1. Introduction

As one of the main developments of the standard Heckscher-Ohlin model, the issue of variable returns to scale has drawn much attention in the literature of trade theory. It actually deserves serious attention because increasing returns to scale operate on production in a considerable number of industries nowadays and because a good deal of modern trade seems to rely on a scale merit arising from this feature. When increasing returns to scale exist in an industry, the industry usually has a tendency to be monopolized. But a different style of variable returns to scale can be recognized when scale economies are external to firms. In this case, perfect competition is consistent with variable returns to scale.

This chapter, like the previous chapter, treats this latter case, but we are now concerned with an economy where two factors exist and where each country is diversified in production. The challenge of this sort of economy is to re-examine the validity of the standard comparative static theorems such as the Stolper-Samuelson and Rybczynski theorems. Moreover, the factor price equalization theorem is also an important subject to examine. We discuss these topics in sections 3 and 4 after the introduction of the model in the following section. Furthermore, the pattern of trade by country size, which was posed in the preceding chapter as a main topic, is analysed in the present framework in section 5. Finally section 6 is devoted to comments on some possible extensions of the earlier analysis and to the analysis of the gains from trade.

2. The Model

Consider an economy with two tradeable commodities and two nontradeable factors. The factors are capital and labour. We assume that in each industry there

(1) Concerning the analysis of scale economies with monopolistic competition or monopoly, see, for example, Krugman[1979 and 1980], Helpman[1981] and Markusen[1981].
exist economies or diseconomies generated by output, external to the firm and internal to the industry, so that the typical firm's production function of the ith industry has the form

$$x_i = g_i(x_i)f_i(l_i, k_i), \quad i = 1, 2.$$  

Here $l_i$ and $k_i$ are, respectively, labour and capital employed by the typical firm in the ith industry, $f_i$ is the "kernel" production function faced by the typical firm in the ith industry and is assumed to be linearly homogeneous as well as strictly quasi-concave, and $g_i$ is a positive function describing the role of externalities.

On the other hand, the industrial production function in the ith industry takes the form

$$x_i = g_i(x_i)f_i(l_i, k_i), \quad i = 1, 2.$$  

Here $L_i$ and $K_i$ are, respectively, the total labour and capital employed in the ith industry.

Defining $\varepsilon_i = (x_i/g_i)(dg_i/dx_i)$, we can show that the ith industry obeys increasing returns to scale (IRS) or decreasing returns to scale (DRS) according to whether $\varepsilon_i > 0$ or $\varepsilon_i < 0$. Moreover, output can expand unboundedly if $\varepsilon_i > 1$ and a constant level of output can be maintained irrespective of the level of inputs if $\varepsilon_i = -\infty$. Thus, in order to exclude these economically paradoxical cases, we assume $-\infty < \varepsilon_i < 1$, for $i = 1, 2$.

Full employment is assumed, so that

$$L_1 + L_2 = L, \quad K_1 + K_2 = K,$$  

where $L$ and $K$ are the fixed supplies of labour and capital, respectively.

Since external economies or diseconomies are external to each firm, the conditions of production equilibrium can be described as

$$w = p_i g_i(x_i)(\partial f_i/\partial l_i), \quad i = 1, 2,$$

$$r = p_i g_i(x_i)(\partial f_i/\partial k_i),$$

under perfect competition, where $p_i$, $w$ and $r$ stand for the price of the ith commodity, wage rate and rental rate, respectively.

Equations (1)-(3) determine $x_1, x_2, L_1, L_2, K_1, K_2, w$ and $r$ if $p_1, p_2, L$ and $K$ are given. On the other hand, the production functions (1) and the equilibrium