Education, Health and Mortality

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Introduction: Education and Survival

- A relationship between life expectancy and variables correlated with education. Over the period 1997-2001 a profession man aged sixty-five had a life expectancy five years longer than that of a manual worker.
- Barker et al. (2011, *Population Development Research*) suggests effects of education are clearer for younger people than old people.
- Economou and Theodossiou (2011, *Review of Income and Wealth*) find education and income affect health status.
- Lleras-Muney (2005, *Review of Economic Studies)* suggests that one year of education raises life expectancy at thirty-five by 1.7 years.
- Clark and Royer (2013, *American Economic Review*) find that the 1947 RoSLA seemed to be associated with a decline in health status between ages 45 and 69.
- Dorsett et al. (2014, *Labour Economics*) find graduates have a life expectancy 3.2 years higher than poorly-educated men at age sixty-five, after controlling for smoking status and health reported at

Survival and Returns to Education

- Increased survival may be part of the return to education
- Explore this using a model with a simple specificiation of the link between education and survival.
- The value put on life is bound to affect the optimum extent of education.

A Model of Education-dependent Mortality

Basic model: $t = age$

$$m_t = -\dot{s}_t / s_t = -d \log s_t / dt = (\rho + \gamma e^{\kappa t})$$

Extended model: $\tau =$*years of education*, $t > \tau$

$$\begin{aligned} m_t &= -\dot{s}_t / s_t = -d \log s_t / dt = (\rho + \gamma e^{\kappa t}) e^{-\mu \tau} \\ \log s_t &= -\left\{ \rho(t - \tau) + \frac{\gamma}{\kappa}(e^{\kappa t} - e^{\kappa \tau}) \right\} e^{-\mu \tau} + \log s_\tau \end{aligned}$$

Also

$$\frac{ds_t}{dt_1} = -\mu s_t \log \frac{s_t}{s_{t_1}}$$

Education incomplete, $\tau = t$

$$\begin{aligned} m_t &= -\dot{s}_t / s_t = (\rho + \gamma e^{\kappa t}) e^{-\mu t} \\ \log s_t &= \frac{\rho(e^{-\mu t} - 1)}{\mu} + \frac{\gamma}{\kappa - \mu}\left(e^{(\kappa - \mu) t} - 1 \right) \end{aligned}$$

Observations

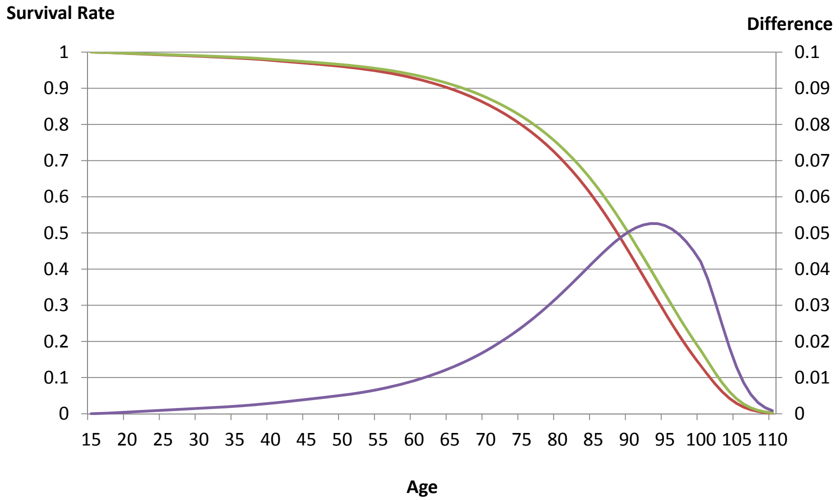
Model performs poorly for children, but these are not the focus of the study. Fit to mortality rates from age of 16 and assume model applies from age 11. Then for $\tau > t \geq 11$ where the model gives the survival rate conditional on survival to age 11.

$$\log s_t = \rho(\frac{e^{-\mu t} - e^{-11\mu}}{\mu}) - \frac{\gamma}{\kappa - \mu} \left(e^{(\kappa-\mu)t} - e^{11(\kappa-\mu)} \right)$$

