Maternal Literacy and Numeracy Skills and Child Health in Ghana[†]

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Abstract

This paper examines the impact of maternal literacy, numeracy and schooling on the production of children's health in Ghana. The analysis considers intermediate outcomes including pre- and post-natal care and vaccinations, and final outcomes, including illnesses and mortality. Previous studies of the determinants of child health have mostly been limited to investigating the impact of maternal schooling only and, as a consequence, largely have not considered skills and also have ignored alternative routes to acquiring skills, such as adult literacy programs. Analyzing a recent household survey for Ghana from 1999, this paper addresses both of these issues. To address endogeneity, the skills, schooling and child health demand equations are estimated jointly using the Mroz-Guilkey correction (Mroz and Guilkey, 1992). Preliminary results indicate statistically significant effects from literacy and numeracy skills independent of the effects from schooling.

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1. Introduction

This paper examines the impact of maternal literacy and numeracy on household non-economic outcomes in the form of child health. It considers how these skills affect the production of health, including mothers' pre-natal care and children's vaccinations and post-natal care and how they affect outputs, including children's illnesses and mortality.

Previous studies of the determinants of child health in Ghana have mostly been limited to investigating the impact of maternal schooling only and, as a consequence, largely have not considered skills and also have ignored alternative routes to acquiring skills. Exceptions are Asenso-Okyere, Asante and Nubé (1997) and Glewwe and Desai (1999). However, since these studies analyze the first and the second rounds of the GLSS, respectively, only a limited subset of the skills impacts that I propose may be analyzed: Asenso-Okyere, Asante and Nubé (1997) include numeracy and overall, that is, language non-specific literacy skills,[1] while Glewwe and Desai (1999) include numeracy and English reading skills. More generally, the literature as a whole rarely, if ever, considers these issues.

This paper contributes to this literature by (1) analyzing the impact on child health from human capital skills, including reading and writing skills and that for both the case of English and Ghanaian languages, as well as numeracy skills and other human capital skills and skills effects, including remittances and signaling effects (2) include adult literacy course participation as a pathway of achieving human capital skills. The contribution of this paper to the economics literature is therefore both to that specific for Ghana but also more broadly to that of child health production more generally, trying to understand both the possibly differential impacts of

[1] The literacy questions in GLSS 1 are based on responses to the questions "Can [NAME] read a newspaper?" and "Can [NAME] write a letter?" but do not specify the language.

indigenous and foreign language and other human capital skills and, in so doing, additionally the role played by adult education.

Preliminary results using standard probit models suggest that literacy and numeracy skills, childhood schooling and adult literacy course participation all have individual and statistically significant impacts on child health outcomes in Ghana. This approach, however, does not address the potential endogenity of literacy and numeracy skills, formal schooling and adult literacy course participation. I will therefore extend the current analyses—which effectively disregards endogeneity by assuming that outcomes relating to past decisions may statistically be regarded as pre-determined—by applying the Mroz-Guilkey random effects correction approach (Mroz and Guilkey, 1992).

The remainder of this paper is structured as follows. The next section briefly sketches the conceptual framework, section three presents the data. A description of estimation issues follows in section four. Section five presents the preliminary results and section six summarizes and concludes.

2. Conceptual Framework

The inter-linkages between skills and child health are examined in the context of Grossman's (1972) "human capital" health model. In the original model, the individual maximizes utility with respect to his/her own health. Also, the impact from education runs from one's own education to one's own health. Grossman's original model is adapted by letting the mother obtain utility from child health and by the human capital effects coming from a set of individual skills, rather than from education per se. Further, the skills effects run from the mother's skills to the child's health.

Specifically, I consider a household production model (Becker, 1965) in which a two-person household consisting of a mother and a child has preferences over multiple commodities, one of which is child health. The commodities are produced using market goods/services and time inputs. The time available to the household may either be spent working in the market or engaging in home production. The household faces a budget constraint, whereby income for purchasing market goods come from either market work the household or transfers and remittances. The household's decision problem therefore is to decide the amount of time and goods inputs in the production of child health and housing services and the amount of time devoted to market work so as to maximize utility subject to the set of constraints. Solving the model yields the reduced form market goods demands and production time supply functions. These will depend on all exogenous variables and parameters and preference and production shifters in the model; here, wages, transfers and remittances, input prices, literacy, numeracy and other skills and the taste and needs effects. The reduced form (input) demand for child health will be the focus of the empirical implementation, examining the determinants of various child health inputs such as vaccinations and pre- and post-natal care. Additionally, the determinants of child health outcomes such as child illnesses and child mortality will be examined. These measures are all important indicators of child health, capturing different dimensions: vaccinations, and pre- and post-natal care feed into subsequent child (and later adult) well-being, while illnesses serve as an acute measure of child health; mortality, in effect, is a lower bound of child health.

