Attachment I.
(FACE SHEET)

ETHICAL REVIEW COMMITTEE, ICDDR,B.

Date 14.10.1996

Principal Investigator Dr. Kaivan Munshi

Trainee Investigator (if any) 360.

Application No. 96-020

Supporting Agency (if Non-ICDDR,B) Boston University & BADC

Title of Study Social Effects & Changes in Reproductive Behavior: Evidence from Matlab, Bangladesh

Project status:
( ) New Study
( ) Continuation with change
( ) No change (do not fill out rest of form)

Circle the appropriate answer to each of the following (If Not Applicable write NA).

1. Source of Population:
   (a) Ill subjects — Yes No
   (b) Non-ill subjects — (Yes) No
   (c) Minors or persons under guardianship — Yes No
2. Does the study involve:
   (a) Physical risks to the subjects — Yes (No)
   (b) Social Risks — Yes (No)
   (c) Psychological risks to subjects — Yes (No)
   (d) Discomfort to subjects — Yes (No)
   (e) Invasion of privacy — Yes (No)
   (f) Disclosure of information damaging to subject or others — Yes (No)
3. Does the study involve:
   (a) Use of records, (hospital, medical, death, birth or other) — (Yes) No
   (b) Use of fetal tissue or abortus — Yes (No)
   (c) Use of organs or body fluids. — Yes (No)
4. Are subjects clearly informed about:
   (a) Nature and purposes of study — Yes No
   (b) Procedures to be followed including alternatives used — Yes No
   (c) Physical risks — Yes No
   (d) Sensitive questions — Yes No
   (e) Benefits to be derived — Yes No
   (f) Right to refuse to participate or to withdraw from study — Yes No
   (g) Confidential handling of data — Yes No
   (h) Compensation &/or treatment where there are risks or privacy is involved in any particular procedure — Yes No

   NA

5. Will signed consent form be required:
   (a) From subjects — Yes No
   (b) From parent or guardian (if subjects are minors) — Yes No

   NA

6. Will precautions be taken to protect anonymity of subjects — (Yes) No
7. Check documents being submitted herewith to Committee:
   ___ Umbrella proposal - Initially submit an overview (all other requirements will be submitted with individual studies).
   ___ Protocol (Required)
   ___ Abstract Summary (Required)
   ___ Statement given or read to subjects on nature of study, risks, types of questions to be asked, and right to refuse to participate or withdraw (Required)
   ___ Informed consent form for subjects
   ___ Informed consent form for parent or guardian
   ___ Procedure for maintaining confidentiality
   ___ Questionnaire or interview schedule *

* If the final instrument is not completed prior to review, the following information should be included in the abstract summary:
1. A description of the areas to be covered in the questionnaire or interview which could be considered either sensitive or which would constitute an invasion of privacy.
2. Examples of the type of specific questions to be asked in the sensitive areas.
3. An indication as to when the questionnaire will be presented to the Cttee. for review.

I agree to obtain approval of the Ethical Review Committee for any changes involving the rights and welfare of subjects before making such change.

Principal Investigator Dr J Munshi

Trainee

ENTERED 2 1 JUN 1998

CHECK-LIST FOR SUBMISSION OF PROPOSALS TO THE RESEARCH REVIEW COMMITTEE (RRC)

[Please tick (✓) the appropriate box]

1. Has the proposal been reviewed, discussed and cleared at the Division level ?

Yes ☐

No ☑

If 'No', please clarify the reasons: The topic is very specific and specialized in the field of health economics. The P.I who developed the proposal may be able to present the subject while he will be in Dhaka.

2. Has the proposal been peer-reviewed externally ?

Yes ☒ by the Institute of Economic Development Boston University.

No ☐

If the answer is 'NO', please explain the reasons: _____

3. Has the proposal scope to address gender issues ?

Yes ☐ The study focuses on contraceptive use among women.

