ENGINEERING TRIPOS PART IIA

Business Economics 3E1

2013-2014

CRIBS

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Version 3

1 (a) With reference to the theory of the 'rational consumer':

(i) Explain and illustrate how consumer choices can be modelled as optimisation problems; [20%]

In rational consumer theory it is assumed that consumers are utility maximisers. They base their consumption decisions on their preferences and the identification of the possible bundles of goods and/or services they can afford to purchase. The first step of this answer involves explaining that the standard way in which preferences are modelled in microeconomics makes use of indifference curves (IC) When indifference (or utility) curves are conventionally shaped (i.e. the axioms of choice and the assumptions of non-satiation and strict convexity are respected), they will present diminishing marginal rates of substitution (MRS, the slope of the indifference curve, i.e. the rate at which a consumer is willing to substitute one good for another).

The second step of a good answer to this question involves the definition of the consumer budget constraint, which determines that set of affordable bundles of goods/services as $p_1x_1 + p_2x_2 \leq M$, where p_i is the price of good i, x_i is the quantity of good i, and M is income. This corresponds to a 'budget line' whose slope is the (negative) ratio of the prices of the goods. The final step is the presentation of the consumer's optimal choice as the solution to a utility maximisation problem subject to the budget constraint. Graphically, the consumer's problem is to choose the bundle of goods that lies on the highest IC, subject to satisfying the budget constraint represented by the budget line. This implies the identification of the tangency solution at which the marginal rate of substitution is equal to the (negative) ratio of the prices.

(ii) What are 'normal' and 'inferior' goods? [15%]

'Normal' goods are goods for which the quantity demanded increases (decreases) with a rise (fall) in income (as is the case for most goods and services). 'Inferior' goods are instead goods for which the quantity demanded decreases (increases) with a rise (fall) in income (examples: low-quality goods, such as cheap breakfast cereals, frozen meals and canned goods). The better students may include graphs with relevant indifference curves and budget constraints, and/or graphs plotting the relationship between quantity demanded and income as an Engel curve.

(iii) Define and graphically identify the 'substitution' effect and the 'income' effect generated by a change in the price of a normal good on the quantity demanded of that good. **[15%]**

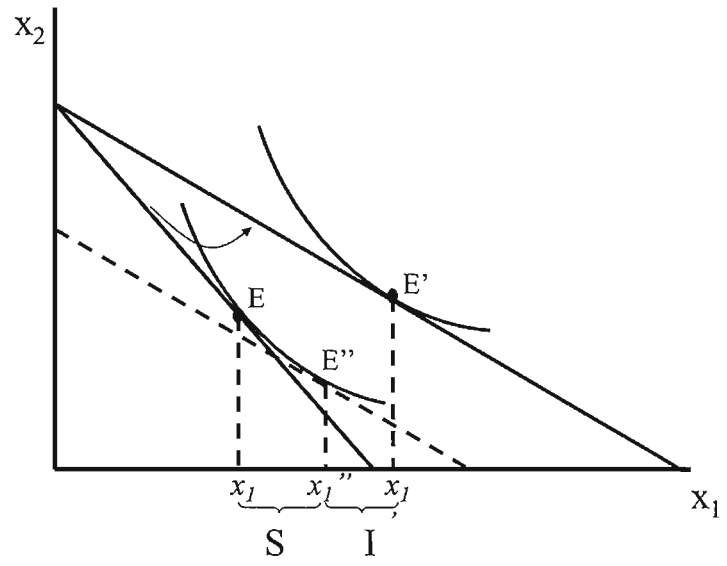
The effect of a change in the price of a good on the quantity demanded of that good may be decomposed into two components:

1) The substitution effect (S), corresponding to the change in quantity demanded that results from the change in relative prices (with utility held constant);
2) The income effect (I), corresponding to the change in quantity demanded that results from the change in utility (with relative prices held constant).

For a normal good these can be illustrated by means of the following graph (from the lectures). If the price of x_1 falls, the chosen bundle shifts from E to E' and the quantity demanded of x_1 increases from x_1 to x_1'. S and I can be identified by adding an extra budget line that reflects the new price ratio and the original level of utility. Faced with the extra budget line, the consumer would choose point E'', which identifies the S and I effects below.

The substitution effect is $(x_1'' - x_1)$

The income effect is $(x_1' - x_1'')$



(b) In the context of macroeconomic analysis:

(i) Define the concept of investment; **[10%]**

An essential component of aggregate demand, investment is defined as new spending on capital goods (physical assets) which will allow increased output of goods and services in the future. Investment has a direct impact on productive capacity in individual industries and an indirect impact on the benefit consumers will derive from goods produced by means of the new capital goods, when these embody technological progress. The better students will be able to distinguish business fixed investment (i.e. firms' spending on equipment for use in

production), residential investment (i.e. purchases of new housing units) and inventory investment (i.e. the value of the change in inventories of finished goods, materials and supplies, and work in progress).

