EE312 Macroeconomic Theory
Semester 1/2015
Mid-Term Examination

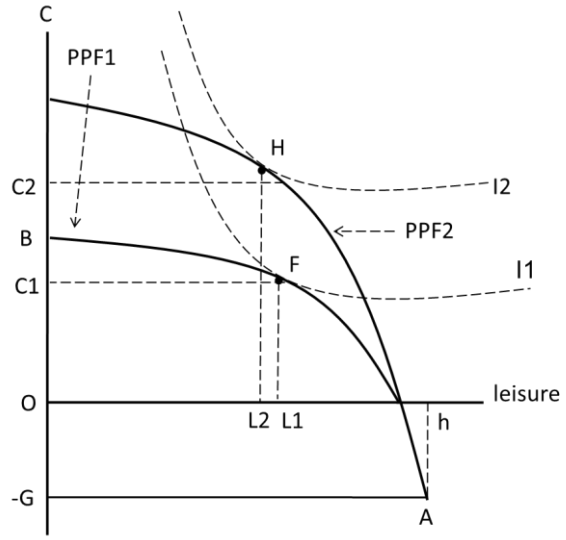
Date: Wednesday 7 October 2015
Time: 11:00 – 13:00 hr.

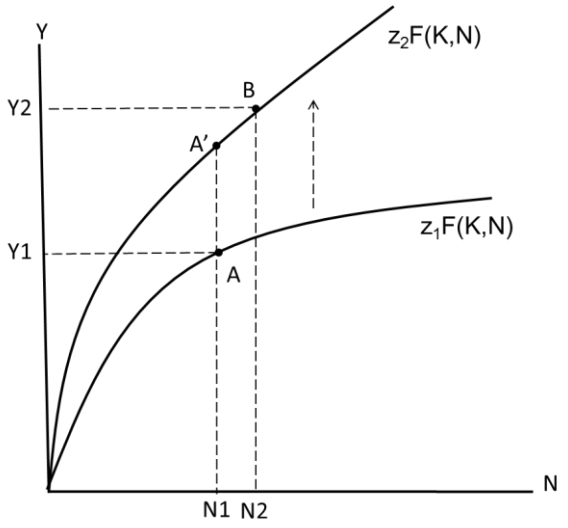
Questions:

1. Assume that total factor productivity increases in **the Closed-Economy, One-Period Macroeconomic Model**. Analyze the effects of the productivity increase on aggregate output, consumption, employment and the real wage. (10 points)

Answer:

The initial competitive equilibrium is at point F where the firm's Production Possibility Frontier, PPF1, touches the consumer's highest indifference curve I1. At A, the firm maximizes profit and the consumer maximizes utility at the real wage rate equal to the slope of the PPF ($MRT_{C,L}$) and I1 ($MRS_{C,L}$). The optimal consumption bundle for the consumer is consumption goods equal to c1 and leisure equal to L1. So the consumer's working time (and labor supply) is h – L1.





The increase in total factor productivity (z) from z1 to z2 causes the production function to rotate upwards from Y1 = z1F(K,N^d) to Y2 = z2F(K,N^d), given capital (K) and labor (N^d) inputs. The slope of the production function at A increases to A' at the initial level of labor input. The marginal product of labor (MP_N) is higher, inducing more demand for labor by the firm which offers a higher real wage (MP_N = w).

The upward rotation of the production function causes the PPF1 to shift upwards to PPF2. The competitive equilibrium changes from F to H. The real wage increases as the slope of PPF2 at H is steeper than the slope at F.

The increase in the real wage has the substitution effect and income effect. **The substitution effect** causes the consumer to increase consumption goods and reduce leisure (because the cost of leisure has become higher). **The income effect** causes the consumer to increase both consumption goods and leisure (both are normal goods). In short, consumption goods will increase from C1 on PPF1 to C2 on PPF2, but the change in leisure (and labor supply) is unclear.

Here we assume **a stronger substitution effect**. So leisure decreases from L1 to L2 and labor supply increases from (h – L1) to (h – L2). Employment increases from N1 to N2 and, through the production function, output increases from Y1 to Y2. The real wage is still higher at the new competitive equilibrium as the slope of the production function at C is still steeper than at A.

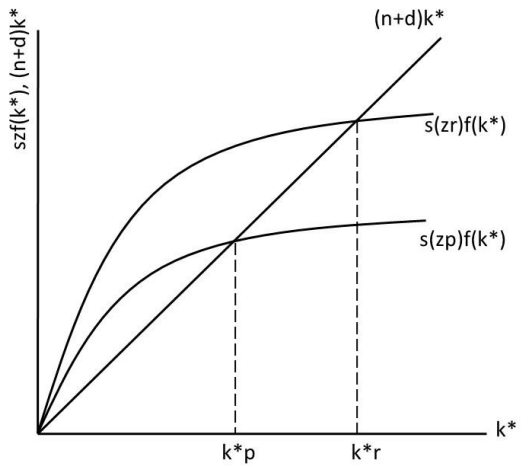
In conclusion, the increase in total factor productivity results in higher consumption, lower leisure, higher employment, higher output and income and a higher real wage (assuming the stronger substitution effect).

