Strategic Delegation of Responsibility in Competing Firms

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Abstract

This paper investigates the strategic impact of organizational design on product market competition. In a duopoly model of horizontal and vertical product differentiation, each firm's manager can impose a product location, or delegate responsibility to select product location to his subordinate. The task of a subordinate is to develop and produce the good. Quality is determined by his effort level, which depends on his private benefits. The managers compete on a product market by selling the goods produced by their subordinates. Conditions for existence of equilibria are derived, and implications for management strategy are discussed.

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1   Introduction

Top managers of firms do not only make "strategic" decisions, for instance on product choice and price setting, but also decide on organizational issues like delegating responsibility to subordinates. Think, for instance, of a product manager who is responsible for his firm's market strategy, and has to decide which product variety to sell in some market segment. A layer below him in the hierarchy, there is a middle manager, such as the head of the development and production department. In this paper, I study the strategic impact of organizational structure, or more specific, of giving the middle manager a say in the choice of a product variety that his department has to develop and produce.

Consider, as an example of the model, an oligopolistic market for some soft drink, say cola, in which consumers have different preferences for different varieties (such as regular cola, cherry cola, diet cola, and caffeine-free cola). For each variety, consumers are willing to pay more for higher quality. Suppose price competition is fierce: for given qualities, a firm gains more if it positions its brand in a market niche (by differentiating its product), than if it sells a drink aimed at an "average" taste.[1]

Each firm consists of a product manager and his subordinate (or middle manager), who represents the development and production department.[2] The product manager has to choose which cola type to sell, and at which price. The subordinate performs development and production activities; quality is determined by his effort level. Whereas a product manager cares about sales or profits, his subordinate is motivated by private benefits. For instance, because of career concerns he finds the acquisition of professional experience important, or alternatively, he is challenged by technical innovativeness of

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[1]Casual empirical evidence suggests that product differentiation is an important source of profits in soft drink markets. Coca-Cola, for instance, has recently introduced, among other varieties, ginseng-based and milk-based drinks in Japan, and sugar-free colorless cola in America (*The Economist*, "Fizzing," September 4th 1993, 67-71).

[2]Obviously, there may also be conflicts of interest between the middle manager and the engineers of his department, raising a host of additional interesting issues.

products. Developing and producing a certain type of cola requires specific technical knowledge (e.g. about chemicals and production processes), so that his enthusiasm for different types of colas will vary.

A product manager does not know how his subordinate's preferences. The subordinate, however, has to invest costly time and effort to find out his potential personal gains. A manager can either impose which variety has to be produced (e.g. impose diet cola), or give his subordinate a say in the choice of variety (e.g. let him choose between diet cola and caffeine-free cola, but not regular and cherry cola). If the subordinate has sufficient discretion, he will want to acquire information about the possible drink types, so that he can recommend his preferred variety. If he is allowed to develop and produce his preferred variety, he will exert maximal effort, and high quality will result.[3]

In the model, a product manager faces the following tradeoff. If he gives his subordinate more discretion, it becomes more likely that he will get informed in order to make a proposal which, if accepted, will lead to a high quality drink (a premium brand). The subordinate's proposal, however, may imply little differentiation from other cola varieties, and therefore result in fierce price competition. Less discretion enables the manager better to position a drink in a market niche, so that local monopoly profits can be enjoyed. The subordinate's incentives to take initiative and exert effort, however, decrease, so that expected quality will be lower.

In the model, the possible cola varieties correspond to locations on an interval representing consumers' different tastes. It is therefore convenient to make a comparison with the Hotelling model. In the standard Hotelling

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[3] *The Economist* discusses empirical support for the claim that firms "[...] which give middle managers a say in forming strategy perform better" and provides examples of delegation of responsibility. For instance, "Honda developed its Civic car by giving a group of young middle managers broad guidelines (make it youth-friendly and fuel-efficient) and letting them get on with the job." Also, "Motorola's middle managers have had a say in designing its Iridium satellite project." ("The salaryman rides again," p. 70, February 4th, 1995.) Obviously, there may be a combination of reasons (e.g. incentives, information, flexibility, work overload) for decentralizing strategic decisions.

model with quadratic transportation costs, the demand effect (firms want to be "where the demand is"), outweighs the strategic effect (firms want to be local monopolists) (see D'Aspremont et al. [3]). Consequently, firms differentiate their products as much as possible in order to soften price competition. In my model, an *incentive effect* also counteracts the strategic effect. If this effect becomes stronger, managers will delegate more responsibility to their subordinates, and products will be less differentiated. In particular, a higher impact of quality on profits favors more discretion in equilibrium.

Delegation decisions relate to organizational structure and market strategy. Thus, studying the strategic nature of delegation yields several implications in the field of management strategy.[4] The optimal level of discretion, as a function of the discretion level in the rival firm, may be increasing ("strategic complements") as well as decreasing ("strategic substitutes"), depending on the revenue functions. Delegation of responsibility makes a firm "tough" in the sense that it reduces the profits of the rival firm; more discretion results in a higher probability of high quality, and a less horizontally differentiated product. Moreover, from the viewpoint of an incumbent facing a potential entrant, an optimal entry accomodation strategy is to give the subordinate little discretion (in the terminology of the taxonomy of management strategies of Fudenberg and Tirole [6]: adopt a "puppy dog" strategy). The reason is that delegating less responsibility results in a more differentiated product, which softens price competition if entry occurs. By the same intuition, the optimal entry deterrence strategy is to empower the agent (to become a "top dog").

An interesting observation is that in the model, an authoritarian leadership style (the subordinate gets little discretion) corresponds to a soft stance on the product market, and "hands-off" management corresponds to an aggressive market stance. Without claiming generality, this result points out that leadership styles may be perceived quite differently inside and outside a firm.

