Thus, for the rural Southern farm population electrification, along with telephone and education, were the most consistently and important negative factors associated with fertility decline between 1930 and 1950.

The report discusses the possibility of a telephone-electricity interaction. However, given the aggregate nature of the data no analysis of this point is possible.

(I) The Bangladesh Study

Rural electrification is relatively new to Bangladesh. In Winter 1983-84 the Rural Electrification Board (of the Government of Bangladesh) undertook the first evaluation of the socio-economic impact of electrification in those areas which had been "energized" in the first phase, 1980-81 (Robinson et al, 1984). This evaluation involved a survey of six villages in each of four rural cooperative areas chosen randomly from a list of all villages in the areas. "The number of... villages chosen was arbitrary and based on a desire to obtain a large enough sample of homesteads to permit some area analysis but small enough to make field work manageable." In each selected village about one of six of the listed electricity users was selected randomly, yielding a total of 400 electrified households. Some 200 non-electrified households were also selected randomly in the same villages for comparison purposes. Female interviewers were employed and a detailed fertility-family planning questionnaire administered as well as the socio-economic questionnaire put to the head himself by male interviewers.

There was a modest but discernable effect of electrification on the fertility-family planning variables. Some 82 percent of the women in electrified households found family planning "acceptable" whereas only 73 percent in the non-electrified group did. Children ever born averaged about

the same for the two groups - 5.4 and 5.9 - but desired family size was lower in the electrified group, 2.9 as opposed to 3.2. These modest differences can perhaps be explained by the relatively short time since the households received electricity, and also by continued problems in creating a functioning family planning service supply network in rural Bangladesh. Thus, low use does not necessarily mean low latent demand.

The most striking finding was a sharp attitudinal change among these largely illiterate rural women. "Over 64 percent were firm in their expectation that their children's education would benefit in future due to electrification... 60 percent desired their daughters to have at least matriculate level education. And 72 percent desired that their daughters be able to work outside the home earning money." These responses suggest major changes are underway which, with proper family planning service and supply, could lead to a sharp increase in contraceptive practice and decline in fertility.

Summary of Empirical Findings

The studies which have been reviewed encompass a wide range of areas, definitions, approaches, and findings. In general, the studies fall into two groups: those which make a categorical comparison of electrified as compared to non-electrified units (whether states, counties, villages, or households); and those which incorporate some measure of electrification as an independent variable in a multiple regression-based analysis. In reviewing Table 1, which presents a summary of the findings, several major points emerge:

(1) By and large there are real differences in the fertility-related dependent variables when electrification is used in an explanatory way. This seems to be true for fertility itself and also for contraceptive knowledge,

Table 1: Summary of Fertility-Electrification Studies*

Place and Time Study	Sample Size Unit of Analysis	Years Electrified	Measure of Electrification	Measure of Demographic Behavior	Method of Analysis	Strength of Relationship
Misamis Oriental, Philippines, 1979	10 electrified villages, 10 non-electrified covering 468 eligible women	Between 1 and 9 years	Presence or absence of electricity in village and household	Birth per woman in last 5 years and lest 2 years; current contraceptive practice	Comparison of rates - electrified ---------- regression analysis	Electrified villages had 20% low fertility and 18% higher prevalence ---------- standardized beta coefficients of impact of electrification of household of - .386; and for electrification of village to current contraceptive practice of - .124.
India 1960-70	16 states of India	Not stated	per capita electric consumption	CBR CPR	Stepwise Regression	No significant relationship of electrification with CBR CPR and electrification show an R^2 = .61
Northeast Thailand 1980	300 households in each of two villages	5	presence or absence of electricity in Village	-Cumulative fertility -Recent Fertility -CPR	Comparison of rates, elec. vs. non-elec.	In electrified villages - CPR is 20% higher - Cumulative fertility is 20% lower - Recent fertility is 23% lower
Thailand 1979	2,136 households	10	presence or absence of electricity in village	CPR	Path analytic regression	When presence-absence of electricity is controlled in the impact of contraceptive availability on CPR is reduced by 1/2.
1979	64 villages	10	% houses electrified	CPR	Path analytic regression	Of the 57% of the variance explained by the model, 39% was accounted for by the direct path from electrification to CPR
Northeast Thailand 1981	4,986 households in 16 provinces	not stated	presence or absence of electricity in village	-CEB -CPR -ideal family size	dichotomous comparison - path analytic regression	Electrified villages had - 5% lower CEB - 10% higher CPR - 7% lower ideal family size