(ii) Identify and explain the role of each component of the following investment function:

$$I = I_n\,[MPK - (P_K/P)(r + \delta)] + \delta K \qquad \textbf{[25\%]}$$

The fundamental point about this (gross) investment function is that investment (I) is a function of the real interest rate r (the nominal interest rate corrected for inflation). The real interest rate is the cost of borrowing and the opportunity cost of using one's own funds to finance investment spending. Firms will invest in new capital when the benefit of doing so exceeds the cost (that is to say when the profit rate – in brackets – is positive). The benefit (per unit of capital) is defined as R/P where R is the nominal rental rate and P is the price of output. At the profit maximizing point of production, this benefit is equal to the marginal product of capital MPK. The real costs of capital positively depends on the relative price of capital (P_K/P), the real interest rate r and the depreciation rate δ. $I_n[\ ]$ is thus a function that shows how net investment responds to incentives to invest. In order to obtain gross investment (total spending on business fixed investment) we add the replacement of depreciated capital δK. The better students may include these graphs to illustrate that:

(iii) What other factor or factors not captured in the function above may also influence investment, and in what way? [15%]

Investment projects involve a degree of risk, and often uncertainty of revenue streams (particularly in industries and markets that are sensitive to cyclical and exchange rate fluctuations). Costs also are subject to change over time and there is no guarantee that a project will yield the expected (or required) rate of return. Changes in *business confidence* can have a substantial impact on planned capital spending projects. Confidence is affected by many factors, but is heavily driven expectations which may or may not be rational. A drop in business optimism can lead to delays in capital projects being given the go ahead or cancellations of entire projects. Other factors that can have a significant impact on investment include the firm's profitability, public policies (incl. erratic government policies may lead to increased uncertainty and decreases in investment), inadequate financial systems, overemphasis on dividends in the stock market (i.e. distorted incentives for the firm) and technological shocks.

2 (a) With reference to the theory of the profit maximising firm:

(i) Why is profit maximised at the level of output at which marginal revenue equals marginal cost? [15%]

The profit maximising firm will chose to produce at the point at which an extra unit of output adds to costs as much as it adds to revenues. Formally, this is the point at which the rates of change of costs and of revenues with respect to output are equal to one another. The firm solves the maximisation problem: max TR(Q) – TC(Q). The first order condition for the finding the maximum is: MR(Q) – MC(Q) = 0. Therefore it must be true that profits are at their optimal level when MC(Q) = MR(Q).

(ii) What is a Cobb-Douglas production function and how may it be used to explain the firm's optimal choice of capital and labour? [15%]

A production function describes the relationship between the inputs a firm employs and the output it produces. The function represents the state of technology. A standard Cobb-Douglas production function simplifies to two factors all relevant inputs and has the form $Q = AK^{\alpha}L^{\beta}$, where Q is output, K is capital, L is labour, with parameters A, α and β. Firms' technologies can be represented by isoquants, showing combinations of inputs that produce the same amount of output, as level curves of the production function. Conventionally shaped isoquants are smooth and strictly convex to the origin, and therefore exhibiting a degree of substitutability between inputs. Graphs can be included to illustrate. The better students will explicitly refer to the 'Law' of diminishing marginal product and the marginal rate of technical substitution to explain the standard shape of isoquants. The students may choose any example of Cobb-Douglas and should be able to comment on the returns to scale of the chosen function.

(iii) Explain how the firm's profit maximisation problem differs in the long run relative to the short run. [20%]

First, it is expected that the students appropriately define the short- and the long-run. In a simple two-input case it is usually assumed that capital (K) is fixed in the SR (e.g. at K_1) while labour (L) is variable. Total costs (TC) of production depend on factor use and factor prices can be calculated as: $TC = wL + rK$, where w is the labour's wage and r is capital's rental rate (i.e. w and r are the factor prices). In the SR, total costs are made up of variable costs and fixed costs: $STC = wL + rK_1$. In the LR, however, there are no fixed costs by definition and the firm will choose the level of all inputs that maximises profits.

In the long run the firm will solve: max $pf(K, L) - wL - rK$, where p is the price of output. The optimal choice of inputs, K^* and L^* will be at $pMP_L(K^*, L^*) = w$ and $pMP_K(K^*, L^*) = r$.

This means that profits are maximised when the marginal products of the factors of production are equal to their costs. In the short run the only choice for the firm is the amount of the variable factor, L, since the other factor, K, is fixed. The firm will solve: max $pf(K_1, L) - wL - rK_1$ .The only condition for optimal choice in the SR is $pMP_L(K^*, L^*) = w$.

