E C O N O M I C S B U L L E T I N

How to control market power of activity centers? A theoretical model showing the advantages of implementing competition within organizations

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Abstract

One important issue in firms' governance is how to create incentives so that activity centres can become more efficient. In this paper, we first introduce an agency contract where the salary of the manager of an activity centre that produces an intermediate product is dependent of its performance. Secondly, we add competition within the organization. This latter point is new in the literature. We then develop a "static analysis" comparing a firm that has only one activity centre producing an intermediate product with another firm that has two activity centres producing the same intermediate product, in a context where the technology manifests increasing returns to scale. We conclude that the introduction of internal competition makes the firm globally more efficient, even though it cannot fully explore the existence of increasing returns to scale.

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1. Introduction

Microeconomics studies markets as a complex system where firm are assumed as “black boxes” that transform inputs into outputs. But the micro scale is unable to predict firms’ internal reorganization in result of market dynamics. Since firms only exist while they perform that input-output transformation in a way more efficient than the market (Coase, 1937, Conner, 1991), we need to perceive firms as complex networks of sub-systems that trade between them goods (out of the market). For each sub-system, a number of inputs are bought in the market while other inputs are produced inside the firm by other sub-systems. The analysis of the efficiency of these sub-systems, designed as activity centers, is one of the basic concerns of the management accounting and control systems (Kaplan and Cooper, 1998). In order to promote an efficient allocation of resources it is necessary to determine a transfer price for each intermediate good (Atkinson, 1987).

The determination of transfer price, as well as the corresponding distribution of costs, is identical to the macroeconomic determination of the price by a central planner (Ijiri, 1968, Livingstone, 1969, Farag, 1967, 1968, and Kaplan, 1973), which uses the input-output analysis of Leontief (1941). According with this perspective, the organization is managed centrally, where activity centers are planned in order to maximize the overall profit.

Being firm complexity identical to market complexity, due to the imperfect information it is impossible to compute the efficient transfer prices, Hayek (1945). Even though firms’ smaller size reduces this information difficulty, the absence, within the organization, of competition magnifies it.

When, as standard, activity centers do not have internal competition they do not have incentives to disclose their private information. Due to secrecy requirements (e.g., of technology details) external competition does not significantly affect firms’ activity centers.

Since the curve of production possibilities of activity centers (the efficient curve) is not revealed, manager is unable to determine the efficient transfer price. Hence, the activity center gain depends, to a great extent, on its capacity in generating "false information" and in using its market power within the organization. This perspective, although partially covered by the agency theory (Alchian and Demsetz, 1972, Rajan, 1992), has been little explored in literature.

In this work we use a new perception of the internal allocation of resources by using models known from the industrial organization. We compare the allocation of resources in two organizations that have to produce an intermediate good. In the first organization the intermediate good is produced by a single activity center, i.e. the activity center is an “internal monopolist” while in the second organization the intermediate good is produced by two identical activity centers, i.e., we have an “internal duopoly”. By using numerical simulation, we conclude that, even when there are technological increasing returns to scale, the existence of competition inside the firm increases the overall efficiency of the organization.

2. Theoretical model

Assume a firm that produces one intermediate product and two final products. The firm is organized in three activity centers. One activity center produces the intermediate product while the other two produce the final products. Denote the intermediate output by I_1 and the final products by F_1 and F_2. The firm produces each final product using two inputs: the intermediate product I_1 and input I_2, which is acquired in the market (e.g., energy). The

intermediate product I_1 uses two inputs, the work of the manager responsible for this center, L, and input I_2 (see figure 1).

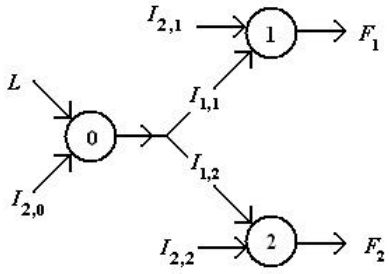

Figure 1: Firm's production layout

Assume also that the technology is *Cobb-Douglas*. The two final products use a technology with constant returns to scale, while the intermediate product uses a technology with increasing returns to scale. Therefore, the technology is represented by:

$$\begin{cases} I_1 = A_0\ L^j\ I_{2,0}{}^{x-j} & ,0 < j < x,\ x \geq 1 \\ S_1 = A_1\ I_{1,1}{}^{a}\ I_{2,1}{}^{(1-a)} & ,0 < a < 1 \\ S_2 = A_2\ I_{1,2}{}^{b}\ I_{2,2}{}^{(1-b)} & ,0 < b < 1 \end{cases} \tag{1}$$