Korea 1980	1,136 households in 96 villages	up to 20	length of time village electrified	-CEB -children recently born -ideal family size	regression analysis	Electrification had a very small non-significant effect on the dependent variable when only community level variables wer included and also when individual characteristics and community variables were included.
USA 1940-1970	48 states of US for - 1940 - 1950 - 1960 - 1970 - pooled	not stated	% of farm households electrified	child/ population ratio	multiple regression	Standardized beta coefficients for impact of electricity on child population ratio. 1940 : -.27 1950 : -.10 1960 : -.25 1970 : -.31 pooled: -.34
Rural South USA Counties 1930-1950	716 rural counties 1930, 1950, 1960	not stated	% of farm households electrified	child/ woman ratio	multiple regression	Standardized beta coefficients for impact of elect. on child/woman ratio 1930 : -.13 1940 : -.22 1950 : -.13
Bangladesh 1982	600 households in 24 villages, 200 h.h. without 400 h.h. with electricity	3	households electrified or not	-completed family size -Ideal family size -CPR	comparison of means and rates	Electrified households had - 10% lower completed fertility - 10% lower ideal family size - no difference in CPR

CBR = Crude Birth Rates

CPR = Contraceptive Prevalence Rate

CEB = Children Ever Born

Sources: As cited in accompanying text.

attitude and practice. The exception is the Korean study but this study is atypical since a low level of rural fertility had already been reached by the time of the study (1980). Also, electrification had been in-place almost universally in Korea for over a decade. In other words, even if there had been a linkage between the spread of electrification and the onset of the rural fertility decline in Korea, this point was well past by the time of the study (1980). This interpretation is also consistent with the two U.S. studies which show a gradually lessened effect of electrification over time as rural fertility falls and electrification becomes more widespread.

(2) In all of the studies except two, electrification functions as a community level variable rather than an individual or household variable. For example, the Northeast Thailand Studies used the definition "the village has electricity" and the Thailand Diffusion Study used "percentage of houses electrified in each village." Only the Bangladesh study and the second Philippine study have data on electrified versus non-electrified households, and their conclusions are similar to the others. This finding makes intuitive sense in that the presence of electricity in a village effects all households, whether or not they have electricity.

(3) The length of time over which electricity has been present seems important. Generally, those areas which have been electrified 5 years or more show the strongest link between electrification and fertility, up to the point at which the link begins to weaken when low levels of fertility are reached. Thus, the electrification impact on fertility-related behavior in Bangladesh is less pronounced than others in the group due perhaps to only two or three years having passed for most villages since energization occurred. It is also true, however, that when electrification has been present for a very long period of time, as in the Korean study, fertility differentials may no longer be present.

(4) Electrification is often positively correlated with other socio-economic development indicators such as literacy, educational attainment, urbanization and the presence of other development projects. Yet this relationship is not very pronounced. In some cases (Bangladesh, Northeast Thailand) no other significant public sector development projects were present yet the electrification-fertility link is strong. In several cases (Thailand Contraceptive Use Study, Northeast Thailand and the two U.S. studies) where other development inputs were present, regression and path analytic analyses showed that the electrification effect persists, even when other factors are controlled for. Electrification seems to exert an independent effect which is at least as important as other key independent variables such as education or health.

(5) In reviewing Table 1, there seems to be no question as to the presence of a strong relationship between electrification and fertility. However, the nature of the linkage between individual, household, and community-level effects has not been placed in a theoretical framework. Section II presents a preliminary version of such a framework.

II. A FRAMEWORK FOR THE ANALYSIS OF THE IMPACT OF ELECTRIFICATION OF FERTILITY

Recent research on the proximate determinants of fertility by Bongaarts (1978), the earlier work on intermediate variables of Davis and Blake (1951) on economic theory of fertility by Caldwell (1976) and on community level variables by Freedman (1974) and Bilsborrow (1983) all provide a useful background to the development of a framework. However, electrification does not fit easily into any one of these approaches, perhaps because it

is simultaneously a community-level and a household-level variable. Figure 1 presents a preliminary version of a framework which includes impacts on fertility from both of these levels.