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[4]Management strategy studies how a manager optimally designs the firm's organization and market strategy, taking any public constraints into account (see Spulber [11]).

In typical models of industrial organization, firms are viewed as "black boxes." Although this approach has led to important insights, it has major shortcomings. As Spulber [10] argues: "For economic models to have practical value to managers, they need to address the choice of both *competitive actions* and *organizational design*" (p. 536, emphasis in original). By combining organization theory and industrial organization, this paper makes a preliminary attempt at shortening the gap between economic theory and management strategy.

The main literature on competition and organizational incentives studies situations in which managers play a market game on behalf of owners (see for instance Vickers [14], Fershtman and Judd [5], Sklivas [9], and Katz [8]). The question in that literature is whether contracts between owners and managers can serve as precommitments. Having an agent play the market game may, for instance, result in lower quantities or higher prices. The fundamental difference with that literatures is that I abstract from agency problems between owners and managers, and instead look at delegation *inside* firms. Delegation of responsibility serves an organizational purpose – namely, it motivates a subordinate to take initiative and exert effort (although commitment may play a role). Also, an important difference is that in my model, the *principals* compete on the market, by selling goods produced by their agents.

In Horn et al. [7], contracts between owners and managers give a manager incentives to reduce the cost of production. A common feature of their paper and mine is that organizational design takes place before market decisions are taken. Their analysis suggests a negative relation between incentives to reduce costs and the competitiveness of product market interaction. In my model, which focuses on quite different issues, stronger incentives (more responsibility for a subordinate) result in more severe price competition.

The organizational model is based on De Bijl [4]. In that paper, which in turn was inspired by Aghion and Tirole [1], I investigate a principal-agent relationship in which the principal appeals to the agent's private benefits from exerting effort, such as job satisfaction, by giving him a say in the selection of the project the agent has to implement. Although the principal has the

formal authority to select a project, it is in his interest to pick one that generates interest from the agent. Thus, although the superior has formal authority (the decision right), the subordinate may to some extent have real authority (see also Tirole [13]).

The model is presented in the next section. The formal results are derived in section 3. Section 4 discusses implications for management strategy. Finally, section 5 concludes.

2   The Model

The model consists of three building blocks: a Hotelling-type product market, the organization of a firm, and competition between vertical structures. These will be taken up in turn.

Product Market Competition:

There are two firms, called 1 and 2. Firm 1 can choose a horizontal product specification (or product location) $x_1 \in [-1, 0]$, and firm 2 a product specification $x_2 \in [0, 1]$.[5] The vertical product quality of firm i is denoted by r_i.

Consumers are uniformly distributed along the interval $[-1, 1]$. The willingness to pay of a consumer "located" at z for firm i's product is decreasing in the distance between z and x_i, and increasing in r_i. A consumer has an inelastic demand for one unit; she purchases the good that gives her the highest net surplus.

Once product characteristics are fixed (see below), the firms compete on the product market by simultaneously setting prices. Marginal costs are equal and normalized to zero. Before the price competition stage, the firms observe each others' product characteristics. To keep the analysis tractable, price competition is not modeled explicitly. I will assume that given product locations x_1 and x_2, and qualities r_1 and r_2, there exists a unique equilibrium

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[5]This assumption rules out coordination problems among firms, in order to focus the analysis on more crucial issues.

in the price subgame. Also, qualities are sufficiently high so that the market is always covered.

Given the unique equilibrium outcome in the price subgame, firm i's revenue (or profit) function is denoted by $R_i(x_1, x_2; r_1, r_2)$, which is twice continuously differentiable in x_1 and x_2 ($i = 1, 2$). Also, $R_i(x_1, x_2; r_1, r_2) \geq 0$.

Assumption 1 *(Revenue functions)*
(i) $R_i(x_1, x_2; r_1, r_2)$ is strictly increasing in r_i, and strictly decreasing in r_j, for all x_1, x_2, $i = 1, 2$.
(ii) $R_i(x_1, x_2; r_1, r_2)$ is strictly decreasing in x_1, and strictly increasing in x_2, for all r_1, r_2, $i = 1, 2$.

The interpretation of assumption 1 is direct. A firm's profit level is increasing in its own vertical product quality, and decreasing in its rival's quality. Furthermore, given quality levels, the firms would like to differentiate as much as possible to soften price competition. So implicitly, on the interval $[-1, 1]$ the strategic effect (firms want to be local monopolists) dominates the demand effect (firms want to be "where the demand is").[6] Thus, the model applies to markets in which it is profitable for firms to position brands in market niches. Moreover, the assumption will allow for easy comparison with the maximum differentiation result of the Hotelling model with quadratic transportation costs.

Organization of a Firm:
The way a firm is organized is adapted from De Bijl [4]. Firm i consists of a principal P_i (the manager) and an agent A_i (the manager's subordinate), $i = 1, 2$. The role of a principal in a firm is either to impose a horizontal product specification or to delegate the product location to his agent. Given

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[6]Cf. the Hotelling location model with quadratic transportation costs, some finite reservation value for consumers, and possibly different vertical product qualities. The willingness to pay of a consumer located at z for good i in that model is $r_i - p_i - d(z - x_i)^2$, where p_i is the price of the good, and d a measure of the transportation cost. For $r_1 = r_2$, product locations in equilibrium are $x_1^* = -1$ and $x_2^* = 1$ (see D'Aspremont et al. [3]).

product location, the subordinate takes care of development and production, and vertical product quality is determined by his effort level. Once location and quality are determined, the manager chooses a price in order to maximize expected profits.