Incorporating the mother's human capital production in this model, I will distinguish between two types of skills effects: effects that affect child health directly and effects that work indirectly on child health through their impact on consumption possibilities.

The most important direct child health effect is a home productivity effect. This effect is likely to be strong: the production of child health depends crucially on literacy and numeracy skills—being able to read and accurately follow prescriptions, for example—and health issues play a major role in education, particularly in adult literacy programs (where 10 out of the total 28 topics taught in addition to literacy and numeracy skills include health related issues, for example "Family Planning", "Immunization", "Safe Motherhood and Child Care" and "Safe Drinking Water"). Increased efficiency in the (home) production of child health either directly from literacy and numeracy skills or from childhood schooling or adult literacy course participation will tend to shift production towards the production of child health (assuming that this is a normal good and that it is not relatively "much" more time-intensive than other commodities). At the same time, however, there will be more time available for market work, which will enable the individual to purchase more of the market-good input for child health production. The net effect will likely be positive, thus increasing the demand for child health.

The indirect effects working through impact on consumption possibilities are divided into effects working through literacy and numeracy and effects from other skills. First, there is a direct wage or earnings effect: literacy and numeracy skills (obtained from childhood or adult schooling, as case may be) affect productivity in the labor market, which affects earnings, and in turn translates into higher consumption possibilities; this is the standard human capital story. Here, additionally, the overall effect of literacy and numeracy skills on household income can be decomposed into effects within income generating activities (including farming, non-agricultural self-employment and wage employment) and access to these activities (Appleton, 2001). The impacts of the different literacy and numeracy skills will vary according to location: in urban areas, especially the capital of Accra, English would seem to be the more important skill relative

to Ghanaian languages. The reason for this is that English, here almost fifty years after independence, remains the "official" language of the government and the public administration. In rural areas, therefore, one would expect Ghanaian language skills to be more—or at least no less—important than English language skills. Whether the increased consumption possibilities necessarily translate into higher household expenditures, however, is uncertain; indeed, without further assumptions it will be an empirical issue altogether. Specifically, due to the change of efficiency in production coming from the wage increase effectively causing time to become more "expensive", individuals will substitute from time inputs to goods inputs, whereby the net effect on labor supply—and therefore ultimately on household expenditures—is ambiguous.

Second, literacy and numeracy skills may give rise to a home productivity effect, whereby an increase in literacy and numeracy skills will increase the efficiency in home production. While the immediate effect may be a decline in per capita expenditures as a result of increased efficiency in home production, at the same time more time will be available for market work. In turn, the income effect will increase consumption so that the net-effect on expenditures will most likely be positive.

Third, literacy and numeracy skills may generate a "needs" or "taste" effect coming through via the utility function or production function(s). For example, literacy and numeracy skills may decrease actual and/or desired fertility and, in an extended multi-person model, therefore, reduce the number of dependent children. The net-effect on per capita household expenditures is unambiguously positive.

Fourth, literacy and numeracy may cause a "transfers and remittances effect": if the adult remaining in the household is literate and/or numerate, it is likely that migrated family-members are, too. In turn, this affects the earnings of migrants and therefore possibly their transfers or

remittances back to the household. Since this leaves the relative prices unaffected, the impact on household expenditures will depend on whether commodities are normal or inferior goods, as well as the relative time intensity in their production. If they are normal, household expenditures will unambiguously increase; if one or more are inferior, household expenditures will decrease. However, if a sufficient number of commodities are inferior and time intensive, labor supply may actually increase, resulting in higher household expenditures.

So far only effects on household expenditures from literacy and numeracy skills have been considered. Are there other effects from child schooling or adult literacy course participation on household expenditures? That is, do students obtain skills above and beyond (the observable) literacy and numeracy skills as a result of attending either formal (child) schooling or participating in adult literacy programs? While literacy and numeracy skills are likely to be the major outcomes from schooling, which subsequently affect household expenditures, I suggest that there are several additional channels through which schooling may affect household expenditures.

