# Management turnover, strategic ambiguity and supply incentives

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March 6, 2021

**Abstract**

When a firm changes its manager, it reopens room for contractual frictions with its partners. We explore *strategic ambiguity* as a potential friction with a supplier. The firm's new manager likely holds fuzzy expectations about the supplier's strategy. An optimistic manager weights favorable strategies more than detrimental ones whereas a pessimistic manager does the reverse. We show that the manager's degree of optimism is critical: above a threshold it can incite the supplier to change its timing of contracting and increase its profits. We also find that this threshold degree of optimism depends on the length of product substitution.

**Keywords**: vertical contracting; strategic ambiguity; ambiguity attitude

**JEL classification**: L14; L22; D8

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# 1 Introduction

An upstream monopolist contracting with two downstream firms may build on repeated relationships to design better contracts and increase its profits (Ryall and Sampson, 2009; Gilo and Yehezkel, 2020). After years of contracting, it is likely that a downstream firm incurs a management turnover (succession, demission...) implying that the monopolist now has to deal with a new manager. This new relationship reopens room for contractual frictions and potentially threatens the monopolist's profits.

In this paper, we consider that contractual friction takes the form of *strategic ambiguity*. In other words, the new manager holds fuzzy expectations about the monopolist's strategy. This can occur because, for example, the new manager is hired from outside the firm and does not trust the supplier at its first encounter. Experimental evidence shows that individuals do exhibit strategic ambiguity towards other players' choices in games (Eichberger *et al.*, 2007). As a consequence, the new manager has an objective function which differs from one with rational expectations.

Complementary to strategic ambiguity, the manager holds some attitude towards this ambiguity. We say the manager is optimistic when he likes ambiguity while he is pessimistic when he dislikes ambiguity. Optimism leads the manager to weight favorable monopolist's strategies more than detrimental ones whereas pessimism does the reverse. Again, experimental evidence shows that individuals exhibit optimism and pessimism in games (Ivanov, 2011). Moreover, Armstrong and Huck (2010) points out that entrepreneurs are even more prone to optimism, about one's own ability or about the probability of favorable outcomes, than other individuals.

Our paper theoretically demonstrates that the monopolist can benefit from contractual frictions when the latter takes the form of strategic ambiguity. Provided the new manager is sufficiently optimistic, the monopolist does earn greater profits than without management turnover by sequencing its contracting. Interestingly, product substitution affects this minimum optimism threshold condition in a non-monotonic way. The optimism threshold is maximal for an intermediate level of product substitution (not accounting for unrelated goods). The intuition for this main result is as follows.

Upon management turnover, the monopolist approaches the new manager first so that the latter cannot observe its contract with the remaining firm. This creates room for strategic ambiguity. With perfect substitutes, optimism leads the new manager to expect exclusivity and therefore to be a monopolist in the market. The manager orders close to the monopoly quantity. The monopolist then lets the remaining firm serve the residual demand and earns more than with simultaneously observable offers. Imperfect substitutes mitigates this result by acting on the manager's worst scenario which does not systematically trigger a nil profit. Actually, the latter now depends on the monopolist's quantity offer. If the offer is sufficiently low with respect to product substitution, then the manager expects positive profits which creates non-monotonicity in the effect of product substitution on the optimism threshold.

Our paper contributes to the flourishing literature that revisits industrial organization settings with ambiguity concepts derived from decision theory (Eichberger *et al.*, 2009; Król, 2012; Kauffeldt and Wiesenfarth, 2018). Eichberger *et al.* (2009), the closest paper to ours, shows that firms, in a Cournot duopoly, have a unilateral incentive to hire an optimistic manager who feels ambiguity about the rival's strategy. To the best of our knowledge, this literature is silent regarding strategic ambiguity in vertical relationships. Our contribution is thus twofold. Thanks to strategic ambiguity, we model a situation where the monopolist can earn more than the monopoly quantity (in the short run). It is not possible in the standard literature about vertical contracting because the first contracting firm rationally expects the second to serve the residual demand (McAfee and Schwartz, 1994). This anticipation can be muted with strategic ambiguity. On the other hand, in contrast to Eichberger *et al.* (2009), hiring an optimistic manager is detrimental for the firm when the latter makes the former interact with a monopolist supplier. We nonetheless discuss that this latter result depends on the monopolist's bargaining power.

Our paper also relates, but to a lesser extent, to the literature about manager hiring. In this literature, Englmaier and Reisinger (2014) shows that firms hire overconfident managers in a Cournot setting to commit to be more aggressive on the market. However, it is worth underlining that this literature puts the uncertainty on the consumer's demand and not on the rival's decisions. Hence, even if the results are somehow similar to Eichberger *et al.* (2009) (incentive to hire an optimistic/overconfident manager) the models are different (demand uncertainty vs. strategic uncertainty). The closest paper to ours in this literature with demand uncertainty is Meccheri (2021). It points out that the incentive to hire an overconfident manager in Cournot duopoly turns out to depend on the degree of product substitution when firms are supplied by a monopolist. In our setting with strategic ambiguity towards the monopolist supplier, we show that hiring a very optimistic manager is not optimal for a firm irrespective of the degree of product substitution.

The paper is organized as follows. Section 2 presents the benchmark situation, which is the absence of management turnover. Section 3 states the new equilibrium strategies consecutive to management turnover, i.e. to the introduction of strategic ambiguity. Section 4 compares the two situations. Section 6 concludes. All proofs are relegated to the Appendix.

## 2 Before management turnover (benchmark)

□ **The model.** We assume an upstream monopolist, denoted by $U$, producing inputs at zero marginal cost. This monopolist supplies two potentially differentiated downstream firms, denoted $D_1$ and $D_2$. To this end, $U$ proposes a contract $c_i = (q_i, f_i)$ to each $D_i$, with $i \in \{1, 2\}$, and $q_i \in [0, 1]$ stands for the input quantity delivered to $D_i$ while $f_i \in [0, 1]$ is the fixed tariff paid by $D_i$ to $U$ in exchange for such a quantity.[1] Let $\mathcal{C}_i = [0, 1]^2$ be the set of the contracts $U$ can propose to $D_i$. Each $D_i$ decides whether to accept, $a_i = 1$, or reject, $a_i = 0$, its contract offer and pays $f_i$ upon acceptance.

A strategy for U is to propose two bilateral contracts. Formally, it denotes $c = (c_1, c_2)$, or equivalently $c = (q_1, f_1, q_2, f_2)$. The set of U's strategies is therefore the set of these bilateral contracts, which denotes $\mathcal{C} = \mathcal{C}_1 \times \mathcal{C}_2 = [0, 1]^4$. The monopolist's profit is:

$$\pi_U(c, a_1(c), a_2(c)) = a_1(c) \cdot f_1 + a_2(c) \cdot f_2, \tag{1}$$

where $a_i(c)$ is the response by firm $i$ to the monopolist contract strategy $c$.

[1] We suppose such a contract set to avoid slotting allowances (case where $f < 0$) and unfeasible contracts given our inverse demand (case where $f > 1$).

Once a contract is accepted or rejected, it is transparently disclosed to the firms. The firms transform the inputs into homogeneous outputs on a one-to-one basis and compete downstream *à la Cournot* with their inverse demand $p_i(q_i, q_j) = 1 - q_i - \gamma q_j$ with $j \neq i$ and where $\gamma$ refers to the level of product substitution. When $\gamma = 0$, goods are unrelated whereas as $\gamma$ tends towards 1, goods become more en more substitutes until they reach perfect substitution $\gamma = 1$.

We assume for simplicity that if the firms have purchased quantities $q_1$ and $q_2$, they find it optimal to transform all units of inputs into final goods. Structural reasons such as a sufficiently high cost for stocking or destroying the inputs support this behaviour. Firm $i$'s revenues can thus be summarized by Cournot total revenue functions and its profit is:

$$\pi_i(a_i, a_j(c), c) = a_i[(1 - q_i - \gamma a_j(c).q_j)q_i - f_i] \qquad j = 1, 2 \ \& \ j \neq i \tag{2}$$

From the linear demand function and given final outputs, we get the following consumer surplus, denoted by CS:

$$CS = \frac{(q_1)^2 + 2\gamma q_1 q_2 + (q_2)^2}{2} \tag{3}$$

In this situation before management turnover, we consider that the monopolist has reached the best possible situation in the literature about vertical contracting. That is to say, the monopolist makes simultaneous offers and can commit not to renegotiate the contracts. The timing of the game is as follows: (i) the monopolist makes simultaneous and observable offers to the firms, (ii) the firms observe the offers and decide whether to accept. Profits are made.

□ **The equilibrium.** We solve the game using the Subgame Perfect Nash Equilibrium (SPNE) concept. We focus on the symmetric equilibrium because, though potentially differentiated, firms are symmetric at this point. We find the standard result that the monopolist supplies half the monopoly quantity to each firm and the monopolist earns the monopoly profit (Rey and Tirole, 2007). Result 1 summarizes our findings:

**Result 1.** *In the benchmark situation, the symmetric SPNE in pure strategy implies the following* *equilibrium outcomes:*

$$q_1^B(\gamma) = q_2^B(\gamma) = \frac{1}{2(1+\gamma)}\ , \quad f_1^B(\gamma) = f_2^B(\gamma) = \frac{1}{4(1+\gamma)} \tag{4}$$

$$\pi_U^B(\gamma) = \frac{1}{2(1+\gamma)}\ , \quad CS^B(\gamma) = \frac{1}{4(1+\gamma)} \tag{5}$$

In addition, Result 1 shows that the monopolist is better off as product substitution decreases ($d\pi_U^B/d\gamma = -1/(2(1+\gamma)^2) < 0$). This happens because consumers disentangle more and more the products and as a consequence competition softens. At some point, i.e. when products are unrelated ($\gamma = 0$), firms even become local monopolists.