An agent is motivated to exert effort by private benefits, which are related to horizontal product characteristics. Private benefits may include job satisfaction, a sense of achievement and accomplishment, perks on the job, the acquisition of professional experience, career concerns, and so on. For simplicity, the agent does not respond to pecuniary incentives. For instance, the agent is infinitely risk averse with respect to income. Accordingly, each agent receives a constant salary equal to his reservation wage, which is normalized to zero.[7]

A_1's private benefits are determined by Nature as follows. Exactly one point in $[-1, 0]$ yields the agent benefits $\bar{b}$; all the other product locations yield $\underline{b} < \bar{b}$ (where $\underline{b} > 0$). The location of the high private-benefit point is uniformly distributed on $[-1, 0]$.[8] The private benefits of A_2 are determined in a similar fashion on the interval $[0, 1]$, and are independent of A_1's private benefits. Let

$$\Delta \equiv \bar{b} - \underline{b}.$$

If A_i is not allowed to produce the high private-benefits good then he will exert low effort, which results in low vertical quality $r_i = \ell > 0$. Conversely, producing a good which yield high private benefits results in high product quality $r_i = h > \ell$.[9] Note that by abstracting from pecuniary incentives, punishments based on low effort are ruled out.

The realization of A_i's private benefits can only be observed by A_i, but

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[7]In De Bijl [4] I show that abstracting from payments does not harm generality if an agent is relatively more responsive to private benefits than to money.

[8]The discontinuity in the distribution simplifies the exposition; it is not crucial for the insights.

[9]One can explicitly model an agent's behavior. Suppose an agent has a utility function $U(b, e)$, where b denote private benefits and e his effort level. Assume $U(b, e)$ is increasing in b for all e, strictly concave in e for all b, and satisfies $\partial^2 U(b, e)/(\partial b \partial e) > 0$. It follows that the agent's optimal effort level $e^*(b)$ is increasing in b.

he has to incur a private cost $F \geq 0$ (for instance, time and effort) to do so. The principal cannot verify whether his agent gets informed.

P_1's delegation decision is expressed by a function $p_1 : [-1, 0] \to [0, 1]$, such that if A_1 recommends product location x_1, he is allowed to produce the good located at x_1 with probability $p_1(x_1)$, but has to produce the good at -1 with probability $1 - p_1(x_1)$. Similarly, P_2's delegation scheme is described by a function $p_2 : [0, 1] \to [0, 1]$ (A_2 has to produce good 1 with probability $1 - p_2(x_2)$ given proposal x_2). So

$$p_i(x_i) = \Pr(A_i \text{ is allowed to produce good } x_i \mid A_i \text{ proposed } x_i).$$

Whether an agent will learn his private benefits depends on the discretion he has. A_1 gets informed if and only if[10]

$$\int_{-1}^{0} [p_1(x_1)\bar{b} + (1 - p_1(x_1))\underline{b}]\mathrm{d}x_1 - F \geq \underline{b},$$

or equivalently,

$$\int_{-1}^{0} p_1(x_1)\mathrm{d}x_1 \geq \frac{F}{\Delta}. \tag{1}$$

One can write down a similar inequality for A_2. To make the model interesting, the following assumption is made:

Assumption 2 $F < \Delta$, *implying that if an agent has complete responsibility concerning product location ($p_i(x_i) = 1$ for all x_i) then he will get informed.*

An uninformed agent is indifferent between the possible locations. For simplicity, he will then propose the principal's preferred location.

I assume that a principal can commit himself to a delegation scheme; the focus of the paper is on delegation as a means to motivate a subordinate.[11] A justification is that a manager cares about his reputation to keep a promise. Since selling a high-quality good located at x_i may yield higher profits than selling a more differentiated low-quality good for all x_i that satisfy $p_i(x_i) > 0$,

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[10] To be precise, $\bar{b}$ and $\underline{b}$ represent the private benefits obtained by the agent given his optimal effort level; e.g., using notation introduced in footnote 9, $\bar{b}$ represents $U(\bar{b}, e^*(\bar{b}))$.

[11] It will be shown that $p_i(x_i) \in \{0, 1\}$ for all x_i, so that there is no need to assume that principals can commit themselves to carry out randomizations.

delegation schemes may be optimal ex post; the assumption is not crucial. This is typically the case if high quality has a relatively large impact on revenues, compared to differentiation.

Competing Organizational Structures:

The principals compete with each other; they face each other on the product market. There is no interaction between the agents, and they cannot communicate with each other. The course of events is as follows:

$t = 0$: Nature selects the agents' private benefits, unobserved at this stage.

$t = 1$: The principals simultaneously choose delegation schemes, unobservable outside each firm. Each principal communicates the delegation scheme to his agent, who then decides whether to learn his private benefits. The latter decision is private information for an agent. The agents then simultaneously recommend product locations to their principals. Product locations are simultaneously selected according to the delegation schemes. An agent's proposal and the selected location are unobservable outside each firm at this stage.

$t = 2$: Each agent picks a production effort level, and vertical product qualities are realized.

$t = 3$: Product locations and qualities are observed. The principals simultaneously set prices and the goods are sold on the market.

It is important to notice that once production has taken place, delegation schemes no longer matter; only product locations and qualities influence the prices that are charged in the market.

In the analysis that follows, subgame perfect equilibria in pure strategies are derived. Since the price stage is not modeled explicitly, essentially the principals compete by simultaneously selecting delegation schemes. The analysis focuses on symmetric equilibria.

3 Analysis

The first proposition allows us to represent delegation schemes by well-defined "discretion levels." In particular, in any equilibrium $p_i^*(x_i) = 1$ for all x_i in some interval containing firm i's maximally differentiated product location, and $p_i^*(x_i) = 0$ otherwise.[12] A discretion level for firm i's agent, denoted by X_i, is accordingly defined as the length of the interval on which $p_i(x_i) = 1$. A higher level of X_i corresponds to more responsibility for agent A_i. In particular, if $X_i = 0$ then firm i's manager imposes his agent to produce the maximally differentiated product. If $X_i = 1$, agent A_i has full responsibility.