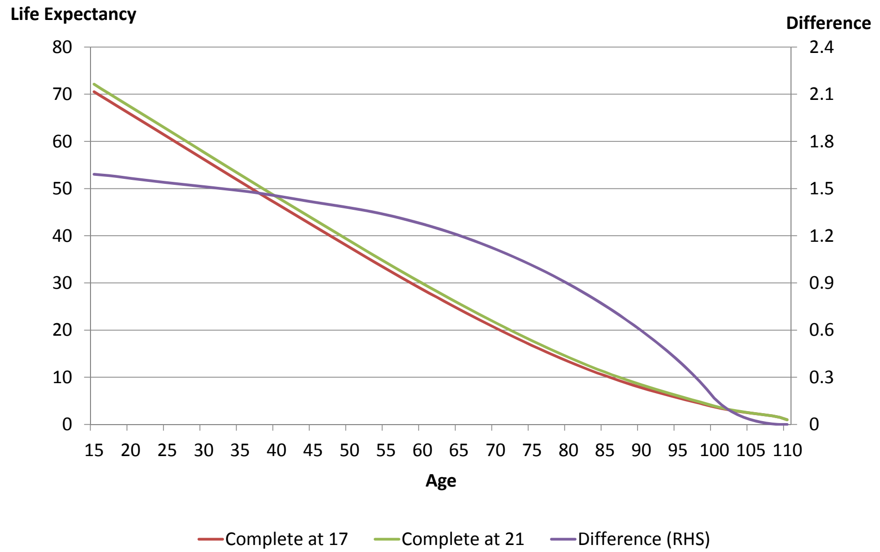
Assume $\mu = 0.035$. One year of education reduces the mortality rate by about five per cent. Estimate by NLS. Note choice of μ has very little bearing on fit of model. For $t > \tau$, κ and ρ adapt fully.

Implications

Apply to cohort mortality rates for men born in 1966 once they reach the age of 16. Assume average age of completing education was 17.



Life Expectancy



Life-cycle Decision-making

$$U(c_t, \zeta_t, \chi_t, m_t) = \frac{c_t^{1-\sigma} - \tilde{c}^{1-\sigma}}{1-\sigma} - (\zeta_t + \chi_t)\pi m_t^{\nu}$$

$\tilde{c}$ is subsistence consumption (Murphy and Topel, JPE, 2006). In their work $c_t > \tilde{c}$ ensures that utility is positive. If this is not true "life is not worth living". The disutility of work has two implications. First, that utility may be negative while people are working, but life-time utility may nevertheless be positive- looking forward to retirement. Secondly, even if $c_t > \tilde{c}$ life-time utility may be negative because of the disutility of work. Negative utility will discourage education if education affects mortality ζ_t indicates the proportion of time spent in education and χ_t the proportion of time spent in work. πm_t^{ν} represents the disutility of education/work which is declining in health and represented, therefore, as rising in the mortality rate.

The Value Function

$$V = \int_0^T s_t(t_1)e^{-\delta t}\left\{\frac{c_t^{1-\sigma}-\tilde{c}^{1-\sigma}}{1-\sigma}-(\zeta_t+\chi_t)(\zeta_t+\chi_t)\pi m_t^{\nu}\right\}dt$$
$$+\lambda\int_{t_1}^{t^*} e^{(g-r)t}s_t(t_1)\chi_t w_0 e^{\int_0^{t_1}\theta(\tau)d\tau}-\lambda\int_0^T c_t e^{-rt}s_t(t_1)dt$$

The Education Decision

$$
\begin{aligned}
\frac{dV}{dt_1} &= \int_{t_1}^{T} \frac{ds_t(t_1)}{dt_1} e^{-\delta t} \left\{ \frac{c_t^{1-\sigma} - \tilde{c}^{1-\sigma}}{1-\sigma} - (\zeta_t + \chi_t)\, \pi m_t^{\nu} \right\} dt \qquad \text{(A)} \\
&\quad -\lambda e^{(g-r)t_1} \psi\left(h_{t_1}\right) s_t\left(t_1\right) w_0 e^{\int_0^{t_1} \theta(\tau) d\tau} \qquad \text{(B)} \\
&\quad +\lambda \int_{t_1}^{t^*} e^{(g-r)t_1} w_0 e^{\int_0^{t_1} \theta(\tau) d\tau} \left(s_t\left(t_1\right) \theta(t_1) + \frac{ds_t(t_1)}{dt_1} \right) dt \qquad \text{(C)} \\
&\quad -\lambda \int_{t_1}^{T} c_t e^{-rt} \frac{ds_t(t_1)}{dt_1} dt \qquad \text{(D)}
\end{aligned}
$$

Interpretation

A. Incremental effect of education on the expected joy of living
C. Education effect influences expected income because it shows the impact on the probability of actually earning it.
D. The effect of education on the expected life-time cost of consumption.

