Economies of Scope, Agglomeration and Location of the Multinational Firm

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Abstract   A classification of the locational patterns of firms (with economies of scope present) is outlined, in order to cast light on the location of the multiplant, multinational firm. This is driven by three forces: economies of scope that follow from the co-location of different activities; transportation costs of the final good; and factor mobility costs. It is concluded that the single-plant firm prevails when spatial economies of scope are strong in relation to either transportation or mobility costs. The vertical (horizontal) multiplant firm emerges when mobility costs of factors (transportation costs on the final good) are high. These two kinds of spatial costs, which are mutually exclusive, favor the formation of multinational firms.

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1. Introduction

The theory of multinational corporations has provided an explanation for the location of the firm within a set of nations. Three possibilities are usually recognized. First, the firm can be a single-plant firm, located in one nation and exporting to other nations. Second, it can be a vertical multiplant firm, with a segmented production process, each segment being undertaken by a plant located in a different nation. Finally, it can be a horizontal multiplant firm that supplies the market in each nation from a decentralized plant located within that nation. Apart from the work of MARKUSEN et al. (1996), the theory of multinational corporation tends to lack a unity. Vertical multinationals (HELPMAN, 1984) are viewed as resulting from the fact that nations have different relative factor endowments and that different segments of the firm (for example, headquarters R&D activity and manufacturing activity) have different factor requirements. If transportation costs are low, the segments will separate spatially, with each segment locating in a nation that is abundant in the factor of production used intensively by that segment. Thus, the headquarters will be located in the nation abundant in skilled labor and the manufacturing plant locates in the region relatively well endowed with unskilled labor. By contrast, horizontal multinationals are seen to result from the fact that economies of scale at the plant level are low in relation to economies of scale at the firm level and in relation to transportation costs of the final good (HORSTMANN and MARKUSEN, 1992). If fixed costs at the firm level (as in the case of R&D activity) are high in relation to economies of scale at plant level, it pays the multinational to set up several plants that use jointly the R&D activity supplied by the headquarters. If transportation costs are high in relation to

economies of scale at the plant level, it is more efficient for each nation to be supplied from a local plant rather than from a single central plant.

The lack of unity within the theory stems from the fact that the concept of economies of scale, which is used in the case of the horizontal multinational firm, does not assume significance in the case of the vertical multiplant firm. However, as GOLDSTEIN and GRONBERG (1984) have argued, the concept of economies of scale can be usefully supplemented by the concept of economies of scope (PANZAR and WILLIG, 1981). In this case, efficiency does not derive from the fact that an activity is undertaken on a large scale, but rather from the fact that different, though related, activities are undertaken by the same firm, so that the various activities share the services of a common input such as physical equipment or some technical expertise. Important for our purposes are spatial economies of scope. These emerge when the relevant activities have to be co-located, thus forming the basis for agglomeration economies.

An attempt has recently been made to classify firms (enjoying economies of scope) in terms of their locational patterns within a nation (PARR 2004). According to this classification, 'Firm l' produces each good at the same location within a region, and benefits from spatial economies of scope. 'Firm 2' produces each good in a different region, in order, for example, to save on transportation costs on the weight-losing input that is specific of each product. Finally, 'Firm 3' produces all goods in each region in order, for example, to save on transportation costs to the consumers in each regional market. Interestingly, these three firm types match the categories of firms commonly found in the literature on foreign direct investment and multinational corporations. Firm l corresponds to the single-plant, multiproduct firm, and Firm 2 corresponds to the vertical

multinational firm, while Firm 3 is comparable to the horizontal multinational. The advantage of this framework lies in the fact that the different firm types have a common basis (namely, the interaction between economies of scope and the transportation costs of inputs and final goods), and do not therefore depend on diverse foundations. In what follows, this framework is applied to a monopolist firm, in order to isolate the factors that determine each firm type. In this way we seek to outline the rudiments of a unified theory of location for the multinational firm.

2. The Background

We assume that within a spatial economy the following assumptions are satisfied.

1. There are two nations (or types of nation) U and S. Nation U has only unskilled workers, while nation S has only skilled workers. For simplicity, the distance between the nations is set at one, and the distance between two points within the same nation is zero.

