Sir Edward West and the Principle of Diminishing Returns:*

Its Application to the 1815 Corn Law Question

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I Introduction

In his *Essay on the Application of Capital to Land* (1815), Edward West (1782–1828) set himself in opposition to the approval of the new Corn Law bill in 1815. His discussions on the Corn Law question include some original ideas, which were different from those of his contemporaries such as David Ricardo (1772–1823) and Robert Torrens (1780?–1864), who were against the bill. One of West's original ideas can be found in his argument about the effect of free importation of corn on domestic agriculture, of which Mawatari (1997, 85–86) provides a simple diagrammatic understanding that falls short of being satisfying.¹

We formalize West's idea into a tractable model and theoretically demonstrate that even if cheap foreign corn was freely imported, as far as the principle of diminishing returns in the production of corn is valid, producers in the home country would not completely disappear from the market.²

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1 Grapp (1970: 325–26) argues that West's demonstration anticipated the theorem of equalization of marginal costs contained in the Hecksher–Ohlin (–Samuelson) model of international trade. However, the marginal cost equalization observed in West's two-country, one-good, one-factor illustration is fundamentally different from the factor price equalization in the Hecksher–Ohlin (–Samuelson) model with two countries, two goods, and two factors.

2 West's theoretical and numerical approach to this matter may be attributed to his experience of mathematical education in Oxford (Grapp 1970, 317). The usage of “mathematical language” (1815, 23) can also be found in his pamphlet.

II The Principle of Diminishing Returns

Several years before the approval of the Corn Law bill, West found “a principle in political economy” (1815, 1). He states:

The principle is simply this, that in the progress of the improvement of cultivation³ the raising of rude produce becomes progressively more expensive, or, in other words, the ratio of the net produce⁴ of land to its gross produce is continually diminishing. (1815, 2)

Here, the “principle” means a law of increasing costs or of diminishing returns in agricultural production. It should also be noted that he clearly discriminated between the extensive and intensive diminishing returns: “The additional work bestowed upon land must be expended either in bringing fresh land into cultivation, or in cultivating more highly that already in tillage” (1815, 9; also see 2–3, 9–10). To disseminate this principle was the “chief object” of West’s pamphlet.

III The Effect of Free Trade of Corn on England’s Agriculture

West (1815, 45–46) discussed this issue as follows. Let England freely import foreign corn, of which price would be cheaper because the foreign country would not progress the extension of cultivation into inferior land as much as England. English farmers then would have to decrease their output and, eventually, would be driven out of the market. “But there are limits to this dependence of any country on foreigners for an article of the first necessity.” These limits could be found in the principle of diminishing returns, which shows “that in such case, as the growth of the foreigner increased the proportionate expense of his growth would increase, and as the home growth was diminished, the proportionate expense of the home growth would also be diminished.”

Now, we formalize West’s discussion into a model with two countries (Home country *H* and Foreign country *F*) and one good (corn). Let the pro-

3 As Stigler (1952, 196) and Brewer (1988, 506) highlight, the phrase “progress of the improvement” should be interpreted as the growth of output, or in West’s own words, “the progress of society” (1815, 10).

4 The “net produce” was defined as the “gross produce” minus “the expense of production” (West 1815, 2).

duction function $F_i: \mathbb{R}_+ \rightarrow \mathbb{R}_+$ in country $i \in \{H, F\}$ be as follows:

$$Y_i = F_i(L_i) \equiv A_i L_i^{\alpha_i}, \quad (1)$$

where $A_i \in \mathbb{R}_{++}$ is a constant technology coefficient, $L_i \in \mathbb{R}_+$ is the amount of agricultural labor employed and $\alpha_i \in \mathbb{R}_{++}$ is a coefficient denoting diminishing returns, with $0 < \alpha_i < 1$.

Denoting the rate of money wages of labor by w_i with $w_i > 0$, the “expense of production” can be written as $w_i L_i$; and denoting the price of corn by p_i , the “gross produce” in terms of value can be written as $p_i Y_i$. Thus, the “net produce” can be written as $p_i Y_i - w_i L_i$. West’s argument implicitly assumes that agricultural producers in each country maximize the net produce by adjusting production according to the corn price and money wage rate given the available technology shown in equation (1). Solving this implies that the following condition must be satisfied.

$$L_i = (A_i \alpha_i)^{\frac{1}{1-\alpha_i}} \left(\frac{w_i}{p_i} \right)^{-\frac{1}{1-\alpha_i}}. \quad (2)$$

Substituting (2) into (1), we derive the corn supply function respective to price.

$$Y_i = A_i^{\frac{1}{1-\alpha_i}} \left(\frac{\alpha_i}{w_i} \right)^{\frac{\alpha_i}{1-\alpha_i}} p_i^{\frac{\alpha_i}{1-\alpha_i}}. \quad (3)$$

From (3), we rearrange the inverse supply function as follows.

$$p_i = \left(\frac{w_i}{\alpha_i A_i^{\frac{1}{\alpha_i}}} \right) Y_i^{\frac{1-\alpha_i}{\alpha_i}}. \quad (4)$$

When H imports corn from F , the domestic demand for corn is balanced with combined domestic and foreign supply.

$$D_H = Y_H^* + Y_F^*. \quad (5)$$

West demonstrates the limit of free importation of foreign corn with his principle of diminishing returns in the following numerical example.

Say that the first year of importation we import half a million quarters; the next year the foreign grower, in order to meet the increased demand for foreign corn, will increase his growth, say half a million quarters, and the foreign growing price will rise, say from 45 to 50s. the quarter. The home grower will diminish his growth half a million quarters, and the home growing price will fall, say from 90 to 80s. the quarter. The actual price of both in the market must meet and be at some point between 50 and 80s. say at 65s. (West 1815, 46–47; “s.” stands for *shilling*.)

