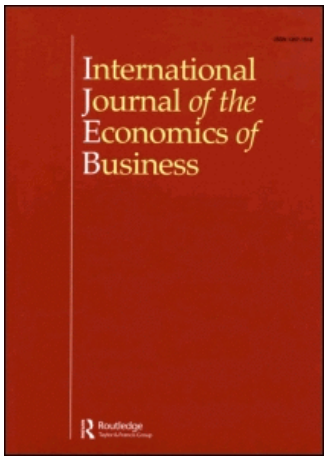

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Strategic Positioning of Alliances

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ABSTRACT *In this paper we use a simple linear demand structure to analyze firms' and alliances' strategic positioning with regard to cost reduction and product differentiation. In particular, we compare investment decisions under competition and in alliances and analyze comparative static properties concerning changes in market size. In contrast to Porter (1980), this model explicitly allows firms to allocate their budget between the two strategies. The analysis reveals that the optimal allocation of resources for strategic positioning changes markedly when a firm enters an alliance: the general investment level decreases with a shift towards more cost reduction and less product differentiation. Another finding is that alliances (as well as independent firms) in larger markets invest more in both strategies and investment is driven towards product differentiation. These results are in line with Klepper's (1996) findings as they show that the attractiveness of following cost leadership or differentiation strategies changes through industry evolution.*

Key Words: Alliance; Strategic Positioning; Competitive Strategy; Cost Reduction; Product Differentiation; Innovation; Game Theory.

JEL Classifications: C72, L1, L13, O32.

1. Introduction

When managers discuss the strategic positioning of their products or companies they often argue along the lines of two primary strategies: cost leadership and product differentiation. Competitive strategy is strongly influenced by these generic strategies defined over twenty years ago by Michael Porter (1980), who argued that a firm's strategic position within an industry is determined by its competitive advantage, achieved by one of the two fundamental options: offer the

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lowest price or get closer to customer needs and differentiate your offer. Firms that attempt to pursue both strategies simultaneously, he argues, often become 'stuck in the middle' between demand and cost parameters.[1]

Even though Porter (1980) considered the two strategies of cost reduction and differentiation to be basically incompatible, several empirical and analytical studies indicate that the presumed trade-off may not be as strong as suggested and that a firm's advantage is rarely based entirely on cost *or* differentiation.[2] The following analysis integrates these studies in such a way that firms do not necessarily have to choose between two mutually exclusive strategies, but rather allocate their budget optimally among both alternatives.

In such a less polarized world, the optimal level of investment in cost reduction and in product differentiation, both determining a firm's strategic position, may alter significantly when externalities of the firm's activity on other firms' profits are changed. This is especially the case when alliances are formed. Porter's (1980) original concept is primarily focused on the identification and realization of competitive advantages in a market of individual firms.

As more and more firms are entering cooperative arrangements with competitors or otherwise related firms, the following analysis extends this question about the competitive strategy to alliances. The increasing number of alliances is related to the change in policy orientation in the US and Europe. Starting in the early 1990s, the *per se* rules of anticompetitive effects of cooperative agreements were replaced by a 'rule-of reason' standard in the US and by 'block exemption regulations' under Article 81(3) in the EU.[3]

With regard to strategic positioning, the agreement between PSA Peugeot/Citroën and Fiat/Lancia may serve as a prominent example of a joint venture targeting both process and product innovation. This alliance produces a multi purpose vehicle (MPV) dubbed 'Eurovan'. Each of the companies involved produces a technically identical van with a slightly differentiated body and sells it under the brand names Peugeot 806, Citroën Evasion, Fiat Ulysse, and Lancia Zeta.[4] By analysing their R&D investment decisions, we see that alliances show striking differences to the strategic positioning of individual firms and that they may in fact have welfare reducing consequences, even when the joint venture partners remain competitors on the product market.

Another extension, which Porter's (1980) concept does not explicitly cover, is the stage of industry evolution at which an alliance is entered. Klepper (1996) analyses industry evolution in a formal model and identifies the role of firms' innovative capabilities and size in conditioning R&D spending. Yin and Zuscovitch (1998) extend Klepper's analysis by considering strategic effects. They find that the 'composition of firm's R&D portfolios (…) depends on the firm's initial market share and on the subsequent effects of R&D on the post-innovation market structure' and that large firms invest less in product and more in process innovation than small firms. While they consider an *ex ante* asymmetric setting in which the different incentives to introduce a drastic product innovation are analyzed, our analysis starts from a symmetric situation. To incorporate factors of industry evolution, we consider the influence of market size on an *individual* firm's and an alliance's strategic positioning and the comparative static properties of their R&D portfolios.

