Hitotsubashi Journal of Economics 47 (2006), pp.17-35.

MEASURES OF EFFECTIVE LITERACY: A THEORETICAL AND EMPIRICAL NOTE

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Received March 2005; Accepted October 2005

Abstract

This paper discusses the measurement issue of intra-household externality of literacy. Extending the work of Basu - Foster (1998), we present axiomatic characterisations of several effective literacy measures that generalizes the extent of externality effect on proximate illiterates. The determinants of externality considered are several attributes of the members of the household such as age, sex, level of education etc. We also do an empirical analysis based on the already developed theoretical measures using interstate NSS data of India and village level primary data from Assam, a state of India.

Key Words: Proximate Illiterate, Isolated Illiterate, Measurement, Age, Gender, Education, NSS, Assam.
JEL classification numbers: I21

I. *Introduction*

The literature on literacy says little about intra-household externalities of literacy and education. One might well expect that literacy may have spillover benefits within a household. Green et. al. (1985) and Dreze and Saran (1995) note how the advantages of literacy can spread to others in the household. But, traditionally the literacy rate is defined as the ratio of number of adult literates to the total number of adults. Basu and Foster (1998) (henceforward

* The authors would like to thank Prof. Kaushik Basu and an anonymous referee for their helpful comments and suggestions on an earlier draft. The usual disclaimer applies.

BF) have suggested an alternative measure of effective literacy in which the distinction is made between proximate illiterates (proximate illiterates are the illiterate members of the household with at least one literate member) and isolated illiterates (isolated illiterates come from a household with no literate member). A proximate illiterate is assumed to be α-equivalent to a literate member of the household with $0<\alpha<1$. The significance of this alternative measure in designing literacy education programme is also documented by Basu et al (1999). Some theoretical modifications and comments on this measure are also available in Chakravarty and Majumder (2001), Subramanian (2001), Mishra (2001), Mitra (2001), Valenti (2001) and Dutta (2002).

However, in all these works, the external effect of literacy on the proximate literates is independent of the set of characteristics of the literate members of the household. In reality, the magnitude of the external effect of literacy on the proximate illiterate depends on the various characteristics of the literate members in the household. Age of the literate member is one such determinant because an elder literate member usually exerts a greater external effect on the illiterate than an younger literate member. A female literate member should have a larger effect than a male literate member because the females play a more active role in the domestic activities of the household. BF partially takes care of this point in footnote 5, section 5 and 6 (last paragraph) of their paper. Also, the gender of the recipient illiterate might also matter in the determination of this externality. The literate member who stays in the home should have a greater effect than a migrant literate member. Also the level of education of the literate member is an important determinant of α as an illiterate member has a greater respect for the literate member with higher educational qualification.

In this note we extend the BF measure of effective literacy in the light of describing α as representative of the above mentioned characteristics of the literate members of the household. We propose a set of axioms that the ideal measure of literacy should satisfy; and which postulates the effect of the characteristics like age, sex and level of education of literate members on a proximate illiterate. Our suggested extensions of BF measure satisfy these axioms; and are reduced to BF measure itself in the special case when insensitivity of the external effect to the relevant characteristics is assumed.

We have carried out an empirical analysis illustrating the proposed alternative measures of effective literacy using household level NSS data on different states of India.[1] A second analysis uses household level primary data collected from seven villages in Assam, a state of India. All the states/villages do not have same ranking for different measures of literacy.

The paper is organised as follows. In section 2, the axioms are described and preliminary observations are made. The formulae and characterisation results for a household level effective literacy measure are presented in section 3. We briefly indicate how to aggregate the household level effective literacy measures to arrive at a society wide measure of effective literacy in section 4. In this section, brief comments are made regarding the contrast between our work and the BF formulation. We provide empirical illustrations of our methodology using NSS data on the states of India and village survey data from Assam in section 5. Conclusions are drawn in section 6.

[1] These are National Sample Survey Data on employment-unemployment (43rd round, 1993-94).

II. *Preliminaries*

We will now describe the relevant set of variables that we deem are important characteristics of a literate person with respect to the externality effect that she exerts on an illiterate member of the same household. For any person i, $i=1, \ldots, N$, in an N-person household, we define the variables in the following way.

(i) Level of education, $e_i \in E=[0, k]$ or $\{0, 1, 2, \ldots, k\}$ for some $k \geq 1$, integer. k is considered to be the highest attainable level of education. That is, we consider education to be measured on a continuous scale or may allow several discrete levels of education. For technical simplicity, we will do the analysis for the continuum situation, but the results and their demonstration can also be adapted to the discrete case.

(ii) Sex, $s_i \in \{m, f\}$; m = male and f = female.

(iii) Age, $y_i \in R_+$.

Thus, for our purpose, person i is now completely described by the characteristic vector $c_i=(e_i, y_i, s_i)$. Define the set $C^N=(E \times \{m, f\} \times R_+)^N$ for positive integer N (household size), as the set of all possible characteristic vectors for a given household size. Also define $C=\cup_{N \geq 1} C^N$ as the union of C^N over all positive integers N. Therefore we can define the measure of household level literacy as a function P defined over all possible sets of characteristic vectors for each individual in the household to a real number between 0 and 1. More precisely, P: $C \to [0, 1]$.

Whatever follows is actually much more general, as any set of individual characteristics that includes the level of education may be considered as the relevant characteristic set. Our use of age and sex is just one of many possibilities that may be considered relevant. Other possibilities may include the pattern of time use by the literate members of the family. Analysis with just one additional characteristic is also feasible but we have considered two to allow for interactions between characteristics which are often considered relevant. Valenti (2001) also uses the information on distribution of literates in the household in her analysis but does not consider Sex and Age variables. Thus, our work can be thought of as a generalization.

To facilitate subsequent discussion, denote any set of characteristic vectors $\{c_1, c_2, \ldots, c_N\}$ of a household of N members by Ω_N. The set of vectors without the i^{th} element $\{c_1, \ldots, c_{i-1}, c_{i+1}, \ldots, c_N\}$ by Ω_N^{-i}. We now introduce the set of basic assumptions on our literacy measure P.

A1 (Additivity): The aggregate literacy status of the household is the average of each person's literacy status in the household.

$$P(\Omega_N)=\frac{1}{N}\sum_{i=1}^{N} p(c_i; c_j, j=1, \ldots, N)=\frac{1}{N}\sum_{i=1}^{N} p(c_i; \Omega_N)$$

where $p(c_i; \Omega_N)$: $C \to [0, 1]$ is the identical literacy indicator function for member i of the household, with characteristic vector c_i and Ω_N is the set of characteristics of all the members in the household.

Thus, assumption (A1) provides us with a convenient breakdown of the general effective literacy measure of the household, $P(.)$, in terms of the effective literacy status of each individual in the household, $p(.)$, and postulates that $P(.)$ is a simple average of the $p(.)$ values of all the members of the household. This ensures symmetry among the members of the household with respect to any other individual attributes which are not included in Ω_N. Note that, by definition, the effective literacy measure $P(.)$ depends on the characteristic vectors of all the members of the household. Due to (A1), this property is translated to the individual level effective literacy measure $p(.)$. Thus the individual $p(.)$ values also depend on the relevant characteristics of the other members of the family, like their literacy status, age and sex, along with the characteristics of the individual. This is the simple formulation of externality that we use in this paper.