No ☐

If the answer is 'YES', have these been adequately incorporated in the proposal. Please indicate: _____

4. Has a funding source been identified ?

Yes ☐

No ☐

If the answer is 'YES', please indicate the name of the donor: BADC

5. Whether the proposal is a collaborative one ?

Yes [✓]

No [ ]

If the answer is 'YES', the type of collaboration, name and address of the institution and name of the collaborating investigator be indicated:

Dr. KAIVAN MUNSHI

Dept of Economics - Boston University

6. Has the budget been cleared by Finance Division ?

Yes [✓]

No [ ]

If the answer is 'NO', reasons thereof be indicated: _____

7. Does the study involve any procedure employing hazardous materials, or equipments ?

Yes [ ]

No [✓]

If 'YES', fill the necessary form.

Date

Dr. J. NYAUP.

Signature of the
Principal Investigator

APPLICATION FOR PROJECT GRANT

1.	Principal Investigator	:	Dr. Kaivan Munshi[1]
2.	Co-Principal Investigator	:	Dr. Jacques Myaux[2]
3.	Title of Project	:	"Social Effects and Changes in Reproductive Behavior: Evidence from Matlab, Bangladesh."
4.	Starting Date	:	25 November, 1996
5.	Date of Completion	:	25 January, 1997
6.	Funding Source	:	Boston University & Belgian Administration for Development Cooperation
7.	Total Budget Requested	:	US $ 4,500
8.	Division	:	Community Health Division
9.	Approval by Division Head	:	Dr. A. de Francisco Acting Division Director Community Health Division

[1] Associate Professor, Boston University

[2] Visiting Scientist, International Centre for Diarrhoeal Disease Research, Bangladesh

MYAUX

Background and Significance

While it is well known that individual behavior may be predicated on underlying social influences, the specific mechanism through which such influences operate remains poorly understood. Social effects are known to have played an important role in two of the most significant transformations observed in LDCs over the past four decades; the dramatic diffusion of "Green Revolution" agricultural technology and, more recently, the demographic transition observed in many third world countries. External information programs are also believed to have played a significant role in motivating the changes described above. The effectiveness of such programs would be greatly enhanced if their design took account of the social externality associated with individual adoption of the new technology or practice.

Economic theory has traditionally ignored social effects when studying individual decision-making. However, in recent years there has been an attempt to formalize a class of such effects through what is known as "social learning." With social learning, the individual is seen to learn about a new and uncertain technology or practice through the previously observed actions and experiences of his neighbors (see, for instance, Banerjee, 1992, 1993, Bikhchandani, Hirshleifer and Welch, 1992, Ellison and Fudenberg, 1993). Recent empirical evidence suggests an important role for social learning in the diffusion of new agricultural technology (Besley and Case, 1994, Foster and Rosenzweig, 1995, Munshi, 1996). Pure social effects, such as peer-influence, continue to remain outside the scope of economic theory and the empirical studies listed above ignore such effects in attempting to identify the role of social learning in technology diffusion. While it may be reasonable to ignore pure social effects when characterizing the diffusion of new agricultural technology, these effects clearly play an important role in motivating changes in reproductive behavior, the subject of the proposed study.

The International Center for Diarrhoeal Disease Research, Bangladesh (ICDDR,B) launched a family planning program covering seventy villages in Matlab district, Bangladesh in 1977. Households in these villages were provided with family planning and health services, as well as contraceptives. The Contraceptive use Prevalence Rate (CPR) in the treatment area (comprising the seventy target villages) has increased substantially over the past seventeen years, up from 23.6% in 1977 to 57.1% in 1990. While the ICDDR,B family planning program has clearly contributed significantly to the increased prevalence of contraceptive use, there remains substantial variation in the rate of adoption across villages in the treatment area. In our study we investigate whether part of the variation in CPR across villages may be due to the social effects mentioned above. Before doing so, we briefly discuss some alternative explanations for the inter-village variation that have been proposed in the literature. We will attempt to control for each of these explanations in the econometric analysis.

The simplest explanation for the variation in contraceptive use across villages follows variation in the characteristics of individuals located in different villages. For instance, we would expect that villages with a greater proportion of literate women would have higher CPR if a literate woman was more likely to use contraceptives. A number of previous studies conducted in Matlab demonstrate that a household's socio-economic characteristics as well as demographic variables, such as the number and sex of surviving children, are important determinants of the contraceptive use decision. We will consequently control for these "individual effects" in our analysis. A related explanation for inter-village variation in CPR is due to unobserved variation

in the economic environment at the village level. Neoclassical economic theories of reproductive behavior are based on the economic opportunities available to the household, which may be correlated across the households in a village. The general perception among researchers at ICDDR, B appears to be that economic conditions in Matlab district have remained essentially unchanged over time. The primary occupations continue to be agriculture and fishing. The same methods have been used in these economic activities for centuries. In addition, most of the cultivated land is allocated to rice with jute, the main cash crop, playing a relatively small role in the local economy. We will nevertheless attempt to control for "correlated economic effects" as potential determinants of the inter-village variation in CPR in the analysis.