# 3 After management turnover

In this section, we suppose that downstream firm $D_1$ changes its manager and it raises *strategic ambiguity*. We choose firm $D_1$ without loss of generality. The symmetric result would occur if we suppose firm $D_2$ changes its manager instead.

## 3.1 Simultaneous contracting

If the supplier continues to make simultaneous offers then observability and non-renegotiation mute strategic ambiguity: the new manager is able to observe all the contract when it has to choose whether to accept its own. Consequently, the result would be the same as in the benchmark situation.

## 3.2 Sequential contracting

When the monopolist sequences its timing of contracting and enters first into contracts with the new manager, it gives room to strategic ambiguity.[2] The timing of the game changes as follows: (i) the monopolist makes an offer to the new manager of firm $D_1$, (ii) the new manager decides

[2]Note that if it enters first with $D_2$, which has not changed its manager, then there is no room for ambiguity anymore as the new manager will observe the contract made by the supplier to $D_2$ upon deciding whether to accept the supplier's contract offer.

whether to accept, (iii) the monopolist makes an offer to $D_2$, (iv) $D_2$ observes the two offers and decides whether to accept its offer. Profits are realized.

□ **Additional assumption.** We focus on the situation where the new manager feels strategic ambiguity towards the monopolist's strategy and not towards the rival's acceptance strategy. This could happen because the new manager has time to monitor the rival but not the monopolist. In addition, we assume the monopolist knows the attitude towards ambiguity of the new manager. This could happen because the monopolist has sufficient time to monitor the new manager before making its offer, whereas the new manager likely lacks the time to monitor the monopolist additively to the rival when receiving its offer.

□ **Manager's preferences.** We model the new manager's preferences in the face of strategic ambiguity using an $\alpha-$ MaxMin Expected Utility ($\alpha-$MEU).[3] The new manager of firm $D_1$ takes a decision weighting the best and worst profits it can get given the action of the monopolist, $c_1$, its expectation about the future strategies available to the monopolist, $c_2$ - which the manager feels ambiguous about - and given the expectation about the strategy of the rival, $a_2(c)$ - which the manager does not feel ambiguous about. The expected profit of the manager for choosing action $a_1(c_1)$ thus is:

$$E\pi_1(a_1(c_1), a_2(c), c) = a_1(c_1)[(1-\alpha) \max_{c_2 \in \mathcal{C}_2} \pi_1(a_1(c_1), a_2(c), c) + \alpha \min_{c_2 \in \mathcal{C}_2} \pi_1(a_1(c_1), a_2(c), c)] \tag{6}$$

Criterion (6) has been axiomatically characterized by Chateauneuf *et al.* (2020). The parameter $\alpha \in [0,1]$ represents the level of pessimism of $D_1$, i.e. its attitude towards strategic ambiguity.

□ **Backward induction.** We look for the SPNE in pure strategies of the game and thus solve the game by using backward induction. We now refer to the new manager and $D_1$ as the same entity to ease the explanation and notations. Also, we omit to write the history of strategies as functions of history of past strategies to alleviate notation.

When $D_2$ observes its offer, it also observes the previous contract offer and $D_1$'s decision. $D_2$

[3] In our case, this utility function boils down to the Hurwicz criterion (Hurwicz, 1951; Arrow and Hurwicz, 1972).

accepts whenever its profit is positive. Formally, it means:

$$a_2^*(c_2, a_1, c_1) = \begin{cases} 1 & \text{if } \pi_2(a_2 = 1|c, a_1) \geq 0 \\ 0 & \text{otherwise} \end{cases}$$

where $\pi_2(a_2 = 1|c, a_1) = (1 - q_2 - \gamma a_1 q_1)q_2 - f_2$. We focus on equilibria where the firms accept their offers, this means that the monopolist's offer to $D_2$ must satisfy $f_2 \leq (1 - q_2 - \gamma a_1 q_1)q_2$.

When the monopolist makes the offer to $D_2$, it anticipates $D_2$'s decision, given its own previous decision and $D_1$'s one. The monopolist thus maximizes $\pi_U = f_1 + f_2$ where $f_2 \leq (1 - q_2 - \gamma a_1 q_1)q_2$ and $f_1$ is sunk (because already paid by $D_1$ at this stage). The profit is increasing in $f_2$ so the monopolist extracts all the rent and the profit rewrites $\pi_U = (1 - q_2 - \gamma a_1 q_1)q_2$. The monopolist maximizes this profit for any contract offer $(q_2^*(a_1, c_1), f_2^*(a_1, c_1))$ such that

$$q_2^*(c_1, a_1) = \frac{1 - \gamma a_1 q_1}{2} \quad \text{and} \quad f_2^*(c_1, a_1) = \frac{(1 - \gamma a_1 q_1)^2}{4}$$

where $q_2^*(c_1, a_1)$ is simply the Cournot best response to $a_1 q_1$.

When $D_1$ gets its offer $c_1$, it has to anticipate the other firms' future decisions. This anticipation is critical. $D_1$ perfectly anticipates $D_2$'s decision, $a_2^*$. However, since $D_1$ is ambiguous towards the monopolist's decision, it weighs the best and worst outcome induced by all the strategies available to the monopolist at the next stage, $c_2 \in \mathcal{C}_2$.

More formally, and by applying eq.(6), we get that $D_1$'s expected profit from accepting the offer is $E_{c_2}\pi_1(a_1 = 1, c_2, a_2^*|c_1) = (1 - \alpha)\max_{c_2 \in \mathcal{C}_2} \pi_1(a_1 = 1, c_2, a_2^*|c_1) + \alpha \min_{c_2 \in \mathcal{C}_2} \pi_1(a_1 = 1, c_2, a_2^*|c_1)$. $D_1$ accepts whenever its expected profit is positive and we now formally get:

$$a_1^*(c_1) = \begin{cases} 1 & \text{if } E_{c_2}\pi_1(a_1 = 1, c_2, a_2^*|c_1) \geq 0 \\ 0 & \text{otherwise} \end{cases}$$

where the expected profit simplifies to $E_{c_2}\pi_1(a_1 = 1, c_2, a_2^*|c_1) = (1-\alpha)(1-q_1)q_1 + \alpha(1-\gamma-q_1)q_1 - f_1$ if $q_1 \leq 1 - \gamma$ and $E_{c_2}\pi_1(a_1 = 1, c_2, a_2^*|c_1) = (1 - \alpha)(1 - q_1)q_1 + 0 - f_1$ when $q_1 \geq 1 - \gamma$.

**Lemma 1.** *Upon acceptance, the worst outcome expected by the new manager of firm $D_1$ depends on the monopolist's offer $q_1$ and product differentiation in the following way: if $q_1 \geq 1-\gamma$ then $\min_{c_2 \in \mathcal{C}_2} \pi_1(a_1 = 1, c_2, a_2^*|c_1) = 0 - f_1$, and if $q_1 \leq 1-\gamma$ then $\min_{c_2 \in \mathcal{C}_2} \pi_1(a_1 = 1, c_2, a_2^*|c_1) = (1-q_1)q_1 - f_1$.*

Intuitively, given contract offer $c_1 = (q_1, f_1)$, the best outcome appears in the event where the monopolist offers nothing to $D_2$, $q_2 = 0$, and requests nothing to the latter (so that $D_2$ accepts this contract). The worst outcome appears in the scenario where the monopolist offers the maximum quantity to $D_2$, i.e. $q_2 = 1$, which potentially drives the market price to zero, and requests nothing in exchange of such a quantity (so that again $D_2$ accepts). Under imperfect substitution, even if the monopolist gives the maximal quantity to the rival, $q_2 = 1$, but provides a sufficiently low quantity to $D_1$, $q_1 \leq 1-\gamma$, the latter can expect a positive market price - and hence positive profits- in the worst case.

We focus on equilibria where the firms accept, so the monopolist's offer to $D_1$ must satisfy $f_1 \leq (1-\alpha)(1-q_1)q_1 + \alpha \max\{(1-\gamma-q_1)q_1, 0\}$. When the monopolist decides the offer for $D_1$, it anticipates the other firms' strategies. The monopolist thus maximizes $\pi_U = f_1 + f_2$ where $f_2 \leq \frac{(1-\gamma q_1)^2}{4}$ and $f_1 \leq (1-\alpha)(1-q_1)q_1 + \alpha \max\{(1-\gamma-q_1)q_1, 0\}$. The profit is increasing in the fees so, for a given level of pessimism $\alpha$, the monopolist extracts all the rent.

□ **The monopolist's offer to $D_1$.** As stated by Lemma 1, the monopolist's simplified program depends on the product differentiation. We develop first the two extreme cases (perfect substitutes and unrelated products) and then study the intermediate case. Last, we summarize the three cases in a graph.