A2 (Normalization): The maximum value $(=1)$ of literacy status for the individual i is attained when $e_i>0$. That is,

$p((e_i, y_i, s_i); .)=1$ if and only if $e_i>0$.

The minimum value $(=0)$ is attained when there are no literate members in the household. That is,

$p((e_i, s_i, y_i); \{(e_j, s_j, y_j), j=1, \ldots, N, j\neq i\})=0$ if and only if $e_j=0$ for all $j=1, \ldots, N$.

For all other cases, $0<p(.)<1$.

Thus, we are not allowing an illiterate to have equal literacy status as a literate person under any circumstances. Also, the externality value is assumed to be strictly positive.

A3 (Monotone externality of literates): The effective literacy status of any person is determined by his own characteristics and that of the literate members (if any) only and is non-decreasing if more literates are introduced into the household.

That is, we can write $p(c_i; \Omega_N)=p(c_i; L_N)$, where $L_N=\{(e_j, s_j, y_j)\in\Omega_N | e_j>0\}=$ the set of characteristics of the literate members in the household. Denote the size of this set by $l=|L_N|$. As a consequence, we can write $P(.)$ as

$$P(\Omega_N)=\frac{1}{N}\sum_{i=1}^{N}p(c_i; L_N). \tag{1}$$

(A3) postulates that each proximate illiterate's effective literacy status, $p(c_i; L_N)$, (weakly) improves if the number of literate members in the household increases.

(A1) - (A3) is our basic set of axioms. Note that (1) is the most general form of effective literacy measure that we consider.

We will now introduce the additional set of axioms, which are dependent on alternative judgements about the externality effect we are trying to model.

A4 (Education level sensitivity): For any $(e_j, s_j, y_j)\in L_N$

$$\frac{\partial p}{\partial e_j}((0, s_i, y_i); L_N)\geq 0.$$

That is, the externality effect of any literate member j on the illiterate member i in the household, given other things, is nondecreasing in the level of education of person j. Note that if $L_N=\phi$, the empty set, this axiom is vacuously satisfied.

This assumption postulates that the externality benefits will be larger, higher the education level of a literate member in the household. A more educated person may be able to exert a larger beneficial influence on an illiterate member of the same household. Basu, Narayan and Ravallion (2002) finds empirical support for this axiom. We define neutrality to education level of the effective literacy measure by the following axiom.

A4' (Education level insensitivity): The externality effect of any literate member j on the illiterate member i in the household is independent of the level of education of j.

A5 (Gender sensitivity): There can be several variants of such axiom. We present two of those.

(i) For any $c_j=(e, m, y)\in L_N$ and $c_k=(e, f, y)\in L_N$ and $c_i=(0, s_i, y_i)$,

$$p(c_i;\, L_N^{-j})\geq p(c_i;\, L_N^{-k}),$$

where $L_N^{-j}=L_N-\{c_j\}$ etc. That is, female literates has higher externality on the literacy status of illiterates in the household than the male literates. As females spend more time in household activities, this structure is justified.

(ii): For any $c_j=(e, m, y)\in L_N$ and $c_k=(e, f, y)\in L_N$ and any $c_i=(0, m, y_i)\in\Omega_N$,

$$p(c_i;\, L_N^{-j})\leq p(c_i;\, L_N^{-k})$$

The inequality is reversed if $s_i=f$.

Given other factors, female literates has a higher externality on female illiterates than on male illiterates. Similarly for a male literate.

Basu, Narayan and Ravallion (2002) finds empirical support for this axiom. This variant of the axiom implies that the characteristics of the recipient are also important for measuring the extent of externality that a literate may exert on other members of his/her family.

Again we can define A5' (Gender insensitivity) in the same manner as in (A4'). This axiom postulates that the externality is independent of gender considerations.

A6 (Age ordering sensitivity): For an illiterate person i with $c_i=(0, s_i, y_i)$ and any $c_j=(e_j, m, y_i+k)\in L_N$ with $k>0$,

$$p(c_i;\, L_N)\geq p(c_i;\, L_N^{-j}\cup\{(e_j, s_j, y_i-h)\}),$$

where $h>0$.

That is, externality effect is more effective on younger persons than on elders. (Justifying adult education programmes.) This axiom is particularly relevant for measuring effective literacy for households in a traditional society where the intra-household power hierarchy is very much chronologically determined.

Again, we can define A6' (Age ordering insensitivity) in an analogous manner. The externality effect on an illiterate person of a literate is independent of their birth order.

A7 (Insensitivity to additional literates with lower externality): For (e_1, s_1, y_1), (e_2, s_2, y_2) $\in L_N$

$$p(c_i;\, L_N)=p(c_i;\, L_N^{-2})$$

for illiterate person i if $p(c_i;\, \{(e_1, s_1, y_1)\})\geq p(c_i;\, \{(e_2, s_2, y_2)\})$.

This axiom says that multiplicity of identical literates is ineffective with respect to externality effect on illiterates. Also, additional literates do not exert any externality on the illiterate members if their extent of externality is of lower order. This is a sort of crowding out argument that is also embodied in the BF externality axiom. Subramanian (2001) argues against it and proposes a measure of effective literacy that takes into account the proportion of literates in the household (see below). We will explore the consequences of the presence and absence of this axiom explicitly in our subsequent results.

Note that, if (A4'), (A5') and (A6') are always satisfied, then all literates are treated as identical - similar to that in BF and Subramanian (2001) (See propositions 1 and 3 below).

Before we proceed to discuss our results in the next section, let us recall the salient measures of household level proximate literacy proposed in the literature. The first two are due to BF and are given by (using our notation)

$$P_{\alpha}=\frac{l+(N-l)\alpha}{N}$$

and their gender sensitive prescription

$$P_{\alpha_m,\,\alpha_f}=\frac{l+\alpha_m(N-l)}{N} \text{ if there are no female literates in the household,}$$

$$=\frac{l+\alpha_f(N-l)}{N} \text{ otherwise.}$$

Here $0<\alpha<1$, and $0<\alpha_m<\alpha_f<1$.

The other important measure of effective literacy that we want to relate our findings to is by Subramanian (2001), defined as

$$P_S=\frac{l+(N-l)\,\frac{l}{N}}{N}.$$

For a discussion of the properties of this measure, op. cit.

III. *The Results*

In the following propositions, we identify precise sets of conditions that characterise alternative forms of the effective literacy measure.

Proposition 1: The form of the effective literacy measure becomes identical to the BF P_{α} formulation if and only if it satisfies (A1) - (A3), (A4'), (A5'), (A6') and (A7).

Proof: For any proof, we assume that $l>0$ as otherwise the proof becomes trivial as $p(.)=0$. In that case the household has no literates and the question of proximate literacy does not arise.