Another explanation for inter-village variation, currently the subject of a research study at ICDDR,B, is that differences in the quality of Community Health Workers (CHWs) may account for spatial patterns in contraceptive use prevalence. The idea here is that the CHW provides "common information shocks" to the households in her area of operation. Variation in these common information shocks could give rise to inter-village variation in CPR. Since the area covered by a CHW does not correspond to village boundaries it is possible to control for common information shocks in the analysis, since the village is treated as the relevant social unit.

Turning to the alternative social effects which we mentioned earlier, the family planning program focused on the adoption of injectable contraceptives which are effective for an extended period of three months. There appears to have been some uncertainty in the early years of the program regarding the reversibility of the new technology, which would have significantly affected the adoption decision of household interested in using the contraceptive for birth-spacing. Under such circumstances a neighbor's decision to adopt the new contraceptive provides the household with information about the new technology through the social learning mechanism described above. In addition it is known that there was strong social resistance to the CHWs and the family planning program in its early years. Under such circumstances, a neighbor's decision to adopt the new technology would lend social support and acceptance for the household's own adoption decision, in addition to the information that was provided. The principal objective of this study is to separately identify these simultaneous social effects, as determinants of the variation in contraceptive use across villages.

The peer-influence effect refers to the social externality associated with a neighbor's decision to adopt the new contraceptive technology. Instead of providing information, the neighbor's decision now provides social support and acceptance for the household's own (potential) decision to subsequently adopt the new technology. As we mentioned earlier, peer-influence effects lie beyond the scope of economic theory. We would, however, expect peer-influence to be generally increasing in the proportion of households in the village that have adopted the new technology. We would also expect wealthier, more educated, households to exert more social influence with their adoption decisions.

The alternative social learning effect is motivated by the information externality associated with a household's decision to adopt the new contraceptive technology. The idea here is that the injectable contraceptive is perceived to be risky, with regard to reversibility in its effect, and consequently households require sufficient information to be convinced about the quality of the new technology prior to adoption. Each household receives a private signal about the quality of

the new technology from the local CHW and other external information sources. While signals received from the same CHW are likely to be correlated, there remains a idiosyncratic component in the information received by each household. It is this idiosyncratic private information that is released into the system (village) when a household adopts the new technology, providing the social learning effect.

The magnitude of the information externality associated with a household's decision to adopt does not depend on its attributes, such as wealth or literacy, *per se*, but rather on the timing of its adoption decision conditional on these attributes. For instance, a household that is expected to adopt late provides more (positive) information with early adoption than a well-endowed household predictably adopting early. It is this feature of social learning that we use to distinguish it from peer-influence. Decisions out of sequence matter with social learning. In contrast, peer-influence depends on the attributes of the adopting household, regardless of the time of adoption.

The decomposition of the alternative social effects associated with contraceptive use facilitates the design of optimal information programs by specifying the social externality associated with individual adoption. The results of the proposed study may also improve our understanding of the role that female literacy plays in changing reproductive behavior by specifying the precise link between female literacy and the social effects described above.

Preliminary research

The proposed research builds on a voluminous literature that has attempted to study determinants of contraceptive use in Matlab district. In the frame-work of our earlier discussion, this literature has focused essentially on individual effects and common information shocks as determinants of reproductive behavior. Individual-effects that have been considered include socio-economic characteristics and demographic variables at the level of the household. Common information shocks have been studied as the effect of family planning and health programs established by ICDDR,B, as well as through the performance of the Community Health Workers (CHWs).

Beginning with the individual-effects, a 1990 KAP Survey covering both the treatment as well as the control area found contraceptive-use levels to be positively correlated with the age of the parents, the number of living children and the number of living sons (Koenig *et al.*, 1992). Chowdhury, Bairagi and Koenig, 1993, using longitudinal data obtain similar results, with a higher proportion of sons associated with higher contraceptive use. An additional result of this study is that while sex preference remained largely unchanged, its effect on contraceptive use declined over time.