Proposition 3.1 *In any equilibrium, there exist discretion levels $X_i^* \in [0, 1]$, $i = 1, 2$, such that A_1's recommendation x_1 is followed up if and only if $x_1 \leq -1 + X_1^*$, and A_2's recommendation x_2 is followed up if and only if $x_2 \geq 1 - X_2^*$.*

Proof: See the appendix.

Intuitively, given the level of responsibility the rival firm's agent has, each principal faces the following tradeoff. Giving his agent little discretion results in a lack of initiative: the agent has no incentive to learn his private benefits and make a recommendation. The maximally differentiated product will be produced, but quality will be low. Much discretion results in initiative: the agent will get informed and recommend his preferred product location. The product will be less differentiated, but quality will be high if the proposal is followed up.

Using (1), a direct consequence of proposition 3.1 is that A_i gets informed if and only if he has enough discretion.

Corollary 3.1 *Agent A_i gets informed if and only if $X_i \geq \frac{F}{\Delta}$.*

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[12]A similar result is obtained in De Bijl [4], with a discrete number of projects and in the absence of a rival firm.

Some additional notation is introduced. Let $\rho_i : [0,1] \times [0,1] \to \Re$ denote P_i's expected revenue as a function of (X_1, X_2), given that both agents get informed, $i = 1, 2$. Accordingly,

$$\rho_i(X_1, X_2) = \int_{-1}^{-1+X_1} \left(\int_{1-X_2}^{1} R_i(x_1, x_2; h, h) dx_2 + (1 - X_2) R_i(x_1, 1; h, \ell) \right) dx_1$$

$$+ (1 - X_1) \left(\int_{1-X_2}^{1} R_i(-1, x_2; \ell, h) dx_2 + (1 - X_2) R_i(-1, 1; \ell, \ell) \right).$$

Firm i's expected profits, a function $\pi_i : [0,1] \times [0,1] \to \Re$, can now be defined as follows.

$$\pi_i(X_1, X_2) = \begin{cases} \rho_i(X_1, X_2) & \text{if } X_1 \geq \frac{F}{\Delta} \text{ and } X_2 \geq \frac{F}{\Delta}, \\ \rho_i(X_1, 0) & \text{if } X_1 \geq \frac{F}{\Delta} \text{ and } X_2 < \frac{F}{\Delta}, \\ \rho_i(0, X_2) & \text{if } X_1 < \frac{F}{\Delta} \text{ and } X_2 \geq \frac{F}{\Delta}, \\ \rho_i(0, 0) & \text{otherwise.} \end{cases}$$

With expected profits written as functions of levels of discretion, we are ready to derive the main results. The following lemma will be invoked repeatedly in the analysis below.

Lemma 3.1 *(i) $\rho_i(X_1, X_2)$ is strictly decreasing in X_j, for all X_i, $i, j = 1, 2$, $i \neq j$*
(ii) $\rho_i(X_1, X_2)$ is strictly concave in X_i, for all X_j, $i \neq j$, and
(iii) $\partial \rho_1(0, X_2)/\partial X_1 > 0$, for all X_2; and $\partial \rho_2(X_1, 0)/\partial X_2 > 0$, for all X_1.

Proof: Differentiate $\rho_i(X_1, X_2)$ partially (twice to prove part (ii)) and apply assumption 1. $\square$

If we suppose that agents can costlessly observe their private benefits, so that $\pi_i(X_1, X_2) = \rho_i(X_1, X_2)$, $i = 1, 2$, then lemma 3.1 has straightforward interpretations. According to part (i), a principal wants the agent of the rival firm to have as little discretion as possible. Notice the similarity with the assumption that a firm wants the rival firm to locate as far away as possible. The effect of little discretion for the rival firm's agent is, however, twofold: first, it softens price competition, and second, it results in a low probability

that the rival product will be of high quality. Using terminology of Fudenberg and Tirole [6], delegation of responsibility makes a firm "tough," in the sense of reducing the rival firm's profits.

A straightforward implication of lemma 3.1 (iii) is the following:

Corollary 3.2 *If $F = 0$ then in any equilibrium each principal gives his agent some responsibility, i.e., $X_1^* > 0$ and $X_2^* > 0$.*

The next proposition gives necessary and sufficient conditions for existence of an equilibrium in which both agents have full discretion. Informally, proposition 3.2 states that both agents have full discretion in an equilibrium when selling a high-quality product is more profitable than selling a maximally differentiated product. Expected product locations are $-\frac{1}{2}$ and $\frac{1}{2}$. Since the agents have complete freedom to pick product location, both products will be of high quality.

Proposition 3.2 *There exists an equilibrium in which each principal gives his agent complete responsibility, i.e., $X_1^* = X_2^* = 1$, if and only if*

$$\int_0^1 R_1(0, x_2; h, h) dx_2 \geq \int_0^1 R_1(-1, x_2; \ell, h) dx_2. \tag{2}$$

Proof: By lemma 3.1 we have $\rho_1(X_1, 1)$ is strictly concave in X_1, and also $\partial \rho_1(X_1, 1)/\partial X_1 \mid_{X_1=0} > 0$. Therefore, $X_1^* = 1$ is a best response to $X_2^* = 1$ if and only if

$$\frac{\partial \pi_1(X_1, 1)}{\partial X_1} \bigg|_{X_1=1} \geq 0,$$

equivalent to inequality (2). The result follows by symmetry. □

Inequality (2) can be interpreted directly in terms of product characteristics: given that the rival firm's agent has full discretion (which implies high vertical product quality), a principal prefers to sell a high-quality product located at the center (that is, at 0) to a low-quality product that is maximally differentiated.

Proposition 3.2 demonstrates that in addition to the demand effect, there is an *incentive effect* that opposes the strategic effect. A manager may want

to empower his subordinate to select product location because it will result in high product quality. Under condition (2), and also under the conditions for equilibria with intermediate discretion that are given in proposition 3.4 below, the incentive effect is sufficiently strong so that we do no longer observe the maximal differentiation result of the Hotelling model.

