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Product Positioning and Incentives to Innovate

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ABSTRACT

This paper shows that product positioning affects the incentives to invest in process innovation. The result is found using a model of price competition with three firms under horizontal product differentiation—and then extended to a more general Bertrand triopoly. The central firm may have a higher gain from a cost reduction than the peripheral firms, even if it reaps a lower profit or has a lower demand. By contrast, the peripheral firms have a larger gain if, and only if, they also have larger profits. Furthermore, we argue that the central firm exploits a reduction in the marginal cost mainly to expand its sales, whereas the peripheral ones to increase their markup. We finally show that the aggregate innovation incentives are larger the more clustered toward the center are the firms and the larger the preinnovation cost asymmetry. We also analyze the effects of mergers on innovation incentives, confirming that they tend to reduce the merged firms' incentives to innovate.

1 | Introduction

The classical analysis of incentives to innovate in oligopoly finds that the number of firms, and hence their size, is a crucial determinant factor of their willingness to invest (starting with Dasgupta and Stiglitz 1980). In general, a firm's output affects its incentive to innovate (Arrow 1962; see also Tirole 1988). As to other factors the analyses so far have focused on competitive pressure (proxied by the number of firms, demand elasticity, and restrictions to entry); the most insightful and complete analysis can be found in Vives (2008). Oligopolies with asymmetric cost structures have also been studied (Bester and Petrakis 1993; Ishida et al. 2011).[1] Recently, the effects of horizontal mergers, which reduce the number of firms, have also been scrutinized (e.g., Motta and Tarantino 2021; Bourreau et al. 2025). In what follows, we argue that the incentive to innovate in a differentiated oligopoly also depends on the product positioning of the firm, that is, whether the firm targets consumers near the "center" or "at the extremes" of the distribution of consumer tastes. This is novel, to the best of our knowledge.[2] The price-competition model in which we frame the argument is characterized by a common feature of address models: the matrix of first price derivatives displays cross partial derivatives with zero values. Address (location) models make it explicit that two firms may belong to the same industry even if their price-cross elasticities are null (as emphasized in Gabszewicz and Thisse 1986). We later also extend our results to a framework of price competition with less specific asymmetry in elasticities.

Our paper is also related to the management literature tackling the relationship between the characteristics of the demand and innovation.[3] One of the most relevant contributions in this strand of literature is by Adner and Levinthal (2001), who stress the importance of demand-driven innovation as opposed to that determined by internal capabilities. This literature focuses on niche versus mass markets, rather than products, and in general argues that operations in niche markets stimulate product innovation, while operating in mass markets favors process innovation. Tisdell and Seidl (2004) explore the relationship between market niches and competition, and maintain that niches may shield firms from competition, thus allowing them to innovate more freely. Along these lines, Guerzoni (2010) classifies industry types inside the cells of a matrix with demand size and consumer sophistication on the axes. He argues that firms operating in mass markets (large demand coupled with low sophistication) are more inclined to undertake process innovation, while firms in niche markets (low size and high sophistication) invest in product innovation.

The implication for innovation incentives is that the position introduces an intrinsic asymmetry between firms. In our main model, three firms are located in a Hotelling linear city, with exogenous locations. One firm is positioned at the midpoint. This firm is the central firm, the other two are the "peripheral," or "niche," firms. Firms produce under constant marginal costs. Research and development (R&D) investment is represented by a sunk investment incurred before production takes place; the larger this sunk investment, the smaller the marginal cost of the firm.

Needless to say, in many industries, niche (or specialized) producers coexist with central (or generic) ones. One example is the smartphone market: some companies, like, Doogee, Blackview, and Oukitel, primarily target the niche for rugged, military-grade smartphones, where the selling points are long battery life and resistance to harsh environmental conditions. In contrast, market leaders like Samsung and Xiaomi offer a limited number of rugged devices, if any, while providing a wide array of everyday-use smartphones, ranging from budget to high-end models that feature cutting-edge technology and high customization options. Apple, by contrast, caters to consumers who prefer a seamless ecosystem, long-term performance, and a premium user experience. Similar examples can be found in the camera industry. Hasselblad cameras are designed for the professional niche, while companies like Canon, Nikon, and Fuji offer a broader range of products that span from professional to purely recreational, such as Fuji's Instax line. In the music industry, the three major labels (Sony, Universal, and Warner) boast extensive catalogs that cover most musical genres, yet they coexist with specialized independent companies like Nuclear Blast and Season of Mist in the extreme metal sector, as well as Harmonia Mundi and Naxos on the classical side of the musical spectrum. The cinema industry follows a similar pattern: the five major studios (Paramount, Sony, Universal, Walt Disney, and Warner Bros.) compete with independent and specialized companies like Legendary Entertainment (focusing on horror and sci-fi) and Studio Ghibli (animation). Restaurants may specialize in vegan or Barbecue menus or simply aim to attract a larger number of customers by including a selection of varied dishes. Empirical evidence can be collected from the managerial literature analyzing asymmetric competition, see, for example, DeSarbo et al. (2006), Ringel and Skiera (2016), and the references therein.[4]

To delve into the role of relative positioning, we decompose the total effect of a cost reduction on the equilibrium profits of a firm into the sum of a *business-stealing* effect and of a *size* effect. The first accounts for the increase in demand due to a lower price following the cost reduction, for a given markup. The second measures the increase in markup due to a cost reduction, for a given demand. We describe the relative size of these effects as a function of the firms' locations and identify the conditions under which the aforementioned effects are larger for the central, or peripheral, firms. Interestingly, we show that, although the relative size of the effects depends on the location of firms, there is a feature that does not: the same reduction in marginal production costs is exploited by the central firm mainly to expand its demand (and only secondarily to increase the markup), whereas the opposite holds true for the peripheral firms. We also show that, contrary to models with symmetric cross-price elasticities, a higher than the rivals' preinnovation profit does not uniformly translate into a higher than the rivals' incentive to innovate: this is true only for the peripheral firms, while the central firm may have larger innovation incentives though reaping the lowest preinnovation profit. This confirms the importance of the location to determine the incentives of firms to innovate. Also, we show that location matters to define the *aggregate* incentives to innovate. In fact, the aggregate incentives grow as firms cluster up toward the center. We also show that, if the central firm has a preinnovation marginal-cost larger than its rivals, the aggregate incentives increase with the larger the ex ante cost differential.