Under (A1-3), the form of the individual effective literacy measure becomes as given by (1). Now, if we impose (A5') and (A6') then the measure becomes independent of the sex and age information of the individuals concerned. So, we can redefine the effective literacy measure for illiterate person i, $p((e_i, s_i, y_i), L_N)$, retaining only the education level variable as

$$p^e(0;\, e_1, e_2, \ldots, e_l) \tag{2}$$

where l is the number of literates in the household. Now, if we invoke (A4') then the function will become independent of the level of education of each literate and only the information that they are literate will be important. So, effectively, the function p^e can now be redefined as

$$p'(0;\, 1, 1, \ldots, 1).$$

Now we finally use (A7) and, as a consequence, the function becomes independent of the number of literates, so we finally get the following form for the effective literacy measure,

$$p''(0,\, 1)=\alpha, \tag{3}$$

say, where $0<\alpha<1$ by (A2). Hence, using (1) to sum over all individuals in the household, the effective literacy status of the household finally becomes,

$$P(\Omega_N)=\frac{l+(N-l)\alpha}{N},$$

which is just the measure P_α. It is easy to verify that P_α satisfies (A1) - (A3), (A4'), (A5'), (A6') and (A7).

This is an intuitive and the simplest formulation of the externality effect of literates on a proximate illiterate. We will now explore alternative possibilities that allow for sensitivities with respect to the relevant characteristics in the effective literacy function. In the following proposition, we capture the effect of both sex and age ordering simultaneously and demonstrate the resulting form of the effective literacy measure. To do this in a very general manner, we consider the axioms (A5(ii)) and (A5(ii)). That is, we allow the literacy externality effects to depend on the sex of both the literate and the illiterate member. The age dependence is captured by (A6). To make the subsequent discussion precise, let us define the following.

Definition 1: For any illiterate person i with characteristic $c_i\in\Omega_N$, the set L_N is said to be of type $(f, 1)$ with respect to person i if there exists a $c_j\in L_N$ with $s_j=f$ and $y_j>y_i$. We say that L_N is of type $(f, -1)$ with respect to person i if there exists a $c_j\in L_N$ with $s_j=f$ and $y_j\leq y_i$. analogously define types $(m, 1)$ and $(m, -1)$.

When we do not allow for multiplicity in the presence of literates to be beneficial, we have the following general result.

Proposition 2: When the effective literacy measure satisfies (A1) - (A3), (A4') and (A7), we have the following equivalences.

(i) The function $p(.)$ satisfies, in addition to the above, axioms (A5(i)) and (A6) if and only if it is defined by the following.

$p(c_i; L_N)=1$ if $e_i>0$,
$=p*(f, 1)$ if $e_i=0$, L_N is of type $(f, 1)$
$=p*(f, -1)$ if $e_i=0$, L_N is not type $(f, 1)$, not type $(m, 1)$, but type $(f, -1)$
$=p*(m, 1)$ if $e_i=0$, L_N is not type $(f, 1)$, not type $(f, -1)$, but type $(m, 1)$
$=max\{p*(m, 1), p*(f, -1)\}$ if $e_i=0$, L_N is not type $(f, 1)$, but type $(m, 1)$ and type $(f, -1)$
$=p*(m, -1)$ if $e_i=0$, L_N is not type $(f, 1)$, not type $(f, -1)$, not type $(m, 1)$, but type $(m, -1)$,

where $0<p*(m, -1)<p*(f, -1), p*(m, 1)<p*(f, 1)<1$ are real constants.

(ii) The function $p(.)$ satisfies, in addition to the above, axioms (A5(i)) and (A6') if and only if the form of the effective literacy measure is identical to the BF gender sensitive P_{α_m, α_f} formulation.

(iii) The function $p(.)$ satisfies, in addition to the above, axioms (A5(ii)) and (A6) if and only if it is defined by the following.

$$p(c_i; L_N)=1 \text{ if } e_i>0$$

Otherwise, if $e_i=0$, we consider two alternative possibilities. First, suppose that $s_i=f$. Then, $p(.)$ is defined as follows.

$p(c_i;\, L_N) = p_f * (f,\, 1)$ if L_N is of type $(f,\, 1)$
$= p_f * (f,\, -1)$ if L_N is not type $(f,\, 1)$, not type $(m,\, 1)$, but type $(f,\, -1)$
$= p_f * (m,\, 1)$ if L_N is not type $(f,\, 1)$, not type $(f,\, -1)$, but type $(m,\, 1)$
$= max\{p_f * (m,\, 1),\, p_f * (f,\, -1)\}$ if L_N is not type $(f,\, 1)$, but type $(m,\, 1)$ and type $(f,\, -1)$
$= p_f * (m,\, -1)$ if L_N is not type $(f,\, 1)$, not type $(f,\, -1)$, not type $(m,\, 1)$, but type $(m,\, -1)$,

where $0 < p_f * (m,\, -1) < p_f * (f,\, -1),\, p_f * (m,\, 1) < p_f * (f,\, 1) < 1$ are real constants. For $s_i = m$, we have the following.

$p(c_i;\, L_N) = p_m * (m,\, 1)$ if L_N is of type $(m,\, 1)$
$= p_m * (m,\, -1)$ if L_N is not type $(m,\, 1)$, not type $(f,\, 1)$, but type $(m,\, -1)$
$= p_m * (f,\, 1)$ if L_N is not type $(m,\, 1)$, not type $(m,\, -1)$, but type $(f,\, 1)$
$= max\{p_m * (f,\, 1),\, p_m * (m,\, -1)\}$ if L_N is not type $(m,\, 1)$, but type $(f,\, 1)$ and type $(m,\, -1)$
$= p_m * (f,\, -1)$ if L_N is not type $(m,\, 1)$, not type $(m,\, -1)$, not type $(f,\, 1)$, but type $(f,\, -1)$,

where $0 < p_m * (f,\, -1) < p_m * (m,\, -1),\, p_m * (f,\, 1) < p_m * (m,\, 1) < 1$ are real constants.

(iv) The function $p(.)$ satisfies, in addition to the above, axioms (A5(ii)) and (A6') if and only if it is defined by the following.

$p(c_i;\, L_N) = 1$ if $e_i > 0$
$= p_f * (f)$ if $e_i = 0$, $s_i = f$, L_N is of type $(f,\, 1)$ or type $(f,\, -1)$
$= p_f * (m)$ if $e_i = 0$, $s_i = f$, L_N is not type $(f,\, 1)$, not type $(f,\, -1)$
$= p_m * (m)$ if $e_i = 0$, $s_i = m$, L_N is of type $(m,\, 1)$ or type $(m,\, -1)$
$= p_m * (f)$ if $e_i = 0$, $s_i = m$, L_N is not type $(m,\, 1)$, not type $(m,\, -1)$,

where $0 < p_f * (m) < p_f * (f) < 1$ and $0 < p_m * (f) < p_m * (m) < 1$ are real constants.

