**Supplement Section A: Estimating the impact of an additional year of schooling on changes in mortality**

*A.1 Results from the hierarchical model*

Pradhan et al. (2018) finds that adjusting for income, technological progress and allowing for the impact of technological progress to vary by each country, one year of increase in average female schooling is associated with 2.2 percent reduction in adult male mortality, 3.7 percent reduction in adult female mortality, and 4.2 percent reduction in under-five mortality.

**Table A.1 Impact of female schooling on health outcomes: Results from the hierarchical model**

|  |  |  |  |
| --- | --- | --- | --- |
| **Dependent Variables** | | | |
|  | Ln [Adult mortality rate], male | Ln [Adult mortality rate], female | Ln [Under-five mortality rate] |
| **Independent Variables** |  |  |  |
| Mean years of schooling (female)  Schooling ratio (male: female)  Ln [GDP per capita] | -0.022 \*\*  0.019 \*  -0.034 \* | -0.037 \*\*\*  0.010  -0.079 \*\*\* | -0.042 \*\*\*  -0.009  -0.127 \*\*\* |

Note: GDP = gross domestic product. Ln[x] denotes natural log of variable x. Period: 1970–2010. Countries: 80. Observations: 688. Standard errors and goodness of fit measures reported in Pradhan et al. (2017), annex 30D. \*p < .10; \*\*p < .05; \*\*\*p < .01.

*A.2 Estimating changes in mortality from an additional year of schooling*

(i) Reductions in under-five mortality

The reductions in under-five mortality (are accounted in the benefit stream over a woman’s reproductive age, assuming equal benefit at each age [20,39] given the expected number of children over those years.

=

. (1.1)

Where, ,

(ii) Reductions in adult male and female mortality

= , and

= , and

, and (1.2)

(1.3)

where,

g

g

We derive by minimizing the following equation (1.4) (for male and female adult mortality separately):

(1.4)

Where we have,

Or,

(1.5)

(1.6)

Here,

**Supplement Section B: Estimating the costs and benefits of an additional year of schooling for SSA**

This section describes our method for estimating costs and benefits of additional year of schooling given the reductions in mortality rates described in supplement section A. We first consider the health benefits, followed by the earnings benefits, then the direct and opportunity costs of schooling. The health-inclusive rate of return and benefit cost ratio consider all these benefit and cost streams.

*B.1 Benefit stream*

The health benefit stream at age (a) of an additional year of schooling () simply accounts for the mortality rates reduced at each age with the VSL at each age.

(2.1)

,

,

,

(2.2)

(2.3)

,

,

The **total benefit stream** at age (a) then sums the health benefit () above, and earnings benefit () of an additional year of schooling per pupil.

(3)

where, , and

.

*B.2 Cost stream*

We consider the direct cost of schooling () and opportunity cost of schooling () of an additional year in our analysis. Both the direct cost and opportunity cost are incorporated for the additional year a pupil enrolls in school. The total cost then is the direct and the opportunity cost combined. We have:

, and (4)

where,

= 14 (for LMCs)

**Supplement Section C: Estimating reduction in mortality at each age**

In this section, we tabulate the changes in mortality at each age, estimated from equations in supplement section A (Table C.1). As seen in Table C.1, the under-five mortality reductions are only realized between ages 20-39, and adult male and female mortality reductions between 15 to 59.

Since the VSL is estimated separately for under five mortality reductions versus adult mortality reductions in the case when we assume VSL is dependent on YLLs, Table C.2 tabulates the age-adjusted mortalities for under-five and adult mortality reductions. Table C.1 shows the age-unadjusted mortality. The age-adjusted under-five ΔMs are higher than age-unadjusted ΔMs and the adult ΔMs are higher for ages less than 35 and lower for ages higher than 35 compared to age-unadjusted adult ΔMs.

