Questions and Problems

1.

a. False. This is true for the growth rates, not for the levels.

b. True. $\frac{I}{Y} = (\delta + g_A + g_N)\frac{K}{Y}$, so if g_A increases, the income will also increase.

c. False. In the steady state output per effective worker does not grow.

d. True. In the steady state output per worker grows at the rate g_A

e. False. In the steady state the growth rate of *Y* depend only on the rate of population growth and the rate of technological progress. Changes in saving rate increase the steady state level of output per effective worker.

f. True, R&D process depends on the fertility of the research process and the appropriability of results of the research. If these factors are poor, it is better for the firm to invest in a new but known machine.

g. True. The appropriability of research is a crucial factor in the R&D process.

h. Uncertain. Growth depends not only on knowledge, but also on factors as institutions of a country and government.

2.

a. R&D spending is important to increase the level of the technological frontier. It is also one of the principal determinants of technological progress in a country. The higher is the appropriability of the results of research and the higher is the amount of fertility, the higher are the returns on R&D spending and the higher will be the amount of R&D spending.

b. An increase in patent protection policy increases the appropriability, the R&D spending and the output in the long run. It decreases fertility. Too much protection can also decrease R&D spending.

c. Tax credits will increase fertility, R&D spending and output in the long run. Appropriability remains unaffected.

d. A decrease in funding will decrease fertility, R&D spending and output in the long run. The appropriability remains unaffected.

e. The elimination of patents on drugs will cause an increase in fertility but a decrease in appropriability. R&D spending will probably decrease because without the patents the investment is riskier for the big firms, the effect on output in the long run is uncertain.

3.

a. Growth from the 1950s has been the result of a rapid technological progress rather than the accumulation of capital. The development of a new technology has been the main strategy for the industrial countries.

b. Developing countries can import technology from more technological countries. This is the imitation growth strategy.

c. A poorer patent protection is better in countries far from the technological frontier. In this case, the best strategy for growth is imitation, and patent protection puts limits to the possibility of imitate technology. When the developing country will catch up, a more stringent protection policy will be better to stimulate innovation.

4.

a. A permanent reduction in the rate of technological progress will decrease forever the growth rate of the economy, and the steady state level of output, both in the medium and long run.

b. A permanent decrease in the saving rate will decrease the output growth rate in the medium run. In the long run, only the steady state level of capital and output will decrease, but the growth rate will remain the same.

5.

a. $€Y_1 = 150\,000, €Y_2 = 225\,600$.

b. $Y_2 = 188\,000$ at $t = 1$ prices. $g_Y = 0.253 = 25.3\%$.

c. The GDP deflator is: $P = \frac{€Y}{Y} = \frac{225\,600}{188\,000} = 1.2$ The growth of nominal GDP is: 50.4%. The GDP deflator inflation is $\pi = 50.4\% - 25.3\% = 25.1\%$.

d. $\frac{Y_1}{N} = \frac{150\,000}{100} = 1500, \frac{Y_2}{N} = \frac{188\,000}{110} = 1709$. Labour productivity is $a_L = g_Y - g_N$.
$g_N = 20\%, a_L = 25.3\% - 20\% = 5.3\%$.

e. $Y_1 = 280\,000, Y_2 = 367\,400$ at $t = 1$ prices $g_Y = 0.31 = 31\%$

f. The growth of nominal GDP is equal to 39.7%. The inflation rate is: $\pi = 39.7\% - 31\% = 8.7\%$.

g. $g_N = 13\%$. Labour productivity is $a_L = g_Y - g_N = 31\% - 13\% = 18\%$.

h. The statement is true. If we include telebanking in the computation of GDP, we obtain a lower inflation rate and a higher productivity growth, due to the technological growth.

6.

a. i. Capital stock per effective worker

From the formula:

$$s\frac{Y}{AN} = (\delta + g_A + g_N)\frac{K}{AN}$$

$$\frac{K^*}{AN} = \left(\frac{s}{\delta + g_A + g_N}\right)^2$$

Substituting the values of the parameters:

$$\frac{K^*}{AN} = \left(\frac{0.16}{0.1 + 0.04 + 0.02}\right)^2 = 1$$

ii. Output per worker

$$\frac{Y}{AN} = \sqrt{\frac{K}{AN}} = 1$$

iii. The growth rate of output per effective worker is equal to zero in steady state.

iv. The growth rate of output per worker is equal to the growth rate of technology: $g_{\frac{Y}{N}} = 0.04 = 4\%$

v. The growth rate of output is equal to: $g_{\frac{Y}{N}} = g_A + g_N = 0.04 + 0.02 = 0.06 = 6\%.$

b. i. Capital stock per effective worker

From the formula:

$$s\frac{Y}{AN} = (\delta + g_A + g_N)\frac{K}{AN}$$

$$\frac{K^*}{AN} = \left(\frac{s}{\delta + g_A + g_N}\right)^2$$

Substituting the values of the parameters:

$$\frac{K^*}{AN} = \left(\frac{0.16}{0.1 + 0.08 + 0.02}\right)^2 = 0.64$$

ii. Output per worker

$$\frac{Y}{AN} = \sqrt{\frac{K}{AN}} = 0.8$$

The equilibrium level of capital and output decreases because the required investment needed to maintain a given level of capital per effective worker increases.

iii. The growth rate of output per effective worker is equal to zero in steady state.

iv. The growth rate of output per worker is equal to the growth rate of technology: $g_{\frac{Y}{N}} = 0.08 = 8\%$

v. The growth rate of output is equal to: $g_{\frac{Y}{N}} = g_A + g_N = 0.08 + 0.02 = 0.1 = 10\%$. The growth rate of output per worker and output increase because the growth rate of technology increases.

c. i. The equilibrium level of capital per worker is the same of case b: $\frac{K^*}{AN} = 0.64$

ii. Also the equilibrium level of output per worker is the same of case b: $\frac{Y}{AN} = \sqrt{\frac{K}{AN}} = 0.8$

iii. The growth rate of output per effective worker is equal to zero in steady state.

iv. The growth rate of output per worker is equal to the growth rate of technology: $g_{\frac{Y}{N}} = 0.04 = 4\%$

v. The growth rate of output is equal to: $g_{\frac{Y}{N}} = g_A + g_N = 0.04 + 0.06 = 0.1 = 10\%$. While output growth rate is the same as in b, the growth rate of output per worker now is lower. People are better when there is an increase in technology growth rate.

7.

a. The geographic location influences the steady state level of output per worker through K, H and A.

b. Education influences steady-state level of output per worker through the human capital H.

c. The protection of property rights influences output per worker through technology A: it is a part of R&D process.

d. Openness to trade influences output per worker through K, H and A.

e. Low tax rates influence output per worker through physical capital K because there is more saving.

f. A good public infrastructure influences output per worker through physical capital.

g. A low population growth influences output per worker through human capital.

8.

a. $(g_Y - g_N)$ is the growth rate of output per worker, or the labour productivity. $(g_K - g_N)$ is the growth rate of capital per worker.

b. The growth rate of capital per worker is: $(g_Y - g_N) = 3(g_Y - g_N) - 2g_A$.

c. $(g_Y - g_N)^{\text{USA}} = -0.76\%$

$(g_Y - g_N)^{\text{F}} = 3.04\%$

$\left(g_Y - g_N\right)^{\text{J}} = 5.9\%$

$\left(g_Y - g_N\right)^{\text{UK}} = 2\%$

Capital accumulation in the United States remained stable over the last 50 years, while the other rich countries converged to the same level of capital per effective worker and output per effective worker of the United States.