Although Porter (1980) sparked off a stream of literature in management, formal approaches in economics only recently considered the possibility that firms invest in cost reduction as well as product differentiation. Most earlier

models on innovation suggest that firms invest either in one or the other kind of innovation and determine optimal innovation strategies under this assumption. See, for example, Reinganum (1989) and De Bondt (1997) for comprehensive surveys of innovation models.[5] Bonnano and Haworth (1998) consider a vertically differentiated industry with unit demand and compare the choice of a firm between either cost reduction or product differentiation depending on the degree of competition (*Cournot and Bertrand*). Their paper confines the analysis to the decision of a single firm. In a setting of horizontal product differentiation and monopolistic competition Rosenkranz (2003) considers the simultaneous choice of cost and differentiation parameters and finds conditions under which firms invest in both kinds of activities. In contrast to that model, the following analysis is extended to include vertical product differentiation. This allows us to capture the notion of Porter's differentiation advantage in a broader sense, including especially R&D as well as marketing activities, as his argument is explicitly concerned with *higher* quality or *better* performing products and the fact that higher advertising and promotion expenditures are needed.

In summary, the following questions are going to be addressed in the analysis: how does an alliance's strategic positioning differ from the positioning of two competing firms? Should an alliance generally invest more or less than two competing firms? Should an alliance invest more in cost reduction or more in product differentiation than two competing firms? What influence does potential market size have on a firm's and on an alliance's strategic positioning? Should firms or alliances generally invest more when the potential market size increases? Should they invest more in cost reduction or more in product differentiation?

The paper is organized as follows: section 2 presents our model with its basic assumptions. In section 3 we derive the optimal quantity choice for the product market. Moreover we characterize the impact of cost reduction as well as product differentiation on quantities. Section 4 analyzes the strategic positioning of competing firms while section 5 considers the optimal positioning of alliances. Section 6 then focuses on how the technological life-cycle affects the optimal mix between cost reduction and product differentiation. In section 7 we conclude this paper with a brief discussion of the managerial implications of our results.

2. The Model

On the *demand side* we assume that consumers buy all products but consider them to be at least partially substitutable to each other. Furthermore, we assume that a product's perceived substitutability affects consumers' choice in a non-rational manner, as it is a consequence of the product's image due to persuasive and emotional advertising, a certain fashion or fashionable design. Due to the lack of a *general* comprehensive psychological theory of choice behavior in the context of non-informative advertising, we sidestep the problem of modelling consumers' choice by assuming for simplicity that firms i, j face linear inverse demand functions of the following form:

$$P^i(q^i, q^j, s^i) = a - (q^i + s^i q^j), \text{ and}$$
$$P^j(q^i, q^j, s^j) = a - (q^j + s^j q^i).$$

where $a > \max\{c^i, c^j\}$ with c^i, c^j representing firms' marginal production costs and $s^i \in [0, 1]$ measures the degree of product substitutability. The higher s^i is, the higher the degree of substitutability is. When s^i tends to zero, firm i effectively becomes a monopolist, while for $s^i = 1$ the good of firm j is a perfect substitute to the good of firm i. It is important that with this demand system, we assume that product substitutability need not be symmetric: a customer may view the product of firm i to be perfectly substitutable by the product of firm j but not vice versa.

This assumption brings together the ideas of monopolistic competition models (see Dixit and Stiglitz, 1977; Spence, 1976) and of models of vertical product differentiation (see Gabszewicz and Thisse, 1979, 1980; Shaked and Sutton, 1982, 1983). In contrast to the latter models, there exists a representative consumer in this model who consumes a bit of every available good. In contrast to the former models he may consume the products in different quantities. It is this assumption that allows us to introduce a feature of vertical differentiation into a model of monopolistic competition.[6]

On the *supply side* we consider an duopolistic industry, consisting of two firms i, j that produce quantities q^i and q^j. The two firms operate under constant returns to scale. The firms' unit costs of production are given by c^i and c^j with $c^i, c^j \in [0, a]$, which can be chosen through the level of investment in cost reduction before the market opens. The product characteristics which determine the degree of product substitutability given by s^i and s^j can also be influenced by the firms i, j through investment in s^i, and s^j respectively, with $s^i, s^j \in [0, 1]$. These characteristics, which effectively differentiate the products, can be emotional as well as physical attributes which the firm can influence by marketing or product development.

