0.1 The natural-resource curse

0.2 Trade, resources, and property regimes

In chapter **??**, we have compared various property regimes in a general equilibrium setting. It was assumed throughout that the price of the resource was fixed, effectively corresponding to the case of a small open economy. 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.[1]

We shall consider four regime combinations: *trade* or *autarky* on the one hand; *open access* or *restricted access* on the other. Note that for the time being, we assume no transaction costs with restricted access, as in Pethig (1976), Chichilnisky (1994) and Brander and Taylor (1998). The existing property regimes are therefore *exogenous* to the analysis. In section 0.3, we extend the analysis to the case of an endogenous property regime. 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

[1] MENTION Margolis and Shogren (2009) AND Margolis (2009)?

be respected regardless of the trade or property regime:

$$\begin{aligned}
\text{resource demand} \quad & x_1 = \tfrac{\alpha Y}{p} && (1)\\
\text{manufacture demand} \quad & x_2 = (1-\alpha)Y && (2)\\
\text{national income} \quad & Y = py_1 + y_2 && (3)\\
\text{labor constraint} \quad & L_1 + L_2 = \bar{L} && (4)\\
\text{manufacturing output} \quad & y_2 = a_2 L_2 && (5)\\
\text{resource output} \quad & y_1 = f(L_1) && (6)\\
\text{wage} \quad & w = a_2 && (7)
\end{aligned}$$

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:

$$\begin{aligned}
\text{open access resource labor} \quad & w = p\tfrac{f(L_1)}{L_1} && (8)\\
\text{exclusive property resource labor} \quad & w = pf'(L_1) && (9)
\end{aligned}$$

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:

$$\begin{aligned}
\text{autarky resource clearance} \quad & x_1 = y_1 && (10)\\
\text{autarky manufacturing clearance} \quad & x_2 = y_2 && (11)\\
\text{trade price} \quad & p = p_T && (12)\\
\text{trade balance} \quad & p(y_1 - x_1) + (y_2 - x_2) = 0 && (13)
\end{aligned}$$

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 (1) to (7) are respected in all regime types. Depending on the prevailing property regime, either equation (8) or (9) applies. In autarky, equations (10) and (11) must be respected, while with trade, they are replaced by equations (12) and (13). Given that one of the two consumption demand equations (1) or (2) is redundant (by Walras' law), one verifies that there are nine equations for each regime combination.

Figure 1 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.)

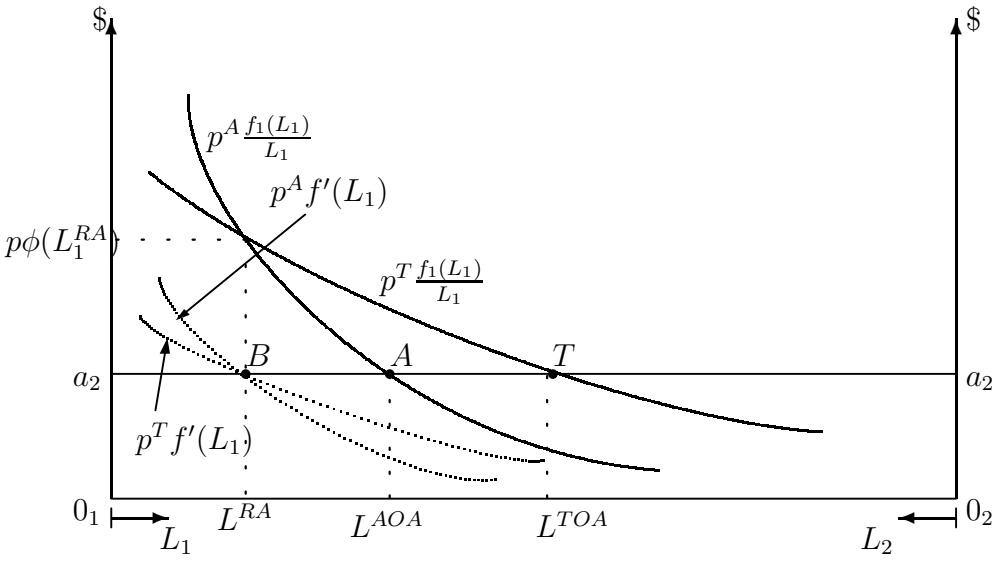

Figure 1: Open access and trade regimes

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.

