Trade, Natural Resources, and Property Rights

0.1 The problem of exclusion

Let y denote the total output from a resource which depends on total effort X as per the following increasing and concave function $f(X)$:

$$y = f(X),\ f'(X) > 0,\ f''(X) < 0,\ f(0) = 0. \tag{1}$$

For concreteness, assume that the resource is a fishing ground, so that y denotes the total fish harvest, say in tons. We note that harvest function $f(X)$ exhibits diminishing returns. Effort types typically include man-hours spent at sea, the number of vessel outings in a year, the types and size of the fishing gear being used, and so on.

To simplify, fishing effort has constant unit cost c and there are no fixed cost. A ton of fish fetches a constant price of 1 on the market. In this case, efficiency calls for an input use X^* such that the marginal product is equal to marginal cost; that is,

$$f'(X^*) = c. \tag{2}$$

0.1.1 Open access

We define an open access regime as follows:[1]

Definition 1 *A resource (or productive asset) is subject to an* ***open-access*** *exploitation regime when an unlimited number of users have unrestricted access the resource.*

In order to best apprehend the implications of open access, we assume that users are all equally productive with their efforts to exploit the resource. More specifically, for any given total effort X, each unit effort yields the average product $f(X)/X$ to its user. (For clarity of exposition, the average product curve is henceforth denoted $\phi(X) \equiv f(X)/X$.) Given this an the fact that the supply of users is unlimited, we shall now argue that the only admissible equilibrium is one in which the value of the average product is equal to the unit cost; that is $\phi(X^{OA}) = c$.

[1] The insights from this section are drawn mainly from Gordon (1954).

Let us assume indeed that this is not the case and that the total input level is at, say, the first-best level X^* defined earlier by condition $f'(X^*) = c$. As illustrated point A in figure 1, we have $\phi(X^*) > c$. This inequality indicates that a unit of effort produces a net positive gain to its user and consequently, a newcomer to the resource may earn a strictly positive gain by joining the fishery with additional efforts. Now under the assumption that the supply of newcomers is unlimited, inputs will be added this way as long as one expects the average product value to exceed the unit cost. For this reason, we conclude that the open-access equilibrium input level X^{OA} is characterized by an equality between marginal products and average costs; that is, $\phi(X^{OA}) = c$ as illustrated by point B in figure 1.

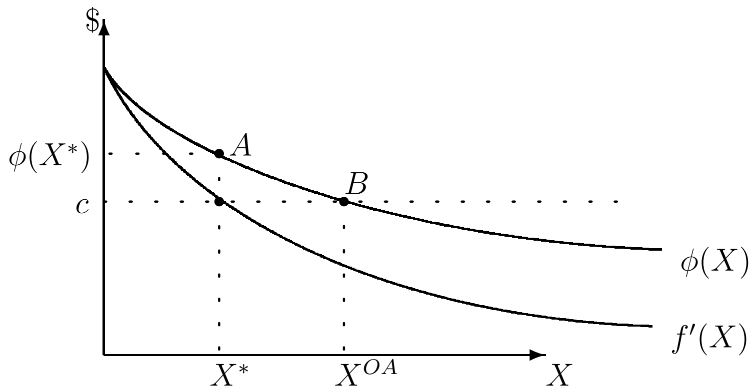

Figure 1: The open access equilibrium

The open access equilibrium is therefore characterized by two important properties: It is inefficient and rents are totally dissipated. Inefficiency can be seen from the fact that above X^*, any additional effort yields less than its cost; the resource is therefore over-exploited. Rent dissipation derives from the fact that total cost are equal to total revenues at X^{OA}.

0.2 Trade, resources, and property regimes

We now wish to extend the analysis to a comparison of trade and autarky under various property regimes. The resource price will thus be allowed to vary between the two.

We shall consider four regime combinations: *trade* or *autarky* on the one hand; *open access* or *restricted access* on the other. The basic features of the economy are the following.