Proof: (i) Due to (A1)-(A3) and (A4'), the level of education becomes unimportant for the members of L_N. Then one can simplify and redefine the individual effective literacy measure as

$$p^{sa}((s_i,\, y_i);\, (s_1,\, y_1),\, \ldots,\, (s_l,\, y_l)). \tag{4}$$

We now invoke (A6) on (4). Now, given (A6), we need only consider whether, for each literate j, $y_j > y_i$ or not. We denote this event by a variable I_J in the set of arguments of p' that takes a value of "1" when the condition hold and in case of the converse event it equals "-1". As before, we redefine p^{sa} and write it as

$$p'(s_i;\, (s_1,\, I_1),\, \ldots,\, (s_l,\, I_l)) \tag{5}$$

Now given (A5(i)) and (A6), we need to consider four alternative possibilities of externality effects, namely those due to the presence of an older female literate (type $(f,\, 1)$) or older male literate (type $(m,\, 1)$) or younger female literate (type $(f,\, -1)$) or, finally, a younger male literate (type $(m,\, -1)$) in L_N. Note that, due to the conjunction of (A5(i)) and (A6), an older female can exert the highest influence on an illiterate household-member. The younger male literate has the least influence and older males and younger females are in the intermediate zone. A comparison between the externality effects of a younger literate female and that of an older literate male is ambiguous given our assumptions.

In our notation, if $\{(s_i, y_i); (s_1, y_1), \ldots, (s_l, y_l)\} \ni (f, 1)$ and given that due to (A5(i)) and (A6), this configuration has the highest externality, then due to (A7), $p'(s_i; (s_1, I_1), \ldots, (s_l, I_l)) = p'(s_i; (f, 1)) = p*(f, 1)$ say, as this is a constant independent of s_i.

Otherwise, if $\{(s_i, y_i); (s_1, y_1), \ldots, (s_l, y_l)\} \not\ni (f, 1)$, then we check for the presence of $(m, 1)$ or $(f, -1)$, the two intermediate effects in terms of (A5(i)) and (A6). This would give rise to the following three possibilities and corresponding externality effect parameters due to (A7) again.

(a) $p'(s_i; (s_1, I_1), \ldots, (s_l, I_l)) = p'(s_i; (f, -1)) = p*(f, -1)$ if $(f, -1) \in \{(s_i, y_i); (s_1, y_1), \ldots, (s_l, y_l)\}$ and $(m, 1) \notin \{(s_i, y_i); (s_1, y_1), \ldots, (s_l, y_l)\}$. (b) $p'(s_i; (s_1, I_1), \ldots, (s_l, I_l)) = p'(s_i; (m, 1)) = p*(m, 1)$ if $(m, 1) \in \{(s_i, y_i); (s_1, y_1), \ldots, (s_l, y_l)\}$ and $(f, -1) \notin \{(s_i, y_i); (s_1, y_1), \ldots, (s_l, y_l)\}$. And, (c) $p'(s_i; (s_1, I_1), \ldots, (s_l, I_l)) = p'(s_i; (f, -1), (m, 1)) = max\{p*(f, -1), p*(m, 1)\}$ if $(f, -1) \in \{(s_i, y_i); (s_1, y_1), \ldots, (s_l, y_l)\}$ and $(m, 1) \in \{(s_i, y_i); (s_1, y_1), \ldots, (s_l, y_l)\}$.

Finally we have the residual case $p'(s_i; (m, -1)) = p*(m, -1)$.

It is easy to verify the reverse implication.

(ii) The proof of this part can be deduced from that of part (i). In the presence of (A6'), the two externality effects $p*(f, 1)$ and $p*(f, -1)$ will now be equal. So we redefine them as $p*(f, 1) = p*(f, -1) = \alpha_f$, say. Similarly, we have the situation $p*(m, 1) = p*(m, -1) = \alpha_m$. Due to (A5(i)), $\alpha_f > \alpha_m$. Note that, the presence or otherwise of a female literate in the household now affects all the illiterates in the same manner. So, using (1) to sum over all i, we finally get the effective literacy measure in this case as

$$P(\Omega_N) = \frac{l + \alpha_m(N-l)}{N} \text{ if there are no female literates in the household,}$$
$$= \frac{l + \alpha_f(N-l)}{N} \text{ otherwise.}$$

This is evidently same as the Basu-Foster gender sensitive prescription P_{α_m, α_f}. It is easy to check that P_{α_m, α_f} satisfies (A1) - (A3), (A4'), (A5(i)), (A6) and (A7). Thus we have the desired result.

(iii) We again proceed as for the proof of part (i). Given (A1)-(A3), (A4') and (A6), $p(.)$ can be redefined as in (5). Due to (A5(ii)), now the recipient's gender also matter in the determination of the extent of externality. So, we analyse the two possibilities separately.

When $s_i = m$, we look at

$$p'(m; (s_1, I_1), \ldots, (s_l, I_l)). \tag{6}$$

Now we proceed with (6) in exactly the same manner as with (5) in part (i). Again, due to the conjunction of (A5(ii)) and (A6), we now see that type $(m, 1)$ now has the highest externality effect and type $(f, -1)$ the lowest with $(m, -1)$ and $(f, 1)$ being the two intermediates. Thus, we finally arrive at the parameters $p'(m; (m, 1)) = p_m*(m, 1)$, $p'(m; (m, -1)) = p_m*(m, -1)$, $p'(m; (f, 1)) = p_m*(f, 1)$, $p'(m; (f, 1), (m, -1)) = max\{p_m*(f, 1), p_m*(m, -1)\}$ and $p'(m; (f, -1)) = p_m*(f, -1)$.

The case $s_i = f$ is dealt with similarly and we omit the details. Again, reverse implication is easy to check.

(iv) Again, this part is reduced from part (iii), in the presence of (A6'), in exactly the same way as the reduction of part (ii) from part (i). The parameters $p_x*(y, 1)$ and $p_x*(y, -1)$ are equalised and denoted by $p_x*(y)$; $x, y=m, f$.

The normalisation of all the relevant constants between 0 and 1 is due to (A2).

In each of the cases analysed above, the measures will be completely characterised by a well defined set of parameters. The actual form will depend on the presence of certain combinations in the set of literates and the sex of the illiterate member. The parameters can be ordered unambiguously if we impose more structure on comparability. For example, being able to rank the externality effect of $(f, -1)$ and $(m, 1)$ from a female illiterate's point of view. That is, whether we can rank $p_f^*(f, -1)$ and $p_f^*(m, 1)$.

Below, we illustrate the above proposition by an example.

Example 1: (a) This corresponds to the most general situation, as depicted in part (iii) of Proposition 2. Consider the situation where $p_f^*(f, 1)=p_m^*(m, 1)=\alpha_f$, $p_f^*(f, -1)=p_m^*(m, -1)=\beta\alpha_f$, $p_f^*(m, 1)=p_m^*(f, 1)=\alpha_m$, and $p_f^*(m, -1)=p_m^*(f, -1)=\beta\alpha_m$.

(b) Now, to illustrate part (i) of Proposition 2, consider $p*(f, 1)=\alpha_f$, $p*(m, 1)=\alpha_m$, $p*(f, -1)=\beta\alpha_f$ and $p*(m, -1)=\beta\alpha_m$.

(c) Finally, illustrating part (iv) of Proposition 2, suppose $p_f*(f)=p_m*(m)=\alpha_f$, $p_f*(m)=p_m*(f)=\alpha_m$.