(A) Community Level Impacts

In discussing the importance of including community-level data in fertility, Bilsborrow (1983) has pointed out that "it is increasingly recognized not only by sociologists but even by some economists that individual behavior is influenced by its social context or environment." He goes on to suggest that for unbiased statistical analysis of fertility, the inclusion of exogenous community factors is crucial. The theoretical challenge of electrification is that it can effect community characteristics, household characteristics, and individual characteristics simultaneously and in interacting ways.

The right-hand portion of Figure 1 depicts potential paths of influence of village (or community) level use of electrification on fertility. These include:

(1) It can affect the technological base on which village agriculture operates by making a greater irrigation, mechanization, and hence increasing yields through double cropping and diversification.

(2) It can encourage growth of small-scale rural industrial establishments and lead to a subsequent rise in non-agricultural employment.

(3) It can improve efficiency of operation and utilization of any existing public service institutions such as schools or clinics and encourage new institutions where they do not exist.

(4) It can increase the flow of outside information, ideas and images to the village through radio, TV and through increased time available for

listening, viewing and reading in the evening. Even when the number of TV's, radios or literate persons is small, the impact of such communications outlets spreads throughout the village.

(B) Household Level Impacts

Figure 1 also indicates several household level effects.

(1) The energy base of the household can change, reducing the perceived need for a large supply of unpaid family labor both within the household and as agricultural labor on family-worked land.

(2) Households can experience a rising demand for electricity-related household durables and a more sophisticated pattern of consumption requirements, competing with children-related expenditures and time requirements.

(3) The household work-leisure cycle can change with household members gaining more discretionary time in the evenings for repair of productive facilities, for planning activities, for reading, for family conferences and for record keeping. In short, there can be more building-up and maintaining of human and physical capital within the household.

(4) The changed technological (energy) base of the household and the changed daily work pattern can lead to changed division of labor and roles within the family. The wife, in particular, is likely to be the greatest beneficiary of the changes and can quickly come to see her own new role as different from her role in the traditional labor-intensive dawn-to-dusk household.

(5) The flow of information and outside influences through radio, TV and increased time spent reading (and studying for children) can change values and attitudes within the family.

These household-level impacts interact and the combined effect can be a rapid change in attitudes, expectations and behavior patterns, effecting all aspects of family life.

These household changes are likely to lead to a shift in the perceived costs and benefits of children. As children become more expensive, ideal family life falls, contraceptive use increases, and fertility decreases.

These effects will be most direct in the electrified household through community effects. In fact, most of the community-level variables can best be understood as first working through a group of leading or influential households and then affecting other households via a demonstration effect (Lazarsfeld, 1961).

Generalizing, it seems that availability of electrification serves as a stimulus to the households; households experience electrification as a series of new inputs - information, availabilities and opportunities directly to the household or at least in its surrounding environment; households respond or react to this stimulus by altering behavior patterns and also by changing attitudes; the changed behavior and attitudes spread from the households most directly affected to other households; among these changed attitudes and behavior are marital patterns, male-female roles, ideal family size, contraceptive practice and actual fertility.

The linkages are thus relatively complex. Not all households (or villages) will experience all these effects or will respond in the same way. But, the potential seems clear. Electrification is a powerful external stimulus, an innovation which triggers a range of further changes throughout the household and the community. It is unique in having an impact on technological and economic factors (like improved roads or increased fertilizer inputs), on human capital formation (like education or health services) and

also on individual attitudes, aspirations and motivation (like media advertising or successful government propaganda programs).

The model presented in Figure 1 is still tentative. The paths proposed flow from the empirical review in our earlier section, and fits with the conclusions of the studies undertaken thus far. This model presents a framework for further empirical testing of these tentative conclusions as more data becomes available.

III. CONCLUSIONS AND POLICY IMPLICATIONS

We feel the electrification-fertility "connection" has been established by the research thus far undertaken. Empirically, it is, quite simply, there in various countries, in various time periods, and at various levels of aggregation, even when the investigators are not looking for it. Areas, villages and households with access to electricity have higher contraceptive prevalence and lower fertility than areas, villages and households without access to electricity. The effect seems to function as both a community-level and household-level variable but this is difficult to judge with assurance since most studies thus far have not collected household-level data on electrification.