First, schooling may create other income generating attributes, thus generating an indirect wage or earnings effect. In formal schooling, these attributes include credentialism or "signaling", which affect household expenditures through its impact on wages, transfers and remittances (Spence, 1973). In literacy courses, on the other hand, these attributes include productive skills: (1) the courses include instruction in "income generating activities" including farming, fishing and pottery, and (2) the participants are often encouraged to participate in income generating activities initiated by the instructor in collaboration with the participants. Literacy course participants may, therefore, increase their income generating capacity even without achieving the literacy and numeracy which were the original objective of the program.

Second, formal (childhood) schooling may equip students with "socialization" and "discipline" skills, thus generating a "socialization" or "discipline" effect. These skills may positively impact future income generating activities in and by themselves. This effect will work through the budget constraint by increasing earnings but may also increase productivity in home production. By contrast, due to the limited duration and less frequent meetings of adult literacy programs, as well as participants being older and therefore more "set in their ways", participation in adult literacy programs is much less likely to be accompanied by socialization and discipline skills.

Third, adult literacy course participation may generate a "literacy course home productivity effect" apart from the effect directly related to child health, discussed above. This effect stems from adult literacy course participants also achieving skills which would primarily increase efficiency in home production. For example, two of the topics taught are "Environmental Hygiene" and "Hygienic way of preserving and selling fish", which primarily would seem to affect the efficiency of home production of the two "example commodities", housing and nutrition services. As was also the case from the home productivity effect from literacy and numeracy skills, the literacy course home productivity effect also is likely to increase household expenditures, since more time is available for market work.

There are other reasons why education might be related with household expenditures even after skills are taken into account, however. First, the skills might be prone to measurement error, in turn leading to the associated parameter estimate(s) being biased towards zero. Second, the functional relationship between household expenditures and skills may be misspecified by, for example, skills being entered linearly, while the "true" functional relationship is non-linear. Third, the model may be misspecified, so that omitted variables, which are correlated with

education, have been left out. This will cause the education variable(s) to be correlated with the error-term, thus violating the standard assumptions, and possibly leading to omitted variables bias. All of these factors may cause the impact from skills to erroneously be picked up by the education variable(s) even in the absence of any causal relationship.

Note that this is a greatly simplified model, in two dimensions in particular. First, being a static model, there is no room for savings in this model. In a life-cycle framework, however, savings become important in terms of households' welfare and therefore subsequently also in terms of child health. Second, the present model operates with a two-person household containing only one adult. There may be indirect effects, however, either from having a school or literacy course in the area or from having other literate adults and/or literacy course participants in the household (and/or in the community). Both of these factors may affect either skills or consumption possibilities of households, as non-participants (and/or non-literates) learn from school or literacy course participants (and/or literates). Specifically I conjecture that the household decision-maker might invest in education for the oldest daughter, say, in order to release the mother for market work or working at the farm or other household enterprise, while the oldest daughter takes care of younger siblings.

Research Questions:

Based on the conceptual framework outlined above, I pose the following set of research questions: (1) do literacy and numeracy skills improve final child health outcomes and/or increase demand for child health services (which subsequently affects final child health outcomes) and if so, what is the relative efficiency of the different skills? (2) is the skills effect mainly a direct effect or has it—through its impact on wages, fertility and remittances—merely a mediating effect? (3) has

education any impact on child health once the impact from skills has been controlled for? and (4) if so, which of the two types of education is the most efficient vis-à-vis improving final child health outcomes and child health service demand through the different types of skills and skills effects? (4) are there indirect effects on child health either from having a school or literacy course in the area or from having literates and/or literacy course participants in the household (and/or in the community)—in particular, is it the case that the household invests human capital in the oldest daughter in order to enable the mother to be released for the labor market, while the daughter substitutes for her at home? and (5) are there asymmetries in the impacts of skills related to location due to English reading and writing skills (maybe even literacy and numeracy skills more generally) being more valuable in terms of child health (either directly or via the impact on consumption possibilities) in urban areas?[2]

3. The Data and Descriptive Analysis

The Ghana Living Standards Survey (GLSS) is a nationally representative, stratified multi-purpose household survey, carried out in 1987/88, 1988/89, 1991/92 and 1998/99 as four independent cross-section surveys. In addition to the household survey, each round also includes a community and a price questionnaire. The household part of the GLSS contains modules on education and health among other things.