Here, $0<\beta<1$ and $0<\alpha_m<\alpha_f<1$.

To have a precise numerical illustration, let us take $\alpha_f=0.6$, $\alpha_m=0.4$ and $\beta=0.8$, then we have

(a) $p_f^*(f, 1)=p_m^*(m, 1)=0.6$, $p_f^*(f, -1)=p_m^*(m, -1)=0.48$, $p_f^*(m, 1)=p_m^*(f, 1)=0.4$ and $p_f^*(m, -1)=p_m^*(f, -1)=0.32$.

(b) $p*(f, 1)=0.6$, $p*(m, 1)=0.4$, $p*(f, -1)=0.48$ and $p*(m, -1)=0.32$.

(c) $p_f*(f)=p_m*(m)=0.6$, $p_f*(m)=p_m*(f)=0.4$.

We will now look at alternative forms of the effective literacy measure that arises when we consider effect of the education level of the literates to be important in determining the effective literacy level of the proximate illiterates. To keep the discussion tractable, we will assume that gender and age considerations are not relevant in the context of the following result. In what follows, we will sometimes allow for presence of multiple literates in the household to be beneficial for the illiterate members. This is more in the spirit of Subramanian (2001) who supports the beneficial impact of having a higher number of literates in the household.

Proposition 3: When the effective literacy measure satisfies (A1) - (A3), (A5') and (A6'), we have the following equivalences.

(i) The function $p(.)$ satisfies, in addition to the above, axiom (A4) if and only if the form of the effective literacy measure becomes

$$P_e(\Omega_N)=\frac{l+(N-l)g_1(e_1, e_2, \dots, e_l)}{N}, \tag{7}$$

for a suitably defined function g_1: $\cup_{l\geq 1}[0, k]^l \rightarrow [0,1]$ (weakly) increasing in each of its arguments.

(ii) The function $p(.)$ satisfies, in addition to the above, axioms (A4) and (A7) if and only if the form of the effective literacy measure becomes

$$P_{me}(\Omega_N) = \frac{l + (N - l)g_2(e_{Max})}{N}, \tag{8}$$

where $e_{Max} = Max_{1 \leq j \leq l}\, e_j$ and for a suitably defined (weakly) increasing function g_2: $[0, k] \rightarrow [0, 1]$.

(iii) The function $p(.)$ satisfies, in addition to the above, axiom (A4') if and only if the form of the effective literacy measure becomes a generalisation of the Subramanian (2001) measure P_S.[2]

Proof: Given (A1) - (A3), (A5') and (A6'), the individual externality effect for each illiterate takes the form (2), as already shown in Proposition 1. Now, this effect is identical for each illiterate, so aggregating over all members of the household, the form of (1) becomes

$$P(\Omega_N) = \frac{1}{N}\,(l + (N - l)p^e(0;\, e_1,\, e_2,\, \ldots,\, e_l)) \tag{9}$$

(i) Equation (9) can be rewritten as (7) for a function g_1 as defined above. The range of the function is a consequence of (A2). The increasingness of g_1 in each of its arguments follow from (A4). Reverse implication is easy to check. Hence we have part (i).

(ii) Given (A7), the externality function as given in (2) only depends on the highest education level among the literate members of the household, or e_{Max} as defined above. Thus, in this case, (9) becomes

$$P(\Omega_N) = \frac{1}{N}\,(l + (N - l)p^e(0;\, e_{Max})).$$

Now this can be redefined as (8) for a function g_2 as defined above. The range is due to (A2). The increasingness of g_2 follows from (A4). Reverse implication is easy to check. Hence we have part (ii).

(iii) Again, following the proof of Proposition 1, given (A4'), $p^e(.)$ can be redefined as $p'(0; 1, 1, \ldots, 1)$. Now, the only variable part in the arguments' set is l, the number of "1"s. So, one can rewrite this as $f(l)$: $Z_+ \rightarrow [0, 1]$. f is increasing due to (A3). Then (9) can be rewritten again as

$$P(\Omega_N) = \frac{1}{N}\,(l + (N - l)f(l)). \tag{10}$$

If we consider the particular case $f(l) = \frac{l}{N}$, the traditional measure of literacy, (10) simplifies to the Subramanian (2001) measure,

$$P_S = \frac{l + (N - l)\,\frac{l}{N}}{N}.$$

Once again, the reverse implication is easy to verify.

Proposition 3 explicitly brings into focus the impact of the presence or otherwise of (A7) in the set of axioms. Comparing part (i) and (ii), it is easy to see that, when (A7) is assumed, the effective literacy level of a proximate illiterate depends only on the highest level of

[2] Valenti (2001) characterises similar functional forms. Dutta (2002) reproduces these results.

education available in the household. Other literates exert no influence on the illiterates whatsoever. While, they do have nontrivial impact in this respect, in the absence of (A7). One can consider several interesting special cases of (7) and (8). Below, we illustrate with two of these.

Example 2: (a) Suppose we postulate $\frac{\partial g_1}{\partial e_j}=\beta$, say. This can be thought of as a special case of (A4) when the marginal contribution of education is constant across educational levels and across individuals. Then, by repeated integration,[3] one obtains

$$g_1(.)=\beta\sum_{j=1}^{l} e_j.$$

Due to (A2), $0<\beta\Sigma_{j=1}^{l} e_j<1 \ \forall e_1, e_2, \ldots, e_l$. So, we get $0<\beta lk<1$. So, one may take $\beta=\frac{1}{kN}$ to get

$$P_e(\Omega_N)=\frac{l}{N}+\frac{(N-l)}{N}\frac{\Sigma_{j=1}^{l} e_j}{Nk}. \tag{7.1}$$

(b) Similarly, if we take $g'_2=\frac{1}{N}$ and simplify analogously, we may arrive at a special case of (8) given by

$$P_{me}(\Omega_N)=\frac{l}{N}+\frac{(N-l)}{N}\frac{e_{Max}}{N}. \tag{8.1}$$

Such examples are important in the sense that they are simply parametrised, easily computable and hence very useful for policy purposes. These would be amenable to empirical exercises using real life data, for measuring the impact of literacy programmes and evaluating related policy.

IV. *Discussion*

1. Aggregate Social Effective Literacy

So far we have only discussed the effective literacy status of a household in isolation. But, to be an useful tool for empirical purposes, the measures of effective literacy should be extendable to a society aggregate. We will now take up this issue. Let us consider a society (some well defined unit such as village, town, district, county, state, nation etc.) of M households, where M is any positive integer. Let each individual household be described by the set of individual characteristic vectors, using our notation,

$$\Omega^i_{N_i}=\{c^i_1, c^i_2, \ldots, c^i_{N_i}\}, i=1, \ldots, M.$$

Define the society wide set of such characteristics as

$$A^M=\{\Omega^1_{N_1}, \Omega^2_{N_2}, \ldots, \Omega^M_{N_M}\}.$$

Then, one can define the *aggregate social effective literacy measure* by $P^A(A^M): C \rightarrow [0, 1]$. One can now once again appeal to *decomposability* properties of such measures and define this

[3] This demonstration is similar to the proof of Lemma 3 in Mukherjee (2001). We do not discuss it in detail here.

measure P^A as an average of the effective literacy status of each household in the society. (For discussion on such issues, see for example, the pioneering work of Foster, Greer and Thorbecke (1984) and Chakraborty, Pattanaik and Xu (2002) for a recent treatment. Given these very thorough works, we will not give a repetitious detailed discussion of such issues and will only outline the basic argument we put forward.)

