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QUESTION PAPER

June – 2024

(Solved)

MICROECONOMIC ANALYSIS

MEC-101

Time: 3 Hours] *[Maximum Marks: 100*

Note: *Answer questions from each section as per instructions given.*

SECTION-A

Note: **Answer any two questions from this Section.**

Q. 1. ***(a)*** **Utility function of an individual is given by**

$U = f(x, y) = x^{3/4} y^{1/4}$.

Find out the optimal quantities of the two goods using Lagrangian method, given that price of good x is ₹ 6 per unit, price of good y is ₹ 3 per unit and income (I) of the individual is equal to ₹ 120.

Ans. To solve this problem using the Lagrangian method, we start by setting up the Lagrangian equation. The utility function and the budget constraint are given as follows:

Utility function: $(U(x,y) = x^{3/4} y^{1/4}$

Budget constraint: $(6x + 3y = 120)$

Step 1: Set up the Lagrangian: The Lagrangian (L) is set up by combining the utility function and the budget constraint (multiplied by a Lagrange multiplier, (λ)):

$[£ = x^{3/4} y^{1/4} + \lambda\,(120 - 6x - 3y)]$

Step 2: Take partial derivatives: We take the partial derivatives of (£) *withrespectto (x)*, *(y)*, and (λ), and set them to zero to find the critical points.

Derivative with respect to *(x)*:

$$\frac{\partial £}{\partial y} = \frac{3}{4} x^{-1/4} y^{1/4} - 6\lambda = 0$$

Derivative with respect to (y):

$$\frac{\partial £}{\partial y} = \frac{1}{4} x^{3/4} y^{-3} - 3\lambda = 0$$

Derivative with respect to (λ):

$$[\frac{\partial £}{\partial \lambda} = 120 - 6x - 3y = 0]$$

Step 3: Solve the equations: From the derivatives with respect to (x) and (y):

$$\frac{3}{4} x^{-1/4} y^{1/4} = 6\lambda$$

$$\frac{1}{4} x^{3/4} y^{-3/4} = 3\lambda$$

Divide the first equation by the second:

$$\frac{\frac{3}{4} x^{-1/4} y^{1/4}}{\frac{1}{4} x^{3/4} y^{-3/4}} = \frac{6\lambda}{3\lambda}$$

$$[3x^{-1} y = 2]$$

$$[y = \frac{2}{3} x]$$

Substituting $(y = \frac{2}{3} x)$ into the budget constraint:

$[6x + 3\left(\frac{2}{3} x\right) = 120]$

$[6x + 2x = 120]$

$[8x = 120]$

$[x = 15]$

Then, substituting $(x = 15)$

$[y = \frac{2}{3}\,(15) = 10]$

The optimal quantities of goods (x) and (y) that maximize the individual's utility given the budget constraint are ($x = 15$) units of good (x) and ($y = 10$) units of good (y).

(b) **There are two commodities X_1 and X_2 on which a consumer spends his entire income in a day. He has utility function $U = \sqrt{X_1 X_2}$. Find out the optimal quantity of X_1 and X_2 if price of X_1 and X_2 are ₹ 5 and ₹ 2 respectively and his daily income equals ₹ 500.**

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Ans. We are tasked with finding the optimal quantities of two commodities, (X_1) and (X_2), that maximize the utility of a consumer given their utility function, prices, and income constraint. The utility function is (U = $\sqrt{X_1X_2}$, and the consumer has an income constraint of Rs. 500.

Step 1: Define the budget constraint:

Let:

– ($P_1 = 5$) (*the price of* (X_1))

– ($P_2 = 2$) (*the price of* (X_2))

– *Income* (M = 500)

The budget constraint is:

$P_1 X_1 + P_2 X_2 = M$

Substitute the values of (P_1), (P_2), and (M):

$5X_1 + 2X_2 = 500$ (1)

Step 2: Set up the utility maximization problem: The consumer wants to maximize utility (U = $\sqrt{X_1X_2}$) subject to the budget constraint. To do this, we use the Lagrangian method.

The Lagrangian is:

$£ = \sqrt{X_1X_2} + \lambda(500 - 5X_1 - 2X_2)$

Where (λ) is the Lagrange multiplier.

