Education, Health and Mortality

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Introduction: Education and Mortality

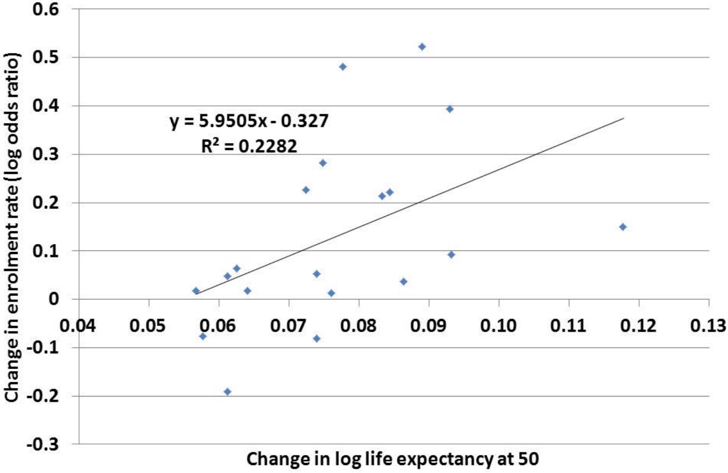
The human capital model of investment in education implies that the longer people have to benefit from it, the more education people will undertake.

- Ben-Porath (*Journal of Political Economy*, August 1967) argued that rising life expectancy was one of the factors behind increasing participation in education.
- Hazan(*Econometrica*, November 2009) pointed out that, although life expectancy had risen for a long period, expected number of hours worked had declined. The expansion of education could not be attributed to rising longevity.
- Cervellati and Sunde (*Econometrica* 2013) disputed Hazan's argument. They pointed out that what mattered was the marginal benefit of education relative to the marginal cost. This could rise even if the expected time spent at work declined.

Working Lives and Survival

- This raises the issue of the link between working lives and life expectancy. It is generally observed that, for much of the period while life expectancy has been rising, working lives have been declining.
- Bloom, Canning and Moore (*Scandinavian Journal of Economics*, July 2014) develop a model which explains this. A rising real wage leads to earlier retirement while rising longevity leads to later retirement. The pattern seen in the 20th century is the balance between these. Bloom *et al.* assume that the disutility of labour depends on health and that health state is measured by the mortality rate. If a life-cycle model a low mortality rate leads to late retirement.
- The aim here is to extend their model to include effects of education on earnings, and thus study how the education decision is affected by health as reflected by mortality rates.

The Relationship between Enrolment in Education (men aged 15-24) and Life Expectancy at Fifty



A Pitfall with a Simple Model of Education

- Suppose that the return to each year of education is constant, θ, (a simple Mincer model) while the interest rate is r , the growth rate is g and the age of retirement is fixed at sixty-five. Then the wage that someone can earn after being educated to age S is $e^{\theta S+gS}$, where the term in the growth rate indicates the effects of economic growth independently of educational attainment.
- The total value of life-time earnings, discounted back to period 0 is

$$e^{\theta S}\int_S^R e^{(g-r)t}dt$$

and the rational individual chooses S to maximise this. The first-order condition is

$$\frac{\theta e^{\theta S}}{(r-g)}\left(e^{(g-r)S}-e^{(g-r)R}\right)=e^{(g-r)S}e^{\theta S}$$

	θ							
r	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.1
0.02	24.5	36.2	42.7	46.8	49.6	51.6	53.2	54.4
0.03		30.3	39.5	44.7	48.2	50.6	52.4	53.8
0.04		18.8	34.5	41.9	46.3	49.3	51.5	53.1
0.05			24.8	37.5	43.8	47.7	50.3	52.2
0.06				29.2	39.9	45.4	48.8	51.1
0.07					32.6	41.9	46.7	49.7
0.08						35.3	43.5	47.8
0.09							37.5	44.9
0.1								39.4

Table: The Optimal Age at which to end Education with Constant Returns to Education (g=0.01)

The Nature of the Problem

- If $\theta > r - g$ then with an infinite horizon, completing education would be delayed indefinitely. With a finite life it matters that working time is lost.
- If θ is considerably $> r - g$ then a large investment in education is desirable. With a high value of r the loss of a working year is heavily discounted, so if θ and $r - g$ are both large, education continues for a long time. Only with values of θ appreciably lower than usually recorded does the model give plausible estimates for years of education.
- Either some account is needed of why the discount rate for labour income is appreciably higher than observed rates of return, or the returns have to be appreciably lower than generally suggested.