We finally consider the effects of mergers on innovation incentives and confirm recent findings on the matter regarding their generally negative impact on the global incentives to innovate (see, e.g., Motta and Tarantino 2021; Bourreau et al. 2025). We find that the incentives to innovate of the nonmerged firm increase, but this effect is muted when the nonmerged firm is the central one. When the merged firms are niche ones, the reduction in incentives does not depend upon a reduction in demand, but upon their positioning.

The remainder of the paper is organized as follows. Section 2 presents the model, Section 3 develops the equilibrium analysis. Section 4 tests the robustness of our results to different model specifications, and Section 5 analyzes the effects of mergers. Finally, Section 6 provides a short conclusion. All proofs are relegated to the Supporting Information: Appendix.

2 | The Model

We analyze an oligopoly with three firms producing differentiated goods. The main feature of the industry environment is the "product positioning," which affects price-competition and cost-reducing R&D efforts. Two of the three firms are "niche" firms as explained above and one is the "central" firm. The latter competes directly and intensely with all niche firms, while these only mildly compete among each other since they *cater to "mutually secluded" segments* of the customer population. The three goods are substitutes; letting (q_1, q_2, q_3) be the vector of quantities demanded, then $\boldsymbol{q}(\boldsymbol{p})$ is a function of the price vector $\boldsymbol{p} = (p_1, p_2, p_3)$. Firm 2 is the central one, implying the following: the nonnegative cross-partial derivatives of the price effects define firm 2 as the "central firm" in that $\frac{\partial q_1}{\partial p_3}$ and $\frac{\partial q_3}{\partial p_1}$ are "small"—indeed in our leading example they are null—compared with $\frac{\partial q_1}{\partial p_2}$ and $\frac{\partial q_3}{\partial p_2}$. Furthermore, the centrality of firm 2 is also reflected in a larger own-price effect, namely, $\frac{\partial q_2}{\partial p_2} < \frac{\partial q_3}{\partial p_3} = \frac{\partial q_1}{\partial p_1} < 0$; this is attributable to a double-sided loss in competitiveness caused by a price increase by the central firm (conversely, a double-sided gain in competitiveness of a price reduction by the same firm). More in detail, our (linear) demand system can be written in vector notation as follows:

$$q(p) = Kp + v, \tag{1}$$

where K is a 3×3 matrix with elements denoted as k_{ij}, v is a (3×1) vector of constants. Cross-price effects are such that $0 < k_{13} = k_{31} < k_{12} = k_{32}$; also, own-price effects intensity is larger for the central firm, so that along the diagonal we assume $k_{22} < k_{11} = k_{33} < 0$. To simplify the algebra, we shall focus on examples where the closeness between the central firm 2 and the peripheral firms 1 and 3 is symmetric, namely, $k_{12} = k_{21} > 0$ and $k_{23} = k_{32} > 0$.

2.1 | The Spatial Model Environment

A well-known competition model is the spatial model developed by Hotelling. It serves as a particularly interesting example of the general model due to its status as a reference point for many studies in product differentiation and the clear interpretability of its results. We will then return to the general model to examine the robustness of these findings in a later section.

The three producers are located at points $(a, 1/2, 1-a)$ in the $[0,1]$ interval, namely, the Hotelling linear city of length 1, with $0 \le a < 1/2$. Production costs are $C_i(q_i) = c_i(y_i)q_i$, where y_i is a sunk cost incurred before production takes place and $c_i(y_i) = \bar{c}_i - r(y_i)$ is a continuous function with continuous first and second derivatives; furthermore, we assume $r'(y_i) > 0$, $r''(y_i) < 0$, $r(0) = 0$, $r'(0) \to \infty$ and $\lim_{y_i \to \infty} r(y_i) = \bar{c}_i$. The function $r(y_i)$ is the reduction in the exogenous marginal cost $\bar{c}_i > 0$ induced by an investment y_i, and is identical across firms.

Firms play a two-stage game where at the first stage they choose y_i and at the second stage they choose the output price p_i. Final profits are then $(p_i - c_i(y_i))q_i - y_i$. The consumer population is of unit mass and is uniformly distributed along the $[0,1]$ interval.[5] The consumer located at x in $[0,1]$ derives utility from buying the product produced by firm i, located at x_i, $V - p_i - t(d)$, where d is the distance $d = |x - x_i|$ and $V > \bar{c}_i$ is the gross consumption utility. The cost $t(d)$ is a measure of the loss in utility for consumer x from buying a good which is different from the preferred specification, x. Two cases are usually considered: (i) quadratic transportation costs ($t(d) = td^2$), (ii) linear transportation costs ($t(d) = td$). We shall deal with both, the latter being however relegated in Supporting Information: Appendix C. Let the consumer indifferent between firms 1 and 2 be denoted x_{12} and the one indifferent between firms 2 and 3 a x_{23}. If $0 < x_{12} < x_{23} < 1$, demand to firm 1 is $q_1 = x_{12}$, that to firm 2 is $q_2 = x_{23} - x_{12}$ and that to firm 3 $q_3 = 1 - x_{13}$. In matrix notation, we have

$$\begin{pmatrix} q_1(p) \\ q_2(p) \\ q_3(p) \end{pmatrix} = B \begin{pmatrix} -1 & 1 & 0 \\ 1 & -2 & 1 \\ 0 & 1 & -1 \end{pmatrix} \begin{pmatrix} p_1 \\ p_2 \\ p_3 \end{pmatrix} + \begin{pmatrix} A_1 \\ A_2 \\ A_3 \end{pmatrix}, \tag{2}$$

where the scalars B and A_i differ in the case one considers quadratic or linear transportation costs.