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 1 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 1, 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]

0.3 Trade, resources, and endogenous property regimes

In section 0.2, we have seen how *given* property regimes can affect trade patterns. In particular, we have seen how trade can be welfare decreasing in a decentralized economy with open access to its resource sector. But as studied in section **??**, existing property regimes may come as the result of deliberate decisions by the resource managers who must also support the cost of excluding others. Once this is taken into account, the relation between property regimes and the desirability of trade becomes less clear-cut.

For simplicity, we consider the same economy as described in section 0.2, to which we add a cost necessary to enforce restricted access in the resource sector. We assume that restricted access requires that L_1^e enforcers be hired. One can think of enforcers as being composed of different types of workers such as private guards, police officers, judges, notaries, etc. Enforcement therefore uses up real resources because enforcers must be subtracted from the labor pool $\bar{L}$, that is, they are no longer available to (directly) produce manufactures or resources. In order to characterize the general equilibrium, this requires the following modification to the labor market clearing condition (4):

$$\text{restricted access labor constraint} \quad L_1 + L_1^e + L_2 = \bar{L} \tag{14}$$

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

For convenience, we shall refer to the labor force hired to produce resources or manufactures as the *directly productive workforce*. Its size is respectively $\bar{L} - L_1^e$ and $\bar{L}$ in the restricted access and open access regimes.

We consider that restricted access in the resource sector is the *de jure* norm in the country, in the sense that the country's institutions recognize the right of users to enforce a restricted access to the resource. However, the entire cost of enforcement must be supported by the users themselves. This means that the general equilibrium can sustain a restricted access only when the net profits from doing so are positive. Consequently, the property regime may be *de facto* open access or restricted access.

Let π_1 denote total profits in the resource sector (gross of enforcement costs) and assume that enforcers are paid the same wage rate as the rest of the labor force. Then the *de facto* property regime will be restricted access if, and only if, the following condition holds:

$$\pi_1 = pf(L_1) - wL_1 > wL_1^e, \tag{15}$$

where L_1 maximizes gross profits as per condition (9).

Figure 2 illustrates the economy with costly enforcement. In the restricted access regimes, the directly productive labor force size is given by segment $\overline{0_1 0_2^e} = \bar{L} - L_1^e$. With open access, segment $\overline{0_1 0_2} = \bar{L}$ still represents the directly productive labor force.

In autarky, an increase in enforcement labor leads to a drop in the price of the resource good. This is because for any given L_1, less manufactures can be produced, as there are fewer directly productive workers available. This lower price causes a downward shift of the restricted access marginal and average product curves. Representing the autarkic price with restricted access as p_A^e, we thus have $p_A^e < p^A$, where p^A is the price with costless enforcement.

Further insight is gained by simulating the model. To this end, we adopt the following form for the resource production function: $f_1(L_1) = a_1 L_1^\beta$. And in order to perform welfare comparisons, we assume that the national welfare is given by the indirect utility function $V(p, Y) = Y/(Kp^\alpha)$, $K = \alpha^{-\alpha}(1-\alpha)^{\alpha-1}$, associated with the utility function of the representative consumer. The following preference and technology parameter values are used: $\alpha = 0.3$, $\beta = 0.5$, $a_1 = a_2 = 1$. The total size of the labor force is set at $\bar{L} = 2$. In line with figure 1, the world price is set equal to the autarky price with restricted access in the absence of enforcement cost. This price being endogenous, we must first perform a simulation before we set the world price.