(b) Describe the standard Solow growth model. **[20%]**

The Solow model applies a production function approach to the problem of economic growth. It posits that in aggregate and simplified terms $Y = F(K, L)$, where Y is output, K is capital and L is labour. The function gives the output that can be produced by using specified quantities of inputs, given existing technical knowledge. The Solow model uses a 'per worker' production function where all endogenous variables are made to depend on k (capital per worker (K/L). The fundamental idea is that investment increases the capital stock while depreciation reduces it, so that changes in capital stock $\Delta k = i - \delta k$. Investment i depends on the saving rate s. Since $I = sf(k)$, this can be expressed as $\Delta k = s f(k) - \delta k$. If investment is just enough to cover depreciation, capital per worker will remain constant ($\Delta k = 0$). This occurs at one value of k, usually denoted k^*, called the steady state capital stock. The main prediction of the Solow model is that the higher the saving rate, the higher k^*. Because investment is positively related to income, the higher the steady state capital stock the higher the income (per person) in the macroeconomy.

(c) With reference to the Solow growth model described in (b):

(i) What is 'the golden rule' level of capital? **[15%]**

The Golden Rule level of capital is the steady state value of k that maximizes consumption. The problem posed by the model is that different values of the saving rate lead to different steady states. It is however possible to identify the 'best' state as the one that achieves the highest possible consumption per person (c^*), defined as a function of s, k^* and y^*: $c^* = (1-s) f(k^*)$.

(ii) Discuss the limitations of the model. **[15%]**

The student is expected to critically assess the theoretical and empirical limitations of the Solow model. This assumes: that a production function is an effective way to model growth; no 'inefficiencies' or 'aggregate demand failures' in the macroeconomy; full employment; the aggregate production function displays decreasing returns to any single factor; constant returns to scale; capital and labour are homogenous and substitutable with one another; and finally – and most importantly – technology is exogenous. Estimations of the model with real data showed that it was not capital accumulation that explained the largest share of the variance of output. It was the parameter A, 'the Solow residual' – taken to represent

technology – which explained changes in aggregate income over time. Empirically, only technical change can explain persistent increases in per capita growth. The major problem is that in the Solow model technology is exogenous. The better students will be able to mention the advances of New Growth Theory, where knowledge and technology are endogenous, and of the National Innovation Systems approach to science and technology in different macroeconomic contexts.

3 (a) In relation to the problem of making strategic choices in an oligopoly market:

(i) What is a 'Nash equilibrium'? Define the concept and provide an example in a normal form game; [20%]

A Nash Equilibrium (NE) is a solution concept widely used in game theory and in the microeconomic analysis of strategic behaviours. A NE is a set of strategies, one for each player, such that each player's strategy is a best response to the other players' strategies. The intuition behind NE is that the solution to a game must not leave any player with an incentive to change what they are doing, given the actions of their opponents. A game may have many, one or no NE.

The students are expected to provide an example of NE by using any normal form game with a NE as a possible solution (Prisoner's dilemma, co-ordination games. etc.). They should correctly structure the players' strategies and associated payoffs in a matrix where players make simultaneous choices. They should then identify and explain the game's NE.

(ii) Define the Cournot model and illustrate it by means of appropriate diagrams; [20%]

The Cournot model is an oligopoly model that assumes:

- A small number of firms, producing similar (identical or differentiated) goods
- Simultaneously choices of output levels, with the market determining the price at which this output sells
- Barriers to entry (which imply no possible threat from firms outside the industry, and therefore an opportunity for positive profits in the long run).

In a Cournot model with two firms (duopoly) producing identical products, each firm chooses its optimal (i.e. profit maximising) level of output, but the profit (i.e. payoff) it achieves for any particular quantity of output depends not only on its chosen output but also on the quantity produced by its competitors (total industry output determines the price each firm receives for its own output). It is therefore possible to specify two reaction functions, one for each firms, summarising the amount of output one firm should produce in order to maximize its profits for any given level of output produced by the other firm. Since the products are substitutes, if firm 2 produces a low level of output firm 1's profit-maximizing level of output will be high, and vice versa.

The students should be able to draw the firms' reaction functions and the isoprofit curves that identify the equilibrium of the model.

