

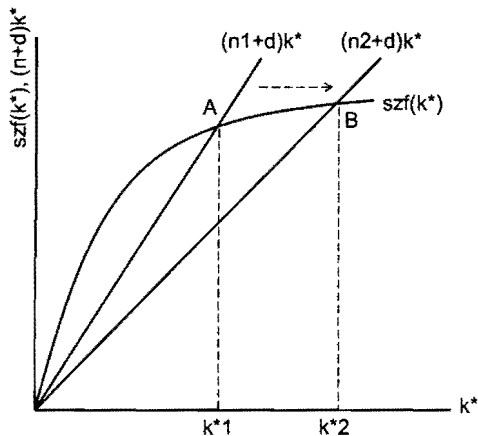
**EE312 Macroeconomics**  
**Semester 1/2013**  
**Mid-Term Examination**

Date: Wednesday 2 October 2013  
 Time: 11:00 – 13:00 hr.

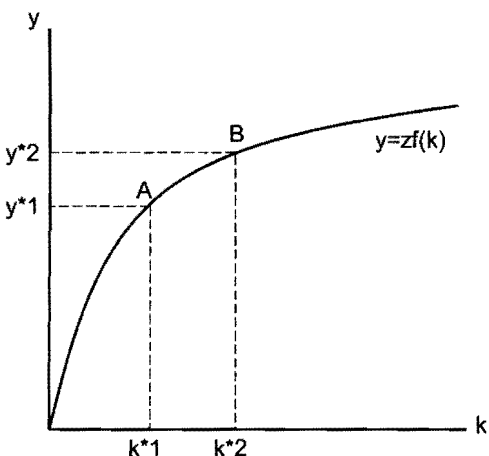
**Questions:**

1. In the **Solow growth model**, suppose the population growth rate ( $n$ ) in the economy decreases. Analyze the effects of the decrease in the population growth rate on the quantity of capital per worker and output per worker in the steady state. Give the economic reason of why capital per worker and output per worker in the steady state change in that way. (10 point)

**Answer:**



The economy starts at point A where steady-state saving  $[szf(k^*)]$  equals steady-state investment  $[(n1+d)k^*]$ . Steady-state capital per worker is equal to  $k^*1$  and steady-state output per worker equal to  $y^*1$ . As the population growth rate is  $n1$ , steady-state aggregate output ( $Y$ ) and steady-state aggregate capital ( $K$ ) are also growing at the rate of  $n1$ .



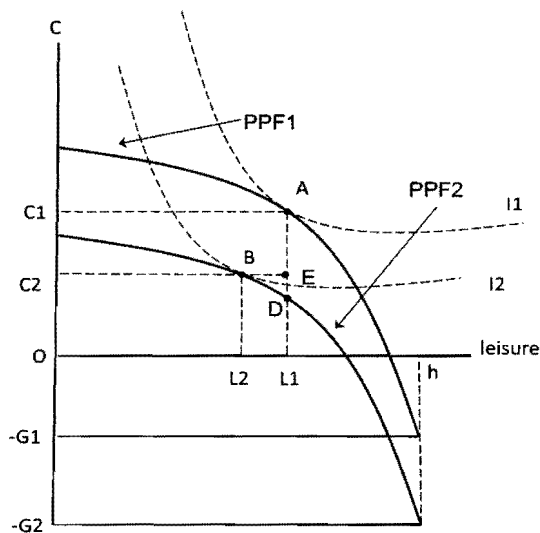
Now assume the population growth rate decreases from  $n1$  to  $n2$ . As the slope of the steady-state investment line is  $(n+d)$ , the decrease in  $n$  causes the steady-state investment line to rotate downwards to  $(n2+d)k^*$ . The new steady-state investment line is equal to the saving curve,  $szf(k^*)$  at point B. So steady-state capital per worker increases from  $k^*1$  to  $k^*2$ . And through the per worker production function, steady-state output per worker also increases from  $y^*1$  to  $y^*2$ . At the new steady state, the economy will have higher capital per worker and output per worker while aggregate capital and aggregate output are growing at the new rate of  $n2$ .

The economic reason is as follows. Initially, when the population growth rate decreases from  $n1$  to  $n2$ , aggregate capital ( $K$ ) is still growing at

the initial, higher rate of  $n_1$ . So in the transition period from point A to point B, aggregate capital is growing faster than population, resulting in rising capital per worker and output per worker. However, additional capital per worker becomes less productive due to diminishing returns in the per worker production function. As a result, capital per worker, output per worker and saving per worker  $[szf(k)]$  are all increasing at decreasing rates. The growth rate of aggregate capital and aggregate output is falling. Finally at point B, the new steady-state saving equals the new steady-state investment again where capital per worker is steady and aggregate capital and aggregate output are growing at the new, lower rate of  $n_2$ .