2. A firm produces a consumer good by engaging in two related activities: R&D activity R, involving the design of the good; and manufacturing activity M, involving the production and sale of the good. Each unit of the consumer good requires one unit of R and one unit of M. This simplification amounts to assuming that the good associated with each activity is designed separately. More realistically, it should be assumed that there is a specific design capacity for a subset of products.

3. The firm is a monopolist in the consumer-good market and charges a fob or mill price p. The firm is a price taker in the factor market, with wu and ws, as the respective unit costs unskilled and skilled labor.

4. For the consumer good the transportation cost per unit of distance shipped, is given by t. Labour from one nation can be hired in another nation, if the employer pays a mobility cost m per unit of labour hired. Together with the assumption that each nation is endowed only with one factor of production, this is a simple way of introducing different factor prices across nations. It would be more realistic to assume that factors are immobile and that nations have different relative endowments.

5. The demand function of each consumer is linear, so that $q = a - bp$, where q is the quantity demanded. There are n consumers in each nation.

6. The cost functions of the complementary activities have a fixed part F, which represents a capital good, and variable part. The variable-cost of activity R is the cost of using α units of skilled labor per unit of output of the consumer good. The variable cost of M is the cost of using α units of unskilled labor per unit of output of the consumer good.

7. Spatial economies of scope (giving rise to agglomeration economies) are present if activities R and M are undertaken at the same location, so that the fixed cost F is shared. This sharing reflects the improved coordination between neighboring activities.

Following PARR (2004), it is further assumed that the firm is able to select from three locational patterns:

Single-plant firm (Firm 1): the firm locates activity *R* and activity *M* at the same location within a nation. As can be seen below, the cost function does not vary with the choice of the nation.

Vertical multiplant firm (Firm 2): the firm locates activity *R* in nation *S* and activity *M* in nation *U*.

Horizontal multiplant (Firm 3): the firm locates activity *R* in nation *S* and activity *M* in both nations *S* and *U*.

It is easily shown that other locational strategies lead to higher costs. Thus strategies with activity *R* in both nations involve a second mobility cost, but do not lead to additional economies of scope or savings in transportation costs of the final good.

3. Alternative Locational Patterns

The profit functions of the monopolist firm under the three strategies are as follows:

$$\pi_1 = n\left[p - \alpha w_u - \alpha\left(w_s + m\right)\right]\left\{(a - bp) + \left[a - b\left(p + t\right)\right]\right\} - F \tag{1}$$

$$\pi_2 = n\left\{(a - bp) + \left[a - b(p + t)\right]\right\}(p - \alpha w_u - \alpha w_s) - 2F \tag{2}$$

$$\pi_3 = n(a - bp)\left[p - \alpha w_S - \alpha(w_u + m)\right] + n(a - bp)(p - \alpha w_u - \alpha w_s) - 2F \tag{3}$$

In order to focus on the parameters *t, m* and *F,* the following specifications are made:

$$a = b = n = w_u = 1 \tag{4}$$

$$\alpha = 0.1$$

$$w_s = 2$$

With these specifications, the profit functions become

$$\pi_1 = (p - 0.3 - 0.1m)(2 - 2p - t) - F \tag{5}$$

$$\pi_2 = (2 - 2p - t)(p - 0.3) - 2F \tag{6}$$

$$\pi_3 = (1 - p)(p - 0.3 - 0.1m) + (1 - p)(p - 0.3) - 2F \tag{7}$$

The profit-maximizing prices in each locational pattern can be readily calculated:

$$p_1^* = 0.65 - 0.25t + 0.05m \tag{8}$$

$$p_2^* = 0.65 - 0.25t \tag{9}$$

$$p_3^* = 0.65 + 0.025m \tag{10}$$

A feasibility condition placed on the parameters is that the firm faces a positive demand in each market at the prices given by (8), (9) and (10). The following two conditions are necessary and sufficient for this to occur. The first is that

$$q = a - b(p_1^* + t) = 1 - (0.65 - 0.25t + 0.05m + t) > 0$$

which is equivalent to

$$t < 0.46667 - 6.6667 \times 0.01m \tag{11}$$

The second condition is that

$$q = a - bp_3^* = 1 - (0.65 + 0.025m) > 0$$

which is equivalent to

$$m < 14 \tag{12}$$

Substituting the profit-maximizing prices (8), (9) and (10) in the respective profit functions (5), (6) and (7), we obtain the profit functions of the firms in terms of the parameters t, m and F.