*Perfect substitutes ($\gamma = 1$)*

With perfect substitutes, downstream competition is fierce. The new manager expects a nil market price - and hence no profit - in the worst scenario because the monopolist would give too much quantity to the rival. Given level of pessimism $\alpha$, the monopolist program is

$$\underset{q_1 \in [0,1]}{\text{Max}} \ \pi_U(q_1|\alpha) = \frac{(1-q_1)^2}{4} + (1-\alpha)(1-q_1)q_1 \tag{7}$$

We find the following SPNE strategy which depends on the new manager's pessimism $\alpha$.

$$q_1^T(\alpha,1) = \begin{cases} \frac{1-2\alpha}{3-4\alpha} & \text{if } \alpha < \frac{1}{2} \\ 0 & \text{otherwise} \end{cases}, \qquad q_2^T(\alpha,1) = \begin{cases} \frac{1-\alpha}{3-4\alpha} & \text{if } \alpha < \frac{1}{2} \\ \frac{1}{2} & \text{otherwise} \end{cases}, \tag{8}$$

$$f_1^T(\alpha,1) = \begin{cases} \frac{2(1-\alpha)^2(1-2\alpha)}{(3-4\alpha)^2} & \text{if } \alpha < \frac{1}{2} \\ 0 & \text{otherwise} \end{cases}, \qquad f_2^T(\alpha,1) = \begin{cases} \frac{(1-\alpha)^2}{(3-4\alpha)^2} & \text{if } \alpha < \frac{1}{2} \\ \frac{1}{2} & \text{otherwise} \end{cases}$$

Because the new manager believes that the market price in the worst scenario is nil and so are its profits, it accepts the monopolist's contract only when the best scenario is sufficiently attractive. This happens when optimism and expected profits are jointly sufficiently high. Otherwise, it rejects the offer. In both circumstances, the monopolist then designs the last contract so that the last firm serves the residual demand.

In the end, there is at least the monopoly quantity in the final market ($q_1^T + q_2^T = 1/2 + (1-2\alpha)/(6-8\alpha) > 1/2\,,\ \forall \alpha < 1/2$ and $q_1^T + q_2^T = 1/2$, otherwise) and the monopolist extracts at least the monopoly profit ($f_1^T + f_2^T = (1-\alpha)^2)/(3-4\alpha) > 1/4\,,\ \forall \alpha < 1/2$ and $f_1^T + f_2^T = 1/4$, otherwise).

**Proposition 1.** *With perfect substitutes, management turnover enables the monopolist to earn at least the monopoly profit irrespective of the new manager's level of optimism.*

*Unrelated products ($\gamma = 0$)*

In contrast, with unrelated products, firms become local monopolists. The new manager expects the same profit in the worst scenario as in the best scenario because it does not consider the rival. Irrespective of the manager's optimism, the monopolist program is

$$\underset{q_1 \in [0,1]}{\text{Max}} \ \pi_U(q_1|\alpha) = \frac{1}{4} + (1-q_1)q_1 \tag{9}$$

We find that the SPNE strategy this time does not depend on the new manager's level of pessimism $\alpha$. The monopolist offers $q_1^T(\alpha,0) = 1/2$, $q_2^T(\alpha,0) = 1/2$ in exchange for $f_1^T(\alpha,0) = 1/4$ and $f_2^T(\alpha,0) = 1/4$. With unrelated products, the firms do not compete anymore. The monopolist thus enables each firm to act as local monopolists on their respective markets. In the end, there is the monopoly quantity in each final market ($q_1^T = q_2^T = 1/2$) and the monopolist extracts the monopoly profits in each market ($f_1^T = f_2^T = 1/4$).

**Proposition 2.** *With unrelated products, management turnover enables the monopolist to earn the monopoly profit on each market irrespective of the new manager's level of optimism.*

Proposition 2 suggests that as product substitution softens the monopolist seems to be better off. This seems to follow the benchmark pattern, however, as we will see the relation is not that simple with management turnover.

*Imperfect substitutes ($0 < \gamma < 1$)*

With imperfect substitutes, the new manager' expectation about the market price - and hence the profit - in the worst scenario depends on the monopolist offer. In particular, even if the monopolist gives many quantities to the rival but provides a sufficiently low quantity to $D_1$, the latter can expect a positive market price - and hence positive profits- in the worst case. Given level of pessimism $\alpha$, the monopolist program is

$$\underset{q_1 \in [0,1]}{\text{Max}} \; \pi_U(q_1|\alpha) = \frac{(1-\gamma q_1)^2}{4} + (1-\alpha)(1-q_1)q_1 + \alpha \,\text{Max}\{(1-\gamma-q_1)q_1, 0\} \tag{10}$$

We find that the optimal choice depends on the values of parameters $\alpha$ and $\gamma$. To ease understanding, let area $A'$ denote the subset $\{(\alpha,\gamma) \in [0,1] \times (0,1) : \; \alpha < \bar{\alpha}(\gamma) \text{ and } 1 > \gamma > \frac{1}{2}\left(\sqrt{5}-1\right)\}$ where $\bar{\alpha}(\gamma) = (1/8)\left(-\sqrt{(\gamma-2)^2(\gamma-1)^2(\gamma+2)(\gamma(\gamma(\gamma+4)-3)+2)}/\sqrt{\gamma^4} - \gamma^2 - 4/\gamma^2 + (\gamma+8)/\gamma\right)$, area $B'$ denote the subset $\{(\alpha,\gamma) \in [0,1] \times (0,1) : \; \bar{\bar{\alpha}}(\gamma) < \alpha < 1 \text{ and } 1 > \gamma > 2/3\}$ where $\bar{\bar{\alpha}}(\gamma) = 1/\gamma - 1/2$ and area $C'$ denote the rest of the set of parameters, i.e. $\{(\alpha,\gamma) \in [0,1] \times (0,1) \setminus (A' \cup B')\}$.

Also, let $q_i^{T_k}$ and $f_i^{T_k}$ denote the equilibrium quantity delivered by the monopolist to $D_i$ and the fixed fee paid by $D_i$ to the monopolist, in area $k = A', B', C'$.

When goods are close substitutes then competition is fierce. If the monopolist offers a sufficiently high quantity ($q_1 \geq 1-\gamma$), the new manager likely believes that the market price in the worst scenario is nil and so are its profits. It therefore accepts this contract only when the best scenario is sufficiently attractive. This happens when optimism is sufficiently high $\alpha < \bar{\alpha}(\gamma)$. This is the upper bound of area $A'$.

Note that the substitution degree indirectly affects expected profits and thus also acts on the acceptance decision and threshold $\bar{\alpha}(\gamma)$. Specifically, a lower substitution degree softens competition and increases the fee paid by the second firm ($\partial f_2/\partial\gamma < 0$). This bolds the monopolist to increase the quantity offer to the first firm ($\partial q_1^{T_{A'}}/\partial\gamma < 0$) and the manager has to hold a higher degree of optimism to accept the offer ($d\bar{\alpha}/d\gamma > 0$).

Suppose now that goods are still close substitutes but $\alpha > \bar{\alpha}(\gamma)$ so that $D_1$ would reject the high quantity offer. The monopolist then offers a sufficiently low quantity ($q_1 < 1-\gamma$) so that the new manager likely believes that the market price in the worst scenario remains positive and so are the profits. This releases the pressure on the best scenario and the optimism threshold of acceptance is higher $\bar{\bar{\alpha}}(\gamma) > \bar{\alpha}(\gamma)$. This is the upper-bound of area $C'$ when goods are close substitutes.

Again note that substitution degree affects this acceptance threshold $\bar{\bar{\alpha}}(\gamma)$. Specifically, a lower substitution degree, by softening competition, increases the fee paid by the second firm ($\partial f_2/\partial\gamma < 0$). Similarly to above, it bolds the monopolist to increase the quantity offer to the first firm ($\partial q_1^{T_{C'}}/\partial\gamma < 0$) however this time the manager can hold a lower degree of optimism to accept the offer ($d\bar{\bar{\alpha}}/d\gamma < 0$) because higher quantities also increase its expected profits in the worst scenario.

Finally, observe that when the new manager prefers to reject the offers then the monopolist is obviously up to offer nothing to the former and we end up in area $B'$. $\bar{\bar{\alpha}}(\gamma)$ is therefore also the lower bound of area $B'$.

When goods are soft substitutes then competition is soft, the firm accepts any small quantity ($q_1 < 1-\gamma$) because it expects low competition and thus optimism to not matter for acceptance anymore. This is the rest of area $C'$. Note that the monopolist still increases its quantity offer as substitution degree decreases ($\partial q_1^{T_{C'}}/\partial\gamma < 0$).

By computing the equilibrium fixed fees in each case, we then find the following proposition.

**Proposition 3.** *With imperfect substitutes, management turnover can make the monopolist earn strictly less than the monopoly profit.*

□ **The equilibrium.** Finally, we find that the general solutions with imperfect substitutes in respectively $A'$, $B'$ and $C'$ apply to the cases of perfect substitutes and unrelated goods so that we can generalise these areas to areas $A$, $B$ and $C$ where the latter include the parameter values $\gamma = 0$

and $\gamma = 1$. Lemma 2 details these solutions in the appendix, and Figure 1 provides a graphical illustration of which solution to consider as function of the substitution degree and the firm's level of pessimism. Note that $\bar{\alpha}(\gamma) \geq 1/2$ and $\bar{\bar{\alpha}}(\gamma) \leq 1/2$.

