
Standardized Sensitivity Analysis in BCA: An Education Case Study

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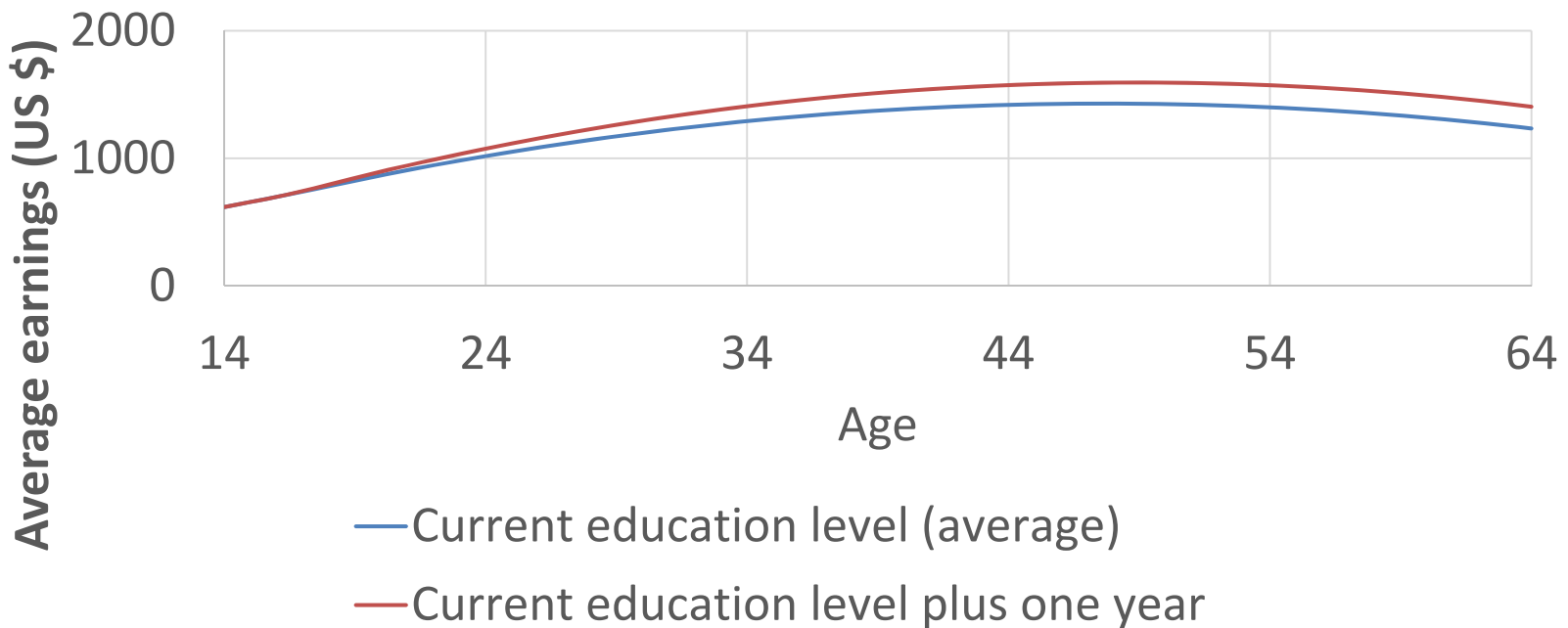
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Overview

- Case study: Costs and benefits of education investments in lower-middle-income countries from a health perspective
 - Estimate economic returns to one additional year of schooling from reductions in under-five and adult mortality in addition to any increases in earnings
- A case for standardized sensitivity analysis
 - Variation of VSL with life expectancy
 - Variation of VSL with income per capita
 - Variation of BCR with discount rate

Average age-earnings profile for current level of schooling and current level plus one year of schooling in lower-middle income countries



Note: Current mean years of schooling for LMCs is 7 years. Earnings streams shown are undiscounted.