The cost functions for investment in cost reduction (e.g. through process improvements) and for investment in product differentiation (e.g. through marketing or product development) are the same for both firms and are described by $R(c^i)$ and $M(s^i)$ respectively, with $R' < 0$, $M' < 0$ and $R'' > 0$, $M'' > 0$.[7] The higher the marginal costs or the higher the degree of substitutability a firm chooses, the lower is the needed investment. Further, (to guarantee interior solutions) we impose that $\lim_{c^i \to 0} R(c^i) = \infty$ as well as $\lim_{s^i \to 0} M(s^i) = \infty$.

Firms play a non-cooperative two-stage game under complete information. In the first stage, they decide on their marginal costs by investing in cost reduction. Simultaneously, they decide on the optimal degree of product substitutability by investing in product differentiation. In the second stage, firms choose the quantities of the products they want to offer on the market. Since these two-stage games are solved by backward induction, we first analyze firms' quantity decisions in the second stage.

3. Decisions on Optimal Product Quantity

The quantity game is a partial equilibrium model with heterogeneous products and Cournot competition. Since we are considering a market in which there are two firms offering quantities q^i and q^j, firm i's profit function is given by:

$$\pi^i(q^i, q^j) = q^i P^i(q^i, q^j, s^i) - c^i q^i$$

Each firm maximizes its profit given the quantity chosen by the other firm. The first-order condition of profit maximization for firm i is:[8]

$$\pi^i_{q^i} = P^i(q^i, q^j, s^i) - c^i - q^i = 0.$$

Deriving the first-order condition for firm *j*, solving for q^j, substituting in the first-order condition for firm *i* and solving for q^i gives the equilibrium solution of the Cournot subgame:[9]

$$q^{i*}(c^i, c^j, s^i, s^j) = \frac{s^i(a - c^j) - 2(a - c^i)}{s^i s^j - 4}. \tag{1}$$

The game has obviously has a unique equilibrium in pure strategies in which the firms choose $q^{i*}(c^i, c^j, s^i, s^j)$ and $q^{j*}(c^j, c^i, s^j, s^i)$.[10] For further analysis it is useful to analyze comparative static properties of the optimal quantities with respect to changes in marginal costs and in the degree of product substitutability. Differentiation of (1) with respect to c^i and c^j yields:

$$q^{i*}_{c^i} = \frac{2}{s^i s^j - 4} < 0 \text{ and } q^{i*}_{c^j} = \frac{s^i}{4 - s^i s^j} > 0. \tag{2}$$

Differentiating (1) with respect to the levels of substitutability s^i and s^j yields:

$$q^{i*}_{s^i} = \frac{2q^{j*}}{s^i s^j - 4} < 0 \text{ and } q^{i*}_{s^j} = \frac{-s^i q^{i*}}{s^i s^j - 4} > 0. \tag{3}$$

As expected in a Cournot setting, each firm's optimal quantity decreases with an increase of its own marginal costs and increases with the marginal costs of its rival. Analogously, each firm's optimal quantity decreases with an increase in the substitutability of its own product, while it increases the higher is the (ceteris paribus) substitutability of the rival's product. Hence, investments of both kinds represent *negative* externalities, as the reduced form profit function of firm *i* is given by:

$$\pi^{i*}(c^i, c^j, s^i, s^j) = q^{i*2}(c^i, c^j, s^i, s^j) = \frac{(s^i(a - c^j) - 2(a - c^i))^2}{(s^i s^j - 4)^2}. \tag{4}$$

In the next section the first stage of the game is analyzed, in which firms choose their strategic positioning, i.e. their optimal level of marginal costs and product substitutability.

4. Strategic Positioning of Individual Firms

Anticipating the outcome of the stage-two game, firms choose optimal investment levels. With a certain investment in cost reduction they choose marginal costs of production and with a separate investment in product differentiation they choose a degree of product substitutability. Firms' strategies are $(c_v, s_v) \in R^2$, with $c_v \in [0, a]$ and $s_v \in [0, 1]$ with $v = i, j$ and a being consumers' prohibitive price (or willingness to pay).