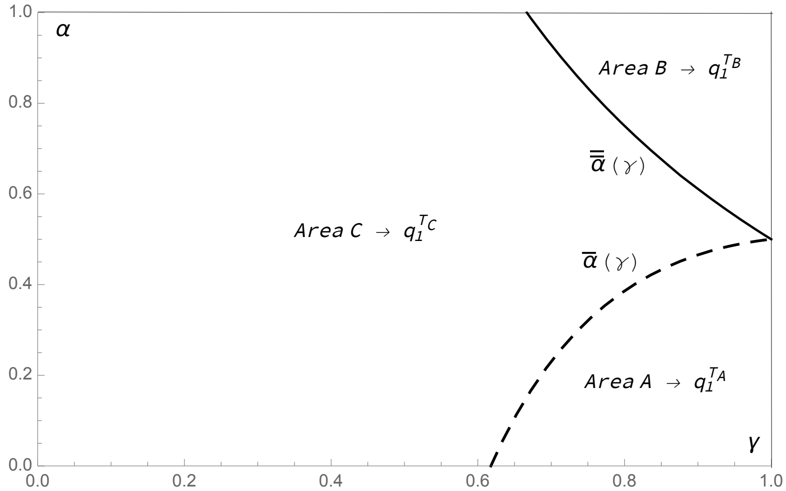


Figure 1: Graph of solution partition

# 4 Comparison

In this section, we compare the new equilibria obtained under management turnover and sequential contracting with the benchmark situation.

☐ **Monopolist's profits.** From proposition 1 and 2 joint with Result 1, we first obtain the following statement:

**Proposition 4.** *With perfect substitutes or unrelated goods, the monopolist is better off contracting first with the new manager irrespective of the manager's optimism level. In addition, with perfect substitutes, it is strictly better off when the manager is sufficiently optimistic* ($0 \leq \alpha < 1/2$)*.*

Imperfect substitution mitigates this result. We find the following pattern.

**Proposition 5.** *With imperfect substitutes, the monopolist is still better off contracting first with the new manager only when the latter is sufficiently optimistic* ($0 \leq \alpha < \tilde{\alpha}(\gamma) < 1/2$)*. However, the monopolist is worse off otherwise.*

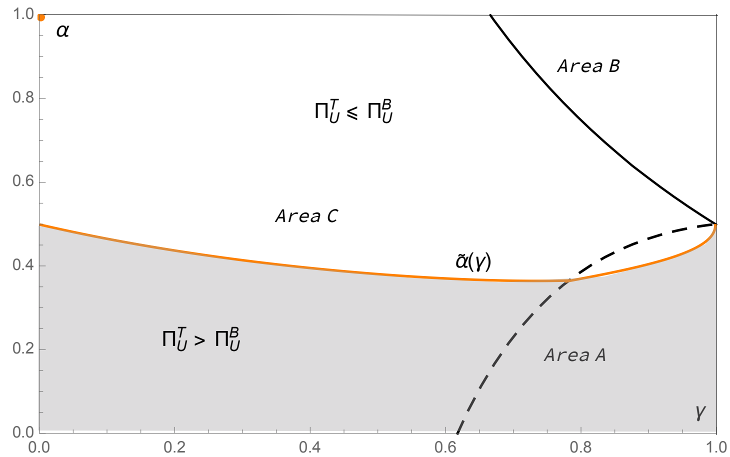


Figure 2: Comparison of the monopolist's profits with imperfect substitutes

The area where the monopolist can take advantage of management turnover is represented in gray on Figure 2. In this part of the graph, the optimism of the new manager lies below the threshold level $\tilde{\alpha}(\gamma)$ which depends on product substitution. Notice that $\tilde{\alpha}(1) = 1/2$ and $\tilde{\alpha}(0) = 1$ so that Proposition 5 also points out that the sufficient level of optimism $\tilde{\alpha}(\gamma)$, which makes management turnover profitable for the monopolist, is greater under imperfect substitutes than with perfect substitutes or unrelated goods. The intuition is as follows.

Consider first perfect product substitution ($\gamma = 1$), we have $q_1^T = q_1^{T_A} = (1 - 2\alpha)/(3 - \alpha)$, providing the manager's optimism is sufficiently high and $q_1^T = 0$ otherwise. At the threshold optimism level $\alpha = \tilde{\alpha}(1) = 1/2$, the equilibrium quantity is nil and the monopolist is indifferent whether management turnover occurs or not, $\pi_U^T = \pi_U^B$. This is because perfect substitutes make the monopolist indifferent between letting both firms being downstream monopolists or letting $D_2$ being the downstream monopolist. In contrast, when the manager is sufficiently optimistic ($\alpha < \tilde{\alpha}(1) = 1/2$), the monopolist is strictly better off offering strictly positive quantities to the new manager and then letting the remaining firm serve the residual demand.

We now tackle the change of the indifference threshold, $\tilde{\alpha}(\gamma)$, as product substitution decreases ($\gamma < 1$). From $\pi_U^T(\tilde{\alpha}(\gamma), \gamma) - \pi_U^B(\gamma) = 0$, and using the implicit function theorem, we find that the sign of the change is pinned down by the following expression:

$$\operatorname{sign}\left[\frac{d\tilde{\alpha}}{d\gamma}\right] = \operatorname{sign}\left[\frac{\partial f_2}{\partial\gamma}(q_1^T) - \mathbb{1}_{[q_1^T<1-\gamma]}\frac{\partial f_1}{\partial\gamma}(q_1^T) - \frac{\partial \pi_U^B}{\partial\gamma}\right] \tag{11}$$

As products become less substitutes, the benchmark profit increases ($\partial\pi_U^B/\partial\gamma < 0$) implying that the benchmark situation is more profitable for larger intervals of optimism levels. Nonetheless, a lower product substitution also increases the fixed fee paid by the second firm in the turnover situation ($\partial f_2^T/\partial\gamma < 0$) which increases turnover profit and mitigates the first effect. Henceforth, the positive - but not that steep - slope of $d\tilde{\alpha}/d\gamma$ in area A.

When product substitution falls below a certain level then the monopolist's quantity offer changes in the turnover situation. This induces a decrease of the latter effect (as $q_1^{T_A} > q_1^{T_C}$ and $\partial^2 f_2^T/\partial\gamma\partial q_1 < 0$) but also introduces a new effect linked to the pessimistic term that the new manager now account for ($\mathbb{1}_{[q_1^*<1-\gamma]} = 1$ in the above equation). This term implies that a decrease in product substitution increases the fixed fee paid by the new manager as even pessimistic manager now expects positive profits ($\partial f_1^T/\partial\gamma < 0$). This additional effect enables turnover profit to overcome the benchmark profit for larger level of optimism, henceforth the negative slope that appears at sufficiently low degree of product substitution.

Finally, when goods are unrelated ($\gamma = 0$), then each firm is a local monopolist and the manager's optimism does not matter anymore. The monopolist is indifferent between the two situations and $\tilde{\alpha}(0) = 1$.

□ **Consumer surplus.** We now turn to the consumer surplus. To do that we replace the equilibrium outputs into the general consumer surplus function in Eq. (3). We find the following result.

**Proposition 6.** *With respect to the benchmark situation, the consumers are better off when contracting is sequential and the new manager is sufficiently optimistic ($\alpha < \hat{\alpha}(\gamma)$). Otherwise, the consumers are worse off. This sufficient level of optimism also depends on the substitution degree.*

We find that $\hat{\alpha}(\gamma) \geq \tilde{\alpha}(\gamma)\ \forall\gamma$, which means that consumers overall benefit from management turnover for a wider range of optimism levels than the monopolist.

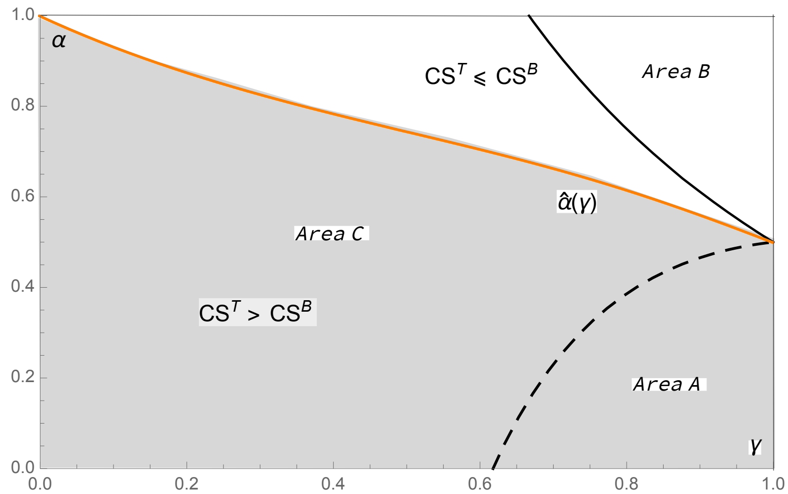


Figure 3: The consumer surplus

This happens because the monopolist's profit depends on the expectations about the fixed fee while the consumer surplus actually directly depends on the quantities released in the final markets. In addition, an increase in $q_2$ can compensate a decrease in $q_1$.