Here, it is crucial to note that firms 1 and 3 belong to the same industry as they compete with each other through the channel provided by the overlap of demand with that of firm 2. Otherwise, the value of the cross derivatives $\partial q_i / \partial p_j = 0$ for $i, j \in \{1, 3\}$.

The second period profits are then given by $\pi_i = (p_i - c_i)q_i(p)$ and standard techniques for finding a Nash equilibrium yield the following triplet of Nash prices at the second stage:

$$\begin{pmatrix} p_1^* \\ p_2^* \\ p_3^* \end{pmatrix} = \frac{1}{12} \begin{pmatrix} 7(A_1 + c_1) + 2(A_2 + 2c_2) + (A_3 + c_3) \\ 2(A_1 + c_1) + 4(A_2 + 2c_2) + 2(A_3 + c_3) \\ (A_1 + c_1) + 2(A_2 + 2c_2) + 7(A_3 + c_3) \end{pmatrix}. \tag{3}$$

Second-period profits at the optimal prices are

$$\pi_i = B(p_i - c_i)^2 \text{ for } i \in \{1,3\} \text{ and } \pi_2 = 2B(p_2 - c_2)^2. \tag{4}$$

We are interested to ascertain the dimension of the incentive to invest in R&D as given by the increase in equilibrium profit provided by an additional money unit of R&D investment y_i.

Before proceeding, it is worth pausing on the effects of the asymmetry in firms' locations on their performance. Consider a peripheral firm, when cutting its price, only triggers a reduction by firm 2. As it will be seen below, this feature shapes the incentives to exploit the intensive margin (markups) versus the extensive margin (expansion by stealing business to rivals).

Consider now the effect of proximity, or clustering toward the center: If a is increased from zero, firms cluster up toward the center and competition for the central consumers becomes harsher, which reduces the margins of all firms. Yet, because of our assumption of full market coverage, the consumers to the left of a and to the right of $1-a$ still all patronize firms 1 and 3, respectively. The presence of these "uncontested" consumers benefits the niche firms. Needless to say, the larger a, the larger this demand advantage. The relative size of demands, margins, profits from a price reduction depend in a nonmonotone way upon clustering, as it shall be detailed in Section 3.

3 | Equilibrium

In the following, we will deal with the case of quadratic transportation costs.[6] As a general remark, observe that, if $a > 0$ increases, locations become more clustered and competition intensifies. In particular, firms 1 and 3 become more aggressive as their best reply functions shift downward.

With quadratic transportation costs, the utility of a consumer patronizing firm i is $V - p_i - td_i^2$. We easily identify the consumers who are indifferent between purchasing the good from firms 1 and 2 and the one indifferent between firms 2 and 3:

$$x_{12}(p_1, p_2) = \frac{1}{4} + \frac{a}{2} + \frac{p_2 - p_1}{t(1-2a)}, \quad x_{23}(p_2, p_3) = \frac{3}{4} - \frac{a}{2} - \frac{p_2 - p_3}{t(1-2a)}, \tag{5}$$

which, letting $B = \frac{1}{t(1-2a)}$, yield the following demand system:

$$q_i(p_i, p_2; a) = \frac{1}{4} + \frac{a}{2} + \frac{p_2 - p_i}{t(1-2a)}, \quad i \in \{1, 3\}, \tag{6}$$

$$q_2(\boldsymbol{p}; a) = \frac{1}{2} - a + \frac{p_1 + p_3 - 2p_2}{t(1-2a)}. \tag{7}$$

The profit of firm i is, accordingly, $\pi_i(\cdot; a, c_i) = (p_i - c_i)q_i(\cdot; c_i, a)$, where the dot stands for the relevant price vector. The best reply of firms 1 and 3 is only a function of p_2, while that of firm 2 is a function of p_1 and p_3. The Nash equilibrium price triplet is easily derived as

$$p_i^* = p_j(\boldsymbol{c}, a) = \frac{1}{12}\{7c_i + 4c_2 + c_k + [3 - 4a(1+a)]t\}, \quad i, k \in \{1, 3\}, i \neq k, \tag{8}$$

$$p_2^* = p_2(\boldsymbol{c}, a) = \frac{1}{12}\{2(c_1 + 4c_2 + c_3) + [3 - 4a(2-a)]t\}. \tag{9}$$

At these prices, letting $T = (12(1-2a)t)^{-1}$, the profits at the optimal prices write as

$$\pi_i^* = \pi_i(\boldsymbol{c}, a) = \frac{T}{12}\{[3 - 4a(1+a)]t - 5c_i + 4c_2 + c_k\}^2, \quad i, k \in \{1, 3\}, i \neq k, \tag{10}$$

$$\pi_2^* = \pi_2(\boldsymbol{c}, a) = \frac{T}{6}\{[3 - 4(2-a)a]t + 2c_1 - 4c_2 + 2c_3\}^2. \tag{11}$$