In another interesting study covering households in Matlab district, Chowdhury, Fauveau and Aziz (1992) study the effect of the death of a child on subsequent contraceptive use. They find that contraceptive continuation is related to maternal age, parity, husband's education and the sex of the last child, consistent with the studies discussed above.

We will include the variables mentioned above as individual household-effects in the statistical analysis, allowing these effects some flexibility to vary over time. Most studies on reproductive behavior in Matlab district have focused on family size and sex preferences, leaving the relationship between household socio-economic characteristics and contraceptive use relatively

unexplored. Detailed socio-economic information is available for all the households in the sample from the 1982 DSS Census. We will consequently include socio-economic variables, such as asset ownership and education, as individual-effects in the statistical analysis. In addition, we will include village migration-rates, as a proxy for unobserved changes in the economic environment over time. Justification for this approach is provided in the next section.

Turning to common information shocks as determinants of changes in reproductive behavior, most studies find higher CPR, both for birth-spacing as well as for limiting, in the treatment area. This is presumably due to the information and contraceptive-delivery program established by the ICDDR,B. The first family planning intervention in the treatment area was the Contraceptive Distribution Project (CDP) which began in 1975, using existing field-staff and illiterate village midwives ("dais") to provide contraceptives to households. After some initial success the CPR dropped back to its earlier level. Subsequently the Family Planning - Health Services (FPHS) Project was launched in 70 villages in 1977, using young married women with a high school education, to provide information and distribute contraceptives, instead of illiterate dais. The FPHS Project is generally seen to have been successful in raising the CPR. For instance, Phillips *et al.*, 1982, find that fertility in the MCH-FP area, covering the 70 treatment villages, was 25% lower than in the comparison area by 1979. There was intense community resistance to the CHWs at the start of the program. While the workers appear to have overcome this initial resistance and subsequently contributed to the sharp increase in the CPR, there nevertheless remains substantial variation in performance across CHWs (Myaux ?). Since the area covered by a CHW does not correspond to village boundaries it is possible to control for common information shocks in the analysis with a dummy variable for each CHW since the village is treated as the relevant social unit.

Apart from spatial variation in common information shocks, the nature and scope of the FPHS Project has also changed over time. CPR rose rapidly at the start of the FPHS Project in 1977, rising from 23% to 33% in the first eighteen months. After remaining relatively stable thereafter for the next five years, the CPR began to rise once more in 1983, reaching 57% by 1990. One potential explanation for this sudden increase is associated with the MCH-FP Project established in 1982 which introduced a substantial non family-planning component to the Program. The treatment area is divided into four administrative blocks and these additional interventions were introduced block-wise. It is thus possible to directly test for their effect on reproductive behavior within the treatment area. DeGraff *et al.*, 1986, find that the additional MCH (Maternal and Child Health) inputs had no incremental impact on CPR. We will nevertheless allow for block-level effects, varying arbitrarily over time, in the statistical analysis. Koenig *et al.*, 1987, attribute the increase in CPR to a sharp rise in the practice of contraception for spacing births. Individual effects included as determinants of contraceptive use in our analysis will presumably control for variation in preference for birth-spacing, rather than limiting, for the households in our sample over time.

Research design and methods

The principal objective of the study is to simultaneously identify social learning and peer-influence as determinants of observed variation in CPR across the villages in the sample. We will attempt to control for other determinants of this variation, such as individual effects, correlated economic effects and common information shocks, later in the econometric analysis. For the time being we will ignore these other determinants of reproductive behavior, focusing on

a simple model of technology adoption that allows us to study the social effects of interest.