- Mincer's model is

$$\dot{w}/w = \theta \text{ giving } \log w(S) - \log w_0 = \theta S$$

- Cervellati and Sunde suggest

$$\dot{w}/w = \theta(S)$$

- An obvious choice is

$$\log w(S) - \log w_0 = \theta_1 (S-a)^2 + \theta_2 (S-a),\ \ \theta_1 < 0; \theta_2 > 0$$

The maximum wage is reached with $S_{\max}$ where

$$2\theta_1(S_{\max} - a) + \theta_2 = 0$$

A Model

- Utility depends positively on consumption and negatively on the fraction of time spend in education, ζ_t or work χ_t.The disutility of work is increasing in health-state, h_t. This is assumed proportional to the mortality rate.

$$U_t = \frac{c_t^{1-\sigma}}{1-\sigma} - (\zeta_t + \chi_t)\,\phi(h_t)$$

- There is a life-time budget constraint. s_t is the probability of surviving to age t. r is the interest rate/discount rate and g is the exogenous growth rate.

$$\int_0^T (e^{gt}\chi_t w_0 e^{\int_0^t \theta(t)\zeta_\tau d\zeta_\tau} - c_t)s_t e^{-rt} dt$$

Constrained optimisation

$$Max \int_0^T s_t e^{-\delta t} \left\{ \frac{c_t^{1-\sigma}}{1-\sigma} - (\zeta_t + \chi_t)\,\phi(h_t) \right\} dt$$

$$+\lambda \int_0^T (e^{gt}\chi_t w_0 e^{\int_0^t \theta(t)\zeta_\tau d\zeta_\tau} - c_t) s_t e^{-rt} dt$$

Marginal Conditions

- Consumption

$$s_t e^{-\delta t} c_t^{-\sigma} = \lambda s_t e^{-rt}; \delta = r \text{ implies } c_t = c^*; \lambda = (c^*)^{-\sigma}$$

- Education

$$e^{(g-r)\tau^* + \theta(\tau^*)} w_0 s_{\tau^*} = w_0 \theta' (\tau^*) e^{\theta(\tau^*)} \int_{\tau^*}^{R} e^{gt} s_t e^{-rt} dt \tag{1}$$

- Retirement

$$s_t \phi(h_t) = \lambda s_t e^{gt} w_0 e^{\int_0^t \theta(t) \zeta_\tau d\zeta_\tau}$$

- The Budget Constraint with τ^* the age at which education is completed and t^* the age of retirement

$$c^* = \frac{w_0 \int_{\tau^*}^{t^*} s_t e^{(g-r)t} e^{\int_0^{\tau*} \theta(\tau) \zeta_\tau d\zeta_\tau} dt}{\int_0^T s_t e^{-rt} dt}$$