Here, it is clear that the profit of each firm decreases in its own marginal cost and increases in the rivals' ones. The niche firms' costs affect each other's profits, but a variation in the marginal cost of a niche firm impacts more upon the central firm than the on the other niche one. Also, all profits decrease with a, as closer locations increase the degree of competition in the market.[7]

We have assumed that the firms are endowed with the same R&D technology, which implies that the marginal cost of reducing the cost $c_i(y_i)$ is the same for all of them, and equals 1. This allows us to delve into the incentives to innovate by analyzing the marginal benefit only. Furthermore, we will focus on the *direct* effect of a reduction in the marginal cost $c_i(y_i)$ of firm i, thus omitting the linkage with the initial investment y_i, which will ease the mathematical notation.[8] By taking the first order derivatives, it is easily observed that

$$B_i(\boldsymbol{c}, a) = \left|\frac{\partial \pi_i^*}{\partial c_i}\right| = -\frac{5\{5c_i - 4c_2 - c_k - [3 - 4a(a+1)]t\}}{72(1-2a)t}, \quad i, k \in \{1, 3\}, i \neq k, \tag{12}$$

$$B_2(\boldsymbol{c}, a) = \left|\frac{\partial \pi_2^*}{\partial c_2}\right| = -\frac{[3 + 4a(a-1)]t - 2(c_1 - 2c_2 + c_3)}{9(1-2a)t}. \tag{13}$$

The absolute value is due to the fact that a marginal increase in cost leads to a marginal reduction in profit.

We are interested in analyzing the difference in the marginal benefits of a reduction in marginal cost between the central and one niche firm. Because the two peripheral firms are symmetric, we will compare firms 1 and 2. Let $D(\boldsymbol{c}) \equiv \frac{41c_1 - 52c_2 + 11c_3}{t(1-2a)}$, the difference between the two marginal benefits is easily computed as

$$\begin{aligned}\Delta B(\boldsymbol{c}, a) &= B_2(\boldsymbol{c}, a) - B_1(\boldsymbol{c}, a) \\ &= (1/72)(D(\boldsymbol{c}) + 9 - 26a).\end{aligned} \tag{14}$$

It is immediate to observe that

$$\Delta B(\cdot) \lesseqgtr 0 \Leftrightarrow a \gtreqless \frac{9 + D(\boldsymbol{c})}{26}. \tag{15}$$

To make our basic point more clear, we are now going to assume.

Assumption 1 (A1). $c_i = c > 0 \ \forall \ i$.[9]

In this case $B_1(a) = \frac{5}{72}(2a+3)$ and $B_2(a) = \frac{1}{3}(1 - \frac{2a}{3})$, furthermore $D(\boldsymbol{c}) = 0$ and condition (15) reduces to $\Delta B(a) \lesseqgtr 0 \Leftrightarrow a \gtreqless 9/26 \approx 0.346$. We state

Lemma 1. *Under A1 (symmetric costs), the central firm enjoys a larger marginal benefit from a reduction in marginal cost than the niche ones if $a < 9/26 \approx 0.346$.*

In our setup, the relationship between the preinnovation profits and the incentives to innovate is more complex than in other oligopoly competition structures, where the ordering of preinnovation profits and that of incentives to innovate are the same.

In fact, in our model, it holds true that certain combinations of parameters exist where firm 2 can achieve the largest profit while also being more inclined to invest compared with firms 1 and 3. Yet, the profit of the central firm is larger than that of the peripheral ones under a different condition than that determining the sign of $\Delta B(\cdot)$, namely, $\pi_2(c, a) \lesseqgtr \pi_1(c, a) \Leftrightarrow a \gtreqless \frac{1}{2}(9 - 6\sqrt{2}) \approx 0.257$. This entails

Proposition 1. *Under Assumption A1:*

i. *The central firm has a larger incentive to invest in process innovation than the peripheral firms, even though it reaps a lower preinnovation profit, if $\frac{1}{2}(9 - 6\sqrt{2}) < a < \frac{9}{26}$.*
ii. *The peripheral firms have a larger incentive to invest in process innovation than the central one if and only if, they enjoy a larger preinnovation profit.*

This is a striking result, because here the central firm, although reaping a lower profit than the peripheral ones, may have nonetheless a larger marginal benefit than the rivals. This should be contrasted with nonlocalized models of competition insofar, in that setup, the firm displaying the largest marginal benefit from innovation is always the firm enjoying the largest profit.

Furthermore, it is easy to ascertain that the sales of the central firm exceed those of the peripheral for any level of a: $q_2^*(c, a) > q_1^*(c, a) = q_3^*(c, a) \ \forall \ a \in [0, 1/2]$. This is a further interesting result because it shows that relative sales volumes are not correlated with relative innovation incentives. Although the central firm has a sales volume always exceeding that of the peripheral ones, its incentive in process innovation is the largest one only if a is small enough, so that its central position is undisputed. On the other hand, peripheral firms always produce less than the central one, nonetheless, they may have larger incentives.

3.1 | Decomposition of Effects

Proposition 1 rests upon two effects: on the size effect (gains from reducing costs on existing production) and on the business-stealing effect (gain from newly acquired business stolen to competitors). It is instructive to decompose the total benefit variation into the two effects.

The size effect is $B_i^{\mathrm{SE}}(\mathbf{c}, a) \equiv |q_i^*(\Delta p_i - \Delta c_i)|$, approximated by $B_i^{\mathrm{SE}}(\mathbf{c}, a) \equiv \left|q_i^*(\frac{\partial p_i}{\partial c_i} - 1)\right|$. Easy computations show that, under A1, the size effect for firms 1 and 2 are, respectively, $B_1^{\mathrm{SE}}(c, a) = \frac{5}{12^2}(2a + 3)$ and $B_2^{\mathrm{SE}}(c, a) = \frac{1}{3}(\frac{1}{2} - \frac{a}{3})$.

