SOLUTIONS CHAPTER 6
HUMAN CAPITAL

6.1 Effects of the invention of a vaccine against malaria. (See accompanying fig 6.1 in solutions-graphs-chap6.pdf.)

As we have seen, the causal link between health and income goes both ways. Curve $h(y)$ denotes the positive effect of income on health. But a better health also allows for a higher income; this is represented by curve $y(h)$.

With a newly invented vaccine, people will achieve better health levels *all else equal*. This means that for any given income level, people will be healthier: curve $h(y)$ shifts up to, say, $h'(y)$. Now before the new vaccine is introduced, the economy is in equilibrium at point A. The first, direct effect is that health jumps to h_B. But with higher health level h_B, people will be able to work better, hence income goes up to y_B. And so on to the final equilibrium at point C, where both health and income have increased taking into account the *multiplier* effect.

6.2 Effects of a more polluted country. (See accompanying fig 6.2 in solutions-graphs-chap6.pdf.)

Suppose that country B is more polluted than country A. For a given income level, people in country A are thus in better health. Curve $h^B(y)$ is thus below curve $h^A(y)$. If nothing else differed between the two countries, then income in country A would be above that of country B, i.e. $y_A > y_B$ at points A and B respectively. In order to reconcile this with the fact that both countries have the same income level, it must be the case that curve $y^B(h) > y^A(h)$, i.e. $y^B(h)$ is to the right-hand side of $y^A(h)$. This means that for any given health level, workers in country B can produce more than workers in A. This could be due to either higher physical and human capital levels or better technology, or both. The equilibrium for country B is at point B', where $y_A = y'_B$.

6.3 Welfare effects of education

We suppose that education has no impact on people's ability to produce more wealth, but it does allow those who are more educated to steal part of the output produced by those who are less educated. In other words, education does not increase the *size* of the pie but simply increases the *share* of the pie for those who have more of it. If this were true, then people would still invest in education in order to receive a larger share of the pie. Now such investments lower the output level because students are not producing any output. As a result, countries with higher human capital would, all else equal, be actually poorer than countries with less human capital in per capita terms. Since the data indicates quite the opposite, the initial assumption does not appear to be valid.

6.4 Measuring the returns to education

Using the numbers from page 164, a worker with nine years of education has a salary of

$$(1.134)^4 * (1.101)^4 * 1.068 = 2.595 w_0,$$

where w_0 is the salary of a worker without any schooling. The share of wages due to education is thus

$$\frac{2.595 - 1}{2.595} = 61.5\%.$$

6.5 (2nd Ed.) Average wage is 17.45$/hr and the salary for "raw work" is 5.85$/hr. This implies that human capital receives $\frac{17.45-5.85}{17.45} =$ 66.5% of all salaries paid, leaving 33.5% for raw work.

6.5 (3rd Ed.) Suppose that the total size of the population in the USA is $L = 1000$ and the salary of a worker without any schooling is 1. Raw work thus receives an aggregate payment of 1000. Total salaries are

schooling	no of workers	salary	total
0	4	1	4
4	8	$1.134^4 = 1.65$	13.2
8	19	$1.65 * 1.101^4 = 2.43$	46.17
10	67	$2.43 * 1.068^2 = 2.77$	185.59
12	362	$2.77 * 1.068^2 = 3.16$	1143.92
14	224	$3.16 * 1.068^2 = 3.61$	808.64
16	316	$3.61 * 1.068^2 = 4.11$	1298.76
TOTAL:	1000		3500.28

The share of salaries due to human capital is thus

$$\frac{3500 - 1000}{3500} = 71.4\%.$$

6.6 We saw that if two countries differ only by the average level of education per worker, then the ratio of income per capita in the long run will be given by

$$\frac{y_i^{SS}}{y_j^{SS}} = \frac{h_i}{h_j},$$

where h_i and h_j denote the human capital of each country respectively. Human capital levels are calculated using the returns to education according to data on schooling. Consequently, for country i, we have,

$$h_i = (1.134)^4 \times (1.101)^4 \times (1.068)^2 = 2.77.$$

And for country j, we have

$$h_j = (1.134)^4 = 1.65.$$

This implies that

$$\frac{y_i^{SS}}{y_j^{SS}} = \frac{h_i}{h_j} = \frac{2.77}{1.65} = 1.67.$$

In the long run, we would expect country i to have an income per capita 67% larger than that of country j based solely on differences in average education level.

6.7 With twelve years of education on average, the average salary in year 2000 will be

$$w_{2000} = (1.134)^4 \times (1.101)^4 \times (1.068)^4 = 3.16.$$

In year 1900 it was

$$w_{1900} = (1.134)^2 = 1.28.$$

If, through the 20th century, the average annual growth in income was given by g, we would have:

$$w_{2000} = w_{1900}(1+g)^{100}.$$

As a result, we have

$$3.16 = 1.28(1+g)^{100},$$

and thus

$$g = \left(\frac{3.16}{1.28}\right)^{\frac{1}{100}} - 1 = 0,0091 = 0,91\%.$$

The accumulation of human capital would be responsible for an annual growth of income per capita of 0.91%. Note that although this number may appear to be small, once compounded over 100 years, it causes people's income to increase by a factor of 2.47!