Step 3: Take the first-order conditions: We now take partial derivatives of (£) with respect to (X_1), (X_2), and (λ), and set them equal to zero.

1. Partial derivative with respect to (X_1):

$$\frac{\partial £}{\partial X_1} = \frac{1}{2} \cdot \frac{X_2}{\sqrt{X_1X_2}} - 5\lambda = 0$$

This simplifies to:

$$\frac{X_2}{2\sqrt{X_1X_2}} = 5\lambda \qquad (2)$$

2. Partial derivative with respect to (X_2):

$$\frac{\partial £}{\partial X_2} = \frac{1}{2} \cdot \frac{X_1}{2\sqrt{X_1X_2}} - 2\lambda = 0$$

This simplifies to:

$$\frac{X_1}{2\sqrt{X_1X_2}} = 2\lambda \qquad (3)$$

3. Partial derivative with respect to (λ) (budget constraint):

$$\frac{\partial £}{\partial \lambda} = 500 - 5X_1 - 2X_2 = 0 \qquad (4)$$

Step 4: Solve the system of equations: Now, we solve the system of equations (2), (3), and (4).

From equations (2) and (3), we can eliminate (λ). Dividing equation (2) by equation (3):

$$\frac{\frac{X_2}{2\sqrt{X_1X_2}}}{\frac{X_1}{2\sqrt{X_1X_2}}} = \frac{5\lambda}{2\lambda}$$

This simplifies to:

$$\frac{X_2}{X_1} = \frac{5}{2}$$

Thus, we have the ratio:

$$X_2 = \frac{5}{2} X_1 \qquad (5)$$

Step 5: Substitute into the budget constraint: Now, substitute equation (5) into the budget constraint (equation (1)):

$$5X_1 + 2\left(\frac{5}{2}X_1\right) = 500$$

Simplifying:

$$5X_1 + 5X_1 = 500$$
$$10X_1 = 500$$
$$X_1 = 50$$

Step 6: Solve for (X_2): Using equation (5), we substitute ($X_1 = 50$) into the expression for (X_2):

$$X_2 = \frac{5}{2} \times 50$$

The optimal quantities of (X_1) and (X_2) that maximize the consumer's utility, given the prices and income constraint, are:

$X_1 = 50, X_2 = 125$

Q. 2. What do you mean by the concept of dynamic stability? In Cobweb model under what condition equilibrium is dynamically stable, when there is linear downward sloping demand and linear upward sloping supply curve?

Ans. Ref.: See Chapter-3, Page No. 25, 'Cobweb Model' and Page No. 27, Q.No. 4.

Q. 3. What do you understand by Walrasian dynamic stability? Derive the time path of a disequilibrium point under Walrasian dynamic stability analysis.

Ans. Ref.: See Chapter-3, Page No. 26, 'Lagged Adjustment in Interrelated Markets' and Page No. 28, Q.No. 5.

Q. 4. The following production function is given:

$Q = L^{0.75} K^{0.25}$

(a) **Find the marginal product of labour and marginal product of capital.**

Ans. Let's break down the production function and solve each part step by step:

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Sample Preview of The Chapter

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MICROECONOMIC ANALYSIS

Theory of Consumer Behaviour : Basic Themes

1

INTRODUCTION

Market aggregate demand curve for a commodity is downward sloping in a situation where market prices are given to consumers and they cannot influence the market prices by changing their consumption. Here, we will investigate the economic rationality behind this for a commodity of all individual consumers. This chapter will enable you to determine the optimum choice of a consumer, explain how the price effect can be decomposed into income effect and substitution effect and determine the individual demand curve. The market demand mainly depends on the nature of demand for a commodity by individual consumers and the demand for a commodity of an individual consumer depends upon the behaviour of the consumer. Now we will begin with the analysis of consumer behaviour to clearly investigate the economic rationality behind the law of demand.

CHAPTER AT A GLANCE

THE BASIC THEMES

The consumer behaviour can be analysed through different approaches. In all approaches, it is assumed that the consumer is rational and derives maximum utility from a given amount of money. He compares the marginal utility derived from one commodity bundle with the marginal utility derived from another commodity bundle and chooses one commodity bundle from among all the commodity bundles. The consumer distributes the resources which are with him in such a way that he derives maximum satisfaction.