The economy There are only two types of goods: natural resources and manufactures, respectively goods 1 and 2. The representative consumer's welfare is represented by $u(x_1, x_2) = x_1^{\alpha} x_2^{1-\alpha}$, where x_1 and x_2 are the consumed quantities of the respective goods. p is the price of the resource good in terms of *numéraire* good 2 and y_1 and y_2 are the respective output quantities of the goods. The *nominal* national product is thus $Y = py_1 + y_2$. Labor is the only factor of production; its total size is $\bar{L}$ and it is mobile domestically between sectors, though not internationally. For simplicity, the marginal product in the manufacturing sector is assumed constant, with $y_2 = a_2 L_2$. The production of good 1, on the other hand, exhibits decreasing returns; it is given by $y_1 = f_1(L_1)$, with $f'(L_1) > 0$ and $f''(L_1) < 0$. The *nominal* wage rate is denoted w. For such an economy, the following set of equations will be respected regardless of the trade or property regime:

$$\text{resource demand} \quad x_1 = \frac{\alpha Y}{p} \tag{3}$$

$$\text{manufacture demand} \quad x_2 = (1-\alpha)Y \tag{4}$$

$$\text{national income} \quad Y = py_1 + y_2 \tag{5}$$

$$\text{labor constraint} \quad L_1 + L_2 = \bar{L} \tag{6}$$

$$\text{manufacturing output} \quad y_2 = a_2 L_2 \tag{7}$$

$$\text{resource output} \quad y_1 = f(L_1) \tag{8}$$

$$\text{wage} \quad w = a_2 \tag{9}$$

Note that we shall only consider interior equilibria for which both sectors are active. For this reason, the nominal wage w is fixed at the constant marginal product of sector 2.

The property regimes The equilibrium condition that characterizes labor employment in the resource sector depends on the property regime in place. With restricted access, the resource manager employs labor such that its marginal product equals the wage rate. With open access, rent dissipation implies that labor's average product equals the wage rate. We therefore have one the following two condition that must be respected:

$$\text{open access resource labor} \quad w = p\frac{f(L_1)}{L_1} \tag{10}$$
$$\text{exclusive property resource labor} \quad w = pf'(L_1) \tag{11}$$

The trade regimes In autarky, the price of the resource is determined by the market clearing conditions between the quantities produced and consumed. In the case of trade, on the other hand, we make the simplifying assumption of a small open economy, that is, the world price is given and denoted p_T. Imports and exports are however set by a zero trade balance condition. Hence the following:

$$\text{autarky resource clearance} \quad x_1 = y_1 \tag{12}$$
$$\text{autarky manufacturing clearance} \quad x_2 = y_2 \tag{13}$$
$$\text{trade price} \quad p = p_T \tag{14}$$
$$\text{trade balance} \quad p(y_1 - x_1) + (y_2 - x_2) = 0 \tag{15}$$

There are nine endogenous variables in this economy: x_1, x_2, y_1, y_2, Y, p, w, L_1 and L_2. Equations (3) to (9) are respected in all regime types. Depending on the prevailing property regime, either equation (10) or (11) applies. In autarky, equations (12) and (13) must be respected, while with trade, they are replaced by equations (14) and (15). Given that one of the two consumption demand equations (3) or (4) is redundant (by Walras' law), one verifies that there are nine equations for each regime combination.

Figure 2 provides an insightful case. Segment length $\overline{0_1 0_2}$ is equal to the labor force size $\bar{L}$. Labor's marginal product value in the resource sector is represented by the two dotted curves for the cases of trade and autarky. Note that the curve must be steeper in autarky than trade because the resource price p_T is fixed with trade, while p^A decreases with L_1 due to the corresponding increased consumption of the resource good and decreased consumption of manufactures in autarky. (Recall also that the currency unit – here represented by $ for convenience – is equal to one manufactured good.)

With restricted access to resources, a specific case in which the autarkic and trade prices are equal is illustrated. Based on the comparative advantage argument, there are consequently no gains from trade to be had with the rest of the world. Indeed, at point B, the size of the labor force in the resource sector is given by $L_1^{RA} = \overline{0_1 L^{RA}}$; the opportunity cost of a resource unit in autarky is thus $a_2/f'(L_1^{RA})$ units of manufactures, which is equal to p_T.