Benefit Cost Ratio

$$\text{hBCR}(r) = \frac{\sum_{a=A}^{65} [\text{ev}(a)(1+r)^{A-a} + \text{hv}(a)(1+r)^{A-a}]}{\sum_{a=A}^{65} [c_1(a)(1+r)^{A-a} + c_2(a)(1+r)^{A-a}]}$$

- c_1 and c_2 are direct and opportunity costs
- $\text{ev}(a)$ = earnings value of one additional year of schooling at age a
- $\text{hv}(a)$ = health value of one additional year of schooling at age a
- hBCR is health-inclusive benefit cost ratio

Internal Rate of Return

$$\text{hPVNR}(r_h) = \sum_{a=A}^{65} \frac{\text{ev}(a) + \text{hv}(a) - c_1(a) - c_2(a)}{(1 + r_h)^{a-A}}$$

- c_1 and c_2 are direct and opportunity costs
- ev earnings value
- hv is health value
- hPVNR is present value of net benefits
- The internal rate of return (IRR) is the value of the discount rate, r_h , that makes $\text{hPVNR} = 0$

Variation of VSL with income

- **Income variant 1** (Constant VSLR, or constant ratio of VSL to income)
 - VSLR ($y, 35$) = 130 for all y
 - $VSL(y, 35) = 130 \times y$
 - Likewise, $VSMU(y, 35) = 0.013 \times y$
- **Income variant 2** (The income elasticity of VSL is constant (and equal to 1.2))
 - $VSL = VSL_r \times \left(\frac{\text{GNI per capita}}{\text{GNI per capita}_r} \right)^{\text{elasticity}}$
 - $VSMU(y, 35) = VSL(y_{US}, 35) \times \left(\frac{y}{y_{US}} \right)^{\text{elasticity}} \times 10^{-4}$
 - $VSLR = VSL(y_{US}, 35) \times \frac{y^{\text{elasticity}-1}}{y_{US}^{\text{elasticity}}}$

