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An Edgeworth Box Culinary Experience

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Key concepts: Edgeworth box; trade gains; utility functions; budget line; maximation of utility.

Once upon a time, at a Spanish campsite, an interesting culinary exchange was about to happen. Two campers: the Spanish camper and the English camper were busy preparing lunch. The Spanish camper was preparing a delightful dish of patatas bravas—a classic Spanish tapa consisting of crispy potatoes topped with a spicy tomato-based sauce. The English camper was passionately cooking up a batch of Cumberland sausages—juicy and flavour-packed sausages characterized by their distinctive spices.

However, the English camper, who had an initial allocation of 6 Cumberland sausages, didn’t have any side dishes to accompany the meal. On the other hand, the Spanish camper, who had an initial allocation of 4 patatas bravas servings, had gone to the supermarket and forgotten to buy a main meal. So, for a perfect lunch both campers would be better off with a combination of both dishes.

Each camper had their own unique set of preferences, captured by their utility functions. These functions quantified the satisfaction or happiness they derived from consuming different quantities of each dish.

The Spanish camper’s utility function: $U_S(x_S, x_S) = x_s * y_s$

The English camper’s utility function: $U_E(x_E, x_E) = x_E y_E^{1/2}$

Where, the suffix S represents the Spanish camper and E the English camper. x_S, x_E represents the number of Cumberland sausages that the Spanish and the English camper have respectively. y_S, y_E represents the number of patatas bravas servings that the Spanish and the English camper have respectively.

The Edgeworth box is a graphical representation that helps visualize the potential trades and allocations between two individuals. In this case, the axes of the box represent the quantities of patatas bravas and Cumberland sausages. Within the box, there lies an area where both campers are content with their allocation—this is the Pareto efficient allocation, where no camper can be made better off without making the other worse off. In this case, the English camper has an initial allocation of 6 Cumberland sausages and 0 patatas bravas servings. The Spanish camper has an initial allocation of 4 patatas servings and 0 Cumberland sausages. Figure 1 represents the initial allocations for both campers in the Edgeworth box. The English camper origin is in the bottom left corner and the Spanish camper origin is in the top right corner (as shown in the reel). Cumberland sausages (good x) is represented in the x-axis and patatas bravas (good y) is represented in the y-axis.

Figure 1. The initial allocation in the Edgeworth box.

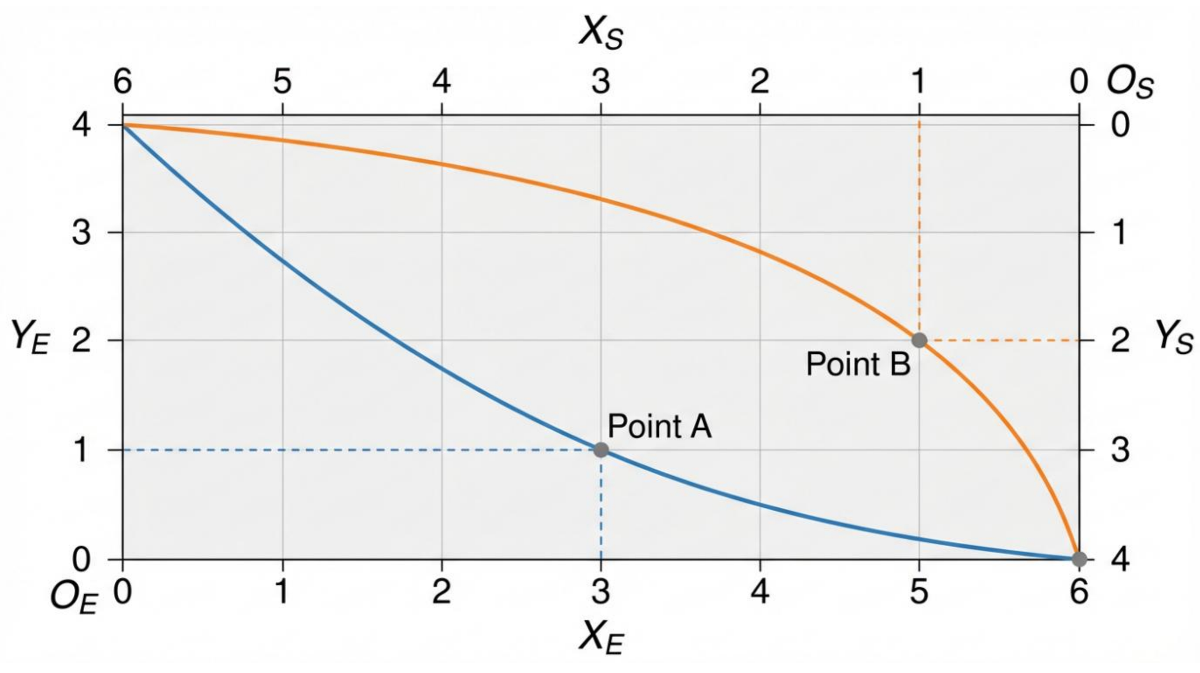
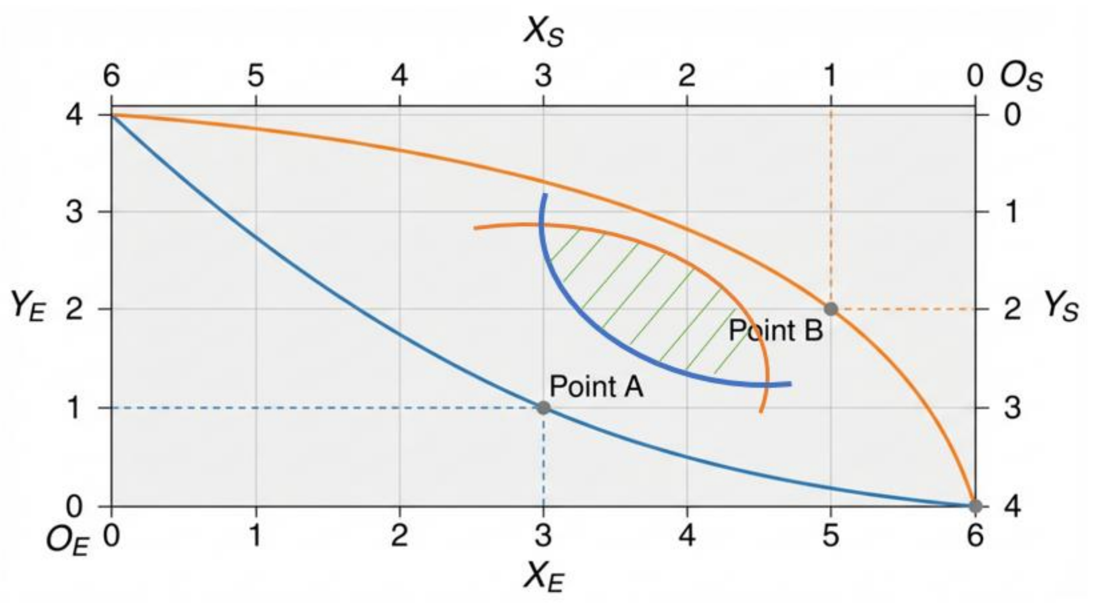