The assumption will be based on the condition that the consumer has a fixed income and the prices of all goods are given and are fully known to the consumer.

CONSUMER CHOICE CONCERNING UTILITY

Every commodity which a consumer consumes yields some utility and the utility is a measurable concept. The consumer cannot maximize his satisfaction unless he measures utility of a commodity. Utility can be measured differently by different approaches. However, there are two main approaches:

1. Cardinal Theory : An Introduction

2. Ordinal Theory : A Short Note

1. Cardinal Theory: An Introduction

The cardinal utility approach is also known as marginal utility analysis. In this approach, utility derived from each commodity is measured on a cardinal scale or numerically in terms of money. It is a short period analysis and here the consumer knows which commodity is preferred and the price of that commodity.

Following are the main assumptions of the cardinal utility approach.

1. Consumer is rational. He aims at maximizing his utility by selecting one of the commodity bundles at given prices of commodities and money income.
2. The total utility of the consumer depends on the quantity of consumption, if the taste and preferences are given.
3. Goods are good. The marginal utility is positive. It means if 'U' is utility level of the consumer and 'x' the consumption level, as 'x' increases (decreases), 'U' increases (decreases).
4. Marginal utility of 'x' is diminishing or downward sloping. It means a 'x' increases (decreases), the MU_x (marginal utility of the consumption) decreases (increases).
5. Utility is measured cardinally or numerically in terms of money. Therefore, the consumer knows which commodity bundle is preferred and by how much amount.
6. The Marginal Utility of money (MU_m) is positive and constant. The validity of this assumption is that the money is used as a measuring rod of utility. Thus $MU_m = \lambda$, where λ is positive and constant. It means as money income increases (decreases) by one unit, utility increases (decreases) by λ unit.

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Consumer Equilibrium

As per the assumption, the gross unity the consumer gets is U(q) for 'q' unit of consumption of the commodity. Here, the consumer must spend p_q. q units of money income if p_q is the cost of the commodity 'q', which is given to the consumer. Thus, the net utility (N(q)) of the consumer will be $N(q) = U(q) - \lambda p_q . q$, where λ and p_q are provided to the consumer and λ represents fall in utility due to one unit fall in money income.

The consumer's objective is to maximize net utility N(q) by choosing 'q'. For that, we can take the first derivative of N(q) and set that equal to zero, $\frac{dN(q)}{dq} = 0$. Or, consumer equilibrium, we get $\frac{dU(q)}{dq} - \lambda\, p_q = 0$. From the first order condition, we can derive the maximum value of 'q' which is (say) $q^* = q^*(p_q, \lambda)$. The second order condition for utility optimization needs $\frac{\partial^2 N(q)}{\partial q^2} = \frac{\partial^2 U(q)}{\partial q^2} < 0$, which is ensured by the assumption of falling MU_q.

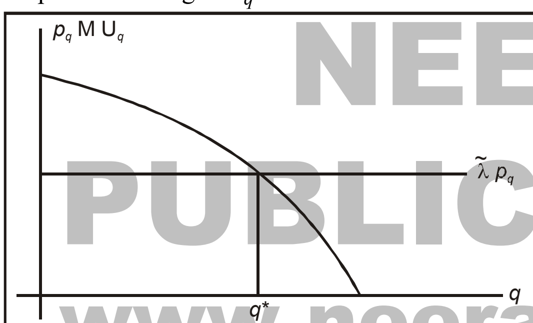

Fig. 1.1: Consumer Equilibrium in Cardinal Theory

2. Ordinal Theory: A Short Note

In ordinal method, utility of a commodity is measured ordinarily or qualitatively and not quantitatively or numerically. Here, the consumer can rank his preferences alternatively as per the order he wants to compare but not in terms of different amounts. Thus, it is more realistic measurement of utility. There are two types of approaches to measure utility in ordinal theory:

1. Indifferent Curve Approach
2. Revealed Preference Approach.

1. Indifferent Curve Approach: Indifference curve is made by taking utility level constant. Thus, different indifferent curves denote different level of utility for some consumers. The equilibrium is obtained when indifferent curve become tangent to the budget line or price line.