To see this, we rewrite the expression of the consumer surplus below. The first term on the right-hand side of the equal sign details the difference between the consumer surplus in market for good 1 and the second term the surplus difference in the market for good 2.

$$CS^T - CS^B = \frac{(q_1^T)^2 - (q^B)^2 + \gamma(q_1^T q_2^T - (q^B)^2)}{2} + \frac{(q_2^T)^2 - (q^B)^2 + \gamma(q_1^T q_2^T - (q^B)^2)}{2}$$

Note that even though the quantities in one market decreases, say $q_1^T < q_1^B$, a sufficient increase in the quantities in the other market, that is $q_2^T > q_2^B$, can lead to an increase of the consumer surplus. In other words, an increase in $q_2$ can compensate a decrease in $q_1$. This is because the increase in quantities of good 2 somehow overcomes the scarcity of good 1 through the lower price of good 1, provided there is some product substitution.

## 5 Discussion

This section discusses two key elements for our main results: the supplier strategy set and its bargaining power.

□ **Strategy set.** We assumed that the supplier strategy set in terms of supply quantity to the rival firm, i.e. $D_2$, is the interval $[0, 1]$. We think this assumption is more realistic. Indeed, it seems unlikely that the manager of firm $D_1$ thinks, in the best event, that the supplier will supply more than the consumer's maximum willingness to pay to each firm. However, one could argue that such a reasoning would not apply to the new manager, who could believe that the supplier always gives so much quantity to the rival that it always drives the market price to zero. This modification of the strategy sets changes our result. In particular, the optimism threshold remains non-linear to product substitution but becomes strictly decreasing in product substitution: the more products are substitutes, the lesser the threshold degree of optimism is for the monopolist to earn higher profit than in the benchmark (see Figure 9 in appendix). Appendix details the computations and displays the equilibrium outcomes.

This observation that the anticipation of the supplier's strategy set plays a key role may be interesting for future research. For example, the supplier may voluntarily commit to restrict its strategy set by committing to a certain capacity constraint $\bar{q}$. Our model thus model a setting where $\bar{q} = 1$. Imagine now that the monopolist commits to supply up to $\bar{q} = 1 - \gamma$, then the worst outcome almost never occur and thus equilibrium quantities when $q_1 \leq 1 - \gamma$ are likely to expand. But these considerations go beyond this paper focus.

□ **Bargaining.** We assumed that the supplier had all the bargaining power when deciding the offers. This especially implies that it extracts all the surplus of the firms through the fixed fee. This is of course the main problem of $D_1$ with its optimistic manager who accepts a too high fixed fee with respect to the future revenues. Suppose the firms can bargain on the fixed fee in the sense that they can propose their owns with probability $1 - \theta$. Interestingly, when the firms decides the fixed fee, they set a nil fixed fee because their profit is decreasing in the fixed fee. We thus have a neat result: the probability acts as if the monopolist can only capture a share $\theta$ of each firm's expected profit. Then all the quantity results are the same (the supplier still determines the quantity and there is just the additional probabibility constant before each fixed fee) but the equilibrium fixed fee differ depending on the value of $\theta$ (they decrease as the probability of the supplier to decide the fixed fees diminishes, i.e. $\theta$ decreases). Consider the simple case of perfect substitutes, then with this new simple setting, $D_1$ can indeed hire an optimistic manager without making losses as long as the monopolist's bargaining power (in the sense of a probability to make the offer on the fixed fee) is sufficiently weak $\bar{\theta}(\alpha) \leq \frac{(1-q_1^*-q_2^*)q_1^*}{f_1^*} = \frac{1}{2(1-\alpha)} \in [0,1]$. Note that, quite intuitively, a rise of optimism, i.e. an increase of $1-\alpha$, diminishes this bargaining threshold which shrinks the range of the monopolist's bargaining power that enables the firm to make positive profits.

# 6 Conclusion

When a firm changes its manager, it reopens room for contractual frictions with its partners. In this paper, we explore *strategic ambiguity* as a potential friction with a supplier. Compared with its experienced predecessor, the firm's new manager likely holds fuzzy expectations about the supplier's strategy. An optimistic manager weights favorable strategies more than detrimental ones whereas a pessimistic manager does the reverse.

We show that the manager's degree of optimism is critical because above a certain threshold it incites the supplier to change its timing of contracting and increase its profits. We also find that this threshold degree of optimism is greater when products are imperfect substitutes. This happens because competition is softer so that the new manager may expect positive profits even in the worst scenario. Nonetheless, the threshold degree of optimism is maximal for an intermediate level of product substitution.

There is a flourishing literature that revisits industrial organization settings in light with ambiguity concepts (Eichberger *et al.*, 2009; Król, 2012; Kauffeldt and Wiesenfarth, 2018). To the best of our knowledge this literature is silent regarding vertical relationships. Our paper contributes to this literature by pointing out that an upstream monopolist can temporarily benefit from a management turnover because of the rise of strategic ambiguity and this result depends on product substitution.

## Acknowledgements

We thank Ani Guerdjikova for insightful comments on a previous draft.


## Conflict of Interest

The authors declare that there is no conflict of interest.

## References


Armstrong, M. and Huck, S. (2010). "Behavioral economics as applied to firms: a primer". *Competition Policy International Journal*.

Arrow, K. J. and Hurwicz, L. (1972). "An optimality criterion for decision-making under ignorance". *Uncertainty and expectations in economics*, **1**.

Chateauneuf, A., Ventura, C., and Vergopoulos, V. (2020). "A simple characterization of the hurwicz criterium under uncertainty". *Revue economique*, **71**(2):331–336.

Eichberger, J., Kelsey, D., and Schipper, B. C. (2007). "Granny Versus Game Theorist: Ambiguity in Experimental Games". *Theory and Decision*, **64**(2-3):333–362.

Eichberger, J., Kelsey, D., and Schipper, B. C. (2009). "Ambiguity and social interaction". *Oxford Economic Papers*, **61**(2):355–379.

Englmaier, F. and Reisinger, M. (2014). "Biased managers as strategic commitment". *Managerial and Decision Economics*, **35**(5):350–356.

Gilo, D. and Yehezkel, Y. (2020). "Vertical collusion". *The RAND Journal of Economics*, **51**(1):133–157.

Hurwicz, L. (1951). "Optimality criteria for decision making under ignorance, cowles commission discussion paper no. 370".

Ivanov, A. (2011). "Attitudes to ambiguity in one-shot normal-form games: An experimental study". *Games and Economic Behavior*, **71**(2):366–394.

Kauffeldt, T. F. and Wiesenfarth, B. R. (2018). "Product design competition under different degrees of demand ambiguity". *Review of Industrial Organization*, **53**(2):397–420.

Król, M. (2012). "Product differentiation decisions under ambiguous consumer demand and pessimistic expectations". *International Journal of Industrial Organization*, **30**(6):593 – 604.

McAfee, R. P. and Schwartz, M. (1994). "Opportunism in multilateral vertical contracting: Nondiscrimination, exclusivity, and uniformity". *The American Economic Review*, **84**(1):210–230.

Meccheri, N. (2021). "Biased managers in vertically related markets". *Managerial and Decision Economics*.

Rey, P. and Tirole, J. (2007). "A primer on foreclosure". *Handbook of industrial organization*, **3**:2145–2220.

Ryall, M. and Sampson, R. (2009). "Formal contracts in the presence of relational enforcement mechanisms: Evidence from technology development projects". *Management Science*, **55**(6):906–925.

# Appendices

## Proofs

**Proof Result 1.** We look for the symmetric SPNE where the two firms accept their contracts. By backward induction, firms accept whenever their profit is positive: $\pi_i(c) = (1 - q_i - \gamma q_j)q_i - f_i$. This happens whenever $f_i \leq (1 - q_i - \gamma q_j)q_i$, for all $i \in \{1, 2\}$. At the contracting stage, the monopolist anticipates this decision, and sets each fixed so as to capture all the firms rent because its profit, $\pi_U = f_i + f_j$, is increasing in $f_i$. In addition, since we focus on the symmetric equilibrium, we have $f_i = f_j = f$ and thus $q_i = q_j = q/2$ which leads to $f = (1 - (q/2) - \gamma(q/2))(q/2) = (1 - (1 + \gamma)(q/2))(q/2)$. The monopolist then maximizes its profit $\pi_U = (1 - (1 + \gamma)(q/2))q$. The First Order Condition gives $d\pi_U/dq = 1 - (1 + \gamma)q = 0$ and therefore : $q_i = q_j = 1/[2(1 + \gamma)]$.