A simple postulated form would be

$$P^A(A^M) = \frac{1}{\sum_{j=1}^{M} N_j} \sum_{j=1}^{M} N_j P^A(A_j^1),$$

where $A_j^1 = \{\Omega_{N_j}^j\}$. One can then simply postulate that the aggregate effective literacy measure P^A coincides with the household level measure P for any society with a single household. That is,

$$P^A(A_j^1) = P(\Omega_{N_j}^j).$$

This formulation presents a consistent method of reducing the computation of the aggregate measure of effective literacy of a society to combining the calculations for each constituent household in a simple fashion. This formulation ensures that the measure is normalised between 0 and 1, it is anonymous, monotonically nondecreasing with respect to the number of literates in the society and the externality is restricted to household level only.

2. A Contrast with the BF Formulation

One can now contrast this formulation with that of BF. If we look back at the measures discussed in section 2 like P_α, P_{α_m, α_f} and P_S, and use the decomposable structure put forth above, it can be checked that social aggregate versions of these measures will indeed be the same as proposed in BF and Subramanian (2001). If we look at the axioms put forth in this paper and theirs, it is easy to match our (A2) with BF *Normalisation*. In the absence of sensitivity with respect to the characteristics that we discuss (as this is not considered by BF), our axiom (A 1), along with decomposability, has the same consequences as the axioms *externality* and *decomposability* in BF (as a consequence of BF, Theorem 1). To focus on the generalization of the externality parameter, we have not gone into the details of the externality mechanism in detail, as they have done, but instead we took the consequences of that as a primitive in our discussion.

If we consider household splits in an analogous manner to BF, then one can compare the externality axiom with our axioms (A3) and (A7). Again, in the absence of sensitivity with respect to gender, sex and education level considerations, in the case of an externality neutral household split, due to (A7), the effective literacy status of the proximate literates in the new households will be the same as before. Just as envisaged by the BF *externality* axiom. For an externality reducing split, due to (A3), the illiterates who now become isolated are worse off. Hence, due to decomposability, the society will now have a lower level of aggregate effective literacy as a whole. Again, the same effect is postulated in BF *externality*. Note that, in the absence of (A7), this relation may not hold. For example, the measures postulated in proposition 3 may not be externality neutral *a la* BF.

V. *Empirical Analysis*

The importance of these alternative theoretical measures of literacy is strengthened when the literacy ranking of different geographical areas becomes different with different measures. We now turn to provide examples.[4]

1. NSS Data for States of India

The data we use here is collected by the National Sample Survey Organization (NSSO) in the 43rd round (1993-4) of their sample survey. The data is collected for all the states and union territories of India.[5] We consider adult literacy, i.e., we consider those individuals with age not less than fifteen years.

Table 1 presents the literacy and effective literacy rates of the states and union territories and their ranks with respect to alternative measures of literacy for alternative values of α, α_f α_m and β. We use six alternative measures of literacy to illustrate. The first one, reported in the column headed LBAG1, is the traditional measure of literacy rate that assigns a value of 1 to each literate and 0 to the illiterate. The measure P_α, as defined in BF and characterized in Proposition 2, is reported in LBAG2. The third column, headed LBAG3, reports the Subramanian (2001) measure P_S, as characterized in Proposition 3(iii). LBAG4 is a special case of the measure postulated in proposition 3(i), as illustrated by Example 2(a), with highest level of education $k=4$. LBAG5 is the BF gender sensitive P_{α_m,α_f} formulation, also characterized in Proposition 2(ii). Finally, LBAG6 is the Age and Gender sensitive prescription as put forward in Proposition 2(i) with values of parameters chosen as in Example 1(b).

We have illustrated the measures by choosing different sets of numerical values for the parameters α, α_f, α_m and β. The alternative choices of parameter values are presented in different subcolumns. These choices are mentioned at the top of each subcolumn. The subsequent rows report the actual computed values of the effective literacy measures for each of the 31 states and union territories considered. Literacy measure of a state is the weighted average of the literacy measures of the households in that state with the household size as the weight. The literacy rate of any state/union territory according to the selected literacy measure and the rank of that state/union territory according to that measure is presented in consecutive rows for each state. The states are arranged according to their rank with respect to LBAG1.

Table 1 has several interesting features.. It is obvious that the values of the effective literacy measures will be larger than the traditional literacy rate, LBAG1. But, what is more surprising is the change in rank (often substantial) of the states in terms of literacy when we consider alternative measures. For example, Delhi and Goa exchange ranks (4 and 5) when we look at LBAG5 (with $\alpha_f=0.6$ and $\alpha_m=0.4$) compared to measures LBAG1 - 4. In fact, when we use LBAG5 with $\alpha_f=0.75$, $\alpha_m=0.25$, the change is more pronounced (Delhi shifts from 4 to 7). Similar changes are observed for Tripura, Assam, West Bengal, Tamil Nadu, Dadra and Nagar Haveli, Bihar, Andhra Pradesh. For these states ranks according to alternative effective

[4] We would like to acknowledge the unstinting help of Ms. Moumika Dutta in preparing this section.

[5] We have not used the data from Andaman and Nicobar Islands due to technical problems.