**Table C.1: Impact of an additional year of female schooling on changes in mortality rates at each age(a)—all rates and changes per 104 population a**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Age (a)** | **Expected # of children at age (a)** | **(mortality rates/104 children)** |  |  |  |  |  |
| 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | 0 | 0 | 0 | 0.27 | 0.19 | 0.46 | 0.46 |
| 16 | 0 | 0 | 0 | 0.27 | 0.19 | 0.46 | 0.46 |
| 17 | 0 | 0 | 0 | 0.27 | 0.19 | 0.46 | 0.46 |
| 18 | 0 | 0 | 0 | 0.27 | 0.19 | 0.46 | 0.46 |
| 19 | 0 | 0 | 0 | 0.27 | 0.19 | 0.46 | 0.46 |
| 20 | 0.14 | 11.05 | 1.56 | 0.36 | 0.26 | 0.62 | 2.18 |
| 21 | 0.14 | 11.05 | 1.56 | 0.36 | 0.26 | 0.62 | 2.18 |
| 22 | 0.14 | 11.05 | 1.56 | 0.36 | 0.26 | 0.62 | 2.18 |
| 23 | 0.14 | 11.05 | 1.56 | 0.36 | 0.26 | 0.62 | 2.18 |
| 24 | 0.14 | 11.05 | 1.56 | 0.36 | 0.26 | 0.62 | 2.18 |
| 25 | 0.14 | 11.05 | 1.56 | 0.39 | 0.31 | 0.70 | 2.26 |
| 26 | 0.14 | 11.05 | 1.56 | 0.39 | 0.31 | 0.70 | 2.26 |
| 27 | 0.14 | 11.05 | 1.56 | 0.39 | 0.31 | 0.70 | 2.26 |
| 28 | 0.14 | 11.05 | 1.56 | 0.39 | 0.31 | 0.70 | 2.26 |
| 29 | 0.14 | 11.05 | 1.56 | 0.39 | 0.31 | 0.70 | 2.26 |
| 30 | 0.14 | 11.05 | 1.56 | 0.43 | 0.38 | 0.80 | 2.37 |
| 31 | 0.14 | 11.05 | 1.56 | 0.43 | 0.38 | 0.80 | 2.37 |
| 32 | 0.14 | 11.05 | 1.56 | 0.43 | 0.38 | 0.80 | 2.37 |
| 33 | 0.14 | 11.05 | 1.56 | 0.43 | 0.38 | 0.80 | 2.37 |
| 34 | 0.14 | 11.05 | 1.56 | 0.43 | 0.38 | 0.80 | 2.37 |
| 35 | 0.14 | 11.05 | 1.56 | 0.51 | 0.48 | 0.99 | 2.56 |
| 36 | 0.14 | 11.05 | 1.56 | 0.51 | 0.48 | 0.99 | 2.56 |
| 37 | 0.14 | 11.05 | 1.56 | 0.51 | 0.48 | 0.99 | 2.56 |
| 38 | 0.14 | 11.05 | 1.56 | 0.51 | 0.48 | 0.99 | 2.56 |
| 39 | 0.14 | 11.05 | 1.56 | 0.51 | 0.48 | 0.99 | 2.56 |
| 40 | 0 | 0 | 0 | 0.64 | 0.63 | 1.27 | 1.27 |
| 41 | 0 | 0 | 0 | 0.64 | 0.63 | 1.27 | 1.27 |
| 42 | 0 | 0 | 0 | 0.64 | 0.63 | 1.27 | 1.27 |
| 43 | 0 | 0 | 0 | 0.64 | 0.63 | 1.27 | 1.27 |
| 44 | 0 | 0 | 0 | 0.64 | 0.63 | 1.27 | 1.27 |
| 45 | 0 | 0 | 0 | 0.87 | 0.87 | 1.74 | 1.74 |
| 46 | 0 | 0 | 0 | 0.87 | 0.87 | 1.74 | 1.74 |
| 47 | 0 | 0 | 0 | 0.87 | 0.87 | 1.74 | 1.74 |
| 48 | 0 | 0 | 0 | 0.87 | 0.87 | 1.74 | 1.74 |
| 49 | 0 | 0 | 0 | 0.87 | 0.87 | 1.74 | 1.74 |
| 50 | 0 | 0 | 0 | 1.25 | 1.25 | 2.50 | 2.50 |
| 51 | 0 | 0 | 0 | 1.25 | 1.25 | 2.50 | 2.50 |
| 52 | 0 | 0 | 0 | 1.25 | 1.25 | 2.50 | 2.50 |
| 53 | 0 | 0 | 0 | 1.25 | 1.25 | 2.50 | 2.50 |
| 54 | 0 | 0 | 0 | 1.25 | 1.25 | 2.50 | 2.50 |
| 55 | 0 | 0 | 0 | 1.95 | 1.84 | 3.79 | 3.79 |
| 56 | 0 | 0 | 0 | 1.95 | 1.84 | 3.79 | 3.79 |
| 57 | 0 | 0 | 0 | 1.95 | 1.84 | 3.79 | 3.79 |
| 58 | 0 | 0 | 0 | 1.95 | 1.84 | 3.79 | 3.79 |
| 59 | 0 | 0 | 0 | 1.95 | 1.84 | 3.79 | 3.79 |