Substituting these values into the fixed fees, we have $f_i = f_j = 1/[4(1 + \gamma)]$ which directly gives the monopolist's profit $\pi_U = 1/[2(1 + \gamma)]$. By symmetry, the consumer surplus rewrites : $CS = (1 + \gamma)q^2$ which gives $CS = 1/[4(1 + \gamma)]$. □

**Proof of Eq. (8) - SPNE with perfect substitutes.** At the time the monopolist enters into contract with the first firm, it maximizes (remind $\gamma = 1$ in this case):

$$\pi_U = (1 - \alpha)(1 - q_1)q_1 + (\frac{1 - q_1}{2})^2.$$

The first order condition and the second order condition gives respectively:

$$\frac{\partial \pi_U}{\partial q_1} = 0 \quad \Leftrightarrow \quad (1 - 2\alpha) - (3 - 4\alpha)q_1 = 0 \tag{12}$$

$$\frac{\partial^2 \pi_U}{\partial^2 q_1} \leq 0 \quad \Leftrightarrow \quad (1 - \alpha)(-2) + (1/2) \leq 0 \tag{13}$$

The FOC is satisfied when evaluated at $q_1(\alpha) = (1 - 2\alpha)/(3 - 4\alpha)$.

When $0 \leq \alpha \leq 1/2$, both eq. (12) and eq. (13) hold. Therefore, $q_1(\alpha) = (1 - 2\alpha)/(3 - 4\alpha) \geq 0$ is a maximum. We then obtain that $q_1^T(\alpha) = (1 - 2\alpha)/(3 - 4\alpha)$ and $f_1^T = (1 - \alpha)(1 - q_1^T)q_1^T =$

$2(1-\alpha)^2(1-2\alpha)/(3-4\alpha)^2$ when $0 \le \alpha \le 1/2$.

When $\alpha > 1/2$, the SOC becomes positive (eq. (13)). On the one hand, when $3/4 > \alpha > 1/2$, $(\partial\pi_U/\partial q_1)$ is negative. Therefore, the profit is decreasing on $q_1 \in [0,1]$ and we find that the maximum actually lies at $q_1 = 0$ in that case. On the other hand, when $\alpha > 3/4 > 1/2$, $(\partial\pi_U/\partial q_1)$ is negative until $q_1(\alpha) = (1-2\alpha)/(3-4\alpha) \ge 0$ and positive above. This time $q_1(\alpha) = (1-2\alpha)/(3-4\alpha)$ is thus a minimum. By computing the profit value at the extrema the interval, we find that $\pi_U(1) = 0$ and $\pi_U(0) = 1/4$. Therefore, the maximum profit is again reached at $q_1 = 0$. To sum up, when $\alpha > 1/2$, the maximum is reach at $q_1 = 0$. We then obtain that $q_1^T(\alpha) = 0$ and $f_1^T = 0$ when $\alpha > 1/2$.

Finally, $q_2^T(\alpha)$ is obtained by implementing the value of $q_1$ into the Cournot best response function of $D_2$, $q_2^T(\alpha) = [1-q_1(\alpha)]/2 = (1-\alpha)/(3-4\alpha)$ if $\alpha < 1/2$, and $1/2$ otherwise. Similarly, the corresponding fixed fee $f_2^T(\alpha)$ is such that $f_2^T(\alpha) = (1-q_1)^2/4 = (1-\alpha)^2/(3-4\alpha)^2$ when $\alpha < 1/2$, and $1/4$ otherwise. □

**Proof of proposition 1.** Denote by $\pi_U(\alpha)$ the profit of the monopolist under strategic ambiguity. By the results under perfect substitutes obtained in the above proof and displayed in Eq. (8) (or in the lemma 2 in the proof of Proposition 5), we have:

$$\pi_U(\alpha) = f_1(\alpha) + f_2(\alpha) = \frac{(1-\alpha)^2}{3-4\alpha}, \tag{14}$$

as long as $\alpha \le 1/2$. For higher values of $\alpha$, $\pi_U$ is equal to $1/4$. The monopoly profit with perfect substitutes is $\pi_U^M = 1/4$. We then get:

$$\pi_U(\alpha) - \pi_U^M = \frac{(1-2\alpha)^2}{4(3-4\alpha)} \text{ when } \alpha < 1/2\,, \quad \text{and } 0 \quad \text{otherwise}$$

which is strictly positive as long as $\alpha < 1/2$ and null otherwise. □

**Proof of the monopolist's SPNE with imperfect substitutes.** At the time the monopolist enters into contract with the first firm, it maximizes

$$\pi_U = (\frac{1-\gamma q_1}{2})^2 + (1-\alpha)(1-q_1)q_1 + \alpha \max\{(1-\gamma-q_1)q_1, 0\}$$

Two cases arise:

(i) *Consider* $q_1 \leq 1-\gamma$*,*

We have $\max\{(1-\gamma-q_1)q_1, 0\} = (1-\gamma-q_1)q_1$, and the first order condition and the second order condition respectively are:

$$\frac{\partial \pi_U}{\partial q_1} = 0 \quad \Leftrightarrow \quad \frac{1}{2}\left(-(2\alpha+1)\gamma + \left(\gamma^2-4\right)q_1 + 2\right) = 0 \tag{15}$$

$$\frac{\partial^2 \pi_U}{\partial^2 q_1} \leq 0 \quad \Leftrightarrow \quad \frac{1}{2}\left(\gamma^2-4\right) \leq 0 \tag{16}$$

The FOC is satisfied when evaluated at $q_1(\alpha,\gamma) = \frac{2-\gamma(1+2\alpha)}{4-\gamma^2}$. Let us suppose $q_1^L(\alpha,\gamma) \equiv \frac{2-\gamma(1+2\alpha)}{4-\gamma^2}$. Eq. (16) holds whenever $(\alpha,\gamma) \in [0,1]^2$. Therefore, $q_1^L(\alpha,\gamma)$ is always a maximum for $\pi_U$. When $\alpha \leq \bar{\bar{\alpha}}(\gamma) \equiv \frac{1}{\gamma} - \frac{1}{2}$, we have $q_1^L(\alpha,\gamma) \geq 0$. $q_1^L(\alpha,\gamma)$ it thus the maximum in this region. When $\alpha > \bar{\bar{\alpha}}(\gamma) \equiv \frac{1}{\gamma} - \frac{1}{2}$, we find $q_1^L(\alpha,\gamma) < 0$. Since a quantity must be positive, the maximum on this region is 0. Last, $q_1(\alpha,\gamma) \leq 1-\gamma$ is satisfied as long as $\alpha \leq \frac{1}{2}\left(-\gamma^2+\gamma-\frac{2}{\gamma}+3\right)$ and henceforth $q_1(\alpha,\gamma) = 1-\gamma$ is the maximum on the region where $\alpha > \frac{1}{2}\left(-\gamma^2+\gamma-\frac{2}{\gamma}+3\right)$. Figure 4 summarizes our findings. The red line refers to $\bar{\bar{\alpha}}(\gamma)$ and the blue line refers to $\frac{1}{2}\left(-\gamma^2+\gamma-\frac{2}{\gamma}+3\right)$.

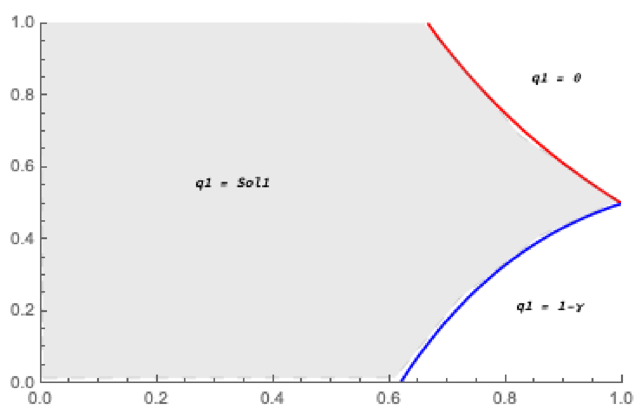


Figure 4: The solution for $q_1 < 1-\gamma$

(ii) <u>*For $q_1 \geq 1-\gamma$,*</u>

We have $\max\{(1-\gamma-q_1)q_1, 0\} = 0$, and the first order condition and the second order condition respectively are:

$$\frac{\partial \pi_U}{\partial q_1} = 0 \quad \Leftrightarrow \quad \frac{1}{2}\left(-2\alpha - \gamma + \text{q1}\left(4\alpha + \gamma^2 - 4\right) + 2\right) = 0 \tag{17}$$

$$\frac{\partial^2 \pi_U}{\partial^2 q_1} \leq 0 \quad \Leftrightarrow \quad \frac{1}{2}\left(4\alpha + \gamma^2 - 4\right) \leq 0 \tag{18}$$

The FOC is satisfied when evaluated at $q_1(\alpha,\gamma) = \frac{2(1-\alpha)-\gamma}{4(1-\alpha)-\gamma^2}$. Let us suppose $q_1^H(\alpha,\gamma) \equiv \frac{2(1-\alpha)-\gamma}{4(1-\alpha)-\gamma^2}$. Eq. (18) holds whenever $\gamma \in [0,1]$ and $0 \leq \alpha \leq \frac{1}{4}\left(4-\gamma^2\right)$. Therefore, $q_1^H(\alpha,\gamma)$ is a maximum for $\pi_U$ when $0 < \gamma < 1$ and $0 \leq \alpha \leq \frac{1}{4}\left(4-\gamma^2\right)$, and a minimum otherwise. When $0 \leq \alpha \leq \frac{1}{4}\left(4-\gamma^2\right)$, we find $q_1^H(\alpha,\gamma) \geq 1-\gamma$ only if $\alpha \leq \frac{(\gamma-2)\left(\gamma^2+\gamma-1\right)}{2-4\gamma}$. It implies that (i) $q_1^H(\alpha,\gamma)$ is the maximum in the area where $\alpha \leq \frac{(\gamma-2)\left(\gamma^2+\gamma-1\right)}{2-4\gamma}$ and (ii) $q_1(\alpha,\gamma) = 1-\gamma$ is the maximum in the area where $\frac{(\gamma-2)\left(\gamma^2+\gamma-1\right)}{2-4\gamma} < \alpha < \frac{1}{4}\left(4-\gamma^2\right)$. When $\alpha > \frac{1}{4}\left(4-\gamma^2\right)$, $q_1^H(\alpha,\gamma)$ is a minimum, we find that the value is higher than $1-\gamma$ meaning that the maximum on this part is either in $q_1(\alpha,\gamma) = 1$ or $q_1(\alpha,\gamma) = 1-\gamma$. It can be shown that the profit at $q_1(\alpha,\gamma) = 1-\gamma$ is higher than that at $q_1(\alpha,\gamma) = 1$ so that $q_1(\alpha,\gamma) = 1-\gamma$ is the maximum on this area. Figure 5 summarizes our findings. The black line refers to $(1/4)(4-\gamma^2)$ and the blue line refers to $\frac{(\gamma-2)\left(\gamma^2+\gamma-1\right)}{2-4\gamma}$.