By corollary 3.2, an equilibrium in which each principal imposes his agent to produce the maximally differentiated product exists only if $F > 0$.

Proposition 3.3 *Suppose that $F > 0$. There exists an equilibrium in which each principal gives his agent no responsibility, i.e., $X_1^* = X_2^* = 0$, if and only if*

$$\int_{-1}^{\frac{F}{\Delta}-1} R_1(x_1, 1; h, \ell) dx_1 < \frac{F}{\Delta} R_1(-1, 1; \ell, \ell). \tag{3}$$

Proof: Let $F > 0$. By lemma 3.1, $\rho_1(X_1, 0)$ is strictly concave in X_1, and $\partial \rho_1(X_1, 0)/\partial X_1 \mid_{X_1=0} > 0$. Therefore, $X_1^* = 0$ is a best response to $X_2^* = 0$ if and only if $\pi_1(\frac{F}{\Delta}, 0) < \pi_1(0, 0)$, equivalent to inequality (3). The result follows by symmetry. $\square$

A necessary condition for (3) is

$$R_1(0, 1; h, \ell) < R_1(-1, 1; \ell, \ell). \tag{4}$$

To see this, notice that by lemma 3.1, inequality (3) (equivalent to $\rho_1(\frac{F}{\Delta}, 0) < \rho_1(0, 0)$) implies

$$R_1(-1, 1; \ell, \ell) = \rho_1(0, 0) > \max_{X_1 \in [\frac{F}{\Delta}, 1]} \rho_1(X_1, 0) \geq$$

$$\rho_1(1, 0) = \int_{-1}^{0} R_1(x_1, 1; h, \ell) dx_1 > R_1(0, 1; h, \ell).$$

Inequality (4) can be interpreted more directly than condition (3). It says that a principal prefers to sell a low-quality, maximally differentiated product to a high-quality, minimally differentiated product, given that the rival firm produces a low-quality product that is maximally differentiated. Thus, high quality does not have a large impact on profits, compared to product differentiation.

As proposition 3.3 demonstrates, the model is able to generate the well-known maximum differentiation result of the Hotelling model with quadratic transportation costs. This occurs when the incentive effect is relatively weak, so that the strategic effect dominates both the demand effect and the incentive effect.

There may also exist equilibria in which agents have an intermediate level of discretion, enough to motivate them to get informed.

Proposition 3.4 *There exists an equilibrium in which each principal gives his agent limited responsibility, i.e., $X_1^* = X_2^* \in [\frac{F}{\Delta}, 1)$, if and only if there exists an $X_1^* \in [\frac{F}{\Delta}, 1)$ such that*

$$\int_{1-X_1^*}^{1} [R_1(-1+X_1^*, x_2; h, h) - R_1(-1, x_2; \ell, h)] dx_2$$

$$\begin{cases} = (1 - X_1^*)[R_1(-1, 1; \ell, \ell) - R_1(-X_1^* + 1, 1; h, \ell)] \text{ if } X_1^* \in (\frac{F}{\Delta}, 1), \\ \\ \leq (1 - X_1^*)[R_1(-1, 1; \ell, \ell) - R_1(-X_1^* + 1, 1; h, \ell)] \text{ if } X_1^* = \frac{F}{\Delta}, \end{cases} \tag{5}$$

and $\rho_1(X_1^*, X_2^*) \geq \rho_1(0, X_2^*)$ if $X_1^* = \frac{F}{\Delta}$.

Proof: (i) Suppose that $X_2^* \in (\frac{F}{\Delta}, 1)$. By lemma 3.1, $\rho_1(X_1, X_2^*)$ is strictly concave in X_1, and $\partial \rho_1(X_1, X_2^*)/\partial X_1 \mid_{X_1=0} > 0$. Therefore, $X_1^* = X_2^*$ is a best response to X_2^* if and only if

$$\frac{\partial \pi_1(X_1, X_2^*)}{\partial X_1} \Bigg|_{X_1 = X_2^*} = 0,$$

equivalent to the equality in (5). The result follows by symmetry.

(ii) Suppose that $X_1^* = \frac{F}{\Delta}$. By lemma 3.1, $X_1^* = \frac{F}{\Delta}$ is a best response to $X_2^* = \frac{F}{\Delta}$ if and only if

$$\frac{\partial \rho_1(X_1, \frac{F}{\Delta})}{\partial X_1} \Bigg|_{X_1 = \frac{F}{\Delta}} \leq 0$$

(equivalent to the inequality in (5)) and $\pi_1(\frac{F}{\Delta}, \frac{F}{\Delta}) \geq \pi_1(0, \frac{F}{\Delta})$. The result follows by symmetry. $\square$

Condition (5) in proposition 3.4 states that X_1^* is a best response to $X_2^* = X_1^*$. For $X_2^* \in (\frac{F}{\Delta}, 1)$, we have a standard first-order condition. For $X_2^* = \frac{F}{\Delta}$, the discontinuity of firm 1's profit function implies that we must require that a marginal increase in A_1's discretion (at $X_1^* = \frac{F}{\Delta}$) does not increase firm 1's expected profits. This explains the inequality in (5).

It is straightforward to derive existence conditions for asymmetric equilibria, but this involves tedious notation without getting additional insights. For simplicity, suppose that $F = \Delta$. Then there exists an equilibrium in which one principal gives his agent responsibility and the other does not, that is, either $X_1^* = 1$ and $X_2^* = 0$ or $X_1^* = 0$ and $X_2^* = 1$, if and only if

$$\rho_1(1,0) \geq \rho_1(0,0) \text{ and } \rho_2(1,1) < \rho_2(1,0). \tag{6}$$

These inequalities are standard Nash equilibrium conditions. The second condition in (6) can also be written as $\rho_1(1,1) < \rho_1(0,1)$. Since $\rho_1(1,1) < \rho_1(1,0)$ and $\rho_1(0,1) < \rho_1(0,0)$, asymmetric equilibria may indeed exist.