2. Suppose the government decides to increase spending. Use **the Closed-Economy, One-Period Macroeconomic Model** to determine the effects of the spending increase on aggregate output, consumption, employment and the real wage. (10 points)

**Answer:**



The initial competitive equilibrium is at point A where the firm's PPF1 touches the consumer's highest indifference curve  $I_1$ . At A, the firm maximizes profit and the consumer maximizes utility at the real wage rate equal to the slope of the PPF and  $I_1$ . The optimum consumption bundle for the consumer is consumption goods equal to  $c_1$  and leisure equal to  $L_1$ . So the consumer's working time (and labor supply) is  $h - L_1$ .

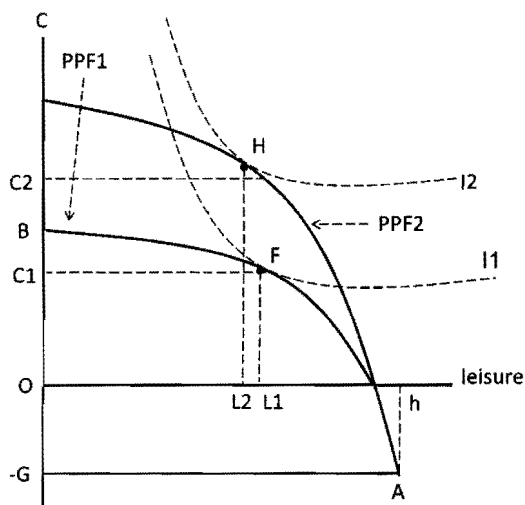
The government increases spending ( $G$ ), causing taxes to increase ( $G = T$ ). Non-wage income ( $\pi - T$ ) and the disposable income decrease. This is a negative income effect. The consumer reduces both consumption goods ( $C$ ) and leisure ( $L$ ) as they are normal goods. Less leisure is equivalent to an increase in working time ( $h - L$ ). The consumer supplies more labor service ( $N^s$ ). The real wage ( $w$ ) drops to induce more labor demand ( $N^d$ ) by the firm. Employment increases. More labor input in production results in larger total output ( $Y$ ).

The increase in government spending and taxes causes the PPF1 to shift down to PPF2 as  $G = T$  increases from  $G_1$  to  $G_2$ . The competitive equilibrium moves from point A to point B at a lower indifference curve  $I_2$ . The optimum amount of consumption goods drops from  $C_1$  to  $C_2$  while leisure decreases from  $L_1$  to  $L_2$ . The consumer's working time increases from  $h - L_1$  to  $h - L_2$ . The real wage decreases because the slope of the PPF2 and  $I_2$  at point B is less steep than at point A. The drop in consumption (the distance  $C_1C_2=AE$ ) is smaller than the increase in government spending (the distance  $G_1G_2=AD$ ).

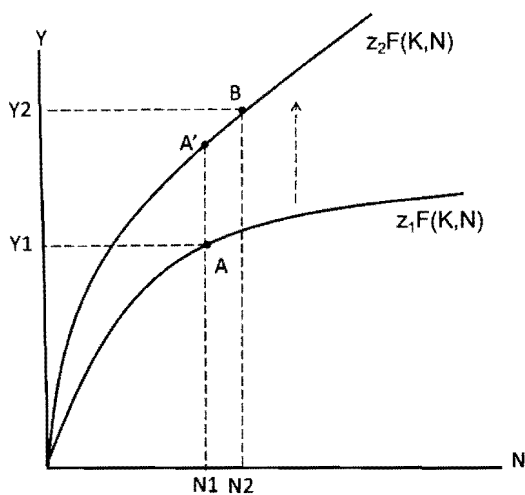
In conclusion, an increase in government spending results in larger total output, lower consumption, higher employment and a lower real wage. The increase in government spending partially crowds out consumption because higher taxes reduce disposable income. The consumer works more at a lower real wage and receives less consumption goods. Consumer welfare and utility are lower.

3. 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  $c_1$  and leisure equal to  $L_1$ . So the consumer's working time (and labor supply) is  $h - L_1$ .



The increase in total factor productivity ( $z$ ), from  $z_1$  to  $z_2$  causes the production function to rotate upwards from  $Y_1 = z_1F(K,N^d)$  to  $Y_2 = z_2F(K,N^d)$ , 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  $C_1$  on PPF1 to  $C_2$  on PPF2, but the change in leisure (and labor supply) is unclear.

Here we assume a **stronger substitution effect**. So leisure decreases from  $L_1$  to  $L_2$  and labor supply increases from  $(h - L_1)$  to  $(h - L_2)$ . Employment increases from  $N_1$  to  $N_2$  and, through the production function, output increases from  $Y_1$  to  $Y_2$ . 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.