TABLE 1. LITERACY INDEX AND RANKING OF THE INDIAN STATES BASED ON NSS DATA

STATES	LITERACY INDEX										
	lbag1	lbag2	lbag3	lbag4	lbag5		lbag6				
		$\alpha=0.5$			$\alpha_F=0.6$ $\alpha_M=0.4$	$\alpha_F=0.75$ $\alpha_M=0.25$	$\alpha_F=0.6$ $\alpha_M=0.4$ $\beta=0.8$	$\alpha_F=0.6$ $\alpha_M=0.4$ $\beta=0.6$	$\alpha_F=0.75$ $\alpha_M=0.25$ $\beta=0.8$	$\alpha_F=0.75$ $\alpha_M=0.25$ $\beta=0.6$	
Kerala	0.903619	0.944004	0.953637	0.925117	0.94929	0.95722	0.94123	0.933553	0.947446	0.937731	
	1	1	1	1	1	1	1	1	1	1	rank
Mizoram	0.888231	0.917488	0.920547	0.89968	0.916765	0.91568	0.912794	0.909112	0.911374	0.907068	
	2	2	2	2	2	2	2	2	2	2	rank
Nagaland	0.801037	0.885612	0.896438	0.84581	0.888918	0.893876	0.875075	0.862657	0.87803	0.862184	
	3	3	3	3	3	3	3	3	3	3	rank
Delhi	0.746914	0.851852	0.856937	0.807598	0.841975	0.82716	0.831852	0.822716	0.816667	0.806173	
	4	4	4	4	5	7	4	4	7	6	rank
Goa	0.72549	0.837255	0.855012	0.796342	0.845882	0.858824	0.824549	0.804627	0.834314	0.809804	
	5	5	5	5	4	4	5	5	4	4	rank
Tripura	0.713852	0.799697	0.806064	0.748693	0.800954	0.80284	0.788277	0.776692	0.788316	0.774117	
	6	8	8	8	8	9	8	8	8	8	rank
Daman & Diu	0.709091	0.836364	0.848377	0.772187	0.84	0.845455	0.819491	0.801018	0.822	0.798545	
	7	6	6	6	6	5	6	6	6	7	rank
Lakshadweep	0.70155	0.823643	0.830966	0.764738	0.835659	0.835659	0.817054	0.79907	0.831589	0.809496	
	8	7	7	7	7	6	7	7	5	5	rank
Manipur	0.672599	0.792232	0.805031	0.742732	0.796949	0.804025	0.776983	0.75878	0.781059	0.758234	
	9	9	9	9	9	8	9	9	9	9	rank
Assam	0.666525	0.768223	0.769951	0.708073	0.766557	0.764058	0.752556	0.739366	0.749141	0.734382	
	10	12	12	11	12	12	12	11	11	10	rank
Sikkim	0.653295	0.776504	0.780072	0.704671	0.774928	0.772564	0.756791	0.740143	0.753223	0.733883	
	11	11	10	13	10	10	10	10	10	11	rank
Pondicherry	0.653153	0.777027	0.777885	0.706328	0.772973	0.766892	0.755135	0.739099	0.746622	0.728604	
	12	10	11	12	11	11	11	12	12	12	rank
Meghalaya	0.610947	0.721302	0.720219	0.720219	0.724734	0.729882	0.707669	0.691089	0.71105	0.692219	
	13	15	15	10	15	15	15	14	15	14	rank
Chandigarh	0.594595	0.747748	0.737495	0.661087	0.75045	0.754505	0.728288	0.707568	0.729505	0.704505	
	14	13	13	14	13	13	13	13	13	13	rank
West Bengal	0.590693	0.700061	0.696821	0.629096	0.698081	0.695112	0.683761	0.670567	0.679426	0.663978	
	15	16	16	16	16	16	16	16	16	16	rank
Himachal	0.578865	0.730225	0.727333	0.642263	0.7348325	0.741744	0.709652	0.686114	0.713658	0.68565	
Pradesh	16	14	14	15	14	14	14	15	14	15	rank
Tamil Nadu	0.566927	0.688493	0.685373	0.614796	0.684982	0.679716	0.668821	0.653728	0.662301	0.645019	
	17	18	18	18	18	19	18	18	18	18	rank
Maharashtra	0.559632	0.695948	0.690974	0.616235	0.6936672	0.690246	0.674596	0.656926	0.669539	0.649006	
	18	17	17	17	17	17	17	17	17	17	rank
Punjab	0.522065	0.672105	0.672105	0.589319	0.6760364	0.681934	0.6518	0.629029	0.655021	0.62851	
	19	19	19	19	19	18	19	19	19	19	rank
Gujarat	0.508892	0.660503	0.644439	0.563438	0.652268	0.639916	0.633309	0.61584	0.6202	0.600805	
	20	20	21	21	21	22	20	20	21	21	rank
Dadra&Nagar	0.504403	0.644025	0.626752	0.546507	0.6314465	0.612579	0.616553	0.602868	0.598176	0.583774	
Haveli	21	23	23	24	23	23	23	23	23	23	rank
Jammu &	0.497908	0.656206	0.646498	0.565981	0.6546722	0.652371	0.630767	0.60841	0.626552	0.600907	
Kashmir	22	22	20	20	20	20	21	21	20	20	rank
Haryana	0.486206	0.658017	0.643829	0.561447	0.6517345	0.642311	0.628418	0.606982	0.617946	0.593991	
	23	21	22	22	22	21	22	22	22	22	rank

STATES	LITERACY INDEX										
	lbag1	lbag2	lbag3	lbag4	lbag5		lbag6				
		$\alpha=0.5$			$\alpha_F=0.6$ $\alpha_M=0.4$	$\alpha_F=0.75$ $\alpha_M=0.25$	$\alpha_F=0.6$ $\alpha_M=0.4$ $\beta=0.8$	$\alpha_F=0.6$ $\alpha_M=0.4$ $\beta=0.6$	$\alpha_F=0.75$ $\alpha_M=0.25$ $\beta=0.8$	$\alpha_F=0.75$ $\alpha_M=0.25$ $\beta=0.6$	
Orissa	0.477425	0.601703	0.592019	0.520925	0.5971975	0.590439	0.581493	0.567089	0.573761	0.557267	
	24	25	25	26	25	25	25	25	25	25	rank
Karnataka	0.475413	0.620034	0.60082	0.531297	0.6162551	0.610586	0.596805	0.578587	0.590031	0.569798	
	25	24	24	25	24	24	24	24	24	24	rank
Uttar	0.423643	0.581285	0.558175	0.555925	0.5686326	0.549654	0.550941	0.534688	0.532342	0.515255	
Pradesh	26	26	26	23	26	26	26	26	26	26	rank
Bihar	0.389865	0.521025	0.505339	0.444215	0.5082349	0.489049	0.495012	0.482967	0.476257	0.463711	
	27	28	28	27	28	29	28	28	29	28	rank
Andhra	0.386957	0.513307	0.496853	0.432029	0.5048979	0.492284	0.489255	0.474566	0.476576	0.461217	
Pradesh	28	29	29	28	29	28	29	29	28	29	rank
Madhya	0.384028	0.532434	0.508576	0.431553	0.5182345	0.496935	0.502211	0.487372	0.481696	0.466596	
Pradesh	29	27	27	29	27	27	27	27	27	27	rank
Rajasthan	0.328477	0.50128	0.458616	0.382765	0.4776454	0.442194	0.46003	0.443394	0.42733	0.412713	
	30	30	30	30	30	30	30	30	30	30	rank
Arunachal	0.26205	0.409091	0.36737	0.306577	0.4	0.386364	0.37745	0.355326	0.36504	0.343868	
Pradesh	31	31	31	31	31	31	31	31	31	31	rank

literacy measures are lower than the rank according to LBAG1. Conversely, for Daman & Diu, Lakshadweep, Pondicherry, Chandigarh, Himachal Pradesh, Maharashtra, Haryana, Karnataka, Madhya Predesh and Uttar Pradesh the rank improves with all or some of the effective literacy measures.

The more dramatic changes are observed for the states Meghalaya (ranks 13th according to LBAG1, 14th/15th according to LBAG2, 3, 5 and 6 but 10th according to LBAG4), Uttar Pradesh (ranks 26th according to LBAG1 - 3, 5 and 6 but 23rd according to LBAG4). In the opposing direction we have Sikkim (rank deteriorates from 10th/11th according to all other measures to 13th according to LBAG4) and Dadra and Nagar Haveli (21st according to LBAG1 but 23rd/24th according to the other measures). In case of Dadra and Nagar Haveli this shows a higher isolation among the illiterates in this state and calls for targeted literacy programmes concentrating on the completely illiterate households. Meghalaya and Uttar Pradesh shows a larger than average presence of highly educated persons among the literates but overall dearth of literates in these states. Sikkim depicts the opposite situation with lower than expected education level among the literates. There are other states that also show similar increments or deteriorations to a lesser extent.