Consider the adoption decision in a village in which all the households are homogeneous. Allowing for both peer-influence and social learning, the decision-rule for individual, i, in period, t, is specified as: adopt if

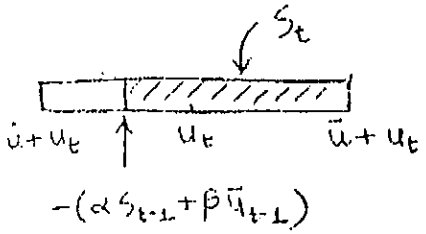
$$\alpha S_{t-1}+\beta \bar{U}_{t-1}+u_{it}\geq 0 \qquad (1)$$

where, S_{t-1} represents the peer-influence effect and $\bar{U}_{t-1}$ represents the social learning effect. S_{t-1} is the proportion of households in the village that adopted in the previous period. Following the earlier discussion we would generally expect the peer-influence effect to be increasing in S_{t-1}. Turning to the social learning effect, $\bar{U}_{t-1}$ incorporates all the common information that was available in the system before the beginning of period, t. Since common exogenous information shocks are ignored in this simple model, the only information that enters the system is through the idiosyncratic information shocks, u_{it}. As we will see below, the level of adoption in period, t, conditional on S_{t-1} and $\bar{U}_{t-1}$, reveals the distribution of idiosyncratic shocks in that period. This unpredicted information is used to update $\bar{U}_{t-1}$ in the subsequent period.

For the current analysis we assume for simplicity that the idiosyncratic shocks are uniformly distributed, with constant variance, in each period. What remains to be learned is the mean of this distribution, U_t. Consider decision-making in period, t. For households that adopt we have the condition, from equation (1),

$$u_{jt}\geq -(\alpha S_{t-1}+\beta \bar{U}_{t-1}) \qquad (2)$$

where, j refers to households that adopt in period, t.



In the Figure above, U_t is the mean of the distribution of idiosyncratic shocks in period, t, with $u_{jt} \in [U_t+\dot{u}, U_t+\bar{u}]$. Conditional on $\bar{U}_{t-1}$, the predicted $U_t=0$ in period, t. U_t is therefore the deviation from the predicted level of adoption in period, t, which is used to update $\bar{U}_{t-1}$ in the subsequent period. From the Figure we obtain,

$$S_t=\left(\frac{\bar{u}}{\bar{u}-\dot{u}}\right)+\left(\frac{\alpha}{\bar{u}-\dot{u}}\right)S_{t-1}+\left(\frac{\beta}{\bar{u}-\dot{u}}\right)\bar{U}_{t-1}+\frac{U_t}{\bar{u}-\dot{u}} \qquad (3)$$

The last two terms in equation (3) are unobserved by the econometrician. Equation (3) is consequently expressed in reduced form as,

$$S_t = \pi_0 + \pi_1 S_{t-1} + \epsilon_t \tag{4}$$

The peer-influence effect (π_1) is estimated consistently if $E(S_{t-1}\,\epsilon_t)=0$. To verify this condition we derive expressions for ϵ_t and S_{t-1} below.

We begin by decomposing the $\bar{U}_{t-1}$ term in ϵ_t. As discussed previously, this term simply collects all the common information that became available in previous periods up to the end of period, t-1. It should be noted here that the U_t term is known to all the households at the end of period, t, from equation (3), $\bar{U}_{t-1}$ being common knowledge by that point in time. The $\bar{U}_{t-1}$ term is consequently updated from one period to the next as more information enters the system. A general specification for $\bar{U}_{t-1}$ is thus obtained as,

$$\bar{U}_{t-1} = U(U_{t-1}, U_{t-2}, \ldots, U_0) \tag{5}$$

Inserting the expression for $\bar{U}_{t-1}$ from equation (5) in the ϵ_t term in equation (3) and (4) we obtain,

$$\epsilon_t = \epsilon(U_t, U_{t-1}, \ldots, U_0) \tag{6}$$

Turning next to the derivation of the S_{t-1} term, we take advantage of the recursive structure of equation (4) to solve for S_t as a function of primitive variables. To see this, begin with the corresponding expression for S_{t-1} from equation (4).

$$S_{t-1} = \pi_0 + \pi_1 S_{t-2} + \epsilon_{t-1} \tag{7}$$

Substituting from equation (7) in equation (4) we obtain,

$$S_t = \pi_0(1+\pi_1) + \pi_1^2 S_{t-2} + (\pi_1 \epsilon_{t-1} + \epsilon_t) \tag{8}$$

Substituting repeatedly as above we obtain,

$$S_t = \pi_0 \sum_{\tau=0}^{t-1} \pi_1^{\tau} + \pi_1^t S_0 + \sum_{\tau=0}^{t-1} \pi_1^{\tau} \epsilon_{t-\tau} \tag{9}$$