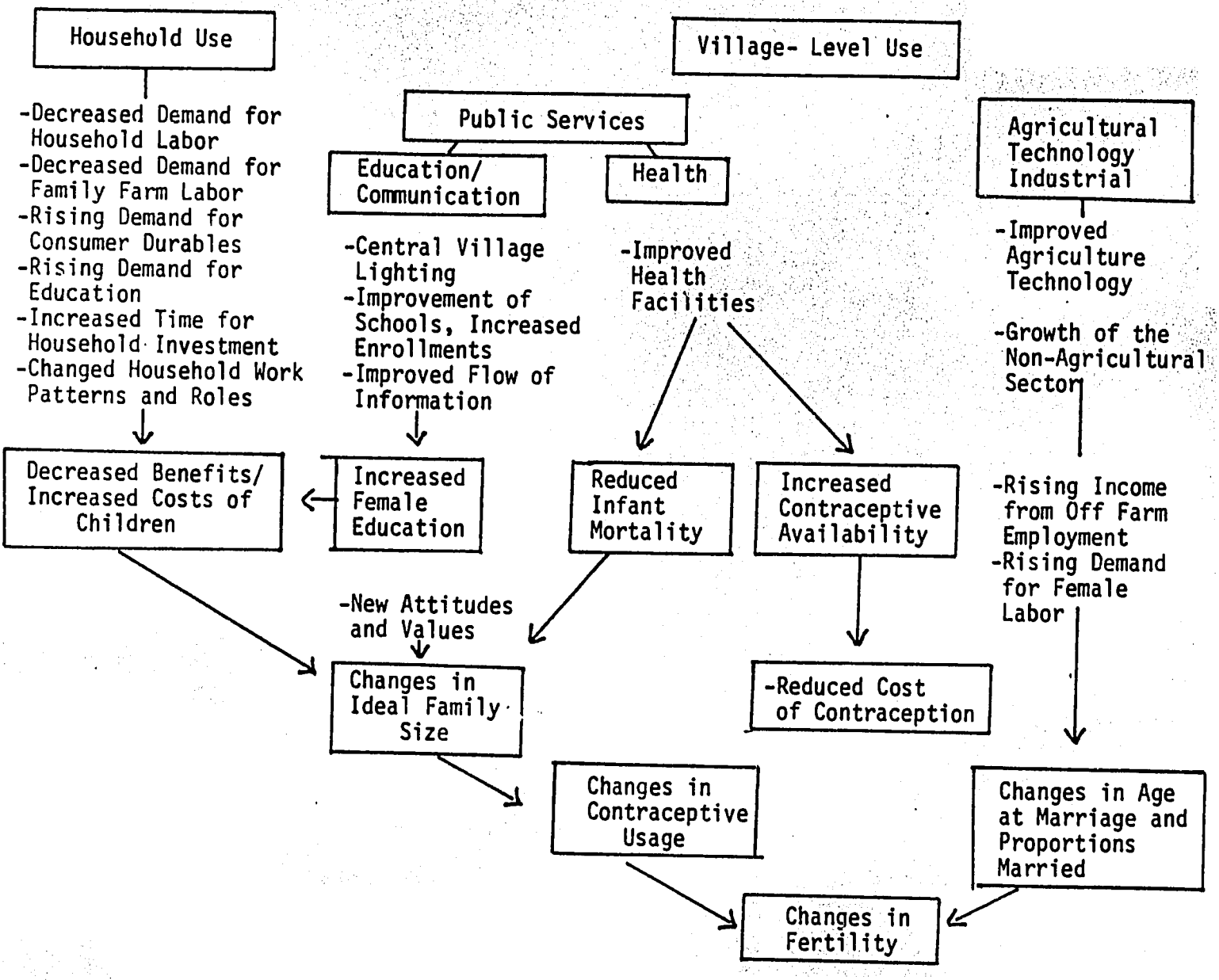
Theoretically, electrification does not fit in well to the standard or schemes of the determinants of fertility. It is not a neat, easily classified variable like age at marriage, or proportion contracepting. Instead it is an important background variable whose effect is pervasive and fundamental, if also illusive. It affects the basic underlying technological structure of production and economic activity in both the village at large and the household. It also leads to important attitude changes, shifts in the household work structure and raised aspirations. Our review of the possible

ways in which electrification can effect fertility explains the consistent empirical results. Some impacts will almost certainly be felt even if not all are there. In any case, we find none of the curious sign-reversal instances which plague research linking fertility to nearly all other independent variables. Education or health are perhaps the only other variables which come close to having such a pervasive, many-faceted effect on fertility (Jain, 1981).