4   Management Strategy

Management strategy studies how a manager optimally chooses organizational structure and market strategy, given any political and regulatory constraints. In this paper, organizational design is determined while taking into account the outcome of market competition – the manager's decision problem is solved by a backward induction process (see also Spulber [11]).

In the model, a manager selects a discretion level for his subordinate while reflecting on resulting product locations, qualities, and prices. In particular, a manager's decision of delegation of responsibility captures his market strategy concerning product characteristics and price, and therefore represents, in the context of the model, the firm's overall strategy. In this section, I investigate the strategic nature of delegation of responsibility.

Strategic Complements or Substitutes?

From a manager's viewpoint, it is interesting to know how the rival firm will react if he gives his subordinate more or less discretion. Applying notions developed by Bulow et al. [2] and Fudenberg and Tirole [6], I will analyze whether an increase of the level of discretion in a rival firm induces a manager to delegate more or less responsibility to his subordinate. In the former case, reaction functions are upward sloping, and discretion levels are said to be strategic complements. In the latter case, reaction functions are downward sloping, and discretion levels are strategic substitutes.[13]

Given a unique equilibrium outcome of the price subgame, we can focus on competition in delegation schemes, represented by the levels of discretion X_1 and X_2. Firm i's best response (or reaction function) to X_j $(j \neq i)$ is defined as

$$X_i^*(X_j) \equiv \arg \max_{X_i \in [0,1]} \pi_i(X_1, X_2).$$

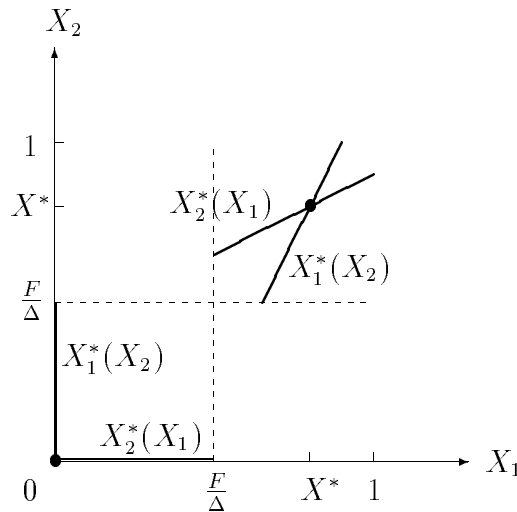The following example illustrates one of many possible situations.

Figure 1 *Reaction functions and equilibria*

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[13]See also Tirole [12].

Example (see figure 1): For an intermediate value of F, suppose that inequalities (3) and (5) hold. By propositions 3.3 and 3.4, there are two symmetric equilibra, namely $(0,0)$ and (X^*, X^*) for some $X^* \in [\frac{F}{\Delta}, 1)$. For an expositional purpose, reaction functions are assumed to be increasing in the regions where agents acquire information.

Suppose now that $F = 0$, so that we need not worry about discontinuities in the reaction functions. Define for all X_1,

$$\alpha_1(X_1) \equiv R_1(-1 + X_1, 1; h, \ell) - R_1(-1, 1; \ell, \ell),$$

and for all X_1 and X_2,

$$\beta_1(X_1, X_2) \equiv R_1(-1 + X_1, 1 - X_2; h, h) - R_1(-1, 1 - X_2; \ell, h).$$

The value of $\alpha_1(X_1)$ is firm 1's gain from selling a high-quality product located at $-1 + X_1$ compared to selling a maximally differentiated, low-quality product, given that firm 2 produces a low-quality product located at the extreme. The value of $\beta_1(X_1, X_2)$ represents a similar gain given that firm 2 sells a high-quality product located at $1 - X_2$.

Proposition 4.1 *Suppose $F = 0$.*
(i) If $\alpha_1(X_1) > \beta_1(X_1, X_2)$ for all X_1, X_2, levels of discretion are strategic complements.
(ii) If $\alpha_1(X_1) < \beta_1(X_1, X_2)$ for all X_1, X_2, levels of discretion are strategic substitutes.

Proof: By differentiating the first-order condition $\partial \pi_i(X_i^*(X_j), X_j)/\partial X_i = 0$ with respect to X_j (assuming an interior solution), and applying lemma 3.1 (ii), it follows that the sign of $\mathrm{d}X_i^*(X_j)/\mathrm{d}X_j$ (determining the slope of reaction function $X_i^*(X_j)$) is equal to the sign of

$$\frac{\partial^2 \pi_1(X_1, X_2)}{\partial X_1 \partial X_2} = R_1(-1 + X_1, 1; h, \ell) - R_1(-1 + X_1, 1 - X_2; h, h) +$$

$$R_1(-1, 1 - X_2; \ell, h) - R_1(-1, 1; \ell, \ell). \tag{7}$$

By rewriting (7) as $\partial^2 \pi_1(X_1, X_2)/(\partial X_1 \partial X_2) = \alpha_1(X_1) - \beta_1(X_1, X_2)$, the result follows. □

The interpretation is direct. Suppose revenues of selling a high-quality product compared to maximally differentiating its product (which would imply low quality) are higher if its rival sells a low-quality product located at the extreme, than if its rival sells a high-quality product (not necessarily located at the extreme). Then P_j's best response to more discretion for agent A_i is to give his agent A_j more discretion as well. There is a similar interpretation of the sufficient condition for strategic substitutes.