a Equations in methods section and supplement section A.

**Table C.2: Age-adjusted mortality rates per 104 population a**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Age** |  |  |  |  |
| 14 |  | 0 | 0 | 0.00 |
| 15 |  | 0 | 0.68 | 0.68 |
| 16 |  | 0 | 0.67 | 0.67 |
| 17 |  | 0 | 0.66 | 0.66 |
| 18 |  | 0 | 0.65 | 0.65 |
| 19 |  | 0 | 0.64 | 0.64 |
| 20 |  | 2.76 | 0.84 | 3.60 |
| 21 |  | 2.76 | 0.82 | 3.58 |
| 22 |  | 2.76 | 0.81 | 3.57 |
| 23 |  | 2.76 | 0.79 | 3.55 |
| 24 |  | 2.76 | 0.78 | 3.54 |
| 25 |  | 2.76 | 0.86 | 3.62 |
| 26 |  | 2.76 | 0.84 | 3.61 |
| 27 |  | 2.76 | 0.83 | 3.59 |
| 28 |  | 2.76 | 0.81 | 3.57 |
| 29 |  | 2.76 | 0.80 | 3.56 |
| 30 |  | 2.76 | 0.90 | 3.66 |
| 31 |  | 2.76 | 0.88 | 3.64 |
| 32 |  | 2.76 | 0.86 | 3.62 |
| 33 |  | 2.76 | 0.84 | 3.60 |
| 34 |  | 2.76 | 0.82 | 3.58 |
| 35 |  | **2.76** | **0.99** | **3.75** |
| 36 |  | 2.76 | 0.97 | 3.73 |
| 37 |  | 2.76 | 0.95 | 3.71 |
| 38 |  | 2.76 | 0.92 | 3.68 |
| 39 |  | 2.76 | 0.90 | 3.66 |
| 40 |  | 0 | 1.12 | 1.12 |
| 41 |  | 0 | 1.10 | 1.10 |
| 42 |  | 0 | 1.07 | 1.07 |
| 43 |  | 0 | 1.04 | 1.04 |
| 44 |  | 0 | 1.01 | 1.01 |
| 45 |  | 0 | 1.34 | 1.34 |
| 46 |  | 0 | 1.31 | 1.31 |
| 47 |  | 0 | 1.27 | 1.27 |
| 48 |  | 0 | 1.23 | 1.23 |
| 49 |  | 0 | 1.19 | 1.19 |
| 50 |  | 0 | 1.66 | 1.66 |
| 51 |  | 0 | 1.61 | 1.61 |
| 52 |  | 0 | 1.56 | 1.56 |
| 53 |  | 0 | 1.50 | 1.50 |
| 54 |  | 0 | 1.45 | 1.45 |
| 55 |  | 0 | 2.12 | 2.12 |
| 56 |  | 0 | 2.05 | 2.05 |
| 57 |  | 0 | 1.97 | 1.97 |
| 58 |  | 0 | 1.90 | 1.90 |
| 59 |  | 0 | 1.82 | 1.82 |

a L(2) = 67.8 years; L(35) = 38.4 years. Equations in methods section and supplement section A.