The business-stealing effect is given by $B_i^{\mathrm{BS}}(\mathbf{c}, a) \equiv |(p_i^* - c_i)\Delta q_i|$, which can be approximated by $B_i^{\mathrm{BS}}(\mathbf{c}, a) \equiv |(p_i^* - c_i)\frac{\partial q_i}{\partial c_i}|$. It is then immediate to show that $B_1^{\mathrm{BS}}(\mathbf{c}, a) = (p_1^* - c_i)\frac{5}{12t(1-2a)}$ and $B_2^{\mathrm{BS}}(\mathbf{c}, a) = (p_2^* - c_i)\frac{2}{3t(1-2a)}$. Under A1, the values of the business-stealing effects are $B_1^{\mathrm{BS}}(c, a) = \frac{5}{12^2}(2a + 3)$ and $B_2^{\mathrm{BS}}(c, a) = \frac{1}{3}(\frac{1}{2} - \frac{a}{3})$. Then one has that

Corollary 1. *Under A1, both the business-stealing and the size effects are larger for the central firm if* $a < \frac{9}{26}$.

Proof. $B_2^{\mathrm{BS}}(c, a) - B_1^{\mathrm{BS}}(c, a) = B_2^{\mathrm{SE}}(c, a) - B_1^{\mathrm{SE}}(c, a) = \frac{1}{144}(9 - 26a)$, which is positive for $a < \frac{9}{26}$. □

The foregoing lemma confirms that, so long as the central position of firm 2 is undisputed, both the business-stealing and the size effects boost the investments of the central firm compared with the peripheral ones, irrespective of the relative size of the preinnovation profits. Also, the lemma points out that the opposite may happen. Indeed, if the location of the peripheral firms is central enough, both the business-stealing and size effects become stronger for them, resulting in larger innovation incentives. It is worth to stress that "undisputed central position" does not refer to the peripheral firms being located closer to the endpoints of the segment than to the central firm (which would require $a < \frac{1}{4}(<\frac{9}{26})$). Neither, it implies the set of locations being such that the central firm serves *most of* the market; in fact, it is easy to ascertain that the demand of the central firm is always smaller than the sum of the demands of firms 1 and 3 ($q_2^*(c, a) < q_1^*(c, a) + q_3^*(c, a)$).

To deepen our understanding of the innovation incentives, it is useful to further disentangle the SE and BS effects for firms 1 and 2. As for the size effect, we have already observed that $q_1^* < q_2^*$. On the contrary, $\left|\frac{\partial p_1}{\partial c_1} - 1\right| = \frac{5}{12} > \frac{1}{3} = \left|\frac{\partial p_2}{\partial c_2} - 1\right|$. Irrespective of the relative magnitude of the size effect, a decrease in the marginal production cost always increases the markup of the peripheral firms more than that of the central one. The peripheral firms' demands are exposed to direct competition only on one of their ends, the other one being unaffected by price changes. Consequently, the same price drop leads to a lower gain in demand for firms 1 and 3 than for firm 2. Thus, the peripheral firms have lower incentives to channel cost reductions following innovation into a large price cut. Instead, they apply a relatively small price reduction, which, combined with the savings on marginal costs, results in a significant increase in the markup. The opposite reasoning applies to the central firm.

As for the business-stealing effect, at equal marginal costs $c_1 = c_2 = c$, we have $p_1^* - c = \frac{1}{12}[3 - 4a(1 + a)]$ and $p_2^* - c = \frac{1}{12}[3 - 4a(2 - a)]t$, and $\left|\frac{\partial q_1^*}{\partial c_1}\right| = \frac{5}{12(1-2a)t} < \frac{2}{3t(1-2a)} = \left|\frac{\partial q_2^*}{\partial c_2}\right|$. It can then be verified that a decrease in the production cost always increases the demand of the central firm more than that of the peripheral ones. This follows from the equilibrium effect of a cost reduction on prices: a reduction in marginal cost pushes the price of the central firm down more than that of the peripheral ones: $-\frac{\partial p_2^*/}{\partial c_2} = -\frac{2}{3} < -\frac{7}{12} = -\frac{\partial p_1^*}{\partial c_1}$.

Corollary 2. *A unit cost reduction*

i. *Boosts the demand of the central firm more than that of the peripheral ones.*

ii. *Boosts the markup of the peripheral firms more than that of the central one.*

This observation yields interesting managerial implications, if one considers the niche firms as producers of "specialized" goods, and the central one as the producer of a "standard" product (as in Bacchiega and Garella 2022). Indeed, in this case, it follows that the producers of "specialized" goods exploit process innovation to increase their markup, relegating to the background volume increases. By contrast, the producers of "standard" goods should leverage the cost reduction to expand their sales, accepting to reap a lower margin. The findings of Koppenberg (2023) provide some support to our conclusion. Indeed, that paper finds that niche diary producers (those specializing on organic products) reap larger markups than ordinary, nonorganic producers. These, by contrast, enjoy on average larger market shares.

3.2 | Firm Location and Global Innovation Incentives

We now move to the analysis of the relationship between the location of the firms in the product space and the aggregate marginal benefits from innovation. Is agglomeration providing the largest total innovation benefits, or is dispersion? To answer this question, we define the aggregate innovation incentives as

$$B(\mathbf{c}, a) \equiv \sum_{i=1}^{3} B_i(\mathbf{c}, a) = \frac{1}{36}\left[27 + 2a + \frac{2(2c_2 - c_1 - c_3)}{(1-2a)t}\right]. \quad (16)$$

It is immediate to state the following.