Cross-tabulations of the incidence of the various child health measures and maternal skills, schooling and adult literacy course participation largely confirm our conjecture of a positive association between child health and maternal literacy skills, schooling and adult literacy course

[2] This research question results from a direct empirical observation while in Ghana and so may require some explanation. The motivation behind this research question is the fact that huge posters inform about for example water safety, how to be protected against HIV/AIDS, particularly in urban areas – in English. Hence, it may be conjectured that English is relatively more important (efficient) for transmitting health knowledge in urban areas, while indigenous languages may be as or possibly even more important (efficient) for transmitting health knowledge in rural areas.

participation (Table 2.1). The only puzzling case is child mortality and the individual vaccinations (i.e. this is not the case for the "ever vaccinated" variable), where there seems to be a negative association with maternal literacy course participation. This could be due to unaccounted individual heterogeneity (selection) of participants but further analyses are required to address this issue.

Table 2.1 Children's Morbidity, Vaccinations, Pre- and Post-natal Care and Mortality Across Maternal Literacy and Numeracy Skills, Schooling and Literacy Course Participation

	Ghanaian Reading	Ghanaian Writing	English Reading	English Writing	Written Calculations	Attended School	Adult Literacy Course Participation	Full Sample Average
Ever vacc.	0.973	0.972	0.977	0.978	0.970	0.957	0.955	0.932
DPT1	0.851	0.852	0.840	0.830	0.862	0.886	0.732	0.862
DPT2	0.829	0.823	0.818	0.815	0.838	0.817	0.644	0.763
DPT3	0.719	0.702	0.717	0.711	0.728	0.698	0.538	0.645
Polio1	0.866	0.867	0.855	0.847	0.881	0.895	0.749	0.874
Polio2	0.824	0.831	0.812	0.808	0.836	0.821	0.660	0.778
Polio3	0.735	0.726	0.730	0.725	0.735	0.704	0.527	0.646
Measles	0.657	0.642	0.637	0.629	0.655	0.608	0.499	0.600
BCG	0.867	0.876	0.833	0.823	0.867	0.879	0.681	0.821
All vacc.	0.559	0.551	0.500	0.476	0.517	0.502	0.332	0.485
Pre-natal	0.838	0.837	0.851	0.849	0.830	0.839	0.835	0.814
Post-natal	0.439	0.429	0.463	0.463	0.447	0.431	0.467	0.410
Mortality	0.200	0.193	0.162	0.157	0.194	0.254	0.549	0.375

Notes: Sample is children 7 years old or younger, except for (1) post-natal care, which is for children 5 years or younger, (2) pre-natal care, which is only measured for women who were pregnant within the past 12 months and (3) mortality, which is measured for women between 15 and 49 years of age. For presentation purposes the individual cell sizes have been omitted; they are available upon request.

4. Estimation Strategies and Issues

From the previous section child health and child health inputs were explained by literacy and numeracy skills, an indirect wage or earnings effect, socialization or discipline skills and a home productivity effect. Due to the nature of the available data, the estimating equations for child health and child health inputs therefore are:

$$H_i = \alpha + \beta_1 S_i + \beta_2 T_{1i} + \beta_3 T_{2i} + \beta_4 W_i + \beta_5 R_i + \beta_6 X_i + \varepsilon_i \quad (4.1)$$

$$I_i = \alpha + \beta_1 S_i + \beta_2 T_{1i} + \beta_3 T_{2i} + \beta_4 W_i + \beta_5 R_i + \beta_6 X_i + \varepsilon_i \quad (4.2)$$

where H_i is child health; I_i is child health input; S_i is literacy and numeracy skills; T_{1i} is childhood schooling; T_{2i} is adult literacy course participation; W_i is wages; R_i is remittances; X_i is a vector of other controls, including age, geographical location, ethnicity and religion and ε_i is and error-term capturing unobservables. (4.1), therefore, is a commodity production function, while (4.2) is a market goods or factor demand function, both of which for the case of child health.

The estimation of (4.1) and (4.2) again is faced with potential endogeneity problems: childhood schooling, adult literacy course participation and literacy and numeracy skills are all explanatory variables in regressions of child health. To address this issue, I will apply the Mroz-Guilkey random effects correction approach (Mroz and Guilkey, 1992).