$$\pi_1 = 0.245 - 0.35t - 0.07m + 0.125t^2 + 0.05tm + 0.005m^2 - F \tag{13}$$

$$\pi_2 = 0.245 - 0.35t + 0.125\,t^2 - 2F \tag{14}$$

$$\pi_3 = 0.245 - 0.035m + 0.00125m^2 - 2F \tag{15}$$

We now plot the locational choice of the monopolist firm in parameter space. Since there are three parameters, two specific values will be assigned to the parameter F. These are $F = 0.1$ and $F = 0.05$. When $F = 0.1$, it is easily shown that the locational choice is described by the following inequalities:

$$\pi_1 > \pi_2 \Leftrightarrow t > -\frac{0.1\left(20 - 14m + m^2\right)}{m} \tag{16}$$

$$\pi_1 > \pi_3 \Leftrightarrow t < \frac{7}{5} - \frac{1}{5}m - \frac{1}{10}\sqrt{m^2 - 28m + 116} \tag{17}$$

$$\pi_3 > \pi_2 \Leftrightarrow t > 0.1m \tag{18}$$

Inequalities (16), (17) and (18) are used in Figure 1 to define the regions of the parameter space (m, t) for $F = 0.1$, where each type of locational pattern prevails. The upper downward-sloping line corresponds to feasibility condition (11). Condition (12) is implicitly fulfilled in each point of the figure.

It is now assumed that $F = 0.05$, and the defining inequalities become:

$$\pi_1 > \pi_2 \Leftrightarrow t > -\frac{0.1\left(10 - 14m + m^2\right)}{m} \tag{19}$$

$$\pi_1 > \pi_3 \Leftrightarrow t < \frac{7}{5} - \frac{1}{5}m - \frac{1}{10}\sqrt{m^2 - 28m + 156} \tag{20}$$

$$\pi_3 > \pi_2 \Leftrightarrow t > 0.1m \tag{21}$$

These inequalities, together with feasibility condition (11), define the regions of the parameter space (m, t) where each locational pattern holds. These regions are depicted in Figure 2.

It is possible to conclude that the Firm l pattern (the single-plant firm) is more likely to occur with high values for spatial economies of scope (as given by F) between activities R and M. It is also a dominant choice for the firm if the transportation costs on the consumer good and the mobility cost of the factors of production are both low. By contrast, the multiplant patterns of Firm 2 and Firm 3 occur at low values for spatial economies of scope, since for these firms there is a spatial separation of activities R and M. The pattern for Firm 2 occurs if the mobility cost is high and the transportation cost is low, while the pattern for Firm 3 prevails if the transportation cost is high and the mobility cost is moderate to low. These two multiplant patterns are mutually exclusive.

4. Concluding Remarks

It has been argued that under certain conditions the alternative locational patterns of a multinational firm are comparable to those of a firm operating within a single nation. This correspondence provided a framework for modeling the location of a multinational firm, where agglomeration of the firm's activities resulted from spatial economies of scope rather than from economies of scale. However, the agglomeration force deriving from spatial economies of scope (leading to a single-plant pattern) might be more than offset by the opposing forces of dispersion, involving different relative factor endowments across nations (leading to a vertical multiplant pattern) or high

transportation costs of the final good (leading to a horizontal multiplant pattern). These two forces of dispersion would be mutually exclusive. An extension of this framework beyond the case of a monopolist firm is both desirable and feasible. Thus it is possible to consider two independent firms, and model their interaction by means of a two-stage game. In the first stage each firm would choose its locational pattern, e.g., a single-plant firm in nation U or nation S; a vertical multiplant firm or a horizontal multiplant firm. In the second stage the firms would compete in the consumer-good market, either in terms of quantitites (HORSTMANN and MARKUSEN, 1992) or discriminatory prices (BELLEFLAMME *et al.*, 2000). This extension would enable us to treat spatial economies of scope as an agglomeration force, encouraging not only the spatial concentration of different activities within each independent firm, but also the co-location of the two firms. However, an extention to the case of a small group of firms is unlikely to affect fundamentally the qualitative conclusions that follow from our locational analysis of the monopolist firm.