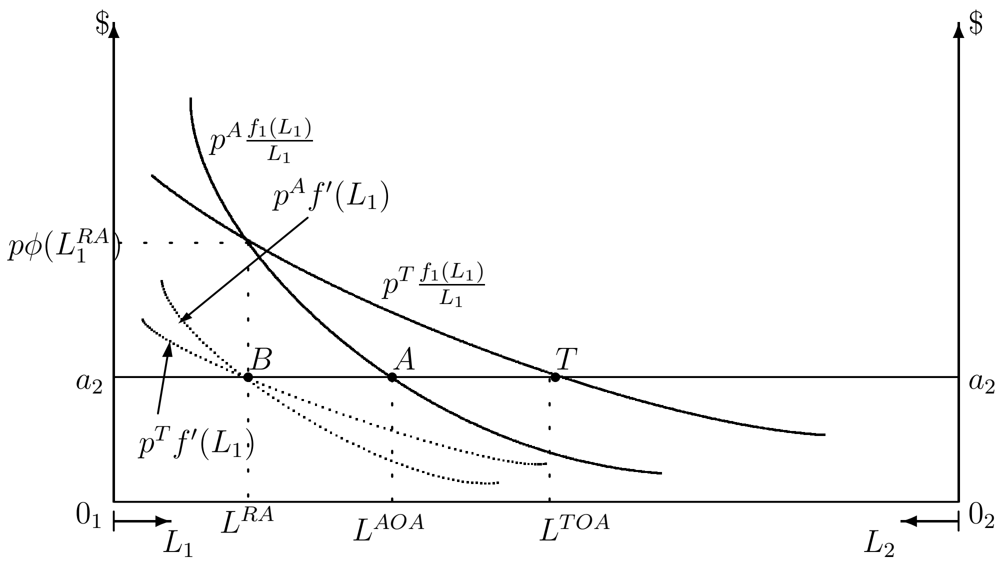

Figure 2: Open access and trade regimes

The story is quite different when the resource is subject to open access. The autarkic and trade equilibria are then located at points A and T respectively, where the average products in both sectors are equalized. The labor force employed in the resource sector is given by $L_1^{OA} = \overline{0_1 L^{AOA}}$ and $L_1^{TOA} = \overline{0_1 L^{TOA}}$ in autarky and trade respectively. The autarkic price of the resource falls below the trade price because in a closed economy, since the price must clear the demand and supply of both goods, a simultaneous increase in resource output and decrease in manufacture output can only lead to a lower equilibrium resource price.

Figure 2 shows clearly how in nominal terms, the open access national product is the same with both autarky and trade. Indeed, Y can be calculated by the product of labor quantities in each sector and their average product. The average product being equal to a_2 in both sectors regardless of the trade regime, we obtain that $Y^{AOA} = a_2 \bar{L} = Y^{TOA}$. Accounting now for the fact that the price of the resource good is higher with trade, we conclude that trade causes the national income to decrease in *real* terms. Hence, trade is welfare decreasing.

This result is remarkable by the simplicity with which it challenges common wisdom about trade gains from specialization. We obtain here that the country can lose from exporting the good for which the autarkic price is lower. Note that this does not imply that the comparative advantage argument is wrong; it rather means that the conditions under which the country's trade pattern is to be dictated by its *true* comparative advantage are not there. Let us see why.

The comparative advantage argument dictates that the country should further specialize in the production of the good for which it has a lower opportunity cost of production than the world trade price. Now at the trade equilibrium T, in order to produce one more resource unit, $a_2/f'(L_1^T)$ units of manufactures must be forgone. The equilibrium, on the other hand, is characterized by the condition $p_T f(L_1^T)/L_1^T = a_2$. Since the average product is strictly above the marginal product, we have $p_T < a_2/f'(L_1^T)$. As a result, by exporting resources, the country receives less manufactured goods in return than it could get on its own.

In the example of figure 2, we have seen that the country had no *real* comparative advantage in the production of either goods. This is due to the fact that its exogenous factor endowments and preferences make the opportunity cost of the resource good equal to the world resource price when all social costs and benefits are properly accounted for. In a decentralized economy, it so turns out that the right prices emerge under the restricted access regime as defined above. But with open access, the private cost of exploiting the resource is below its true social cost, as analysed in chapter **??**. The resulting overproduction in a decentralized economy leads to an autarkic price that falls below the world price, while the opportunity cost is in fact above. As a result, the open access regime leads to an export of resources because of an apparent comparative advantage. The expression *apparent comparative advantage* refers to the fact that with trade, the specialization into the production of resources is based on a choice of institution rather than real endowments and preferences.[2]

[2]The expression *apparent comparative advantage* is due to Chichilnisky (1994).