The Effect of Wage Increases

- Write marginal decision as

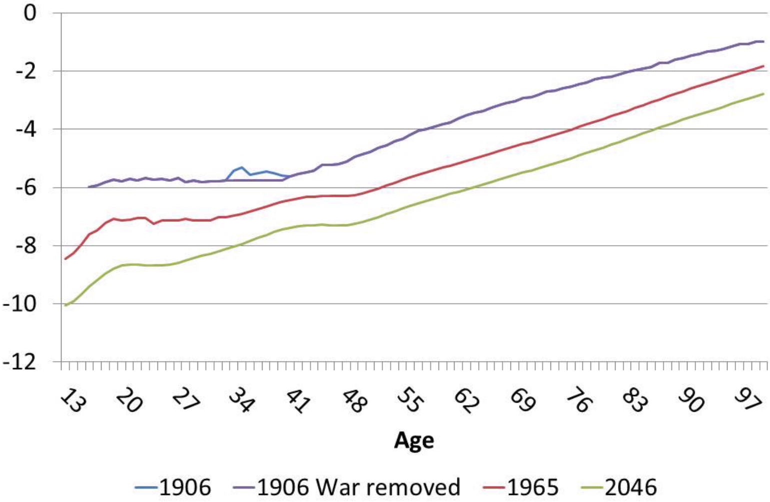
$$\phi(h_t) = u'(w_0\kappa(\tau^*, t^*))e^{gt}\psi(h_t)\, w_0 e^{\int_0^{\tau} \theta(\tau)\zeta_\tau d\zeta_\tau}$$

- For an increase in w_0 to delay retirement we require

$$\frac{u'(w_0\kappa(\tau^*, t^*))}{w_0\kappa(\tau^*, t^*)\, u''(w_0\kappa(\tau^*, t^*))} < -1$$

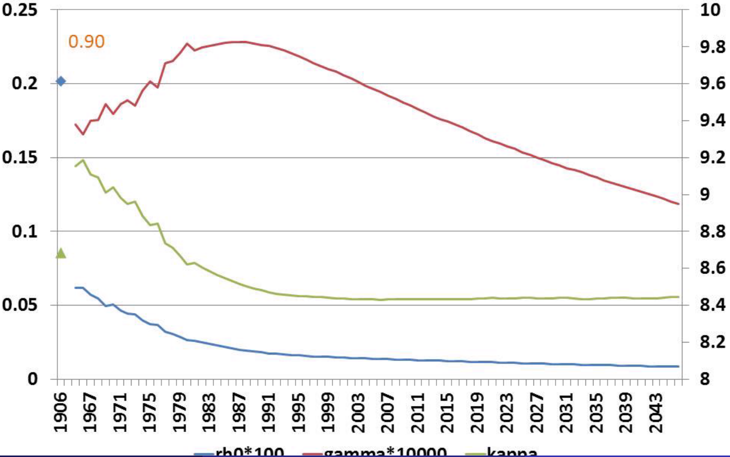
which in turn means $\sigma < 1$.

Log Mortality Rates for Men



A Model of Mortality

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



Some Simulations

Variable		Value
Interest/Discount Rate	r, δ	0.04
Growth of Wage Rate	g	0.012
Return to Education: Quadratic Term	θ_1	-0.002
Return to Education: Linear Term	θ_2	0.13
Age age at which education gives max wage	$S_{\max}$	27
Reciprocal of Intertemporal Elasticity of Substitution	σ	1.5
Wage for someone educated to sixteen	w_0	See text

Table: Model Parameters

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

	1906	**1965**	**2046**
Life Expectancy Age 16	53.1	70.3	78.9
Life Expectancy Age 50	23.8	38.2	45.6
W0	0.5	1	1.5
Complete Education	16.9	17.7	18.1
Marginal Rate of Return	4.1%	3.7%	3.6%
Retire	65.9	70.2	74.3

Table: Table Caption

Removing Effects of Wage Growth

	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	15.5	17.7	18.5
Marginal Rate of Return	4.6%	3.7%	3.4%
Retire	52.1	70.2	82.0

Table: Table Caption

Conclusions

1. The human capital qualitatively links improvements in education to improvements in health.
2. Rising wages result in retirement becoming earlier while increasing longevity makes it later.
3. The effect of rising wages mitigates the effect of rising longevity on educational attainment.
4. Overall simulations suggest that rising longevity explains only a small part of rising educational attainment.
5. The effect would be more powerful if it were assumed that education raised the value of leisure as well as earning power.