2. Revealed Preference Approach: In this approach, consumer equilibrium is obtained by ranking different bundle of goods in the commodity space. The consumer picks the best bundle for which his utility will optimize. Famous economist Paul A Samuelson is the founder of this method.

INTRODUCTION TO DEMAND ANALYSIS

Market demand curve or aggregate individual demand curves, is generally downward sloping. Individual demand curve is made by combining different consumer equilibrium for different prices. Here, the market price is fixed and given to the consumer. In neo-classical theory, demand curve can be obtained if the price is changed exogenously and join all the equilibrium points. In the following section, we will find the individual demand curve by using ordinal theory and taking indifferent curve approach.

ORDINAL THEORY: INDIFFERENCE CURVE APPROACH

In indifference curve approach, the objective of consumer is to maximize his utility by choosing a bundle of commodities among all other available commodity bundles (under budget constraint) where total utility depends on quantity of consumption given his taste and preferences. In a two-commodity world, (if we take x_1 and x_2) utility function is given by $U = U(x_1, x_2)$ and it depends on the consumer's taste and preferences, which is specified by the following axioms:

1. Axiom of Reflexiveness: Consumer's choice is reflexiveness.

If there are two commodities x_1 and x_2 and x_1 is weakly preferred to x_2, we can say $x_2\,Rx_1$ (R stands for weak preference relation). It implies that either x_1 is strictly preferred over x_2 ($x_1\,Px_2$) or x_1 is indifference to x_2 ($x_1\,Ix_2$). Here, P and I stand for strict preference relation and indifference respectively.

Any commodity bundle is either strictly preferred or indifferent over any other commodity bundle. Consumer can choose any commodity bundle. So choice set of this specified by the commodity set 'X'.

2. Axiom of Completeness: Consumer choice is complete.

Consumer, being a rational, must have a unique preference relation. It means the consumer choice will be either x_2Rx_1 or x_1Rx_2. Consumer choice is also consistent or comparable. Consumer choice must be transitive because of unique preference relations. Thus, it can be x_1Rx_2, x_2Rx_3 or x_1Rx_3. x_3 is another commodity.

3. Axiom of Continuity: Consumer's preference relation (R) is continuous. Consumer looks for better one continuously, comparing one with the other commodity. Thus, it is a continuous process. Following three axioms can be included under this:

(a) **Axiom of Non-satiation:** Consumer's choice is non-satiated in all goods.

It implies that larger the consumption of a commodity leads to larger satisfaction or utility and lower the consumption lower is the satisfaction or

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utility. It also denotes that "goods are good" and "more is better". Thus, A will be preferred over B (APB) if A has larger quantity than B (A>B).

(b) **Axiom of Convexity:** The indifference curve for consumer choice is strictly convex to the origin. So the utility is quasi-concave.

(c) **Axiom of Selfishness:** Consumer choice is selfish. Consumer choice is self-guarded and it is not influenced by any other consumer.

Concept of Preference, Utility Function and Indifference Curve

As specified by the above axioms, consumer preference ('R') can be represented by a function where total utility ('U') depends upon the quantity consumption (x_1, x_2) which satisfied all other axioms. Utility function is U (x_1, x_2) which is otherwise U, which the consumer aims to optimize.

Meaning and Definition of Indifference Curve: Indifference curve is a graphical tool to solve the consumer utility maximization problem. Indifference curve is constructed in commodity – commodity plane by joining different goods along which the consumer is indifferent (or he has same level of utility). Therefore, along the indifference curve utility or satisfaction remains unchanged.

Existence of Indifference Curve: Indifferent curve may exit anywhere in the commodity space. It is because consumer may be indifferent between any commodity bundles and such as choice might be continuous. Also, because of axiom of reflexiveness consumer can choose a commodity bundle over another commodity bundle and such a choice might be continuous.

Derivation of Indifference Curve and its Properties

Graphical Presentation

In the diagram given below, there are good I ($x^0{}_1$) and Good II ($x^0{}_2$), from which the consumer gets some utility (U_0). Here, we compare the two commodity bundles and for which we divide the commodity plane into four phases.