Top Dog or Puppy Dog?
Suppose that only one firm, say firm 1, is active in the market, and that firm 2 is a potential entrant. One can distinguish two cases: the incumbent's manager wants to deter entry, or he wants to accomodate entry (for instance because entry deterrence is not profitable). In each case, the incumbent's manager has to formulate an appropriate strategy. In case of accomodation for instance, he will want to choose a strategy that softens post-entry price competition. In what follows, I assume that firm 2's manager decides on entry (and if he enters, on how much responsibility he will delegate) after having observed in which market niche firm 1's product is located, and which quality firm 1 is selling.

The taxonomy of management strategies proposed by Fudenberg and Tirole [6] is used to characterize empowerment as a strategy to accomodate or deter entry. Consider the level of discretion of an agent as the strategic "investment" variable. A difference with Fudenberg and Tirole's set-up is that in my model, the product characteristics resulting from "investment" is observable, whereas in their analysis, investment itself can be observed. This difference, however, does not matter. The reason is that although delegation schemes are unobservable, each manager can observe the other's product location and quality before competing on the product market. What is essential is that once production has taken place, delegation schemes no longer

matter; only the product characteristics are then relevant.

In the product market subgame, prices are strategic complements for given product characteristics.[14] Moreover, by lemma 3.1 (i), delegation of responsibility makes a firm tough in the sense of reducing the rival firm's profits.

Suppose that, for a fixed level of discretion for A_2, the principal of firm 1 delegates more responsibility to A_1. The total effect, which is P_1's incentive to delegate responsibility, is given by $\partial \pi_1(X_1, X_2)/\partial X_1$. This effect can be decomposed into two effects. First, a direct (or profit maximizing) effect of giving A_1 more responsibility is that for given prices, firm 1's expected market share and product quality, and therefore profits, increase. Second, there is a strategic effect, resulting from firm 2's price reaction. If A_1 gets more discretion, the probability that firm 1's product will be located closer to the center increases. Therefore, in expectations the products will be less differentiated, so that price competition becomes more intense. In particular, it will be expected firm 2 will react by lowering its price, thereby decreasing firm 1's market share and profits.

Given that firm 1 wants to accomodate entry, the fact that delegation makes a firm tough implies that P_1 should "underinvest" in delegation.[15] In the terminology of Fudenberg and Tirole, P_1 should adopt a "puppy dog ploy," that is, it should be nice and small in order to avoid to trigger an aggressive response from firm 2. The optimal entry deterrence strategy for firm 1 is to "overinvest" in delegation, that is, adopt a "top dog" strategy in order to be a tough rival. Such a strategy will reduce profits of an entrant.

Different Perceptions of a Management Style

The previous discussion points at an interesting link between a manager's stance inside a firm and his posture on the product market. In particular, in

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[14]See Tirole [12], chapter 7, for a discussion.

[15]More precisely, X_1 will be lower than the open-loop solution, which is defined as the optimal value of X_1 if P_2 cannot observe the product characteristics of firm 1's product before setting a price.

the model there are different perceptions of a single leadership style.

Being nice to the rival firm corresponds to adopting a tougher posture vis-à-vis his subordinate, because there is underinvestment in delegation of responsibility. More general, the model demonstrates that motivating the subordinate to take initiative by delegating responsibility corresponds to a more aggressive stance on the product market. Accordingly, a product manager may give his subordinates a lot of freedom ("hands-off" management); not because he is such a nice and friendly person, but because he is a tough competitor. Vice versa, an authoritarian manager (i.e., a manager who gives his subordinate little or no discretion) is a soft rival in the product market. Summarizing: *a tougher posture of a manager inside a firm (i.e., with regard to his subordinate) corresponds to a softer posture on the product market (i.e., with regard to the rival firm), and vice versa.*

Without claiming generality of this dichotomy, the result tells us that it is important to recognize the strategic consequences of different leadership styles. Moreover, statements like "Mr. X is a tough manager" may have little meaning if one does not specify with regard to whom.

5   Conclusion

A manager of a firm in a competitive environment has to take decisions concerning organizational design and competitive actions. In this paper, a model is developed that integrates both management aspects.

In the model there is a tension between positioning a brand in a market niche and producing a premium brand. A product manager can motivate his subordinate (which is important for quality) by giving him a say in which variety he has to develop and produce. Giving the subordinate enough freedom to select product location motivates him to get informed and make a proposal. In turn, following up the agent's recommendation induces him to exert high effort, because the agent will work harder on developing and producing goods that yield him higher personal gains. Since high effort results in high product quality, a product manager may find it beneficial to give

his agent a say in product location (the incentive effect). In the model, the presence of incentive effects may result in less product differentiation than in the Hotelling model with quadratic transportation costs.

A more general point of this paper is that when incentive effects exist, they may be important. When managers take organizational incentives into account, product differentiation, and therefore also competition, may be affected. In different models, these type of effects may influence competition in various ways. Further work in this direction is needed to enhance our understanding of the influence of incentives inside organizations on competitive behavior.

In reality, there may be a combination of reasons of why top managers delegate responsibility to middle managers – not only incentive issues, but for instance also work overload, flexibility (versus commitment) to adapt to changing market characteristics, or the collection of information about the market. The investigation of the strategic nature of those and other issues related to organizational structure seems to be a fruitful and important area for further research in industrial organization and management strategy.

Appendix

Proof of Proposition 3.1:
First, the following claim will be proved:

Claim 1 *In any equilibrium, there exists a $y_1 \in [-1, 0]$ and a $y_2 \in [0, 1]$ such that*

$$p_i^*(x_i) = \begin{cases} 1 & if \ |\ x_i\ | \geq |\ y_i\ |, \\ 0 & otherwise, \end{cases}$$

for $i = 1, 2$, $x_1 \in [-1, 0]$, and $x_2 \in [0, 1]$.