The Nash-equilibrium strategies of both firms (c^i, s^i) and (c^j, s^j) are defined by the mutual best-response property. That is for firm *i*:[11]

$$(c^i, s^i) \in \arg\max_{c^i, s^i} \{\Pi^i = \pi^{i*}(c^i, c^j, s^i, s^j) - R(c^i) - M(s^i)\}, \tag{5}$$

and firm j's maximization problem is defined analogously. Solving (5) with respect to c^i, substituting (2) and rearranging leads to the following first-order condition:

$$q^{i*}(c^i, c^j, s^i, s^j)\left(\frac{4}{s^i s^j - 4}\right) = R'(c^i) \tag{6}$$

The optimal level of marginal costs is given by the equality of marginal revenues of cost reduction and marginal costs of cost-reducing activities. If such process improvement activities are not too costly (6) should lead to a solution in [0, a]. Due to the assumption concerning the cost function of process improvements, the only corner solution which can arise is $c^{i*} = a$ meaning that the firm does not invest in cost reduction.

Maximizing the firm's profit with respect to s^i, we restrict our attention to symmetric equilibria. Solving (5), then substituting (3), using $q^{j*} = q^{i*}$ and rearranging yields:

$$q^{i*2}(c^i, c^j, s^i, s^j)\left(\frac{4}{s^i s^j - 4}\right) = M'(s^i). \tag{7}$$

Since the firms are identical at the outset, we find analogous conditions for firm j. We assume that simultaneous solutions to (6), (7) and the analogous conditions for firm j exist. Let those solutions be defined by c^{*i}, s^{i*} and c^{j*}, s^{j*}.

If we assume that for (5) the following second-order condition holds

$$(\pi^i_{c^i s^i})^2 \leq (\pi^i_{c^i c^i} - R'')(\pi^i_{s^i s^i} - M'')\Big|c^i = c^{*i}, s^i = s^{i*} \tag{8}$$

then the model satisfies all conditions for the existence of a unique symmetric equilibrium in pure strategies.[12]

5. Strategic Positioning of Alliances

Now suppose that firms coordinate their cost reduction and product differentiation activities within an alliance while they remain competitors on the product market (in the second stage of the game).[13] If firms coordinate their activities in the first stage, they choose investment levels so as to maximize their joint profit, $\pi_i + \pi_j$. Since the second stage is unaffected, only optimal quantities are presented here. We assume that in an alliance firms are committed to choose a common level of marginal costs c^{AL} and of product substitution s^{AL}.[14] This implies that the firms will offer symmetric quantities q_{AL} under this regime. Optimal quantities can therefore be derived from equation 1 by subtituting c^{AL} for c^j and c^i, and substituting s^j and s^i by s^{AL}:

$$q^{AL}\ (c^{AL}, s^{AL}) = \frac{a - c^{AL}}{s^{AL} + 2}.$$

Differentiation with respect to marginal costs yields:

$$q_{c^{AL}}^{AL*} = \frac{-1}{s^{AL}+2}, \tag{9}$$

which of course is different to the competitive case, since firms ignore strategic effects.

Turning to the first stage, now assume that the firms coordinate their strategies so as to maximize joint profit but do not achieve efficiency gains because they remain two independent entities. The firms' joint profit is

$$\prod^{AL} = 2\pi^{AL*}(c^{AL}, s^{AL}) - 2R(c^{AL}) - 2M(s^{AL}).$$

Maximizing joint profit with respect to marginal production costs, using (9) and rearranging leads to the following implicit function, which characterizes optimal investment in process innovation $c^{AL}*$:

$$\frac{-4}{s^{AL}+2} q^{AL*}(c^{AL}, s^{AL}) = R'(c^{AL}). \tag{10}$$

Maximizing joint profit with respect to the level of product substitutability yields the implicit function for $s^{AL}*$:

$$\frac{-4}{s^{AL}+2} q^{AL*2}(c^{AL}, s^{AL*}) = M'(s^{AL}). \tag{11}$$

Obviously also the alliance finds it optimal to invest in both activities, leading to a positive investment in cost reduction and product differentiation.