(iii) Explain why the optimal solution of a Cournot model is a Nash equilibrium. **[10%]**

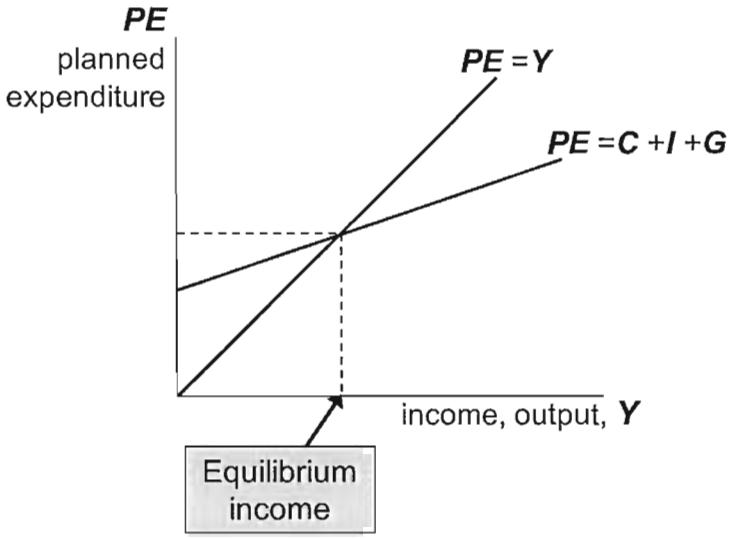
At the equilibrium of the Cournot model, nether firm has an incentive to change its output, given the output of its rival. The reaction function follows the same logic of the concept of 'best response' in game theory. The Cournot Equilibrium consists of a set of outputs, one for each firm, whereby each firm is maximising its own profit given the output decisions of rival firms. In this situation no firm has an incentive to unilaterally change its output. The Cournot Equilibrium is therefore the Nash Equilibrium of the one-shot, simultaneous quantity-setting game.

(b) In relation to the role of government spending in the macroeconomy:

(i) Set out in diagrammatic form the concept of the 'Keynesian cross' relating planned and actual expenditures; **[20%]**

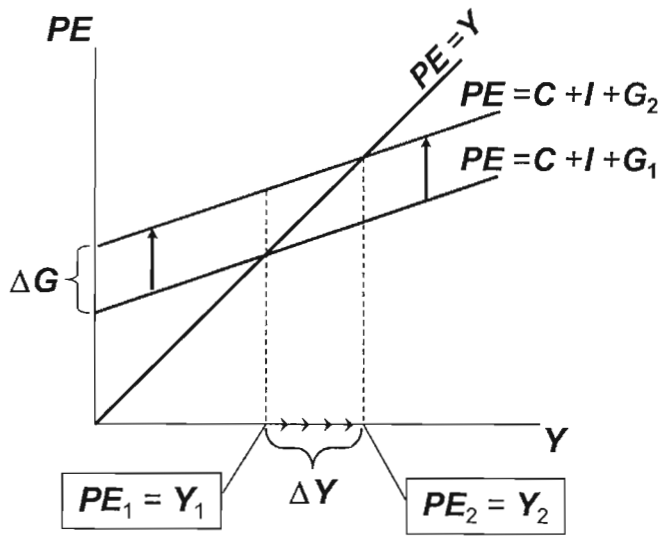
The Keynesian cross is a theoretical approach to modelling the macroeconomy which involves the identification of actual and planned expenditure functions. In a simple closed-economy model in which income is determined by expenditure, $PE = C + I + G$ (planned expenditure) and Y = real GDP = actual expenditure. The difference between actual and planned expenditure represents unplanned inventory investment.

Consumption is a function of income and taxes. With exogenous I, G and T, the equilibrium value of income is identified at the point at which actual expenditure is equal to planned expenditure.



(ii) Use the Keynesian cross to identify the effects on national income generated by an increase in government spending; [20%]

The Keynesian cross makes it possible to identify the implications of changes in government expenditures and taxes for the national income. An increase in government spending shifts planned expenditure upwards, as illustrated in the diagram below (from the lectures).

At Y_1, there is an unplanned drop in inventory. The consequence is that firms increase output, and income rises toward a new equilibrium (new intersection with the actual income curve).	

Solving $Y = C + I + G$ for ΔY gives $\Delta Y = \Delta C + \Delta I + \Delta G$. Holding I constant, $\Delta Y = \Delta C + \Delta G$, and thus $\Delta Y = MPC \times \Delta Y + \Delta G$ where MPC is the marginal propensity to consume. $\Delta Y = 1/(1\text{-}MPC) \times \Delta G$, which identifies the government multiplier $1/(1\text{-}MPC)$. This implies an increase in income greater than the initial increase in G because as increase in income positively affects consumption, which further increases income etc.

(iii) Define the concept of 'tax multiplier'. [10%]

A tax multiplier measures the change in aggregate income generated by changes in government taxes. It is obtained by finding the equilibrium condition of the Keynesian cross holding G and I constant. It is equal to $(-MPC/1-MPC)$, where MPC is the Keynesian marginal propensity to consume. The better students may add that if the tax multiplier is negative, a tax increase reduces C, which reduces income. If it is greater than one (in absolute value), a change in taxes has a multiplier effect on income. If it is smaller than the government spending multiplier, consumers will save the fraction $(1 - MPC)$ of a tax cut, so the initial boost in spending from a tax cut is smaller than from an equal increase in G.

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