14.01 Fall 2010
Problem Set 9

1. **(28 points) R&D and effect of government borrowing**

   A pharmaceutical company is considering whether to invest in the research and development of a new drug. It will incur a cost of $100 million starting in this year for 10 years, and it will get a patent that is worth $1.5 billion at the beginning of the 11th year. Alternatively to the R&D project, the firm can expand advertising for an already existing drug, which will increase its profits by $10 million forever. The interest rate in the economy is 5% and is constant over time.

   (a) (7 points) What's the present value of the project? Write an expression for the net present value.

   (b) (7 points) Suppose that the internal rate of return on the project is 5.28%. Will the project be undertaken? Why?

   (c) (7 points) The government is considering increasing government consumption. Suppose that the market supply of funds is given by $Q_S = i$, where Q_S is funds supplied per year (in billion) and i is the interest rate. Market demand for funds is given by $Q_D = 10 - i$. The government is considering permanently increasing annual borrowing by $1 billion. Will the project get undertaken now? Why?

   (d) (7 points) Given your results in part (c), discuss why a fiscal expansion could hurt productivity growth in the long run.

   Problem 1 courtesy of Plamen Nenov. Used with permission.

2. **(28 points) Intertemporal consumption and savings supply**

   Suppose that there are only 10 individuals in the economy, each with the following utility function over present and future consumption:
   $$U(c_1, c_2) = c_1 + c_2$$
   where c_1 is consumption today, and c_2 is consumption tomorrow. Buying 1 unit of consumption today costs $1 today, and buying 1 unit of consumption tomorrow costs $1 tomorrow. All individuals have income of $10 dollars today and no income tomorrow (they are retired tomorrow), but they can save at the market interest rate $r \geq 0$.

   (a) (7 points) What is the price today of one unit of consumption tomorrow? Why?

   (b) (7 points) Write an expression for an individual's budget constraint in terms of today's and tomorrow's consumption expenditure.

   (c) (7 points) How much of their income would an individual consume, and how much would they save, given the interest rate of r?

   (d) (7 points) Suppose that the market demand for funds is given by $Q_D = 100 - i$. What is the market supply for funds? What is the equilibrium interest rate that clears the capital market? What is aggregate consumption at that interest rate?

   Problem 2 courtesy of Plamen Nenov. Used with permission.

3. **(15 points) Demand for flu shots**

   The demand for flu shots this season is given by: $P = 13 - 0.0005Q$. The marginal cost of a flu shot is $8.

   (a) (5 points) In a competitive market, what are the equilibrium price and quantity of flu shots?

   (b) (5 points) The social benefit of flu shots is $SB = 13Q - 0.0005\frac{Q^2}{4}$. What is the socially optimal quantity in the market? Compare your result here to the quantity in part (a). Explain any differences you see.

   (c) (5 points) What government policies could be implemented to achieve the social optimum in this case?

4. **(29 points) Government Redistribution and Social Welfare**

Consider an economy with only one good, food. There are three people in the economy, A, B and C. A has 400 units of food, B has 100 units, and C has only 16 units. All have the same utility, $U_i = \sqrt{f}$ for $i = A, B, C$. The social welfare function for this society is the sum of the utilities of the three individuals.

(a) (6 points) If each agent simply consumes their own endowment, what is the utility level for A, B and C? Find the social welfare level.

(b) (8 points) The government decides to redistribute food more equally, so it takes 175 units from A and gives them to B. However, the government spoils 79 of these units in transportation, so B ultimately gets only 96 units of food. What is each person's utility level now? Find the social welfare level in this case.

(c) (8 points) Assume now that the government considers a different redistribution scheme. Starting with the original endowments, the government takes 175 units from A. This time it wishes to give them to C, but in transportation it destroys 91 units, so C only gets 84 of these extra units. What is each person's utility level now? Find the social welfare level in this case.

(d) (7 points) Compare parts (b) and (c) in terms of social welfare. Note that the government is more wasteful in (c), and explain your result.

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