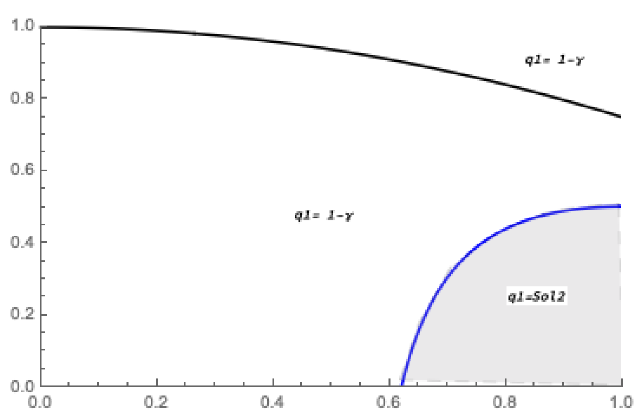


Figure 5: The solution for $q_1 \geq 1-\gamma$

We now derive which solution is the best for the monopolist in each region.

◇ <u>*Maximum profit at optimum solutions.*</u>

Let us denote by $\pi_U^L$ the profit function when $q_1 \leq 1-\gamma$ and $\pi_U^H$ the profit function when $q_1 \geq 1-\gamma$. Note that the profits are the same at $q_1 = 1-\gamma$. Several cases arise:

(i) In the area where $\alpha \leq \frac{1}{2}\left(-\gamma^2+\gamma-\frac{2}{\gamma}+3\right)$, i.e. below the blue line of Fig 4, we find that

$$\pi_U^L(1-\gamma) - \pi_U^H(1-\gamma) = 0 \geq \pi_U^L(1-\gamma) - \pi_U^H(q_1^H)$$

Therefore, $q_1^H$ is solution in this region.

(ii) In the area where $\frac{1}{2}\left(-\gamma^2+\gamma-\frac{2}{\gamma}+3\right) < \alpha < \frac{(\gamma-2)\left(\gamma^2+\gamma-1\right)}{2-4\gamma}$, i.e. between the blue lines of Fig 4 and Fig 5, we find that

$$\pi_U^L(q_1^L) - \pi_U^H(q_1^H) = \frac{2(1-\alpha\gamma)+\alpha(\alpha+1)\gamma^2-\gamma}{4-\gamma^2} - \frac{(1-\alpha)(2-\alpha-\gamma)}{4(1-\alpha)-\gamma^2}$$

This is positive whenever $\alpha > \bar{\alpha}(\gamma) \equiv \frac{1}{8}\left(-\sqrt{\frac{(\gamma-2)^2(\gamma-1)^2(\gamma+2)(\gamma(\gamma(\gamma+4)-3)+2)}{\gamma^4}} - \gamma^2 - \frac{4}{\gamma^2} + \frac{\gamma+8}{\gamma}\right)$ and negative otherwise. The solution in this region is thus $q_1^L(\alpha,\gamma)$ when $\alpha > \bar{\alpha}(\gamma)$ and $q_1^H(\alpha,\gamma)$, otherwise.

(iii) In the area where $\alpha > \bar{\bar{\alpha}}(\gamma)$, above the red line of Fig 4, we find that

$$\pi_U^L(0) - \pi_U^H(1-\gamma) = \frac{1}{4}(1-\gamma)\gamma(4\alpha-(2-\gamma)(\gamma+1)) \geq 0$$

The solution is this region is $q_1(\alpha,\gamma) = 0$.

(iiv) In the last area, we find that

$$\pi_U^L(q_1^L) - \pi_U^H(1-\gamma) = \frac{(\gamma(2\alpha+(\gamma-1)\gamma-3)+2)^2}{4\left(4-\gamma^2\right)} \geq 0$$

The solution is this region is $q_1^L(\alpha,\gamma)$.

These thresholds are summarized in figure 6 below, where $q_1^{T_{A'}} = q_1^H(\alpha,\gamma)$, $q_1^{T_{B'}} = 0$ and $q_1^{T_{C'}} = q_1^L(\alpha,\gamma)$.

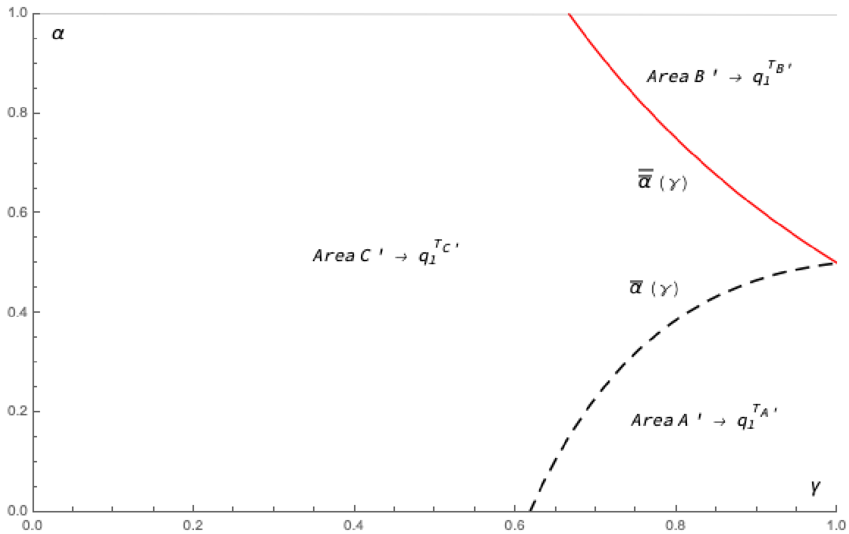


Figure 6: (Equiv. fig 1) Graph of solution partition

With management turnover and imperfect substitutes, the SPNE strategy of U jointly is:

$$q_1^T(\alpha,\gamma) = \begin{cases} \frac{2(1-\alpha)-\gamma}{4(1-\alpha)-\gamma^2}, & \text{if } (\alpha,\gamma) \in AreaA' \\ 0 & \text{if } (\alpha,\gamma) \in AreaB' \\ \frac{2-\gamma(1+2\alpha)}{4-\gamma^2} & \text{otherwise} \end{cases}, \quad q_2^T(\alpha,\gamma) = \begin{cases} \frac{(1-\alpha)(2-\gamma)}{4(1-\alpha)-\gamma^2}, & \text{if } (\alpha,\gamma) \in AreaA' \\ \frac{1}{2} & \text{if } (\alpha,\gamma) \in AreaB' \\ \frac{2-\gamma(1-\alpha\gamma)}{4-\gamma^2} & \text{otherwise} \end{cases},$$

$$f_1^T(\alpha,\gamma) = \begin{cases} \frac{(1-\alpha)(2(1-\alpha)-\gamma)((2-\gamma)(1+\gamma)-2\alpha)}{(4(1-\alpha)-\gamma^2)^2}, & \text{if } (\alpha,\gamma) \in AreaA' \\ 0 & \text{if } (\alpha,\gamma) \in AreaB' \\ \frac{(1-\alpha)(2(1-\alpha\gamma)-\gamma)(2(1+\alpha\gamma)+\gamma-\gamma^2)}{(4-\gamma^2)^2} & \text{otherwise} \end{cases},$$

$$f_2^T(\alpha,\gamma) = \begin{cases} \frac{(1-\alpha)^2(2-\gamma)^2)}{(4(1-\alpha)-\gamma^2)^2}, & \text{if } (\alpha,\gamma) \in AreaA' \\ \frac{1}{4} & \text{if } (\alpha,\gamma) \in AreaB' \\ \frac{(2-(1-\alpha\gamma)\gamma)^2}{(4-\gamma^2)^2} & \text{otherwise} \end{cases}$$

where Area $A'$ denotes the subset $\{(\alpha,\gamma) \in [0,1] \times (0,1): \ \alpha < \bar{\alpha}(\gamma) \text{ and } 1 > \gamma > \frac{1}{2}\left(\sqrt{5}-1\right)\}$ such that $\bar{\alpha}(\gamma) = (1/8)\left(-\sqrt{(\gamma-2)^2(\gamma-1)^2(\gamma+2)(\gamma(\gamma(\gamma+4)-3)+2)}/\sqrt{\gamma^4}-\gamma^2-4/\gamma^2+(\gamma+8)/\gamma\right)$, Area $B'$ denotes the subset $\{(\alpha,\gamma) \in [0,1] \times (0,1): \ \bar{\bar{\alpha}}(\gamma) < \alpha < 1 \text{ and } 1 > \gamma > 2/3\}$ such that $\bar{\bar{\alpha}}(\gamma) = 1/\gamma - 1/2$ and Area $C'$ denotes the rest of the set of parameters. $\square$