**Supplement Section D: Comparing health benefits at each age across SSA for age and income**

This section tabulates the undiscounted health benefits at each age across the standard sensitivity analyses of VSL for age and income (Table D.1). As discussed in supplement section C, the benefit streams when assuming VSL is income elastic is lower than when we assume constant VSL-to-income per capita ratio, and the age-adjustment yields higher benefits to additional year of schooling in early years, and lower in older ages compared to returns not adjusted for age.

**Table D.1: Health benefits at each age across SSA for age and income ($)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Variation of value with age** | | | |
|  | 1. None | | 2. Proportional to remaining life expectancy | |
| **Variation of value with GNI per capita** | Constant VSL to income per capita ratio (=160) | Constant elasticity of VSL with respect to income (=1.5) | Constant VSL to income per capita ratio (=160) | Constant elasticity of VSL with respect to income (=1.5) |
| **Age** |  |  |  |  |
| 15 | 48 | 16 | 70 | 24 |
| 16 | 48 | 16 | 69 | 23 |
| 17 | 48 | 16 | 68 | 23 |
| 18 | 48 | 16 | 67 | 23 |
| 19 | 48 | 16 | 65 | 22 |
| 20 | 225 | 76 | 370 | 125 |
| 21 | 225 | 76 | 369 | 125 |
| 22 | 225 | 76 | 367 | 124 |
| 23 | 225 | 76 | 366 | 124 |
| 24 | 225 | 76 | 364 | 123 |
| 25 | 233 | 79 | 373 | 126 |
| 26 | 233 | 79 | 371 | 125 |
| 27 | 233 | 79 | 369 | 125 |
| 28 | 233 | 79 | 368 | 124 |
| 29 | 233 | 79 | 366 | 124 |
| 30 | 244 | 82 | 376 | 127 |
| 31 | 244 | 82 | 374 | 127 |
| 32 | 244 | 82 | 373 | 126 |
| 33 | 244 | 82 | 371 | 125 |
| 34 | 244 | 82 | 369 | 125 |
| 35 | 263 | 89 | 386 | 131 |
| 36 | 263 | 89 | 384 | 130 |
| 37 | 263 | 89 | 381 | 129 |
| 38 | 263 | 89 | 379 | 128 |
| 39 | 263 | 89 | 377 | 127 |
| 40 | 131 | 44 | 116 | 39 |
| 41 | 131 | 44 | 113 | 38 |
| 42 | 131 | 44 | 110 | 37 |
| 43 | 131 | 44 | 107 | 36 |
| 44 | 131 | 44 | 104 | 35 |
| 45 | 179 | 60 | 138 | 47 |
| 46 | 179 | 60 | 134 | 45 |
| 47 | 179 | 60 | 130 | 44 |
| 48 | 179 | 60 | 126 | 43 |
| 49 | 179 | 60 | 123 | 41 |
| 50 | 258 | 87 | 171 | 58 |
| 51 | 258 | 87 | 165 | 56 |
| 52 | 258 | 87 | 160 | 54 |
| 53 | 258 | 87 | 155 | 52 |
| 54 | 258 | 87 | 149 | 50 |
| 55 | 390 | 132 | 218 | 74 |
| 56 | 390 | 132 | 211 | 71 |
| 57 | 390 | 132 | 203 | 69 |
| 58 | 390 | 132 | 195 | 66 |
| 59 | 390 | 132 | 188 | 63 |

a undiscounted. Equations in methods section and supplement section A.