2. Data from Assam[6]

The data we use for this example are the primary data collected from the seven villages of Narayanpur block of Lakhimpur district of Assam, which is a state of India. All the households of each of these seven villages have been surveyed. Again, we consider adult

[6] The survey work for this section has been funded by a project grant from Indian Statistical Institute. Dr. Prabhat Kumar Kuri of Arunachal University was a collaborator for this project, whose untiring supervision has greatly improved the data set we have used here.

TABLE 2. LITERACY INDEX AND RANKING OF THE VILLAGES IN ASSAM, INDIA

VILLAGES	LITERACY INDEX												
	LBAG1	LBAG2			LBAG3	LBAG4	LBAG5		LBAG6				
		$\alpha_F=0.5$	$\alpha_F=0.25$	$\alpha_F=0.75$			$\alpha_F=0.6$ $\alpha_M=0.4$	$\alpha_F=0.75$ $\alpha_M=0.25$	$\alpha_F=0.6$ $\alpha_M=0.4$ $\beta=0.6$	$\alpha_F=0.6$ $\alpha_M=0.4$ $\beta=0.8$	$\alpha_F=0.75$ $\alpha_M=0.25$ $\beta=0.6$	$\alpha_F=0.75$ $\alpha_M=0.25$ $\beta=0.8$	
Jarabari	0.92723	0.95775	0.94249	0.973	0.96884	0.95881	0.96056	0.96479	0.94977	0.9551	0.95164	0.95822	
	1	1	1	2	2	1	1	2	1	1	1	2	rank
Borpather	0.90756	0.95294	0.93025	0.97563	0.96988	0.95303	0.95966	0.96975	0.94346	0.9539	0.9511	0.96206	
	2	2	2	1	1	2	2	1	2	2	2	1	rank
Singia	0.88359	0.93034	0.90697	0.95372	0.95068	0.93226	0.9374	0.948	0.92069	0.9285	0.92567	0.92567	
	3	3	3	3	3	3	3	3	3	3	3	4	rank
Buhabuhi	0.85426	0.92016	0.88721	0.9531	0.93735	0.91204	0.92868	0.92868	0.9053	0.9163	0.91109	0.92628	
	4	4	4	4	4	4	4	4	4	4	4	3	rank
Kathajan	0.84219	0.90819	0.87519	0.9412	0.92914	0.90385	0.91472	0.92451	0.89093	0.9021	0.89507	0.90979	
	5	5	5	5	5	5	5	5	5	5	5	5	rank
Majarsapori	0.7713	0.86996	0.82063	0.91928	0.89526	0.85308	0.88251	0.90135	0.8504	0.8654	0.85942	0.88038	
	6	6	6	6	6	6	6	6	6	6	6	6	rank
Kasaripather	0.60112	0.74719	0.67416	0.82022	0.75485	0.69821	0.75449	0.76545	0.71326	0.733	0.71545	0.74045	
	7	7	7	7	7	7	7	7	7	7	7	7	rank

Source: Field Survey.

literacy, i.e., we consider those individuals with age not less than fifteen years.

Table 2 (see below) present the literacy rates of the villages and their ranking according to alternative measures of literacy with alternative sets of values of α, α_F, α_M and β as before. The format of the table is also similar to *Table 1* with effective literacy rates of villages being reported instead of states.

The interesting result is that two of these seven villages - Borpather and Jarabari - often interchange their ranking as we move on from one formula to other and from one set of values of α, α_F, α_M and β to another. However, the ranking of the other five villages - Buhabuhi, Kasaripather, Kathajan, Majorsapori and Singia - remains unchanged.

According to the traditional literacy rate shown in column 1 of each of these tables, we find that Borpather is marginally behind Jarabari. However, the percentage of proximate illiterates and the female literacy rate are higher in Borpather than those in Jarabari. This explains the interchanging of ranking of those two villages following the other literacy measures, which take care of proximate illiterates.

VI. *Conclusion*

This note wants to pass on the message that, while measuring effective literacy, one should not only look at the literacy status of the members of the household but also look at the gender, age ranking and educational qualification of the literate members. Some extensions of BF measure have been developed in this paper; and all of them can be used for the measurement of effective literacy rate in a country like India using either Census or NSS data. BF measure with $\alpha=0$, the traditional literacy rate, always appears as a special case of the class of measures suggested and characterised here. In BF, the value of α is arbitrarily chosen. So the literacy ranking of different regions (districts, states, countries etc.) may be different for different arbitrarily chosen values of α. So choice of α is an important task in measuring the extent of effective literacy. We have suggested some relevant individual characteristics that may impact on the externality effect of a literate person on an illiterate member of the family. In particular, we have characterised certain classes of effective literacy measures that are generalisations of those proposed by Basu and Foster (1998) and Subramanian (2001) and other general class of measures.

These measures are useful in testing for the effect of the characteristics under discussion on effective literacy and hence for devising appropriate policy in this direction. For example, if education level sensitivity is high, then higher education programme plays a significant role even in basic literacy improvement, in the proximate sense. Similarly, female literacy campaign should be more important for the purpose of generating higher externality if gender sensitivity is significant.

In the first empirical exercise that we have carried out, using data from NSS, the states were ranked acording to the values of the alternative effective literacy measures. The rankings of most of the states are found to change when we use different measures. In case of some states the change in ranking is quite substantial. In the second empirical exercise, using village level primary data from Assam, the corresponding changes in ranks are not so significant. In fact, only two out of the seven villages interchange their ranking when we use different measures of effective literacy.

Although our proposed measures are very general in nature and allow many alternative possibilities, the final choice of a measure by a practitioner will depend on her subjective value judgement about the acceptability of alternative axioms set out in this paper and specific parametrisation thereof.

In this note we are more concerned with measurement as such than with emphasizing on the issues in literacy planning and policy formulation. BF dealt with a simple idea in order to convey the message that there may be instrumental (effciency-related) reasons for regarding both equity and pro-female gender bias as virtues. However, the BF emphasis on equity may be lost in the present case for some extreme values of the parameters.[7]

The most important research agenda in the field of measurement of effective literacy is the development of important methodology to estimate the actual shape of the externality effect function. The empirical illustration in this paper and most other works shed no light on this. Basu, Narayan and Ravallion (2002) is the only study we know of that has taken up this issue. We hope that other researchers will address this important issue in their future work.

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[7] Suppose that the external benefit conferred by a graduate on illiterates within his family is 0.9, while that conferred by a person who is just functionally literate is 0.1. Suppose funds are available to either provide graduate education to two individuals from two illiterate households or to provide basic literacy to six individuals from six illiterate households. Let the size of each household be five. Then the aggregate effective literacy in the first case will be 1.84 and 1.68 in the second.

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