Proposition 2. *Under Assumption A1, the aggregate marginal innovation benefits are increasing in* a*, namely, increasing in agglomeration.*

Note that the foregoing proposition applies only if all firms find it profitable to invest in process innovation. This, in turn, requires the R&D technology to be efficient enough that firms are still willing to bear the fixed innovation cost, despite the profit erosion caused by clustering. That said, the proposition can be explained as follows.

The larger a, that is, the more agglomerated are the firms, the larger is the aggregate private marginal benefit from process innovation. Yet, it should be noted that the individual incentives of the niche and central firms are at odds with each other, as far as a is concerned. Direct inspection of (12) and (13) reveals that the marginal incentive toward R&D is increasing in a for the niche firms, whereas it is decreasing for the central one. This is not surprising, in light of the discussion above. A larger a increases the competitive pressure on the central firm. This translates in a reduction of the consumers who patronize it, thus, all else equal in a reduction in its sales, and in the benefit from marginal-cost abatement. In fact, remember that the central firm exploits innovation to expand sales, rather than margins. An increase in a, clearly counters the sales expansion. The converse holds for the peripheral firms: a shift toward the center of the segment still decreases their profit, but increases their sales. Niche firms exploit process innovation to boost margins, which, coupled with the increase in volumes due to the center-ward shift, creates a flywheel effect on innovation incentives.

4 | Robustness

The Hotelling setup "naturally" generates asymmetric competition once the number of competitors is larger than two, even with evenly spaced locations. The firms closer to the ends of the line have only one competitor, while all the others (the central one, in the present paper) have two. This serves well our purpose to delve into the role of the location of goods in the characteristics space in the shaping of innovation incentives. We have argued that this product space positioning has relevant implications as far as the innovation incentives are concerned.

One immediate question that comes to mind is about the robustness of our results in more general setups. It can be shown that departing from the Hotelling framework does not alter the message conveyed by our results, so long as a sufficient degree of asymmetry among firms is introduced. In Supporting Information: Appendix D.1, we develop a nonaddress model of triopoly with price-competition and linear demands, where firm 2 is exposed to higher competition from firms 1 and 3 than firms 1 and 3 are from each other. We consider the following demand system with $0 < \gamma < \beta < 1 < \alpha$, and $\alpha\gamma > \beta$:

$$\begin{pmatrix} q_1(\boldsymbol{p}) \\ q_2(\boldsymbol{p}) \\ q_3(\boldsymbol{p}) \end{pmatrix} = \begin{pmatrix} -\alpha\gamma & \beta & \gamma \\ \beta & -\alpha\beta & \beta \\ \gamma & \beta & -\alpha\gamma \end{pmatrix} \begin{pmatrix} p_1 \\ p_2 \\ p_3 \end{pmatrix} + \begin{pmatrix} v \\ v \\ v \end{pmatrix}. \tag{17}$$

Products are differentiated and substitutable; however, competition is not symmetrical among the three firms and it respects the features described in Section 2. In particular, the matrix of the cross-price derivatives implies that product 2 is a "closer" substitute of products 1 and 3, the substitutability between 1 and 3 being instead lower.

The parameter γ captures the extent of this "lower" substitutability. Indeed, a marginal decrease in—say—p_1, dp_1, corresponds to a marginal decrease in βdp_1 in q_2, the "close" substitute's quantity, but only of γdp_1 in the "distant" substitute's quantity q_3. On the other hand, a marginal increase in own price has a larger impact ($-\alpha\beta$) for good 2 than for goods 1 and 3 ($-\alpha\gamma$). This is consistent with the idea that an increase in p_2 displaces the demand of firm 2 away from its good more than does an increase of p_1 on the demand of firm 1 (and p_2 on that of good 2). This assumption "mimics" the idea that, loosely speaking, good 2 is directly competing against goods 1 and 3, while the latter only compete with good 2. It should be noted that although γ directly determines the extent of competitive pressure between firms 1 and 3, it also indirectly influences the pressure on firm 2 through strategic interaction.

This model replicates most of the features of the Hotelling one, and, in particular, it shows that innovation incentives are not only related to margins, profits, or sales, but also to the "location" of a firm's product in the competition chain, as defined by the matrix of the demands' own- and cross-price derivatives. Admittedly, the results are clumsier than those exposed above, and their interpretation is less clear-cut. One of the reasons for this is that the origin of the asymmetry necessary to obtain the result cannot be traced back to some primitives of the analysis. This should be contrasted with the "natural" asymmetry of the Hotelling triopoly.

If the matrix of price derivatives is symmetric, instead, our results cease to hold. In particular, the larger innovation incentives are always correlated to larger preinnovation profits and larger preinnovation sales. This holds true both with homogeneous and differentiated products. In the first case, the analysis can be quickly dealt with. Consider three firms, $i = 1, 2, 3$ facing a linear inverse demand $P(Q) = E - FQ$, with $Q = \sum_i q_i$. Firm i has costs c_i thus, at the optimal Cournot quantities $q_i(\boldsymbol{c}) = \frac{a - 3c_i + \sum_{j\neq i} c_j}{4b}$, the profits of the firms are $\pi_i(\boldsymbol{c}) = \frac{1}{16b}(a - 3c_i + \sum_{j\neq i} c_j)^2$. The marginal benefit from a reduction in own marginal cost is thus $B_i(\boldsymbol{c}) = \left|\frac{\partial \pi_i(\boldsymbol{c})}{\partial c_i}\right| = \frac{3}{8b}(a - 3c_i + \sum_{j\neq i} c_j)$. It is apparent that $q_i(\boldsymbol{c}) \gtreqless q_j(\boldsymbol{c}) \Leftrightarrow \pi_i(\boldsymbol{c}) \gtreqless \pi_j(\boldsymbol{c}) \Leftrightarrow B_i(\boldsymbol{c}) \gtreqless B_j(\boldsymbol{c})$. The business-stealing and size effects coincide, and are larger for the firm with the largest incentive. The same relationship between quantities, prices, and innovation incentives holds in a differentiated-product, price-competition model, if the matrix of own- and cross-price derivatives is symmetric. The analysis is more involved and relegated in Supporting Information: Appendix D.2.