Let us now examine the relationship between the first-order necessary conditions if firms choose their strategies so as to maximize only their individual profits, expressions (6) and (7), and compare these to the conditions when they maximize combined profits in an alliance, expressions (10) and (11). Note that the two problems are comparable in the sense that e.g. in case of cost reduction

$$\frac{\partial \prod^{AL}}{\partial c^{AL}} = \frac{\partial \prod^{i}}{\partial c^{i}} + \frac{\partial \prod^{j}}{\partial c^{i}},$$

and Π^j is the (negative) externality conferred by firm i's cost reduction to the profit of its rival j. Analogously, also the (negative) externality induced through product differentiation activities by firm i on the profit of firm j is added to the competitive advantage externality which the firm's differentiation investment has on its own profit through decreasing the amount of substitutability to its competitor's product. Those externalities are ignored when each firm chooses its cost-reducing expenditure so as to maximize its own profit. They are internalized when the firms coordinate their strategies in an alliance. Each firm's internalization of these externalities is what causes the individual maximization problems to be equivalent to the joint maximization problem that would be solved by a single director of the alliance.[15]

To determine the effect of those strategic terms, the first-order conditions (10) and (11) can be rewritten as

$$\pi^i_{c^i} - R' + \beta\pi^j_{c^i} = 0, \text{ and} \tag{12}$$

$$\pi^i_{s^i} - M' + \beta\pi^j_{s^i} = 0, \tag{13}$$

respectively, with β = 1. By applying comparative statics with respect to β the effects of adding these strategic terms to the firms' first-order conditions of profit maximization can be analyzed.[16] This allows us to determine the effect of an increase in β on the firms' strategies which is summarized in the following proposition:

Proposition 1: *A coordination of strategies induces firms not only to decrease their investment but also to shift their investment towards cost reduction.*

Proof: See the Appendix.

As expected, if firms coordinate their strategies within alliances, the internalization of negative externalities induces them to reduce both kinds of investments. Since the alliance invests less into both kinds of innovation it must be that, due to (2) and (3), for equilibrium quantities the following holds: $q^{i*} > q^{AL_*}$. Thus, we can also conclude that consumers will not benefit from the alliance. But since producers' profits increase, the net effect will be unclear and will depend on the specification of R&D costs. More surprising is the finding that cooperatively oriented firms shift their activities towards cost reduction, suggesting that the externalities of this kind of investment are less strong than those induced by product differentiation. The reasoning behind these results will be presented in section 7.

The slope of the R&D cost function will also determine the welfare consequences in the case that the alliance is able to additionally reduce competition in the marketing stage. Moreover, the effect of increased market power in both stages on the strategic positioning of the alliance will also strongly depend on the shape of the R&D cost functions. But, independent of the R&D cost functions, it can be shown that an alliance with increased market power would reduce production costs more and differentiate products less compared with the previous scenario of separate marketing. Although alliances that include joint marketing are treated more and more favourably under current competition regulation, we focus on alliances that compete in the product market in order to limit our assumptions on R&D cost functions.

6. Changes in Market Size

The analysis of the optimal strategic positioning for alliances has revealed that firms' investment decisions are influenced by strategic externalities. How does this optimal investment decision change with the market size? Comparative statics concerning consumers' prohibitive price helps to answer this question if the prohibitive price is interpreted as the market potential. Up to now, a was considered to be a constant. If this assumption is relaxed, the symmetric equilibrium quantity in the case of competition in the first stage is given by $q^{i*} = q^{i*}(a, c^i(a), c^j(a), s^i(a), s^j(a))$. Hence, it is straightforward to analyze comparative static properties. This allows us to determine the effect of an increase in a on

a firm's cost reduction and product differentiation strategies which is summarized in the following proposition:

Proposition 2: *When the market size increases investment in both kinds of activities is increased and firms invest proportionately more in product differentiation than in cost reduction.*

Proof: See the Appendix.

We observe that in a small market firms invest less in both kinds of activities than in a large market, which is in line with intuition since absolute returns on investment increase with market size. More striking is the fact that given some initial distribution of investment, firms will shift their investment from cost reduction to product differentiation if they are confronted with a larger market. As explained in the following section, the marginal return to investments in differentiating products increases more than that of investments in cost reduction. It is easy to check that these results also apply to alliances.

7. Implications and Conclusion

In this paper we have used a simple linear demand structure which enables us to analyze firms' and alliances' strategic positioning decisions in a vertically differentiated industry. In particular, we compare investment decisions in cost reduction and product differentiation under competition and in alliances and conduct some comparative statics concerning the market size.

The first and rather general contribution of the paper is that it explicitly allows firms to allocate their budget optimally among the two strategic options of cost reduction and product differentiation, instead of forcing them into a polarized strategic position. Only if the costs associated with either process improvement or marketing and product development make investments inefficient, does the the model support the extreme cases of complete specialization on either cost leadership or product differentiation, which are most often discussed in the literature. In contrast to Porter's (1980) original concept, this implication supports the results of Gupta and Loulou (1998) as well as Rosenkranz (2003) and highlights the importance of studying cost and demand parameters jointly. In the strategic positioning of their companies, managers should be aware that a polarized notion of cost leadership and product differentiation as two mutually exclusive options may lead to suboptimal results.