Let what West calls the “actual price” be written as:

$$p = \lambda p_H + (1 - \lambda) p_F, \quad (6)$$

where λ is constant with $0 < \lambda < 1$, p_H is “the home growing price,” and p_F is “the foreign growing price.” In West’s example, $\lambda = 1/2$, $p_H = 80s.$, $p_F = 50s.$, and $p = 65s.$ West went on to argue:

This price is still such as to induce the foreigner to increase his cultivation, and the home grower to diminish his. In consequence the foreigner’s growing price will be still further increased, and the home grower’s still more diminished, say to 60s. the quarter, and say that the actual price in our market falls to 60s. Both the home grower and the foreigner are now just paid the natural price of their produce, and there is no longer any motive to the one to increase his cultivation, nor to the other to diminish his. (West 1815, 47)

In this quotation, we can find a mechanism of quantity adjustment as shown by the differential equation: $\dot{Y}_i = f_i(p - p_i)$ with $f_i' > 0$, $f_i(0) = 0$ and $\dot{Y}_i = dY_i/dt$ (where t is time). Here, we can define equilibrium as the state in which both “the home grower and the foreigner are . . . just paid the natural price of their produce, and there is no longer any motive to the one to increase his cultivation, nor to the other to diminish his.” Thus, in equilibrium, $\dot{Y}_H = \dot{Y}_F = 0$ holds and prices of both domestic and foreign corn should be equal to the actual price:⁵

$$p_H^* = p_F^* = p^*. \quad (7)$$

From (4) and (7), the following equation holds in equilibrium.

$$\left(\frac{w_H}{\alpha_H A_H^{\frac{1}{\alpha_H}}} \right) Y_H^{* \frac{1-\alpha_H}{\alpha_H}} = \left(\frac{w_F}{\alpha_F A_F^{\frac{1}{\alpha_F}}} \right) Y_F^{* \frac{1-\alpha_F}{\alpha_F}}. \quad (8)$$

From (8), we obtain

$$Y_F^* = \left(\frac{w_H}{w_F} \frac{\alpha_F}{\alpha_H} \frac{A_F^{\frac{1}{\alpha_F}}}{A_H^{\frac{1}{\alpha_H}}} \right)^{\frac{\alpha_F}{1-\alpha_F}} Y_H^{* \frac{\alpha_F(1-\alpha_H)}{\alpha_H(1-\alpha_F)}}, \quad (9)$$

5 From (6), $p - p_F = \lambda p_H + (1 - \lambda)p_F - p_F = \lambda(p_H - p_F)$. Since $\lambda \neq 0$, if $p_H = p_F$, then $p - p_F = 0$, or $p = p_F$. On the other hand, $p - p_H = \lambda p_H + (1 - \lambda)p_F - p_H = (1 - \lambda)(p_F - p_H)$. Since $(1 - \lambda) \neq 0$, if $p_F = p_H$, then $p - p_H = 0$, or $p = p_H$. However it should be noted that West did “not” pretend “here to approximate to the degree in which the prices would rise and fall, nor to the point at which the growing prices of home wheat and foreign wheat would meet.” According to him, the “process would be slower, and therefore less violent than” he supposed. He asserted that the growing price of the home wheat would fall, and the growing price of the foreign wheat rise, “till they met at some point between the original prices of each” (1815, 47–48). This shows that the idea of equalization of marginal costs was present in West’s discussions, although it was never used afterwards.

Figure 1 Importation of Foreign Corn (unit: shilling)

$$Y_H^* = \left(\frac{w_F}{w_H} \frac{\alpha_H}{\alpha_F} \frac{A_H^{\frac{1}{\alpha_H}}}{A_F^{\frac{1}{\alpha_F}}} \right)^{\frac{\alpha_H}{1-\alpha_H}} Y_F^* \frac{\alpha_H(1-\alpha_F)}{\alpha_F(1-\alpha_H)}. \quad (10)$$

From (5), (9) and (10), we obtain $D_H = Y_H^* + l^n Y_H^{*n/m} = Y_F^* + l^{-n} Y_F^{*m/n}$, where $l \equiv w_H \alpha_F A_F^{1/\alpha_F} / w_F \alpha_H A_H^{1/\alpha_H} > 0$, $m \equiv \alpha_H / (1 - \alpha_H) > 0$, and $n \equiv \alpha_F / (1 - \alpha_F) > 0$. From (3), $Y_i \geq 0$ if $p_i \geq 0$. From (9), $Y_F^* = 0$ if $Y_H^* = 0$; while, from (10), $Y_H^* = 0$ if $Y_F^* = 0$. Therefore, from (5), $D_H = 0$ if $Y_H^* = 0$; while, $D_H = 0$ if $Y_F^* = 0$. Both cases of $Y_H^* = 0$ and $Y_F^* = 0$ are in contradiction to $D_H > 0$. Hence, $Y_i > 0$, which shows that it is impossible that, in equilibrium, home producers are completely expelled from the market by foreign producers (Figure 1).

VI Concluding Remarks

By applying the principle of diminishing returns to the Corn Law question, West attempted to demonstrate that, even under free trade, England would still produce corn. However, to theoretically derive such a conclusion, we need the assumption of maximization of “net produce,” which is defined as “gross produce” minus “expense of production” subject to the continuously differentiable production function $F_i(L_i)$, with $F_i(0) = 0$, $\lim_{L_i \rightarrow 0} F_i'(L_i) = \infty$ and $F_i''(L_i) < 0$. Nevertheless, the illustration presented by West is interesting in that it is an original attempt to directly apply the principle of diminishing

returns to a specific trade matter, when it was common to apply diminishing returns to differential rent in order to analyze trade issues.

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