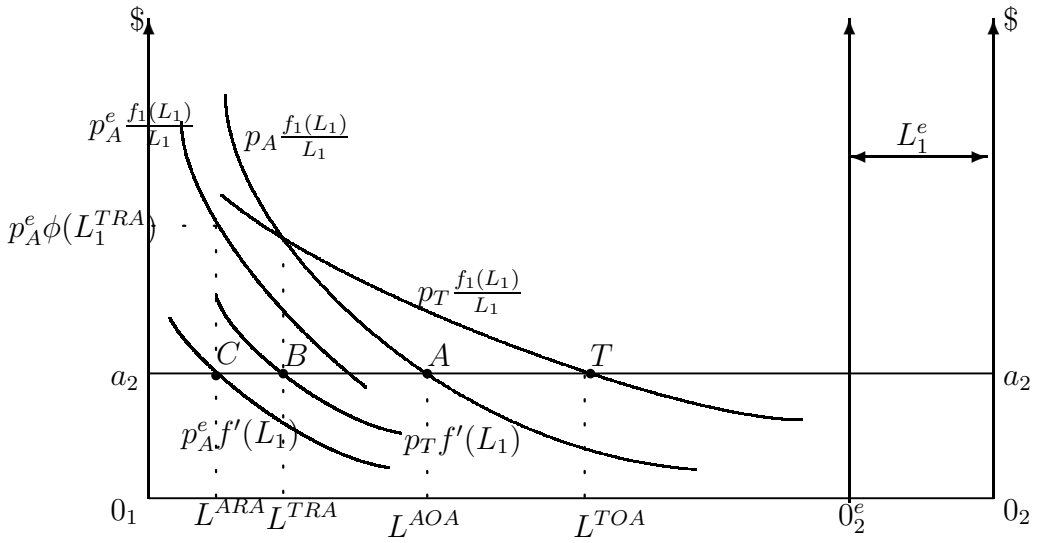

Figure 2: Open access and trade regimes

Tables 1 and 2 present the general equilibrium values for costless and costly enforcement respectively. The equilibrium autarky-restricted-access price is 1.19 when $L_1^e = 0$. We therefore assume that $P^T = 1.19$ throughout. In the case of costly enforcement, we chose $L_1^e = 0.32$ as a particularly interesting case.

In the absence of enforcement costs, the results of table 1 are consistent with those of figure 1. By construction, there are no gains from trade to be had under restricted access. Open access reduces national output in both nominal and utility terms, with or without trade. The drop in utility is however larger with trade than autarky. This implies that under open access, trade decreases welfare. The reason becomes clear when one compares the magnitudes of the movement of workers towards the resource sector with trade and autarky: the shift is larger with trade than autarky. The reason can be found by looking at the price. Under autarky, as workers move to the resource sector, the price of the resource drops: this general equilibrium effect tends to dampen the distortions caused by the absence of restrictions as the average productivity drops faster. This dampening price effect is absent with trade. In the simulated example, the optimal resource labor force size

	AUTARKY		TRADE	
	restricted access	open access	restricted access	open access
L_1	0.35	0.60	0.35	1.42
L_2	1.65	1.40	1.65	0.58
L_1^e	0	0	0	0
y_1	0.59	0.77	0.59	1.19
y_2	1.65	1.40	1.65	0.58
x_1	0.59	0.77	0.59	0.50
x_2	1.65	1.40	1.65	1.40
p	1.19	0.77	1.19	1.19
w	1.00	1.00	1.00	1.00
Y	2.35	2.00	2.35	2.00
π	0.35	0.00	0.35	0.00
$V(p, Y)$	1.21	1.17	1.21	1.03

Table 1: Trade and property regimes with costless enforcement

should be 0.35, or 17.5% of the labor force. Under autarky, this proportion increases to 30% while under trade, it jumps to 71%. In short, because of the absence of feedback from the resource price, trade potentially leads to a scramble for resources under open access which is unmatched under autarky.

Let us now introduce enforcement cost by setting $\bar{L_1^e} = 0.32$. As discussed in figure 2, the equilibrium resource price falls under the autarky-restricted-access regime compared to the case without enforcement costs. However, profits in the resource sector being negative, the autarky *de facto* regime is open access. This is not so with trade, where the *de facto* regime is restricted access. Note, however, that trade remains welfare decreasing even though it leads to a restricted access regime. This is because of the shrinkage in the size of the directly productive workforce. Trade therefore improves resource husbandry but at the cost of a lower welfare in terms of consumption goods because resource husbandry is costly.

	AUTARKY		TRADE	
	restricted access	open access	restricted access	open access
L_1	0.30	0.60	0.35	1.42
L_2	1.38	1.40	1.33	0.58
L_1^e	0.32	0	0.32	0
y_1	0.54	0.77	0.59	1.19
y_2	1.38	1.40	1.33	0.58
x_1	0.54	0.77	0.51	0.50
x_2	1.38	1.40	1.42	1.40
p	1.09	0.77	1.19	1.19
w	1.00	1.00	1.00	1.00
Y	1.98	2.00	2.03	2.00
π	-0.02	0.00	0.03	0.00
$V(p, Y)$	1.05	1.17	1.05	1.03

Table 2: Trade and property regimes with costly enforcement