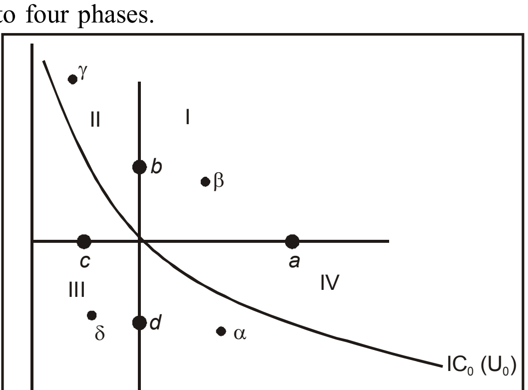

Fig. 1.2: An Indifference Curve

Take any point in Phase I (β), there is larger quantity of both x_1 and x_2 compared to point 'A'. Similarly for any point in '*b*' in vertical axis, we have larger x_2 with same x_1. It means in Phase I, including the borderlines, there is large quantity of at least one good and no less quantity of any other good compared to 'A'. Thus, we have larger utility in Phase I including the borderlines compared to 'A'.

By similar logic, we have lower consumption of at least one good and no large consumption of any other good in Phase III including the borderlines compared to point 'A'. Hence, there is lower level of utility in Phase III including the borderlines compared to 'A' by the axiom of non-satiation for all commodities.

It is clear that utility is not constant between the good bundles compared to point 'A' in phases I and III, including borderlines. Therefore, indifference curve (along which utility is constant) cannot pass through phases I and III including their borderlines.

Take any point in phase IV, excluding borderlines (α), we have larger x_1 (for which utility is larger) and lower x_2 (for which utility is lower) compared to 'A'. Since both the goods are non-satiated, utility of point α may be larger, lower or equal compared to point 'A'. In the same way, for any point in phase II, excluding the borderlines (δ), there is larger consumption of x_2 but lower of x_1 compared to point 'A'. So, by axiom of non-satiation in all goods, utility at point δ may be larger, lower or equal compared to point 'A'.

It is clear that only in Phases II and IV, excluding the borderlines, there is a possibility of the same level of utility between the bundles compared to point 'A'. So indifference curve, along which utility remains constant, must pass through Phases II and IV, excluding their borderlines. Hence, indifference curve is necessarily downward sloping where all goods are non-satiated given that a consumer choice is reflexive, continuous and complete.

Mathematical Presentation

If the utility function is $U = U(x_1, x_2)$, by differentiating we get:

$dU = U_1 dx_1 + U_2 dx_2 = 0$ (as along the indifference curve utility is unchanged, $dU = 0$). So $\frac{dx_2}{dx_1}$ $= \frac{U_1(x_1, x_2)}{U_2(x_1, x_2)}$ = is the slope of the indifference curve. It is negative since $U_1(x_1, x_2) > 0$ and $U_2(x_1, x_2) > 0$ by axiom of non-satiation of all commodities. Therefore, indifference curve is downward sloping as all goods are non-satiated and choice is continuous, reflexive and complete.

Economic Meaning

All goods are non-satiated that means larger (lower) assumption leads to larger (lower) utility. So, for given x_2, as x_1 increases, utility rises. Hence, to maintain the same level, utility must be reduced, which is possible

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by cutting x_2. So, as x_1 increases, x_2 must falls to maintain the same level of satisfaction. Because of that indifference curve is downward sloping.

Properties of Indifference Curve

Property I: Higher indifference curve gives higher utility.

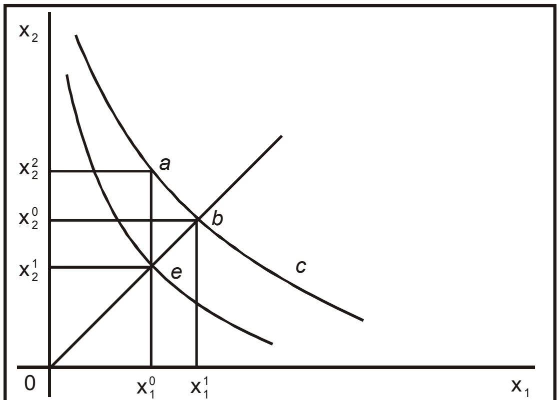

Fig. 1.3: Higher Indifference Curve

Explanation: Since all goods are non-satiated, larger consumption of any good leads to larger utility. Hence, a commodity bundle, which has larger quantity of at-least one good and no less consumption of any other goods, provides larger utility compared to any other commodity bundles. In results, higher indifference curve stands for higher consumption of at least one good and no less consumption of any other goods.