I will compare the results from this approach with those of the "naïve" approach, that is, the results when not instrumenting, using a standard probit/logit (or, alternatively OLS-regression, thereby estimating linear probability models). In so doing, I will examine the sensitivity of the results to the dimension problem related to literacy and numeracy skills. I will apply the procedure to collapse the literacy and numeracy variables across sensible dimensions sketched in Blunch (2003), whereby the dimensionality of the literacy and numeracy measures may be reduced from five to either three, two or one.

Relating the estimating model back to the research questions and the conceptual framework, I will employ an estimating approach proceeding in stages: first, include only literacy and numeracy skills (and additional controls) in the estimation. Second, allow for an intermediating effect from literacy and numeracy skills on wages and remittances by including these additional variables in the regression. Third, include child schooling and adult literacy participation so as to test for the

relevance of skills above and beyond literacy and numeracy skills. Again, referring back to the discussion from the previous chapters, one or both of the education variables may actually come out statistically significant even in the absence of a causal relationship, namely in the presence of one or more of: (1) measurement error in literacy and numeracy skills, (2) misspecification of functional form of literacy and numeracy skills and (3) model misspecification.

5. Results

NOTE: These are VERY preliminary…

Vaccinations (ever vaccinated):

```
Survey probit regression

pweight:  weight                                  Number of obs    =      4677
Strata:   strata                                  Number of strata =         6
PSU:      clust                                   Number of PSUs   =       298
                                                  Population size  = 4870.1776
                                                  F(  21,    272)  =      3.61
                                                  Prob > F         =    0.0000

------------------------------------------------------------------------------
     vaccine |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      female |   .0041067   .0536786     0.08   0.939    -.1015392    .1097526
urban_female |   .2885484    .171476     1.68   0.093    -.0489372     .626034
mreadwrite~n |   .0064756   .1814661     0.04   0.972    -.3506717    .3636228
mreadwrite~h |   .1516729    .188159     0.81   0.421    -.2186469    .5219926
mDwrittenc~s |   .2222019   .1319294     1.68   0.093    -.0374512     .481855
    mprimary |   .0947223   .1145668     0.83   0.409    -.1307591    .3202036
     mmiddle |   .2970721   .1726544     1.72   0.086    -.0427328    .6368769
        mjss |   .1787881   .2309711     0.77   0.440    -.2757911    .6333674
        mage |   .1085899   .0486167     2.23   0.026     .0129064    .2042734
      magesq |  -.0015449   .0007293    -2.12   0.035    -.0029802   -.0001096
       urban |   .2755858    .136801     2.01   0.045     .0063449    .5448268
     Western |  -.1457064   .2239156    -0.65   0.516    -.5863995    .2949867
     Central |  -.4183209   .2410032    -1.74   0.084    -.8926446    .0560027
     Eastern |  -.5029964   .2813437    -1.79   0.075    -1.056715    .0507222
       Volta |  -.0816797   .2239788    -0.36   0.716    -.5224973    .3591378
     Ashanti |  -.0292292   .2101521    -0.14   0.889     -.442834    .3843757
 Brong_Ohofa |  -.2533285   .2589626    -0.98   0.329    -.7629983    .2563414
    Northern |  -.2450796   .2540461    -0.96   0.335    -.7450731    .2549139
  Upper_West |   .0123197   .3170063     0.04   0.969    -.6115872    .6362267
  Upper_East |   .1052463    .270527     0.39   0.698    -.4271837    .6376763
 mlit_course |   .2745882   .1277407     2.15   0.032     .0231789    .5259974
       _cons |  -.3809952   .7851263    -0.49   0.628    -1.926219    1.164229
------------------------------------------------------------------------------note:
msec_and_above != 0 predicts success perfectly
      msec_and_above dropped and 134 obs not used
```