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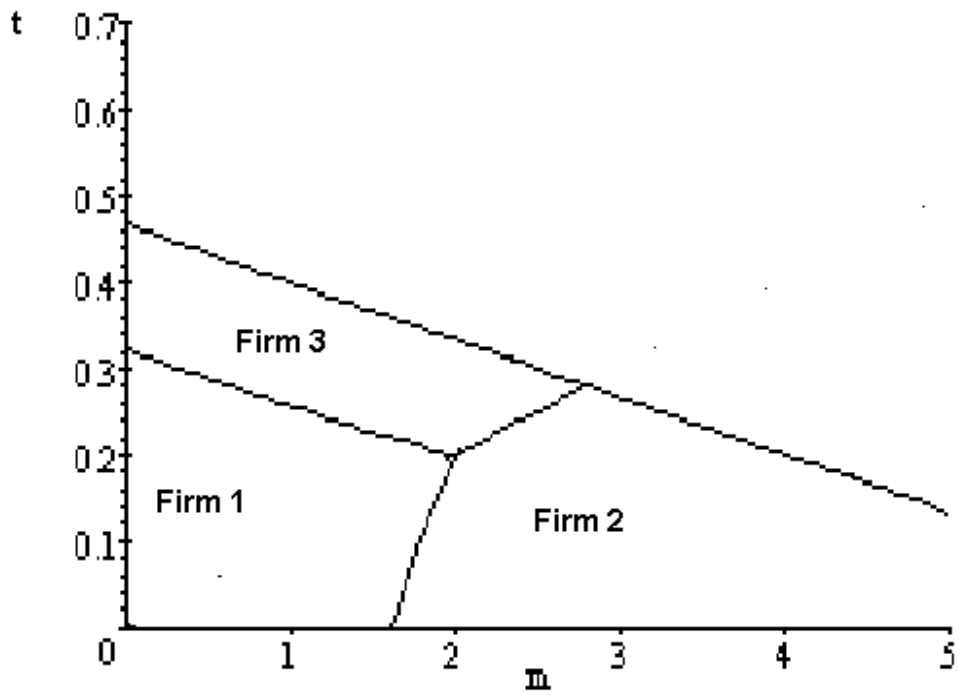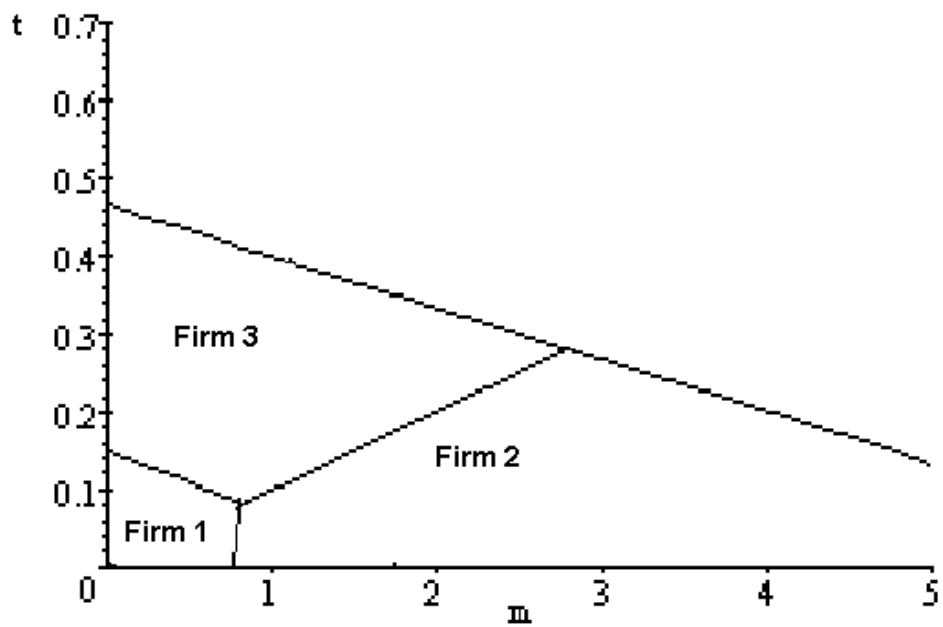
Figure 1: Firm types in *(m,t)* space for *F*=0.1

Figure 2: Firm types in *(m,t)* space for *F*=0.05