where $I_{2,o}$ denotes the quantity of input I_2 used in the production of the intermediate product, $I_{i,j}$ denotes the quantity of input I_i used in the production of the final product F_j, L denotes the work of the manager and A_0, A_1 and A_2 are constants. The market demand curves of the two final products are linear decreasing and given by:

$$\begin{cases} D_1 = a_1 - b_1\ p_1 \\ D_2 = a_2 - b_2\ p_2 \end{cases} \tag{2}$$

where p_i is the price of the final product F_i and a_1 and a_2 are constants. The price of input I_2, traded in a perfectly competitive market, is given by w_2. It is assumed that the transfer price of input I_1 is the average cost of production, w_1. The average cost of production depends on both the cost of input I_2 and the salary of the manager. The salary of the manager is equal to a fixed component, W_0, plus a variable component, which increases with the output of the intermediate input I_1 and depends on the difference between the *standard* cost, $w_1{}^s$, and the cost of production excluding the variable component of the salary, $w_1{}^f$, where $w_1{}^f = (I_{2,0}\ w_2 + W_0)/I_1$. Hence, the salary of the manager is given by:

$$W = W_0 + k_1\ (w_1{}^s - w_1{}^f)\ I_1 = W_0\ (1-k_1) + k_1\ (w_1{}^s I_1 - I_{2,0}\ w_2),\ \ 0 < k_1 < 1 \tag{3}$$

The actual average cost of production of the intermediate product is given by:

$$w_1 = \frac{I_{2,0}\ w_2 + W_0 + k_1\ (w_1{}^s - w_1{}^f)\ I_1}{I_1} = (1-k_1)\frac{I_{2,0}\ w_2 + W_0}{I_1} + k_1\ w_1{}^s \tag{4}$$

Since the transfer price of the intermediate product equals the actual average cost of production, the activity center obtains not profit. Therefore, the profit of the firm, π, equals the sum of the profits of the activity centers that produce the final products, π_1 and π_2. Formally, we have:

$$p = p_1 + p_2, \quad \begin{cases} p_1 = S_1(I_{1,1}, I_{2,1})\ p_1(S_1) - \left(I_{1,1}\ w_1 + I_{2,1}\ w_2\right) \\ p_2 = S_2(I_{1,2}, I_{2,2})\ p_2(S_2) - \left(I_{1,2}\ w_1 + I_{2,2}\ w_2\right) \end{cases} \tag{5}$$

Using (1) and (2), the profit function of the activity center that produces the final product F_1, p_1, is given by:

$$p_1 = A_1\ I_{1,1}{}^{a}\ I_{2,1}{}^{(1-a)}\ \frac{\left(a_1 - A_1\ I_{1,1}{}^{a}\ I_{2,1}{}^{(1-a)}\right)}{b_1} - \left(I_{1,1}\ w_1 + I_{2,1}\ w_2\right) \tag{6}$$

The optimal quantities $I_{1,1}$ and $I_{2,2}$ are then the solution to:

$$\begin{cases} \dfrac{dp_1}{dI_{1,1}} = 0 \\ \dfrac{dp_1}{dI_{2,1}} = 0 \end{cases} \Leftrightarrow \begin{cases} \dfrac{a}{b_1\ I_{1,1}}\left[S_1\ a_1 - 2\ S_1{}^2\right] = w_1 \\ \dfrac{(1-a)}{b_1\ I_{2,1}}\left[S_1\ a_1 - 2\ S_1{}^2\right] = w_2 \end{cases} \tag{7}$$

After simplifying (7), we obtain the demand of inputs I_1 and I_2 by the activity center that produces the final product F_1:

$$\begin{cases} I_{1,1} = \dfrac{w_2}{w_1}\dfrac{a}{1-a}\ I_{2,1} \\ I_{2,1} = \dfrac{m\ a_1\ (1-a) - w_2\ b_1}{2\ m^2\ (1-a)}, \quad m = A_1\left(\dfrac{w_2}{w_1}\dfrac{a}{1-a}\right)^{a} \end{cases} \tag{8}$$

In a similar way we obtain the demand of inputs I_1 and I_2 by the activity center that produces the final product F_2. The demand of input I_1 is then given by:

$$I_1 = I_{1,1} + I_{1,2} \tag{9}$$

Using expressions (1) and (4), the actual average cost at the activity center that produces input I_1 can be rewritten as depending on the effort of the manager and the demand of input I_1:

$$w_1(L, I_1) = (1-k_1)\frac{\left(\dfrac{I_1}{A_0\ L^j}\right)^{\frac{1}{x-j}}\ w_2 + W_0}{I_1} + k_1\ w_1{}^{s} \tag{10}$$