Postnatal care:

```
Survey probit regression

pweight:  weight                                  Number of obs    =      3606
Strata:   strata                                  Number of strata =         6
PSU:      clust                                   Number of PSUs   =       298
                                                  Population size  = 3721.4342
                                                  F(  22,    271)  =      3.08
                                                  Prob > F         =    0.0000

------------------------------------------------------------------------------
   postnatal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      female |  -.0225208    .066014    -0.34   0.733    -.1524443    .1074028
urban_female |   .0486599   .1146326     0.42   0.672    -.1769509    .2742707
mreadwrite~n |  -.1103142   .0876737    -1.26   0.209    -.2828668    .0622383
mreadwrite~h |    .198056   .1116333     1.77   0.077    -.0216518    .4177638
mDwrittenc~s |    .082461   .0842238     0.98   0.328    -.0833016    .2482237
    mprimary |  -.0009908   .0979782    -0.01   0.992    -.1938237    .1918421
     mmiddle |  -.1325863   .1091753    -1.21   0.226    -.3474566    .0822839
        mjss |   .0119757   .1382288     0.09   0.931    -.2600753    .2840267
msec_and_a~e |   .3898445   .1844365     2.11   0.035      .026851     .752838
        mage |  -.0259833   .0348524    -0.75   0.457    -.0945771    .0426104
      magesq |   .0001709   .0005369     0.32   0.750    -.0008857    .0012275
       urban |  -.0121249   .1110063    -0.11   0.913    -.2305988     .206349
     Western |  -.0782517   .1730585    -0.45   0.651    -.4188518    .2623483
     Central |  -.2947721    .185177    -1.59   0.113    -.6592229    .0696787
     Eastern |  -.1707938   .1809727    -0.94   0.346    -.5269701    .1853824
       Volta |  -.0648565   .1667413    -0.39   0.698    -.3930236    .2633106
     Ashanti |   .2007929   .2071857     0.97   0.333    -.2069736    .6085594
 Brong_Ohofa |   .0148752   .1912583     0.08   0.938    -.3615443    .3912946
    Northern |  -.1347728   .2031082    -0.66   0.508    -.5345144    .2649689
  Upper_West |  -.0931818   .2710271    -0.34   0.731    -.6265961    .4402325
  Upper_East |   .2293566   .2151796     1.07   0.287    -.1941431    .6528562
 mlit_course |   .1851747   .0874505     2.12   0.035     .0130614    .3572879
       _cons |   .3853556   .5856434     0.66   0.511    -.7672616    1.537973
------------------------------------------------------------------------------
```

Child mortality (number of children ever died):

(1) Total number of children:

```
Survey ordered probit regression

pweight:  weight                                  Number of obs    =      5865
Strata:   strata                                  Number of strata =         6
PSU:      clust                                   Number of PSUs   =       300
                                                  Population size  = 5953.8541
                                                  F(  20,    275)  =     47.16
                                                  Prob > F         =    0.0000

------------------------------------------------------------------------------
    numdead1 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
readwriteg~n |    .014535   .0740424     0.20   0.845    -.1311854    .1602553
readwritee~h |  -.2310696   .0990685    -2.33   0.020    -.4260429   -.0360963
Dwrittenca~s |   -.145342   .0734776    -1.98   0.049    -.2899507   -.0007333
     primary |  -.0970552   .0787982    -1.23   0.219    -.2521353    .0580248
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      middle |  -.1249822   .0927749    -1.35   0.179    -.3075693     .057605
         jss |  -.1332785    .123295    -1.08   0.281    -.3759311    .1093741
sec_and_ab~e |   -.429359   .1446181    -2.97   0.003     -.713977    -.144741
         age |   .2048854   .0182555    11.22   0.000     .1689574    .2408134
       agesq |  -.0021087   .0002783    -7.58   0.000    -.0026564   -.0015609
       urban |  -.2536646   .0613778    -4.13   0.000    -.3744603    -.132869
     Western |   .4426797   .1105687     4.00   0.000     .2250732    .6602861
     Central |   .4007112   .1206659     3.32   0.001     .1632328    .6381896
     Eastern |    .247184   .1234983     2.00   0.046     .0041312    .4902369
       Volta |   .1399052   .1196236     1.17   0.243    -.0955219    .3753323
     Ashanti |   .4010699   .1064624     3.77   0.000     .1915448     .610595
 Brong_Ohofa |     .27225   .1096349     2.48   0.014     .0564814    .4880187
    Northern |    .524819   .1383361     3.79   0.000     .2525645    .7970736
  Upper_West |   .6445425   .1558794     4.13   0.000     .3377616    .9513235
  Upper_East |   .4329086   .1221073     3.55   0.000     .1925934    .6732238
  lit_course |  -.0122234   .0772922    -0.16   0.874    -.1643395    .1398928
-------------+----------------------------------------------------------------
       /cut1 |   4.985344   .3200421    15.58   0.000      4.35548    5.615208
       /cut2 |   5.761027   .3247334    17.74   0.000      5.12193    6.400123
       /cut3 |   6.321146   .3228472    19.58   0.000     5.685761    6.956531
       /cut4 |    6.87679   .3263733    21.07   0.000     6.234466    7.519114
       /cut5 |   7.189542   .3216299    22.35   0.000     6.556553    7.822531
       /cut6 |   7.491713   .3246169    23.08   0.000     6.852845     8.13058
       /cut7 |    7.93365   .3741754    21.20   0.000     7.197248    8.670052
       /cut8 |   8.026351   .3949953    20.32   0.000     7.248975    8.803728
       /cut9 |   8.182947   .4426823    18.48   0.000     7.311719    9.054175
------------------------------------------------------------------------------
```