Note: students may assume a stronger income effect or equal substitution and income effects.

2. In **the Solow growth model**, the long-term growth process is determined by four exogenous parameters: the saving rate (s), the population growth rate (n), the depreciation rate (d) and total factor productivity (z). How does the Solow growth model explain the lack of absolute convergence (of capital per worker and output per worker) between rich countries and poor countries? (10 points)

Answer: Absolute convergence of income per capita occurs when the poor and rich countries have the same values of these four parameters. They will converge to the same steady-state capital per worker (k*) and output per worker (y*) over the long run although the poor country starts at a lower level of capital per worker and output per worker. The poor country will also have temporary higher growth to catch up with the rich country.

One reason for the lack of absolute convergence is that the poor and the rich countries have different values of the saving rate (s), the population growth rate (n) and total factor productivity (z). (We cannot assume depreciation rates among countries to be much different.) So the poor and the rich countries will have their own respective steady-state capital per worker and output per worker. Each will converge towards its own steady-state value --- what is called '**conditional convergence**'.



However, the observed differences in the values of s and n are not large enough to explain the existing large differences in income per capita between the poor and the rich countries. Thus, the remaining difference in income per capita must be a result of the difference in the value of total factor productivity. The rich country has a higher value of z (at zr) while the poor country has a lower value of z (at zp). Hence, the rich country has higher steady-state capital per worker (k*r) and output per worker while the poor country will have lower steady-state capital per worker (k*p) and output per worker. The poor country will never catch up with the rich country in terms of income per capita at the steady state.

Somehow, the poor country encounters barriers to technology adoption such as labor legislation, trade protectionism, political corruption and undeveloped financial systems, so that it has a lower value of total factor productivity.

3. In **the endogenous growth model**, assume the following variables:

Y = output
C = consumption
z = marginal product of the efficiency units of labor
H and H' = the levels of current and future human capital, respectively
b = the efficiency of human capital accumulation technology; and
u = time allocated to producing output.

Derive the competitive equilibrium condition. What are the growth rates of consumption, output and human capital? Explain why economic growth is unbounded in the model? And how does the model explain the lack of absolute convergence between rich and poor countries? (10 points)

Answer: The consumer's budget constraint is total labor earnings from supplying efficiency units of labor (uH^s) :

$$C = wuH^s$$

And the accumulation of human capital is expressed by:

$$H^{s\prime} = b(1-u)H^s$$

The firm's production function is given by:

$$Y = zuH^d$$

So the firm's profit function is total output (or total revenue minus labor cost):

$$\pi = Y - wuH^d$$
$$\pi = zuH^d - wuH^d$$
$$\pi = (z - w)uH^d$$

The firm maximizes profits at z = w which is also the firm's demand for efficiency units of labor (uH^d). The market clears when the demand and supply of efficiency units of labor are equal ($uH^d = uH^s$). Current output (Y) produced by the firm is equal to current consumption (C) by the consumer:

$$Y = C = zuH$$
$$H' = b(1-u)H$$

The growth rate of human capital is determined by:

$$\frac{H'}{H} - 1 = b(1-u) - 1$$

Current consumption is equal to C = zuH and future consumption is C' = zuH'. Therefore,

$$\frac{C'}{C} - 1 = \frac{zuH'}{zuH} - 1 = \frac{H'}{H} - 1 = b(1-u) - 1$$

Output is also growing at the same rate as consumption as Y = C. So both output and consumption grow at the rate of b(1-u) – 1.

Economic growth in the model is unbounded because the accumulation of human capital is not subject to diminishing returns to scale. The reason is that knowledge is '**non-rivalry**'. One's acquisition of knowledge does not reduce others' ability to acquire the same knowledge. No limit on how productive a person can be, given increasing knowledge and skills. Human capital also has **positive externalities**. One individual's high level of human capital has positive effects on other individuals' human capital and their productivity. So there is no limit on human capital accumulation and economic growth.

There is no absolute convergence between rich and poor countries because rich countries have higher levels of human capital than poor countries. Even if rich and poor countries have the same human capital accumulation technologies (b) and the same time allocated to current production (u) so that they have the same long-run growth rates of human capital, consumption and output at b(1-u)-1, poor countries will never catch up with rich countries.

Poor countries also have lower levels of human capital. They have less contact with rich

countries. So they receive little positive externalities from human capital in rich countries. Poor countries also lose their existing human capital through brain drain problems.