A second contribution of the paper is the finding that the optimal allocation of resources between cost reduction and product differentiation changes when a firm enters an alliance. In the case of coordinated strategic positioning, the firms in the alliance should be able to cut their combined budgets for both cost reduction and product differentiation, since they may be able to 'spare' each other the possibly negative externalities of competing against each other. This so-called 'business stealing' effect induces non-cooperating firms to increase their investment in competitive advantages compared to non-strategic investment decisions in alliances. Since the coordination of strategies in alliances internalizes the business stealing effect, it allows for a reduction in total investment. In such a case, managers should shift their (combined) investment more towards cost reduction and away from product differentiation because, in a world of strategic interaction, changes in product differentiation may have a direct effect on

demand, while cost-reducing investments effect demand only indirectly through possible (but neither necessary nor equivalent) changes in consumer prices. Due to this asymmetry, product differentiation results in stronger negative externalities. Accordingly, alliances are able to cut product differentiation budgets more than those for cost reduction activities and thus shift the strategic focus towards process improvements. This finding depends on the signs of the externalities and thus on the features of the demand function. It is in contrast to Rosenkranz (2003) where, in a setting of horizontal product differentiation, any marketing or product development activity imposes a positive externality on a firm's competitor.

It is important to note that, of course, the presented results depend on the assumptions that are (implicitly or explicitly) imposed. Surely, removing symmetry, changing the process of innovation or the number of firms in and outside of the alliance will affect our results in ways that may be worth-while to analyse in future studies. Also the structure of, and the governing arrangements in, the alliance, or the feasibility of joint profit maximization are interesting issues that would extend the scope of our analysis. Yet, assumptions regarding the sequence of decisions do not seem to alter our findings drastically. Consider the following two modelling alternatives: a) Firms first invest (simultaneously) in R&D and then decide whether to cooperate. There will be two Nash equilibria in this scenario. If firms had invested first according to the independent optimum, there would no longer be an incentive to form an alliance as they overinvested already. (The situation would be different if independent decisions lead to underinvestment.) If both firms had invested on the c_{AL} and s_{AL} level, they would find it optimal to cooperate. *A priori*, firms would be facing a coordination problem that would be difficult to solve without further assumptions. Furthermore, investment could have a commitment effect if decisions were not simultaneous.

b) If we alternatively introduced a first stage in which firms decided on whether to cooperate or not, they would always choose to cooperate not because this leads to higher profits since under joint decision making firms could always mimic the independent situation if that would be profitable.

As a third contribution, this paper supports Klepper's (1996) formalization of the technological life-cycle in a non-strategic setting and shows it is not just an artifact of the underlying linear demand structure. Given our assumptions, the results show that the larger the market potential, the more alliances increase their optimal total investment. This also holds for firms under competition irrespective of the business stealing effect. However, if managers are faced with a large market potential, as is usually the case in the early phases of the technological life-cycle, our model suggests that they should optimally invest more in product differentiation than in cost reduction measures. Here, again, the stronger externalities of product differentiation shift the optimal strategic positioning of alliances (and firms) towards a relatively higher budget for marketing and product development activities. Conversely, if market potential stagnates or decreases in later stages of the technological life-cycle, the model shows that investment in process improvement and cost reduction should be the most important strategy for alliances and competing firms alike.

In summary, our game theoretic analysis in this paper shows that the attractiveness of following cost leadership or differentiation strategies may be different depending on both alliance building and the phase of the technological life-cycle. It is our hope that this model contributes to a more thorough understanding of

alliance building and the strategic positioning of alliances in relation to interactions between demand as well as cost parameters.