There are several important policy implications of the fertility-rural electrification link. (1) Our conclusion suggests that rural electrification may be a key modernization variable which reduces fertility five to ten years after availability at the the village level. This assigns a high priority to electrification as a policy intervention. (2) The social benefits of such fertility reduction may legitimately be added to the other social benefits of rural electrification to justify the rather large capital investment required of such programs. The fertility impact is an important secondary benefit of electrification. (3) Understanding the role of electrification also strongly suggests that family planning services should follow the spread of the rural electrification system since highly favorable attitudes and behavior patterns are likely to be encountered in the electrified areas. This does not mean ignoring other areas, only that a relative concentration in the "modernizing" areas is suggested.

Research on the electrification-fertility link is still at a very early stage. As more studies are undertaken and more data become available the picture proposed in Figure 1 will no doubt be modified. Perhaps the most interesting question is exactly how electrification does relate to the fertility-controlling proximate variables other than contraceptive practice

Figure 1: The Impact of Electrification on Fertility



including age at marriage, breast-feeding practices, health and sanitation practices, and husband-wife interaction in the determination of ideal or desired family size. Only detailed further household studies can answer these questions.

References

Cornwell, Gretchen, and Warren C. Robinson, 1983. The Socio-Demographic Impact of Rural Electrification in the U.S., 1930-1960, a report prepared for the National Rural Electrical Cooperatives Association, Population Issues Research Office, University Park, PA, 1983.

Blau, Peter M., 1960. "Structural Effects," American Sociological Review, Vol. 25, pp. 178-193.

Bilsborrow, Richard E., 1983. "Collecting Community-Level Data for Fertility Analysis" paper presented in World Fertility Survey Seminar on Collection and Analysis of Data on Community and Institutional Factors, London, June 1983.

Bongaarts, John, 1978. "A Framework for Analysing the Proximate Determinants of Fertility," Population and Development Review, Vol. 4, No. 1, pp. 105-132.

Caldwell, John C., 1976. "Towards a Restatement of Demographic Transition Theory," Population and Development Review, Vol. 2, No. 2, pp. 321-356.

Chayovan, Napaporn, et al, 1984. "The Impact of Accessibility on Contraceptive Use in Rural Thailand," report prepared for Population Council - USAID Operations Research Awards Project, Ann Arbor, Population Studies Center, University of Michigan.

Davis, Kingsly and Judith Blake, 1956. "Social Structure and Fertility: An Analytical Framework," Economic Development and Cultural Change, Vol. 4, No. 3, pp. 211-234.

Freedman, Ronald, 1974. Community-Level Data in Fertility Surveys, Occasional Papers of the World Fertility Survey, No. 8, The Hague: International Statistical Institute.

Hauser, Robert M., 1974. "Contextual Analysis Revisited," Sociological Methods and Research, Vol. 2, No. 2, pp. 365-375.

Herrin, Alejando, 1979. "Fertility and Rural Electrification in the Southern Philippines," Population and Development Review, Vol. 5, No. 1, pp. 61-86.

Herrin, Alejando and Amanda Te, 1982. "Rural Electrification, Fertility Change, and Family Planning Practice in the Southern Philippines: A Preliminary Analysis," in : Richard E. Bilsborrow and Pamela F. DeLargy (eds.), The Demographic Effects of Development Projects: Case Studies and Recommendations, monograph being prepared for United Nations Fund for Population Activities, scheduled for publication in 1984.

Jain, Anrudh K., 1981. "Effects of Female Education on Fertility: A Simple Explanation," Demography, Vol. 18, No. 4, pp. 577-595.

Lazarsfeld, Paul F., and Herbert Menzel, 1961. "On the Relation between Individual and Collective Properties," in: Amatia Etziomi (ed.), Complex Organizations, New York: Holt, Rinehart and Winston, pp. 422-440.

Lee, Sang-Gon, 1981. The Decline in American Rural Farm Fertility, 1940-1960, unpublished Ph.D. dissertation, The Pennsylvania State University, U.S.A.

Peknan, Montri, 1982. "Impact of Village Electrification in Northeastern Thailand on Fertility," in: Suchart, Prasith-rathsint, 1982, editor, Fertility and Development Interactions in Thailand, Bangkok: The Population Council, pp. 22-47.

Piampiti, Suwanlee, 1984. "Fertility Effects of Electrification in Northeast Thailand," unpublished report prepared under Population Council - USAID Fertility Impacts of Development Project, Bangkok.