The expression for S_0 is directly obtained from equation (3), recognizing that the S_{t-1}, $\bar{U}_{t-1}$ terms do not appear in period-0:

$$S_0 = \frac{\bar{u} + U_0}{\bar{u} - u} \tag{10}$$

From equation (9) and equation (10) it is evident that the S_t expression has a predictable

component, which varies systematically over time, and a unpredictable component which depends on the exogenous shocks that hit the system over time. The S_t term is consequently expressed as,

$$S_t = S(t) + \eta_t \tag{11}$$

$$S(t) = \pi_0 \sum_{\tau=0}^{t-1} \pi_1^{\tau} + \pi_1^{t}\left(\frac{\bar{u}}{\bar{u}-u}\right)$$

$$\eta_t = \pi_1^{t}\frac{U_0}{\bar{u}-u} + \sum_{\tau=0}^{t-1} \pi_1^{\tau}\epsilon_{t-\tau}$$

Substituting from equation (6), the expression for η_t can finally be expressed more generally as,

$$\eta_t = \eta(U_t, U_{t-1}, \ldots, U_0) \tag{12}$$

We now return to the condition necessary for consistent estimation of equation (4), $E(S_{t-1}\,\epsilon_t)=0$. From equation (11), this condition is alternatively expressed as, $E(\eta_{t-1}\,\epsilon_t)=0$. Comparing equation (6) and equation (12), the condition for consistent estimation clearly fails.

The problem with OLS estimation of equation (4) is that we would erroneously infer the presence of peer-influence, even if that particular social effect were absent, on account of the unobserved $\bar{U}_{t-1}$ term in the residual. The S_{t-1} term simply proxies for the $\bar{U}_{t-1}$ term in that case. It is also interesting to note that if peer-influence is known to be absent, $\alpha=0$, then an OLS regression of S_t on S_{t-1} will correctly identify the presence of social learning, with S_{t-1} proxying for the unobserved $\bar{U}_{t-1}$ term as before. Previous empirical studies have followed this approach, implicitly assuming $\alpha=0$ when testing for social learning.

The usual solution to the endogeneity problem is to find an instrument that is correlated with S_{t-1}, but uncorrelated with η_{t-1} and ϵ_t. A natural candidate in this case is the time-period counter, t. The usual conditions for, t, to be a valid instrument are listed below.

$$E(\eta_{t-1}|t)=0 \tag{13}$$

$$E(\epsilon_t|t)=0 \tag{14}$$

Assuming that the conditions listed above are satisfied, consistent estimates of π_1 are obtained in equation (4), instrumenting for the S_{t-1} term with the time-period counter, t. While this approach

allows us to test for the presence of peer-influence, we cannot identify the simultaneous presence of social learning, through the $\bar{U}_{t-1}$ term. We consequently apply a nonparametric two-step estimation procedure, proposed by Newey, Powell and Vella (1995), to simultaneously identify both peer-influence and social learning. This estimator places slightly stronger consistency-restrictions on equation (14),

$$E(\epsilon_t|t,\eta_{t-1}) = E(\epsilon_t|\eta_{t-1}) \qquad (14')$$

When equation (13) and equation (14') are satisfied, consistent two-step estimation is straightforward.

Step 1: Nonparametric regression of S_{t-1} on t.

This step essentially estimates equation (11) and the residual is obtained as $\hat{\eta}_t$.

Step 2: Nonparametric regression of S_t on S_{t-1} and $\hat{\eta}_{t-1}$.

This step essentially estimates equation (3) with the $\hat{\eta}_{t-1}$ variable proxying for the $\bar{U}_{t-1}$ term. This follows directly by comparing equation (5) and equation (12). Now peer-influence and social learning are simultaneously identified, with U_t remaining in the residual of the Step 2 regression equation.