Notes

1. See Porter (1980), chapter 2. His argument is based on the simple economic trade-off that higher quality or better performing products often cost more to produce. They may, for instance, need more expensive components or higher up-front investment in design work. Also, higher advertising and promotion expenditures may be needed to communicate to consumers that the differentiated product meets their needs in a better way.
2. In consumer durables industries, for example, Miller and Friesen (1986a, 1986b) found that firms with differentiation advantages also tend to have costs per unit that were significantly lower than the industry average. See also Philips *et al.* (1983), Wright (1987) or Miller and Dess (1983). Gupta and Loulon (1998) present a four-stage game, which analyzes cost leadership and differentiation strategies under different distribution channel structures.
3. The National Cooperative Research Act (NCRA) in the US, first limited to pre-competitive research, was subsequently challenged to include downstream activities such as product development, prototyping and production. Amendments to the NCRA were turned into public law known as the National Cooperative Research and Production Act (NCRPA) in 1993. The prerequisites for collaboration in production were determined to be that, first, the joint venture participants had also cooperated earlier in R&D and that, second, they would not ex-clude independent activities in the same field. See Vonortas (2000) or Scott (2006) for detailed describtions of the US policy towards cooperative esearch. The European Union has always had a more positive attitude toward R&D cooperation and in 2000 the European Commission finally stated 'that the development of new or improved products and processes and measures opening up new markets, leading to sales expansion into new territories or to the enlargement of a supply of new products, will generally be assessed favorably'. See Notice 'Concerning Assessment of Cooperative Joint Ventures Pursuant to Article 85', 1993, Official Journal (C43) 2, 17.
4. These are the brand names used for the first generation of 'Eurovans' produced since 1994. See also Jolly (1997) on this case.
5. See e.g. Dasgupta and Stiglitz (1980), Gilbert and Newberry (1982), *Reinganum (1983)* for the traditional literature on cost reduction through process innovation. And see Motta (1992) and Rosenkranz (1995) as examples of the literature on differentiation through product innovation.
6. This is in line with the approach of Symeonidis (2003), but allows a less complex setup for our analysis.
7. In section 4 it is shown that the slope of both cost functions has to be sufficiently high to guarantee the existence of a unique symmetric pure strategy equilibrium.
8. In the following we use subscripts to denote partial derivatives.
9. The Cournot quantity is positive for any first-stage investment decisions which satisfy

$$s_i \leq \frac{2(a-c_i)}{a-c_j} \text{ and } c_i \leq a - \frac{s_i(a+c_j)}{2}$$

   and s_j, $c_j \geq 0$. In the symmetric case, to which we will limit our attention in what follows, these conditions are reduced to c_i, $c_j \leq a$, and s_i, $s_j \leq 2$ and are thus always satisfied.
10. Second-order conditions are satisfied.
11. Firms' second-stage profits *net* of cost-reducing investments are represented by π while gross profits are denoted as Π.
12. Checking all relevant derivatives reveals that firms' individual profits are not supermodular in the two investments. Therefore, also asymmetric equilibria might exist which can presumably be characterized by one firm investing more while the other is less active with respect to *both*, cost reduction and product differentiation.
13. This is a common assumption in analytical studies on alliances and joint ventures, based on the fact that in most countries joint ventures have to be registered and then are monitored by the antitrust authorities. As the 'Eurovan' example (mentioned in the introduction) shows, this assumption is also plausible. Despite joint development and production of the 'Eurovan', the alliance partners remain competitors on the product market.
14. In general, when this equal treatment constraint is not imposed, depending on the R&D cost function firms may have an incentive to reduce costs in one firm so that supplied quantity rises to the

monopoly level and compensate the other firm via side payments for not producing (see *Salant and Shaffer*, 1998; *Amir et al.*, 2003). However, as emphasized in the literature, such solutions are hard to realize in practice, as they are generally prohibited, e.g. in Europe under Article 81(1) of the EC Treaty. A common level of product differentiation and marginal costs can also be observed in reality, as the 'Eurovan' alliance produces jointly, and markets separately with different brands and slight modifications, but very similar prices.

15. See Kamien *et al.* (1992) for a similar argument in the comparison of R&D-cartels to competitive R&D. They apply the same formal approach but in their model firms choose only one strategic variable.
16. If $\beta = 0$ we are in the competitive case.
17. Although cost functions for cost reduction and for product differentiation are assumed to be the same under the two regimes, here we label them with subscripts i and AL in order to be able to distinguish the competitive and the cooperative case.