A further question that may arise concerns the robustness of our results to variations in population distributions. While a full exploration of this issue is beyond the scope of the present paper, we can discuss some potential effects that more general consumer distributions may have on innovation incentives.[10] With a symmetric and unimodal consumer distribution that has a larger mass at the center, more consumers will naturally patronize the central firm compared with the uniform case. For given prices, firm 2's demand increases at the expense of firms 1 and 3. The niche firms will have stronger incentives to compete for the central market, leading to more aggressive pricing and triggering a general price drop as firm 2 reacts.

The impact on innovation incentives is more nuanced. For the central firm, the larger consumer base amplifies the size effect while weakening the business-stealing effect relative to the uniform case. Intuitively, since this firm already serves many central consumers, increasing its margin yields substantial profit gains, whereas expanding outward is less effective due to weaker demand. Conversely, for niche firms, the business-stealing effect strengthens while the size effect diminishes. Expanding inward grants them access to increasingly larger portions of the market, whereas improving margins is less attractive given their smaller customer base. An immediate consequence would be that the business-stealing and size effects no longer coincide within each firm. The total innovation incentives will depend on the balance of these two forces. It is reasonable to conjecture that, at equal ex ante costs, the larger mass at the center would stimulate the incentives of firm 2 and depress those of 1 and 3, therefore making the incentives of the central firm larger than those of the niche firms for values of a larger than those of Lemma 1.[11]

5 | Mergers

Recently, there has been growing interest in understanding the impact of mergers on innovation. The immediate increase in concentration in the industry is the most evident structural effect of the merger, but, in an industry with differentiated goods, the merged entity now offers (a subset of) the products of the firms involved in the merger itself. This firm now internalizes the negative effect of a cut in the price of one of its goods on the demand of the other(s) it offers, and is thus inclined to raise its prices.

The rivals respond strategically by increasing their prices as well, leading to a generalized price rise (see, e.g., Motta 2004; for an analysis in a locational setup, McAffee et al. 1992).

The effects of the loosening of the competitive pressure following the merger extend beyond the price levels. Norman and Pepall (2000), Gandhi et al. (2008), and Brekke et al. (2017), for example, analyze the effects of mergers on product positioning, or product quality. The changes so induced in demands and margins have an impact on the incentives of firms to undertake innovative endeavors, and, recently, a growing stream of literature has started delving into the topic. Some examples are Federico et al. (2017, 2018), Denicoló and Polo (2018, 2021), Rockett and Régibeau (2019), Motta and Tarantino (2021), and Bourreau et al. (2025).

In general, these contributions assert that, absent significant efficiency gains, postmerger synergies, or innovation sharing, the mergers tend to reduce the industry's innovative efforts. Our examination of mergers primarily focuses on the two latter contributions, which outline the conditions that influence whether a merger fosters or impedes innovation.

Our analysis shares the concerns and confirms the results of the above-mentioned literature: in our model, any two-firm merger lowers the global innovation incentives. In particular, the innovation incentives of the merged entity on all the production processes it now controls are reduced by the merger. The extent of such a reduction, however, also depends upon the firms being central or niche ones, as discussed below, while in the quoted literature this element is not modeled.

On this point, we further argue that the identity of the merging firms determines the outsider's incentives to innovate. We show that any merger between the central firm and one niche firm boosts the innovation incentives of the outsider niche firm. If the two niche firms merge, instead, the central firm's innovation incentives are unchanged. This follows from the property that a merger between firms 1 and 3 does not generate price effects, because products 1 and 3 are not in direct competition with each other. This relates immediately to P-neutral mergers, defined by Bourreau et al. (2025) as mergers that have no direct effect on prices, except for those due to the merger-induced changes in the innovation incentives. This contribution traces back P-neutral mergers to the offsetting of the price increase due to increased concentration and the price decrease arising from cost synergies due to the merger. Our analysis suggests that the location in the product space may also determine whether a merger is, or not, P-neutral.

Our main results are summarized here.

Proposition 3. *In our spatial model, any two-firm merger*

i. *Reduces the global incentives to innovate.*
ii. *Reduces the incentives to innovate of the merged firms.*
iii. *Increases the incentives to innovate of the external firm if this is a niche firm, but does not affect them if it is a central firm.*
iv. *If it involves the two niche firms, the reduction of the innovation incentives occurs without a reduction in their equilibrium demand after the merger.*

Interestingly, points (iii) and (iv) imply that the product position of firms has a role in determining the incentives to innovate that go beyond the pure effect of demand reductions; in particular point (iv) applies because the two niche firms anticipate that the cost reduction by one of the merged firms reduces the price of the central firm, which hampers their profits (reduces the business-stealing effect of a cost reduction).