Figure 1: The grey dot in the bottom right corner of the Edgeworth box is the initial allocation. The orange curved line is the indifference curve which represents the Spanish camper’s preferences, following his utility function, for his initial allocation. The blue curved line is the indifference curve which represents the English camper's preferences, following his utility function, for his initial allocation. At any point on a

given indifference curve, each camper gets the same level of satisfaction. Notice we can see that a combination of patatas bravas and sausages is preferred. For example, when starting from their initial allocations, the English camper gets the same utility from giving up 3 sausages and gaining 1 patatas bravas (point A), whilst the Spanish camper is willing to give up to 2 patatas bravas portions for just one sausage! (point B) Can you see where this is going?

That's right! upon observing their preferences, the campers saw an opportunity for trade. Initially, the English camper proposes an exchange that will leave the Spanish camper with an allocation of 1 Cumberland sausage and 2 patatas bravas servings, and the English camper with an allocation of 5 Cumberland sausages and 2 patatas bravas servings. The new allocation is represented by the purple dot in Figure 2.

Figure 2: First exchange



Will trade finish here? No, because the campers could continue to trade and arrive at a situation where both are better off. Any allocation within the indifference curves of the campers in the green-striped shaded area in Figure 2. An allocation within this area will give both campers higher levels of utility, and so it will increase their levels of satisfaction.

Through negotiation, with the information provided can you find the mutually beneficial exchange that would lead to a Pareto improvement? Represent the equilibrium using the Edgeworth box.

Suggested answer and further explanation:

If the initial allocation of the English Camper is (x_E, y_E) - (6, 0), and the initial allocation of the Spanish camper is (x_S, y_S) - (0, 4). Then, the total allocation of Cumberland sausages is x = x_E + x_S = 6 + 0 = 6 and the total allocation of Patatas Bravas servings is y = y_E + y_S = 0 + 4 = 4.

For the final allocation to be pareto optimal, both the English and the Spanish camper must maximise their utility, but also it needs to be a feasible allocation, i.e. that both can afford. To be feasible, the final pareto optimal allocation has to be within the total allocation of the initial goods. This is a trade economy, and so the exchange of the goods will be in relative prices. Assume the relative exchange price of 1 portion of patatas bravas is 1 portion of patatas bravas, and the relative exchange price of 1 Cumberland sausage is p portions of patatas bravas.

