

Lecture XI: Externalities in Production

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Readings

Externalities

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- ▶ Becker Lecture 19
- ▶ Landsburg Chapters 24

Externalities

- ▶ We will do more work developing the firm's problem focusing on the demand for factors of production. However, I want to introduce the concept of a production function with more than one factor

$$y = f(x_1, x_2, x_3). \quad (1)$$

- ▶ This production function implies the profit maximization problem

$$\max_{x_1, x_2, x_3} p_y f(x_1, x_2, x_3) - w_1 x_1 - w_2 x_2 - w_3 x_3 \Rightarrow \begin{cases} p_y \frac{\Delta f(x_1, x_2, x_3)}{\Delta x_1} = w_1 \\ p_y \frac{\Delta f(x_1, x_2, x_3)}{\Delta x_2} = w_2 \\ p_y \frac{\Delta f(x_1, x_2, x_3)}{\Delta x_3} = w_3 \end{cases} \quad (2)$$

- ▶ Some of these inputs may be priced – land, labor and capital. However, some of these inputs may be allocated through an alternative mechanism.
 - ▶ Water in the state of Florida is allocated through administrative water law.
 - ▶ Water in California was historically allocated under a system of senior and junior rights.
 - ▶ Interstate water is sometimes allocated by a series of federal compacts – the Florida/Georgia allocation of the Apalachicola/Flint system.
- ▶ Some of these resources may be so abundant that a property right has not been developed – air, sunlight.

- An alternative problem is the possibility of multiple outputs or joint products

$$\{y_1, y_2\} = f(x_1, x_2, x_3) \quad (3)$$

$$y_1 + \alpha_1 y_2 + A_{11} y_1^2 + A_{12} y_1 y_2 + A_{22} y_2^2 = f(x_1, x_2, x_3)$$

- ▶ Taking a little liberty with the notation

$$\max_{y_1, y_2} p_1 y_1 + p_2 y_2 - C(y_1, y_2, p_x) \quad (4)$$

- The notion of an externality is that p_2 is an unpriced output from the firm's perspective.

- ▶ Thus, the firm's maximization problem does not consider the value of that output

$$p_1 - \frac{\Delta C(y_1, y_2, p_x)}{\Delta y_1} \quad (5)$$

$$p_2 - \frac{\Delta C(y_1, y_2, p_x)}{\Delta y_2}$$

- ▶ From society's standpoint, the optimal tradeoff between good y_1 and y_2 should be

$$\frac{\Delta y_1}{\Delta y_2} = \frac{\frac{\Delta C(y_1, y_2, p_x)}{\Delta y_2}}{\frac{\Delta C(y_1, y_2, p_x)}{\Delta y_1}} = \frac{p_2}{p_1} \quad (6)$$

Output-Output Tradeoff

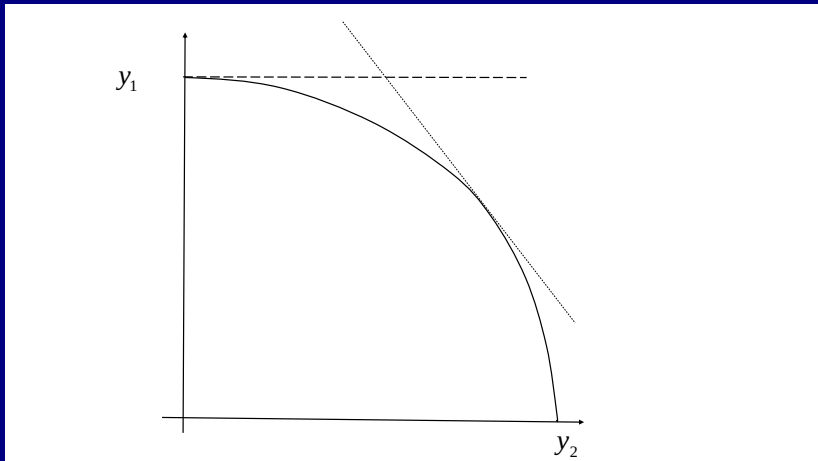


Figure : Output-Output Tradeoff

- ▶ However, other individuals in society have a non-zero price of p_2 .
- ▶ Next, we assume that y_2 is a "bad" such as air pollution. We change the standard product-product formulation slightly to model y_1 and y_2 as complementary in the initial stages of production. The mathematics then become

$$\max_{y_1, y_2} p_1 y_1 - p_2 y_2 - C(y_1, y_2, p_x) \quad (7)$$

The new economic equilibrium are presented in Figure 2.

Complementary Production of y_1 and y_2

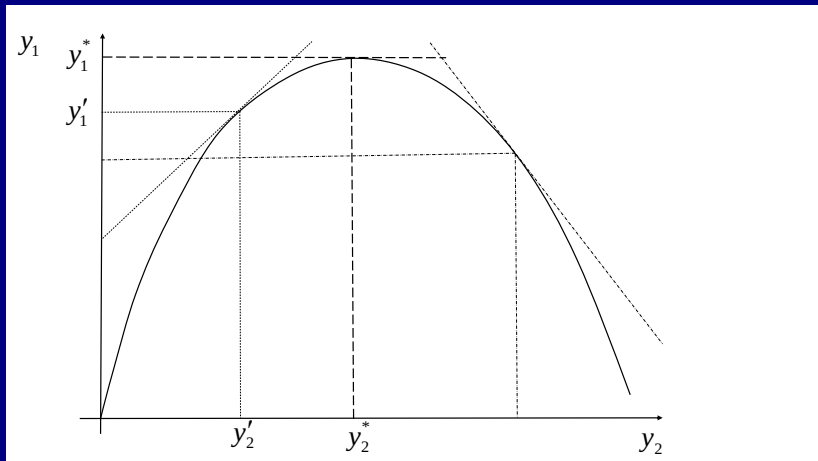


Figure : Complementary Production of y_1 and y_2