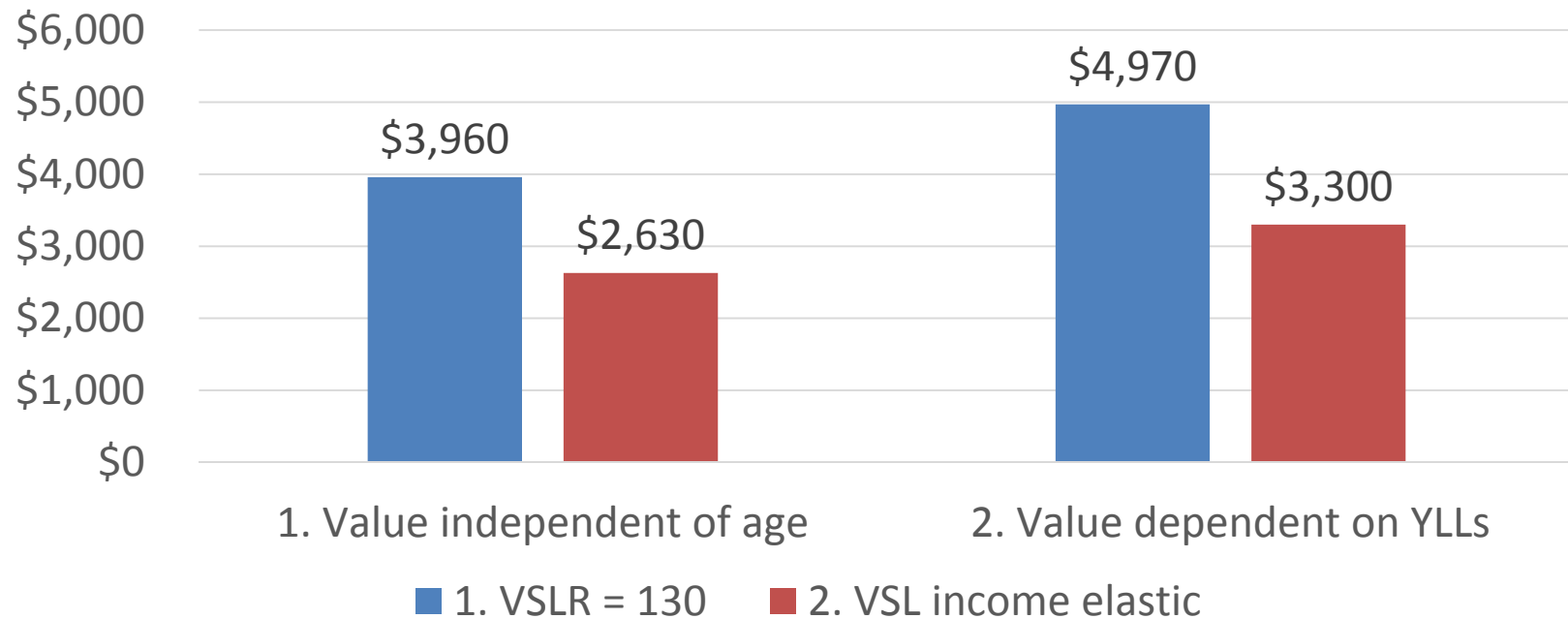
Variation of VSMU with Age

- **Variant 1** (From the BCA literature)
 - $VSMU(50, a) = VSMU(50, 35) = \text{Constant}$
- **Variant 2** (From CEA literature)
 - $VSMU(50, a) = \frac{L(a)}{L(35)} [VSMU(50, 35)]$
 - Where $L(a)$ is life expectancy at age a

The six outputs of a Standardized Sensitivity Analysis^a

Variation of value with GNI per capita	Variation of value with age	
	1. None	2. Proportional to remaining life expectancy
1.1 Constant VSL to GNI per capita ratio (=130)	(1.1,1)	(1.1,2)
1.2 Constant VSMU to GNI per capita ratio (=0.013)	(1.2,1)	(1.2,1)
2. Constant elasticity of VSL with respect to income (=1.2)	(2,1)	(2,2)
3. None [VSMU (y, a) constant with respect to $y = 10^4$]	(3,1)	(3,2)

Present dollar value of mortality reduction benefits across income and age variants



Note: Intervention is one additional year at the current mean of 7 years. Future benefits discounted at the rate of 3% per year. Since income is \$6430 per capita, VSLR is 86 given an income elasticity of 1.2.

BCA for an additional year of education in lower-middle-income countries: A standardized sensitivity analysis^a

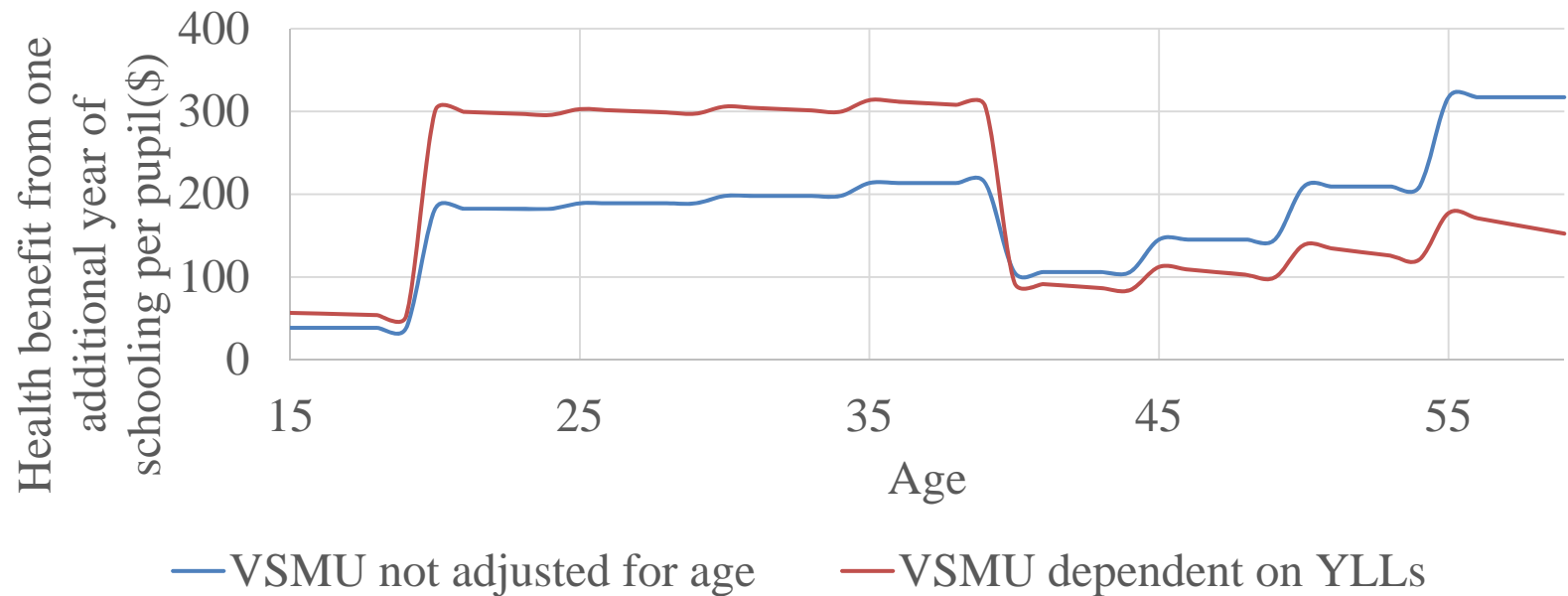
Income variants	Age variants			
	1. Value independent of age		2. Value dependent on YLLs	
	B:C ^b	IRR	B:C ^b	IRR
1. VSLR = 130	5.0	13%	5.8	16%
2. VSL income elastic ^c	4.0	10%	4.5	13%