Considering (3), and assuming that the disutility of effort is given by $k_2.L^2$, the effort exerted by the manager at the activity center that produces input I_1 results from the resolution of the following optimization problem:

$$\underset{L}{Max}\left[W(L, I_1) - k_2\ L^2\right] = \underset{L}{Max}\left[W_0\ (1-k_1) + k_1\left(w_1{}^{s} I_1 - \left(\frac{I_1}{A_0\ L^j}\right)^{\frac{1}{x-j}}\ w_2\right) - k_2\ L^2\right] \tag{11}$$

It is worth noting that the effort exerted by the manager alters (using expression 10) the actual average cost at the activity center that produces input I_1, while this changes (using expression 8) the demand of inputs I_1 and I_2 by the activity centers that produces the final products. The final solution to the problem results from the resolution of the system of non-linear equations represented by expressions (9) and (11).

3. Properties of the model

We start with considering the case where there is only one activity center producing the intermediate product I_1. We use simulation methods because the analytic manipulation of the problem is difficult and removes clarity. Future research might explore the analytic properties of the model.

Case 1 (There is only one activity center producing the intermediate product I_1)

In this case, the activity center that produces the intermediate product acts as a monopolist. Hence, the demand is given by expression (9).

Assuming that $w_1^s = 2$, $w_2 = 1$, $A_0 = 2$, $A_1 = A_2 = 1$, $a = b = j = 0{,}5$, $x = 1.1$, $W_0 = 1$, $k_2 = 1$, $a_1 = a_2 = 5$ e $b_1 = b_2 = 1$, we next represent the profit of the firm, the average cost of the intermediate output and the effort exerted by the manager as the parameter k_1 changes.

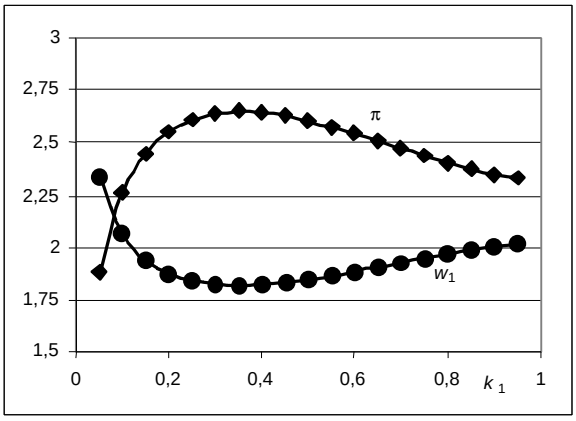

Figure 2: Firm's profit and average cost of the intermediate output

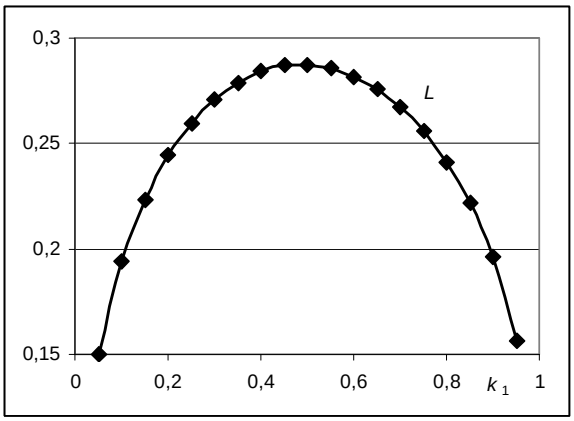

Figure 3: Effort exerted by the manager

Since that the activity center that produces the intermediate product is monopolist, the effort the manager exerts is relatively small, unless the owner of the firm pays to the manager a relative high percentage of the difference between the standard cost and the actual cost. The simulation results show that the profit of the firm is maximized when the owner pays to the manager, as a variable component of the salary, approximately 35% of the difference between the standard cost and the actual cost. Hence, the manager increases his effort and the

average cost reduces. In a sense, we obtain a better congruence between owner interests and manager interests.

Case 2 (There are two activity centers producing the intermediate product I_1)

One way of reducing the market power that results from the fact that there is only one activity center producing the intermediate output is by introducing another competitor within the organization. In this case, each activity center might have a different average cost of production. Moreover, the activity centers that buy the intermediate products choose first the center that practices a lower average cost. In figure 4 we represent the organization of the activity centers.