Robinson, Warren C., Ferdousi Sultana Begum and Rokeya Khatun, 1984. The Impact of Electrification on Fertility in Rural Bangladesh: A Preliminary Report, Policy Paper No. 6, Population and Development Planning Unit, Planning Commission, Government of Bangladesh, Dhaka.

Udry, J. Richard, 1970. "The Effects of the Great Blackout of 1965 on Births in New York City," Demography, Vol. 7, No. 3, pp. 325-327.

World Bank, 1974. Population Policies and Economic Development, A World Bank Staff Report, Baltimore, Johns Hopkins Press.

Yoo, Chul-In, and Dong-il Kim, 1984. "A Study of Demographic, Economic and Technological Interaction at the Farm Level in Korea," unpublished report prepared under Population Council - USAID Fertility Impacts of Development Project, Bangkok.

(cw)
Keep handy!

NRECA NATIONAL RURAL ELECTRIC COOPERATIVE ASSOCIATION
1800 Massachusetts Avenue, N.W., Washington, D.C. 20036
Telephone: (202) 857-9500

October 24, 1984

Mrs. Gale Warshaw
Asia/TR/EFE
USAID/Department of State
Washington, D.C. 20523

Dear Gale:

The National Rural Electric Cooperative Association (NRECA), in collaboration with the Population Issues Research Center of the Pennsylvania State University, is sponsoring a one-day workshop on the "Relationship between Rural Electrification and Fertility Decline." The meeting will take place in the first floor board room of NRECA at 1800 Massachusetts Avenue, N.W., Washington, D.C., on Thursday, November 15, at 9:30 a.m.

The purpose of the meeting is to review what we feel is a significant and growing body of research results suggesting a clear and fairly strong link between the spread of electricity in rural areas and subsequent declines in human fertility. These results are as yet tentative and fragmentary but we feel the potential policy importance is so great that these findings merit a close critical examination by experts in the field, from both the energy and the demographic sides.

As you will judge from the attached agenda the meeting is relatively loosely structured and centers around presentation and discussion of a background paper, a copy of which is enclosed. We hope to examine this paper with respect to: (1) findings; (2) methods and procedures employed; (3) implications for future research-program-policy actions. We invite you (and other persons from your organization) to attend this workshop in your private capacity rather than as a representative of your agency and look forward to a free and frank discussion.

We will appreciate confirmation of people from your organization that plan to attend the workshop by calling Mr. Philip P. Costas at NRECA (202-857-9693) by Friday, November 2. Participants are cordially invited to lunch with the group at NRECA when the morning session concludes.

Sincerely yours,

Warren

Warren C. Robinson
Professor and Associate Director
The Population Issues Research Center
The Pennsylvania State University

Sam

Samuel E. Bunker
Administrator
International Programs Division
National Rural Electric Cooperative Association

Attachment - agenda
Enclosure - background paper

OCT 29 1984

RE

27

THE ELUSIVE CONNECTION:

A ONE-DAY WORKSHOP ON THE RELATIONSHIP

BETWEEN RURAL ELECTRIFICATION AND FERTILITY DECLINE

Thursday, November 15, 9:30 a.m. in the first floor Board Room, National Rural Electric Cooperative Association, 1800 Massachusetts Avenue, N.W., Washington, D.C. Sponsored by NRECA and the Population Issues Research Center, The Pennsylvania State University (with financial aid from the William and Flora Hewlett Foundation).

9:30 - 9:45	**Opening Remarks,** by Samuel E. Bunker, National Rural Electric Cooperative Associaton; and Professor Warren C. Robinson, The Pennsylvania State University
9:45 - 10:00	**Introduction of participants**
10:00 - 10:30	**Background Paper,** "Fertility Decline and Rural Electrification in the Third World Areas," Dr. Warren C. Robinson, The Pennsylvania State University
10:30 - 10:45	**Coffee Break**
10:45 - 12:00	**Panel Discussion on Paper,** by Dr. Ronald Freedman (Univerity of Michigan); Dr. Ozzie Simmons, (Fordham University); and Dr. Richard Bilsborrow, (University of North Carolina)
12:00 - 1:00	**Lunch** (available in the adjoining room)
1:00 - 2:00	**General Discussion,** by participants in the light of their own agency and individual experiences
2:00 - 3:00	**Final Wrap-up Session:** Agenda for future research and program activities