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Appendix

Proof of Proposition 1

Taking all variables as functions of β, total differentiation of (12) and (13) with respect to β yields:

$$(\pi^i_{c^ic^i} - R'' + \beta\pi^j_{c^ic^i})d\,c^i + (\pi^i_{c^is^i} + \beta\pi^j_{c^is^i})d\,s^i + \pi^j_{c^i}d\beta = 0,$$
$$(\pi^i_{s^ic^i} + \beta\pi^j_{s^ic^i})d\,c^i + (\pi^i_{s^is^i} - M'' + \beta\pi^j_{s^is^i})d\,s^i + \pi^j_{s^i}d\,\beta = 0.$$

Applying Cramer's rule leads to:

$$\text{sign}\,(\frac{d\,c^i}{d\,\beta}) = \text{sign}\,(-(\pi^i_{s^is^i} - M'' + \beta\pi^j_{s^is^i})\pi^j_{c^i} + \pi^j_{s^i}(\pi^i_{c^is^i} + \beta\pi^j_{c^is^i})),$$
$$\text{sign}\,(\frac{d\,s^i}{d\,\beta}) = \text{sign}\,(-(\pi^i_{c^ic^i} - R'' + \beta\pi^j_{c^ic^i})\pi^j_{s^i} + \pi^j_{c^i}(\pi^i_{s^ic^i} + \beta\pi^j_{s^ic^i})).$$

To ensure that there exists an equilibrium for all values of β, the second-order condition, given by (8), has to be transformed to:

$$M'' \geq \pi^i_{s^is^i} + \beta\pi^j_{s^is^i} - \frac{(\pi^i_{c^is^i} + \beta\pi^j_{c^is^i})^2}{\pi^i_{c^ic^i} + \beta\pi^j_{c^ic^i} - R''}.$$

By differentiation of (4) it is easy to check that $\pi_{j_{c^i}} > 0$ and $\pi_{j_{s^i}} > 0$ as well as $\pi_{i_{c^is^i}} > 0$ and $\pi_{j_{c^is^i}} > 0$. To ensure that there exists an equilibrium for all values of β, second-order conditions must continue to hold. It turns out that

$$\frac{d\,c^i}{d\,\beta} > 0 \quad \text{and} \quad \frac{d\,s^i}{d\,\beta} > 0.$$

A coordination of strategies leads to lower investments. Next consider the ratio of (7) and (6) in the competitive case:[17]

$$\frac{M^{i'}}{R^{i'}} = q^{i*},$$

and of (11) and (10) under cooperation:

$$\frac{M^{AL'}}{R^{AL'}} = q^{AL*}.$$

Using (2) and (3), we know that due to the fact that $c^i < c^{AL}$ and $s^i < s^{AL}$ for equilibrium quantities the following holds: $q^{i*} > q^{AL*}$. Hence, $\frac{M^{i'}}{R^{i'}} > \frac{M^{AL'}}{R^{AL'}}$, meaning that, compared to the competitive case, firms under cooperation proportionally invest more in cost reduction than in product differentiation.

■

Proof of Proposition 2

Considering equilibrium strategies only, we want the first-order conditions (7) and (6) to hold, if *a* changes:

$$\begin{aligned} c_a^i(\pi_{c^i c^i}^i - R'') + s_a^i \pi_{c^i s^i}^i + \pi_{c^i a}^i &= 0, \\ s_a^i(\pi_{s^i s^i}^i - M'') + c_a^i \pi_{c^i s^i}^i + \pi_{s^i a}^i &= 0. \end{aligned}$$

Applying Cramer's rule, the following relations hold:

$$\text{sign } \left(\frac{d\,c^i}{d\,a}\right) = \text{sign } \left(-(\pi_{s^i s^i}^i - M'')\pi_{c^i a}^i + \pi_{c^i s^i}^i \pi_{s^i a}^i\right)$$

$$\text{sign } \left(\frac{d\,s^i}{d\,a}\right) = \text{sign } \left(-(\pi_{c^i c^i}^i - R'')\pi_{s^i a}^i + \pi_{c^i a}^i \pi_{s^i c^i}^i\right).$$

By differentiation of (4), it is again easily checked that as well as $\pi_{i_{c^i a}} < 0$. To $\pi_{i_{s^i a}} < 0$. To ensure that there exists an equilibrium for all values of *a*, second-order conditions must continue to hold. We therefore find

$$\frac{d\,c^i}{d\,a} < 0 \quad \text{and} \quad \frac{ds^i}{da} < 0.$$

Differentiating the ratio of (7) and (6) with respect to *a* yields:

$$\left(\frac{M'}{R'}\right)_a^{'} = q_a^{i*} + q_{c^j}^i c_a^i + q_{s^i}^i s_a^i + q_{c^j}^i c_a^j + q_{s^j}^i s_a^j > 0.$$

First note that $q_a^{i*} > 0$. Using (2) as well as (3) it is easily checked that the right hand side is positive.

■