From principles of Microeconomics, we know that a consumer maximise their utility when the MRS (Marginal Rate of Substitution) equals the slope of the budget line (tangency rule). In this case, the slope of the budget line is p. Following the definition of the utility functions. The English camper will maximise his utility where his marginal rate of substitution equals the slope of the budget line, so:

$$\frac{2y_E}{x_E} = p$$

The Spanish camper will maximise his utility where his marginal rate of substitution equals the slope of the budget line, so:

$$\frac{y_S}{x_S} = p$$

To be able to solve this problem we will need to calculate the optimal allocation of one camper first and then of the other. If we calculate the optimal allocation of the

English camper first, the problem will need to be in terms of the English camper quantities, i.e. if we reformulate the Spanish camper maximisation condition in terms of the English camper quantities we have:

$$\frac{4 - y_E}{6 - x_E} = p$$

If we first calculate the pareto optimal equilibrium in terms of the quantities consumed by the English camper, then for the final allocation to be feasible the following condition has to hold:

$$x_E p + y_E = 6p + 0$$

So, to calculate the optimal allocation three conditions have to hold. (1) the English camper maximises his utility; (2) the Spanish camper maximises his utility; and (3) the allocation has to be affordable.

$$\left.\begin{array}{r} (1)\ \dfrac{2y_E}{x_E} = p \\ (2)\ \dfrac{4 - y_E}{6 - x_E} = p \\ (3)\ x_E p + y_E = 6p \end{array}\right\}$$

We need to solve the three equations system above with 3 unknowns. We equal (1) to (2), this equality is also showing as that the optimal allocation will happen where the indifference curves for both campers is tangent. Equalling both equations and solving for y_E, we get:

$$y_E = \frac{4x_E}{12 - x_E} \quad (4)$$

Equation (4) represents the contract curve. The contract curve is a set of points, representing final allocations between goods x and y because of beneficial trade. The pareto optimal allocation will be in the contract curve, the final point will depend on the budget line (3).

We substitute (4) into (1) and we solve for p:

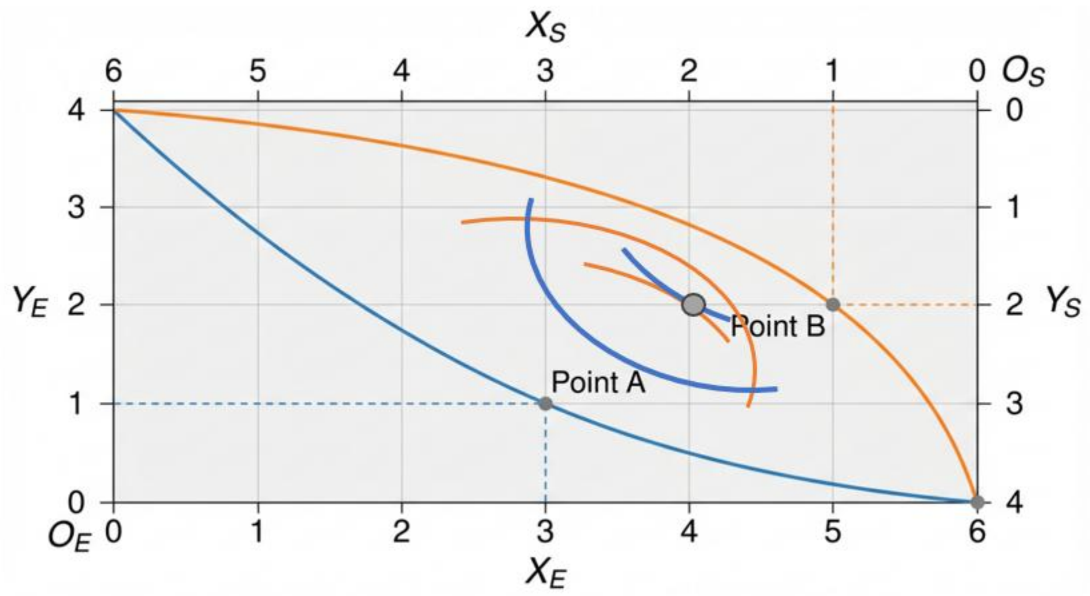
$$p = \frac{8}{12 - x_E} \quad (5)$$

We substitute (4) and (5) into (3) and we solve for x_E, from here we get that the optimal allocation of Cumberland sausages for the English camper is 4, i.e. $x_E = 4$. We now substitute this value into (4) and we get that the optimal allocation of patatas bravas servings for the English camper is 2, i.e. $y_E = 2$

As we know that there are 6 Cumberland sausages in total and 4 patatas servings in total, it is now easy to calculate the final allocation for the Spanish camper: $x_E = 2 \; and \; y_E = 2$

We represent the equilibrium graphically:

Figure 3: The pareto optimal allocation



The story of the Spanish and English campers at the Spanish campsite illustrates the concept of the Edgeworth box and the potential for trade to achieve Pareto efficiency. Through their culinary exchange, they demonstrated how understanding individual preferences and engaging in negotiation can lead to a win-win situation, where both parties are better off. This simple tale serves as a reminder that cooperation and trade can lead to outcomes that maximize overall satisfaction and happiness.