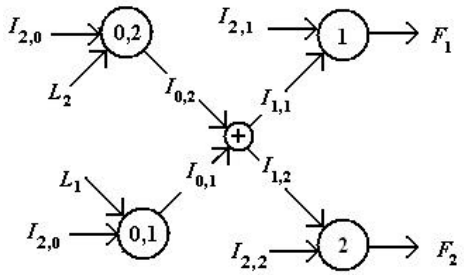

Figure 4: Firm's production layout

In this case, each activity center producing the intermediate product produces only a part of the demand of input I_1. Assuming that the average cost and the quantity produced at activity center (0, j), j = 1, 2 are, respectively, $w_{0,j}$ and $I_{0,j}$, the overall average cost of the intermediate product, which will be used by the activity centers that produce the final products, is given by:

$$w_1 = \frac{w_{0,1}\ I_{0,1} + w_{0,2}\ I_{0,2}}{I_1} \tag{12}$$

Where $I_1 = I_{0,1} + I_{0,2}$ As observed above, it is assumed that the activity center that has a lower average cost produces a higher quantity. Moreover, the distribution between the two activity centers is, by assumption, given by:

$$\begin{cases} I_{0,1} = \dfrac{w_{0,2}}{w_{0,1} + w_{0,2}} \\ I_{0,2} = \dfrac{w_{0,1}}{w_{0,1} + w_{0,2}} \end{cases} \tag{13}$$

Considering the same values used in Case 1, except that $W_0 = 0{,}5$ (w_1' = 2, $w_2 = 1$, $A_0 = 2$, $A_1 = A_2 = 1$, $a = b = j = 0{,}5$, $x = 1.1$, $W_0 = 0{,}5$, $k_2 = 1$, $a_1 = a_2 = 5$ e $b_1 = b_2 = 1$), we next represent the profit of the firm, the average cost of the intermediate product and the effort exerted by the manager as the parameter k_1 changes.

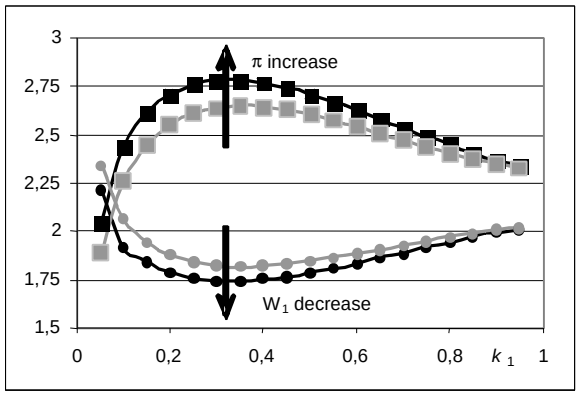

Figure 5: Increase of the profit and decrease of the average cost of the intermediate output when there are two activity centers producing the intermediate output

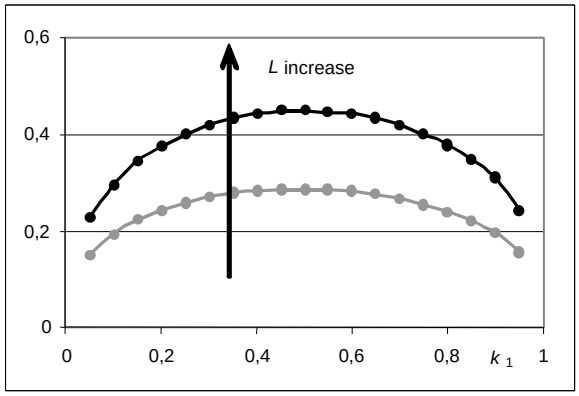

Figure 6: Increase of the effort exerted by the (two) managers responsible for the activity centers that produce the intermediate output

As figure 5 shows, the profit of the firm is maximized when the owner pays to the two managers, as a variable component of the salary, approximately 35% of the difference between the standard cost and the actual cost. More importantly, the profit of the firm increases when we introduce competition, although there are increasing returns to scale in the production of the intermediate output ($x = 1.1$).

4. Conclusion

It is well known that the absence of competition in the markets induces a loss of economic welfare. Similarly, within organizations, the market power that results from the fact that an intermediate product is produced by a single activity center induces an inefficient allocation of resources. This occurs because the activity center does not have incentives to disclose information concerning the (efficient) curve of production possibilities. Consequently, the power to impose the transfer price is the main factor affecting the allocation of resources.

Although it might be a priori more efficient to use a single activity center to produce an intermediate input when there are increasing returns to scale, in this work we show that this is not always the case. Thus, comparing a firm that has a monopolist activity center producing an intermediate product with another firm where the same intermediate product is produced

by two activity centers, we show that, even if there are increasing returns to scale, the firm might become more efficient duplicating activity centers.

The great question we should pose is to know how the production processes should be modified so that it is possible the existence of a great number of activity centers operating in competition.

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