Turning finally to verification of the consistency conditions, equation (13) is satisfied by construction since all time-series effects are captured in the flexible nonparametric specification, S(t). In practice this is implemented as a series estimator. Turning to equation (14'), we see from equation (6) and equation (12) that η_{t-1} provides all the information necessary to determine ϵ_t except for the U_t term. Equation (14') is consequently satisfied if the time-period, t, provides no additional information about U_t. This is the principal identifying restriction of the estimation procedure. If U_t varies systematically over time, then our instrument, t, will proxy for U_t and we will erroneously infer the presence of the peer-influence effect. The identification condition appears to be reasonable in our case since U_t is the deviation in period, t, from the prior, $\bar{U}_{t-1}$. There is no reason to expect such deviations to vary systematically over time.

While the preceding discussion sketched a formal justification for our statistical analysis, the intuition for our approach is that social learning follows from unpredicted changes in adoption behavior, whereas peer-influence is a predictable outcome of the adoption process. Real information about the new technology is obtained when the current adoption level differs from the predicted level $(U_t|\ \bar{U}_{t-1}) = 0$. In contrast, peer-influence depends on the observed level of adoption in the previous period, S_{t-1}, irrespective of the extent to which this level diverges from its predicted value. Nonparametric estimation techniques allow us to specify a flexible functional form, S(t), which approximates any arbitrary time-dependence in the predicted level of adoption in equation (11). What remains is the unpredicted component of the adoption-level, $\hat{\eta}_{t-1}$, which we use to proxy for the social learning effect in the subsequent period, $\bar{U}_{t-1}$.

The econometric test identifying alternative social effects was derived for the special case in which households were homogeneous (identical). As mentioned earlier, individual effects must also be considered as determinants of inter-village variation in CPR when heterogeneity is introduced. Correlated economic effects and common information shocks were also listed as potential determinants of reproductive behavior. Equation (4) is consequently extended to include these additional effects and is now estimated as a discrete-choice model at the level of the individual household.

$$y_{it}=\pi_0+\pi_1 S_{t-1}+X_{it}\pi_2+\pi_3 Z_t+\epsilon_t \qquad (4')$$

where, $_{it}$=1 if household, i, adopts the new technology in period, t
$_{it}$=0 otherwise.

$_{it}$ is a vector of household attributes such as wealth, education, the number of surviving children (by sex), and the age of the parents. A dummy variable capturing the identity of the local Community Health Worker is also included here.

$_{t}$ is a measure of economic conditions in the village. The neoclassical economic model predicates a number of household decisions on the state of the economic environment. These decisions include labor supply, fertility, migration and education. All these variables are assumed to be jointly-determined, responding to exogenous economic conditions such as the wage-rate and the level of unemployment. Since these economic conditions are unobserved by the econometrician, we use available information on migration-levels as a proxy variable. Migration data are available monthly at the household level for the entire sample. It is consequently straightforward to construct a village-level migration variable. Following the usual consistency-condition, this is a valid proxy for unobserved changes in economic conditions if migration, $_{t}$, is orthogonal to the information shock, U_t, in each period. It is quite likely that this condition will be satisfied in practice.

While we attempt to control for as many determinants of the contraceptive use decision as possible, some relevant variables may still be omitted by the econometrician. Such omission does not affect consistency of the two-step estimation procedure if the ignored variables do not vary systematically over time. If time-dependence is present then we face essentially the same problem that was discussed earlier for U_t and inconsistent estimates of π_1 are obtained.

One approach to provide additional support for our results would be to take advantage of the heterogeneity within the sample. While we have not formally derived results with this extension to the model, it is natural to assume that peer-influence will depend on the mix of adopters in addition to the average level of adoption. For instance, we would expect wealthy-literate households to exert greater social influence through adoption than their neighbors with less favorable attributes. In this case the decision-rule in equation (1) would be extended to include the proportion of wealthy-literate households among the set of adopting households. Following our earlier discussion, deviations from the predicted mix of adopters in a given period may also provide information about the distribution of unobserved information shocks. The two-step estimation procedure would proceed as before, with two stage 1 regression equations. A valid instrument for the mix of adopters in a given period appears to be the proportion of wealthy-literate households in the total population (of the village). This extension to the model will provide additional implications for both the peer-influence effect and social learning, which may be independent of the time-dependence condition derived earlier.

ANNEX - 1

Budget for estimated period of 3 months

Travel cost	500	US$
Access to data	3000	US$
Data analysis	1000	US$
**Total-----> **	**4500**	**US$**

Approved by: S. L 14/10/96

Mrs. Shamima Moin
Controller, Budget & Costing