(2) Total number of girls:

```
Survey ordered probit regression

pweight:  weight                                  Number of obs    =      5865
Strata:   strata                                  Number of strata =         6
PSU:      clust                                   Number of PSUs   =       300
                                                  Population size  = 5953.8541
                                                  F(  20,    275)  =     28.24
                                                  Prob > F         =    0.0000

------------------------------------------------------------------------------
numdeadgirls |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
readwriteg~n |  -.0136728   .0756103    -0.18   0.857    -.1624788    .1351331
readwritee~h |  -.1695224   .1043918    -1.62   0.105    -.3749723    .0359275
Dwrittenca~s |  -.0926311   .0777092    -1.19   0.234     -.245568    .0603057
     primary |  -.0624695   .0828567    -0.75   0.451    -.2255368    .1005979
      middle |  -.1832323   .0981288    -1.87   0.063    -.3763563    .0098917
         jss |  -.0629832   .1432342    -0.44   0.660    -.3448774     .218911
sec_and_ab~e |  -.3672926   .2044028    -1.80   0.073    -.7695708    .0349856
         age |   .1682821   .0219067     7.68   0.000     .1251683    .2113959
       agesq |    -.00172    .000337    -5.10   0.000    -.0023833   -.0010567
       urban |  -.2415612   .0662323    -3.65   0.000    -.3719108   -.1112116
     Western |   .3877709    .116488     3.33   0.001     .1585149    .6170269
     Central |   .3705442   .1364782     2.72   0.007     .1019462    .6391422
     Eastern |   .1488565   .1379088     1.08   0.281    -.1225569      .42027
       Volta |   .2157472   .1251381     1.72   0.086    -.0305327    .4620272
     Ashanti |   .3646732    .121882     2.99   0.003     .1248015     .604545
 Brong_Ohofa |   .3490773   .1264819     2.76   0.006     .1001527     .598002
    Northern |   .4592007   .1458928     3.15   0.002     .1720741    .7463273
  Upper_West |   .4595672    .215597     2.13   0.034     .0352581    .8838763
  Upper_East |   .4347056    .133063     3.27   0.001     .1728289    .6965823
  lit_course |   .0064515   .0841412     0.08   0.939    -.1591439     .172047
-------------+----------------------------------------------------------------
       /cut1 |   4.686222    .373958    12.53   0.000     3.950248    5.422196
       /cut2 |   5.552605   .3761802    14.76   0.000     4.812258    6.292953
       /cut3 |   6.281257   .3766554    16.68   0.000     5.539975     7.02254
       /cut4 |   6.725163    .400808    16.78   0.000     5.936347     7.51398
       /cut5 |   7.202179   .3869552    18.61   0.000     6.440626    7.963733
------------------------------------------------------------------------------
```