Property II: Indifference curves cannot intersect with each other.

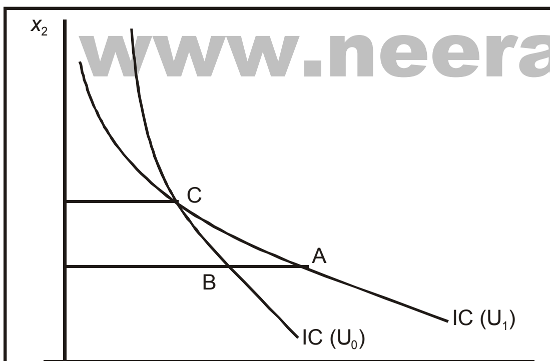

Fig. 1.4: Indifference Curves Can't Intersect Each Other

Explanation: Suppose two indifference curves intersect each other. By definition, utility is unchanged along the indifference curve, Thus, consumer is indifferent between points 'A' and 'C' that lie on the same indifference curve. Similarly, consumer is indifferent between points 'B' and 'C', as they also lie on the same indifference curve. So AIC and BIC, where 'I' implies indifference. Now, from transitivity there is AIB, that means point 'A' and 'B' give the same utility to the consumer. But for given x_2, x_1 is larger in point 'A' compared to point 'B'. So, by the assumption of non-satiation, we have point 'A' that provides larger utility to consumer as compared to point 'B'. This is a contradiction on the fact that point 'A' and 'B' gives the same level of utility to the consumer (as we have proved above). Thus, when all goods are non-satiated and transitivity holds, indifference curves cannot intersect.

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Utility Maximization

Graphical Presentation: Suppose there are two commodity world, x_1 and x_2 representing commodity I and II respectively. Prices, given to the consumer, of good I and II are p_1 and p_2 respectively. Prices here are exogenously given and consumer cannot change them. The consumer's money income (M) is also exogenously given to the consumer. Note that $p_1x_1 + p_2x_2$ is the total expenditure of the consumer when he consumes x_1 units of good I and x_2 units good II. The total expenditure of the consumer cannot exceed his money income, thus

$$p_1x_1 + p_2x_2 \leq M \qquad ...(a)$$

Equation *(a)* is the consumer's budget constraint. Let U = U (x_1, x_2) is the utility function of the consumer. So, consumer must solve the following optimization problem (UMP):

Problem UMP: Max U (x_1, x_2)
Subject to $x_1 > 0$
$x_2 > 0$
and $p_1x_1 + p_2x_2 \leq M$

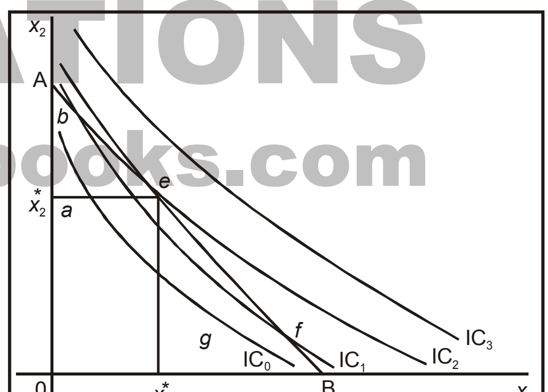

Fig. 1.5: Derivation of Consumer Equilibrium

As consumer aims to optimize his utility and as longer consumption results in larger utility, he always wants to have more of any goods. But he also has to spend some amount of his income to consume larger amount of goods. So, ultimately in equilibrium he will spend all her income and M = $p_1x_1 + p_2 x_2$.

Now if the line segment AB stands for the price line or budget line. Along AB $p_1x_1 + p_2 x_2$ = M holds. Suppose, initial indifference curve of the consumer is IC_0. In IC_0, there are many points along that indifference curve such that $p_1x_1 + p_2 x_2 \leq$ M holds. Thus, utility optimizing consumer will spend more as he moves to

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