We also find that, although the identity of the merging firms determines the specific innovation incentives on each production process, it does not affect the postmerger global innovation incentives, neither does the location of firms (parameter a). This follows from the fact that a merger in our model reduces the number of competing firms from 3 to 2 and that the merged entity completely internalizes the cross-incentive effects on the production processes it now controls. Any incentive change by one firm following a modification in a is thus exactly compensated by an equal and opposite change by the rival firm. This is not the case in a triopoly, because competition between firms 1 and 3 is always mediated by the presence of firm 2.[12] Supporting Information: Appendix E contains the complete analysis.

6 | Conclusion

We have shown that the position of a firm relative to its competitors in the product space is a factor affecting the incentives to innovate, independent of the relative size of equilibrium demand or profit. In a three-firm Hotelling model, with one firm located at the center and the others symmetrically on its sides, the central firm has a larger incentive to undertake process innovation even if it reaps lower profits than the peripheral ones, as long as its central position is undisputed. If its distance from the peripheral firms becomes too short (agglomeration at the center is too strong), instead, its incentive to innovate becomes smaller than that of the rivals. By contrast, niche firms display larger incentives if, and only if, they also reap larger preinnovation profits. Also, we have pointed out that the ranking of the innovation incentives does not match that of the quantity produced. We have decomposed the innovation incentives into a business-stealing effect and a size effect, and argued that these effects also depend on the location of the firms, and not on their profits or demands. It appears that these different underlying forces induce equilibrium responses such that an own-cost reduction benefits a peripheral firm more from its increase in the markup than from the increase in market size, while the opposite holds for the central firm. All the results are extended to a Bertrand triopoly with asymmetric cross-price elasticities that are not too far from those in the Hotelling model.

We have also considered the aggregate innovation incentives, and proved that they increase the more clustered the firms are, provided that they remain all active in the market. These results are robust to the presence of asymmetric marginal production costs, and to the specification of the transportation costs incurred by the consumers.

Finally, we have analyzed the effect of mergers on innovation, a topic that has recently received considerable attention. Our results confirm those proposed by the literature, and in particular that mergers, in general, reduce the aggregate innovative endeavor. We also show, however, that the extent to which individual incentives are affected by the merger depends on the location of the merging firms in the product space.

Stretching the meaning of our result, the prediction of the model indicates that in an industry with differentiated products, the firms that "have a large number of direct competitors" have a stronger incentive to innovate than firms that have a low number of direct competitors. Otherwise stated, niche firms tend to be less innovative unless they gain enough profits.

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Endnotes

[1] Bester and Petrakis (1993) analyze an asymmetric duopoly where only one firm can innovate, and otherwise their demand structure displays a symmetric 2×2 matrix of coefficients. In explaining their Proposition 3 they make it clear that under Bertrand competition a high elasticity of substitution plays a role in increasing the incentive to innovate. Ishida et al. (2011) study a Cournot oligopoly with asymmetric (initial) costs.

[2] In a recent series of papers, Callander et al. (2021) and Callander and Matouschek (2022) analyze the innovation incentive differences between an incumbent firm, located at the center of the Hotelling line, and one entrant. The farther the location of the entrant from the center of the segment, the more innovative, and more uncertain valuewise, is the innovation.

[3] The economic literature has been more interested in the relationship between firm size and innovation, following the early contributions, for example, Kamien and Schwartz (1975), Acs and Audretsch (1987, 1988), and Cohen and Klepper (1996).

[4] For an analysis of the differentiation in the Health Maintenance Organization market, see Dranove et al. (2003).

[5] In Section 4, we shall briefly expand on the implications of more general distribution functions.

[6] The results of the linear case are qualitatively unaffected, see Supporting Information: Appendix C.

[7] In our analysis, we will only deal with the case of oligopolistic competition, with a fully covered market. Intuitively, this requires that the "stand alone" utility V is large enough, so that all consumers, at the optimal oligopoly prices, enjoy a positive utility. Supporting Information: Appendix A expands on this point.

[8] Observing that $\frac{dc_i(y_i)}{dy_i} = -r'(y_i)$, the first-order condition for firm i's profit maximization w.r.t. y_i is

$$\frac{\partial \pi_i^*}{\partial y_i} = -r'(y_i)\left\{\left(\frac{\partial p_i^*}{\partial c_i} - 1\right)q_i + \left(p_i^* - c_i\right)\left[\frac{\partial q_i}{\partial p_i}\frac{\partial p_i^*}{\partial c_i} + \sum_{s \in S}\frac{\partial q_i}{\partial p_s}\frac{\partial p_s^*}{\partial c_i}\right]\right\} = 1,$$

with S being the set of the other relevant prices, and can be rewritten as

$$-\frac{\partial \pi_i^*}{\partial c_i} = \frac{1}{r'(y_i)}.$$

Notice that $r(\cdot)$ is the same across firms and so is its first-order derivative; thus, we focus on the term on the left-hand side to study the marginal investment incentives.

[9] Supporting Information: Appendix B demonstrates that assuming a higher marginal cost for the central firm compared with the peripheral ones does not qualitatively affect our analysis.

[10] With a general consumer distribution function, demand typically becomes nonlinear in prices, leading to profit functions with multiple extrema. This complexity makes it challenging to characterize a closed-form price equilibrium, if it exists. Consequently, profit functions at the pricing stage equilibrium tend to be cumbersome and offer limited analytical insight.

[11] More complex distribution (either skewed or multimodal) should boost the willingness to innovate of the firms close to the peak(s), and reduce those of the firms farther away. However, the effects of clustering toward the center are likely to become much more involved, and, possibly, nonmonotone.

[12] This result is related to the one obtained by Motta and Tarantino (2021) for the Salop model, where "investment is fixed across market configurations" (p. 10). This follows from the fact that the Authors restrict their analysis to the three-firm case, where any price change is directly internalized by all firms, both pre- and postmerger.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.
Supplementary Information.