Proof of Claim 1: Let delegation schemes $p_i^*(\cdot)$, $i = 1, 2$, be given.
(i) Suppose that A_2 is uninformed, so that P_2 will select product location 1. If P_1's best response is to impose product location -1, then the proposition trivially holds. Therefore, suppose that P_1 optimally selects $p_1(\cdot)$ such

that (1) holds. Accordingly, A_1 will get informed. Since $R_1(x_1, 1; h, \ell)$ is decreasing in x_1, there exists a $\tilde{y} \in (-1, 0]$ such that

$$R_1(x_1, 1; h, \ell) - R_1(-1, 1; \ell, \ell) \geq 0 \iff x_1 \leq \tilde{y}.$$

Two cases can be distinguished. First,

$$\int_{-1}^{\tilde{y}} p_1^*(x_1) \mathrm{d}x_1 \geq \frac{F}{\Delta}. \tag{8}$$

P_1's expected returns are equal to

$$\int_{-1}^{0} [p_1^*(x_1) R_1(x_1, 1; h, \ell) + (1 - p_1^*(x_1)) R_1(-1, 1; \ell, \ell)] \mathrm{d}x_1 =$$

$$\int_{-1}^{\tilde{y}} p_1^*(x_1)[R_1(x_1, 1; h, \ell) - R_1(-1, 1; \ell, \ell)] \mathrm{d}x_1 +$$

$$\int_{\tilde{y}}^{0} p_1^*(x_1)[R_1(x_1, 1; h, \ell) - R_1(-1, 1; \ell, \ell)] \mathrm{d}x_1 + R_1(-1, 1; \ell, \ell) \leq$$

(by monotonicity of R_1)

$$\int_{-1}^{\tilde{y}} [R_1(x_1, 1; h, \ell) - R_1(-1, 1; \ell, \ell)] \mathrm{d}x_1 + R_1(-1, 1; \ell, \ell) =$$

$$\int_{-1}^{\tilde{y}} R_1(x_1, 1; h, \ell) \mathrm{d}x_1 - \tilde{y} R_1(-1, 1; \ell, \ell).$$

It follows that P_1 can (weakly) increase his expected profits by selecting for $y_1 = \tilde{y}$,

$$p_1(x_1) = \begin{cases} 1 & \text{if } x_1 \leq y_1, \\ 0 & \text{otherwise.} \end{cases}$$

Second, it may be the case that

$$\int_{-1}^{\tilde{y}} p_1^*(x_1) \mathrm{d}x_1 < \frac{F}{\Delta}. \tag{9}$$

If

$$\int_{-1}^{\tilde{y}} 1 \, \mathrm{d}x_1 \geq \frac{F}{\Delta}, \tag{10}$$

then, by monotonicity of R_1, P_1 can increase his expected profits by selecting for $y_1 = \tilde{y}$,

$$p_1(x_1) = \begin{cases} 1 & \text{if } x_1 \leq y_1, \\ 0 & \text{otherwise.} \end{cases}$$

Now suppose that (10) does not hold. Let $\hat{y} \in (\tilde{y}, 0]$ be implicitly defined by

$$\int_{-1}^{\hat{y}} p_1^*(x_1)\mathrm{d}x_1 = \frac{F}{\Delta}.$$

Note that by (9), $\hat{y}$ is well defined. P_1's expected returns are equal to

$$\int_{-1}^{0} [p_1^*(x_1)R_1(x_1, 1; h, \ell) + (1 - p_1^*(x_1))R_1(-1, 1; \ell, \ell)]\mathrm{d}x_1 =$$

$$\int_{-1}^{\tilde{y}} p_1^*(x_1)[R_1(x_1, 1; h, \ell) - R_1(-1, 1; \ell, \ell)]\mathrm{d}x_1 +$$

$$\int_{\tilde{y}}^{\hat{y}} p_1^*(x_1)[R_1(x_1, 1; h, \ell) - R_1(-1, 1; \ell, \ell)]\mathrm{d}x_1 +$$

$$\int_{\hat{y}}^{0} p_1^*(x_1)[R_1(x_1, 1; h, \ell) - R_1(-1, 1; \ell, \ell)]\mathrm{d}x_1 + R_1(-1, 1; \ell, \ell) \leq$$

(by monotonicity of R_1)

$$\int_{-1}^{\tilde{y}} [R_1(x_1, 1; h, \ell) - R_1(-1, 1; \ell, \ell)]\mathrm{d}x_1 +$$

$$\int_{\tilde{y}}^{\hat{y}} p_1^*(x_1)[R_1(x_1, 1; h, \ell) - R_1(-1, 1; \ell, \ell)]\mathrm{d}x_1 + R_1(-1, 1; \ell, \ell) \leq$$

(by monotonicity of R_1)

$$\int_{-1}^{y_1} [R_1(x_1, 1; h, \ell) - R_1(-1, 1; \ell, \ell)]\mathrm{d}x_1 + R_1(-1, 1; \ell, \ell) =$$

$$\int_{-1}^{y_1} R_1(x_1, 1; h, \ell)\mathrm{d}x_1 - y_1 R_1(-1, 1; \ell, \ell),$$

where $y_1 \in (\tilde{y}, \hat{y}]$ is defined by

$$\int_{-1}^{y_1} 1\ \mathrm{d}x_1 = \frac{F}{\Delta}.$$

It follows that P_1 can (weakly) increase his expected profits by selecting

$$p_1(x_1) = \begin{cases} 1 & \text{if } x_1 \leq y_1, \\ 0 & \text{otherwise.} \end{cases}$$

(ii) The proof of the case in which A_2 learns his private benefits is similar to case (i), and is omitted. $\square$

Claim 1 allows us to define the level of discretion of agent A_1 as the measure of interval $[-1, y_1]$, that is, $X_1 \equiv y_1 + 1$, and similarly, A_2's level of discretion as the measure of $[y_2, 1]$, that is, $X_2 \equiv 1 - y_2$. This completes the proof. $\square$

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