^a Intervention is one additional year at the current mean of 7 years.

^b B:C ratios calculated using a discount rate of 3% per year.

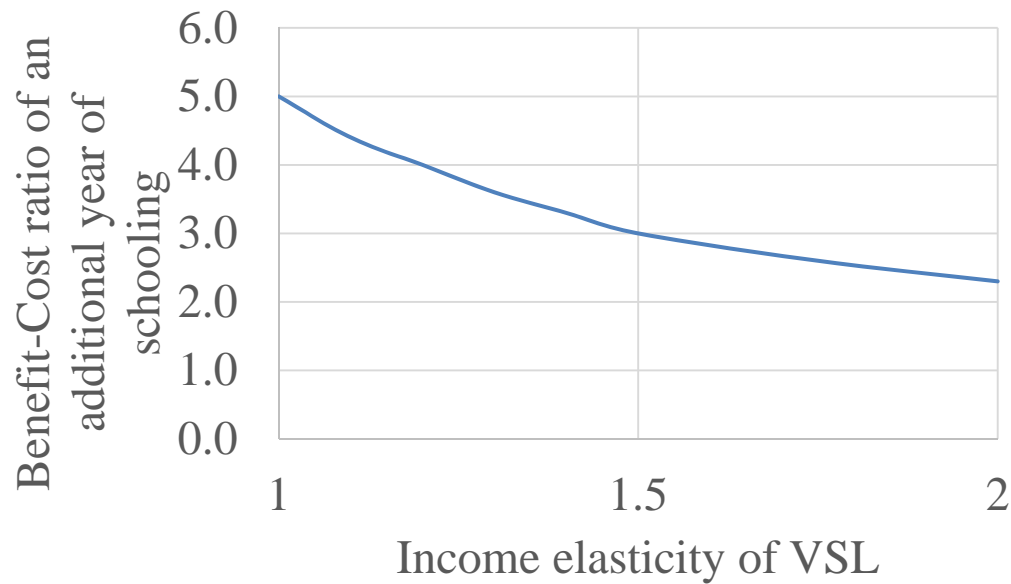
^c Since income is \$6430 per capita, VSLR is 86 given an income elasticity of 1.2.

Health benefit stream from one additional year of schooling in LMICs



Note: Intervention is one additional year at the current mean of 7 years. Benefit streams shown are undiscounted, and are estimated for income variant 1, or when VSLR is constant (and =130).

Relationship between benefit cost ratio of an additional year of schooling and income elasticity of VSL



Note: Intervention is one additional year at the current mean of 7 years. Benefit-cost ratios are estimated for age variant 1, or the case in which VSMU/VSL does not depend on age.

Benefit-cost ratios for an additional year of schooling: Sensitivity analysis on discounting rates^a

Income variants	Age variants					
	1. Value independent of age			2. Value dependent on YLLs		
	r = 1% ^b	r = 3%	r = 5%	r = 1%	r = 3%	r = 5%
1. VSLR = 130	8.3	5.0	3.3	9.0	5.8	4.0
2. VSL income elastic ^c	6.7	4.0	2.6	7.1	4.5	3.0

^a Intervention is one additional year at the current mean of 7 years.

^b r = annual discount rate

^c Since income is \$6430 per capita, VSLR is 86 given an income elasticity of 1.2.