(3) Total number of boys:

```
Survey ordered probit regression

pweight:  weight                                  Number of obs    =      5865
Strata:   strata                                  Number of strata =         6
PSU:      clust                                   Number of PSUs   =       300
                                                  Population size  = 5953.8541
                                                  F(  20,    275)  =     30.87
                                                  Prob > F         =    0.0000

------------------------------------------------------------------------------
 numdeadboys |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
readwriteg~n |   .0386707   .0987186     0.39   0.696     -.155614    .2329555
readwritee~h |  -.2241786   .1194402    -1.88   0.062    -.4592448    .0108875
Dwrittenca~s |  -.1781263   .0959941    -1.86   0.065    -.3670491    .0107964
     primary |  -.1001038   .0899958    -1.11   0.267    -.2772215    .0770138
      middle |  -.0136702   .1146063    -0.12   0.905     -.239223    .2118826
         jss |  -.2694519   .1674751    -1.61   0.109    -.5990539    .0601501
sec_and_ab~e |  -.3559454   .1969042    -1.81   0.072    -.7434658     .031575
         age |   .1944151   .0239395     8.12   0.000     .1473006    .2415296
       agesq |  -.0020369   .0003479    -5.86   0.000    -.0027216   -.0013523
       urban |  -.2106453   .0676164    -3.12   0.002    -.3437188   -.0775718
     Western |    .373649   .1261999     2.96   0.003     .1252792    .6220187
     Central |   .3279455   .1250237     2.62   0.009     .0818907    .5740003
     Eastern |    .235424   .1288185     1.83   0.069    -.0180993    .4889474
       Volta |  -.0346176   .1391677    -0.25   0.804    -.3085089    .2392736
     Ashanti |   .3175333   .1263785     2.51   0.013     .0688121    .5662546
 Brong_Ohofa |   .1113882   .1425848     0.78   0.435     -.169228    .3920045
    Northern |   .4054404   .1449299     2.80   0.005     .1202088     .690672
  Upper_West |    .615842   .1795963     3.43   0.001     .2623848    .9692993
  Upper_East |   .2281917   .1634426     1.40   0.164     -.093474    .5498574
  lit_course |  -.0636774   .0825282    -0.77   0.441    -.2260983    .0987436
-------------+----------------------------------------------------------------
       /cut1 |   5.043391   .4344176    11.61   0.000     4.188428    5.898353
       /cut2 |   5.905587   .4424513    13.35   0.000     5.034814     6.77636
       /cut3 |   6.497218   .4580151    14.19   0.000     5.595814    7.398621
       /cut4 |   7.043622   .4636282    15.19   0.000     6.131171    7.956072
       /cut5 |   7.264845    .469201    15.48   0.000     6.341426    8.188263
       /cut6 |   7.568567   .4952075    15.28   0.000     6.593966    8.543168
       /cut7 |    7.67544   .5248559    14.62   0.000     6.642489    8.708391
       /cut8 |   8.001429   .5527001    14.48   0.000     6.913679    9.089179
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6. Summary and Conclusion

Examining the impact of maternal literacy, numeracy and schooling on the production of children's health in Ghana using data from a recent household survey, this paper fills a void in the previous literature: Previous studies of the determinants of child health have mostly been limited to investigating the impact of maternal schooling only and, as a consequence, largely have not considered skills and also have ignored alternative routes to acquiring skills, such as adult literacy programs.

Preliminary results suggest that literacy and numeracy skills have positive and statistically significant effects on intermediate and final child health outcomes: English reading and writing

affects the probability of a child receiving postnatal care positively significantly and child mortality negatively significantly. The ability to perform written calculations also proves important, improving both child vaccinations and mortality outcomes. Additionally, adult literacy course participation is found to improve children's vaccination, an important determinant of subsequent child (and, later, adult) well-being.

One problem with these preliminary current analyses, however, is that they do not adequately address issues of endogeneity. This issue will be rigorously addressed in an extended empirical analysis, applying the Mroz-Guilkey correction (Mroz and Guilkey, 1992).

References:

Asenso-Okyere, W.K., F.A. Asante and M. Nubé (1997) "Understanding the Health and Nutritional Status of Children in Ghana", *Agricultural Economics*, 17: 59-74.

Becker, Gary S. (1965) "A Theory of the Allocation of Time", *Economic Journal*, 75: 493-517.

Blunch, Niels-Hugo (2003) "Literacy, Numeracy and Household Expenditures in Ghana", mimeo, Department of Economics, The George Washington University.

Glewwe, Paul and Jaikishan Desai (1999) "Child Health and Mother's Schooling in Ghana", in Paul Glewwe (ed) *The Economics of School Quality Investments in Developing Countries: An Empirical Study of Ghana*, London: Macmillan.

Grossman, Michael (1972) "On the Concept of Health Capital and the Demand for Health", *Journal of Political Economy*, 80 (2): 223-55.

Mroz, Thomas and David K. Guilkey (1992) "Discrete Factor Approximations for Use in Simultaneous Equation Models With Both Continuous And Discrete Endogenous Variables", Mimeo, Department of Economics, University of North Carolina, Chapel Hill.