Value of a Life Year

Current increase in discounted utility per unit increase in probability of survival is

$$e^{-\delta t}\left\{\frac{c_t^{1-\sigma}-\tilde{c}^{1-\sigma}}{1-\sigma}-(\zeta_t+\chi_t)\pi m_t^{\nu}\right\}$$

Value of a life year is

$$VLY=\frac{e^{(r-\delta)t}}{\lambda}\left\{\frac{c_t^{1-\sigma}-\tilde{c}^{1-\sigma}}{1-\sigma}-(\zeta_t+\chi_t)\pi m_t^{\nu}\right\}$$

Money value at time t of the increase in discounted life-time welfare per unit increase in the probability of survival. Again, it can be negative.

Consumption and Retirement

With a constant rate of interest equal to the rate of discount

$$\begin{aligned} c_t &= c^* \\ \lambda &= (c^*)^{-\sigma} \end{aligned}$$

Retire when the disutility of work equals its marginal benefit

$$\pi m_t^{\nu} = \lambda e^{gt} w_0 e^{\int_0^{t_1} \theta(\tau) d\tau}$$

Some Simulations

Variable		A	B
Interest/Discount Rate	r, δ	0.02	0.02
Growth of Wage Rate	g	0.012	0.012
Return to Education: Quadratic Term	θ_1	-0.0015	-0.0015
Return to Education: Linear Term	θ_2	0.13	0.13
Age at which education gives max wage	$S_{\max}$	26	26
Effect of Years of Education on Mortality	μ	0.035	0.0
Inter-temporal Elasticity of Substitution		1	1
Elasticity of Health with Respect to Mortality	κ	0.296	0.296
Disutility of Work	λ	23.81	23.81
Subsistence Consumption		1.75	1.75
Wage for someone educated to sixteen	w_0	See text	See text

Table: Model Parameters

Compare Education and Retirement for Men born in 1906, 1965 and 2046.

	$\mu = 0.035$			$\mu = 0$		
	1906	**1965**	**2046**	**1906**	**1965**	**2046**
Life Expectancy Age 16	53.1	70.3	78.9	53.1	70.3	78.9
Life Expectancy Age 50	23.8	38.2	45.6	23.8	38.2	45.6
W0	0.5	1	1.5	0.5	1	1.5
Complete Education	14.0	18.3	17.7	16.2	16.3	16.5
Consumption	4.3	7.2	9.2	4.1	6.3	8.2
Retire	65.0	65.9	62.9	60	57.4	57.7
Value of Life Year	3.9	10.2	15.3	3.5	8.1	12.7

Table: Table Caption

Removing Effects of Wage Growth

	$\mu = 0.035$		
	1906	**1965**	**2046**
Life Expectancy Age 15	53.1	70.3	78.9
Life Expectancy Age 50	23.8	38.2	45.6
W0	1	1	1
Complete Education	11.6	18.3	19.2
Consumption	4.8	7.2	7.8
Retire	37.2	65.9	80.2
Value of Life Year	4.8	10.2	11.6

Table: Table Caption

Observations

1. Rising life-span encourages education and delays retirement.
2. Rising wages have the opposite effect on both variables but not proprotionately.
3. The model generates a plausible value for a life-year.

Conclusions

1. There is evidence for a connection between education and life expectancy.
2. Nevertheless, the effect does not help explain actual take-up of education; it seems likely that required rates of return on education are well above market rates of interest.
3. A log-linear influence of education on mortality is a natural framework to adopt.
4. It means that the discounted benefit of education can be increased when prime age mortality rates are high because the benefits come sooner
5. With or without an education effect on mortality it seems unlikely that rising life expectancy is having a powerful effect on the demand for education.