**Proof of proposition 3** Take for example $\alpha = 1$ and a sufficiently high $\gamma$, say $\gamma > \gamma'$, so that we are in area B. We get $f_1^T + f_2^T = 1/4$ while the monopoly profit is $\pi^M = \pi_U^B = 1/(2+2\gamma)$. With imperfect substitutes, we have $\gamma' < \gamma < 1$, which implies that $f_1^T + f_2^T = 1/4 < 1/(2+2\gamma) = \pi^M$. $\square$

**Proof of proposition 5** Let's remind that $\pi_U^B = 1/(2(1+\gamma))$ is the benchmark profit without management turnover. Let's now denote by $\pi_U^T$ the profit of the monopolist with management turnover. Lemma 2 summarizes the monopolist's SPNE strategies according to the parameter values.

**Lemma 2.** *With management turnover, the monopolist's SPNE strategy jointly depends on the new manager's level of optimism $\alpha$ and the product substitution $\gamma$ such that:*

$$q_1^T(\alpha,\gamma) = \begin{cases} \frac{2(1-\alpha)-\gamma}{4(1-\alpha)-\gamma^2}, & \textit{if } (\alpha,\gamma) \in AreaA \\ 0 & \textit{if } (\alpha,\gamma) \in AreaB \\ \frac{2-\gamma(1+2\alpha)}{4-\gamma^2} & \textit{otherwise} \end{cases}, \quad q_2^T(\alpha,\gamma) = \begin{cases} \frac{(1-\alpha)(2-\gamma)}{4(1-\alpha)-\gamma^2}, & \textit{if } (\alpha,\gamma) \in AreaA \\ \frac{1}{2} & \textit{if } (\alpha,\gamma) \in AreaB \\ \frac{2-\gamma(1-\alpha\gamma)}{4-\gamma^2} & \textit{otherwise} \end{cases},$$

$$f_1^T(\alpha,\gamma) = \begin{cases} \frac{(1-\alpha)(2(1-\alpha)-\gamma)((2-\gamma)(1+\gamma)-2\alpha)}{(4(1-\alpha)-\gamma^2)^2}, & \textit{if } (\alpha,\gamma) \in AreaA \\ 0 & \textit{if } (\alpha,\gamma) \in AreaB \\ \frac{(1-\alpha)(2(1-\alpha\gamma)-\gamma)(2(1+\alpha\gamma)+\gamma-\gamma^2)}{(4-\gamma^2)^2} & \textit{otherwise} \end{cases},$$

$$f_2^T(\alpha,\gamma) = \begin{cases} \frac{(1-\alpha)^2(2-\gamma)^2)}{(4(1-\alpha)-\gamma^2)^2}, & \textit{if } (\alpha,\gamma) \in AreaA \\ \frac{1}{4} & \textit{if } (\alpha,\gamma) \in AreaB \\ \frac{(2-(1-\alpha\gamma)\gamma)^2}{(4-\gamma^2)^2} & \textit{otherwise} \end{cases}$$

*where Area A denotes the subset* $\{(\alpha,\gamma) \in [0,1]^2 : \ \alpha < \bar{\alpha}(\gamma) \textit{ and } 1 > \gamma > \frac{1}{2}\left(\sqrt{5}-1\right)\}$ *such that* $\bar{\alpha}(\gamma) = (1/8)\left(-\sqrt{(\gamma-2)^2(\gamma-1)^2(\gamma+2)(\gamma(\gamma(\gamma+4)-3)+2)}/\sqrt{\gamma^4} - \gamma^2 - 4/\gamma^2 + (\gamma+8)/\gamma\right)$, *Area B denotes the subset* $\{(\alpha,\gamma) \in [0,1]^2 : \ \bar{\bar{\alpha}}(\gamma) < \alpha < 1 \textit{ and } 1 > \gamma > 2/3\}$ *such that* $\bar{\bar{\alpha}}(\gamma) = 1/\gamma - 1/2$ *and Area C denotes the rest of the set of parameters.*

Since on these SPNE, firms always accept, we have our next lemma which displays the monopolist's equilibrium profits with respect to the parameter values.

**Lemma 3.** *With management turnover, the monopolist earns*

$$\pi_U^T(\alpha,\gamma) = \begin{cases} \frac{(1-\alpha)(2-\alpha-\gamma)}{4(1-\alpha)-\gamma^2} & \textit{if } (\alpha,\gamma) \in AreaA \\ 1/4 & \textit{if } (\alpha,\gamma) \in AreaB \\ \frac{2(1-\alpha\gamma)+\alpha(1+\alpha)\gamma^2-\gamma}{4-\gamma^2} & \textit{otherwise} \end{cases} \tag{19}$$

We then get:

$$\pi_U^T(\alpha,\gamma) - \pi_U^B(\gamma) = \begin{cases} \frac{(1-\alpha)(2-\alpha-\gamma)}{4(1-\alpha)-\gamma^2} - \frac{1}{2(1+\gamma)} & \text{if } (\alpha,\gamma) \in AreaA \\ -\frac{1-\gamma}{4(\gamma+1)} & \text{if } (\alpha,\gamma) \in AreaB \\ \frac{\gamma(-2\alpha(\gamma+1)(\alpha\gamma+\gamma-2)+\gamma-2)}{2(\gamma+1)(\gamma^2-4)} & \text{otherwise} \end{cases} \tag{20}$$

which is positive whenever $\alpha < \tilde{\alpha}^a(\gamma) \equiv \frac{1}{2}\left(-\sqrt{\frac{(\gamma-2)\gamma^3+1}{(\gamma+1)^2}} - \gamma - \frac{2}{\gamma+1} + 3\right)$ and negative otherwise in area A, always negative in area B and positive whenever $\alpha < \tilde{\alpha}^c(\gamma) \equiv \frac{-\gamma^2-\sqrt{\gamma^4-5\gamma^2+4}+\gamma+2}{2(\gamma^2+\gamma)}$ while negative otherwise in area C. Figure 2 summarizes our findings and is redisplayed below.

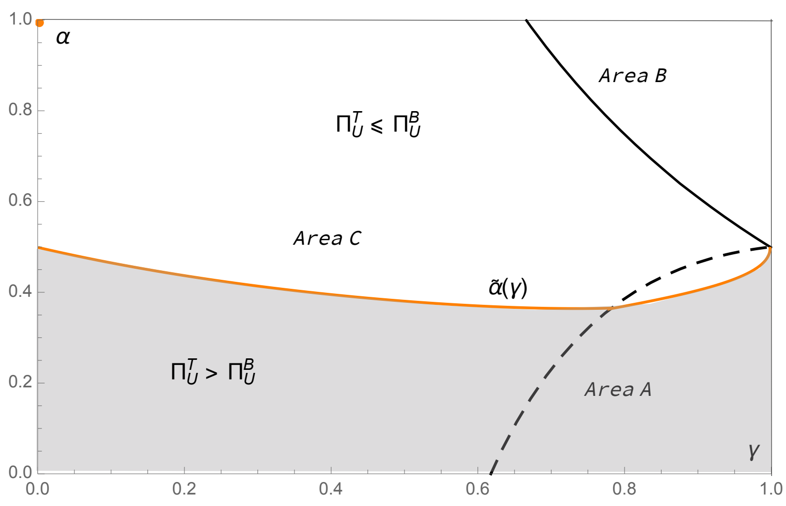


Figure 7: (Equiv. Fig 2) The monopolist's profits

$\diamond$ Let's additionnally prove that the thresholds are inferior to 1/2 for $\gamma \in (0,1)$,

- Consider $\tilde{\alpha}^c(\gamma) = \frac{-\gamma^2-\sqrt{\gamma^4-5\gamma^2+4}+\gamma+2}{2(\gamma^2+\gamma)} \leq 1/2$. It is equivalent to $2+\gamma-\gamma^2-\sqrt{4-5\gamma^2+\gamma^4} \leq (1/2)2(\gamma+\gamma^2) \Rightarrow 2-2\gamma^2 \leq \sqrt{4-5\gamma^2+\gamma^4} \Rightarrow 4(1-\gamma^2)^2 \leq 4-5\gamma^2+\gamma^4 \Rightarrow 4-8\gamma^2-4\gamma^4 \leq 4-5\gamma^2+\gamma 4$

which is true for $\gamma \in (0,1)$.

- For $\tilde{\alpha}^a(\gamma) = \frac{1}{2}\left(-\sqrt{\frac{(\gamma-2)\gamma^3+1}{(\gamma+1)^2}} - \gamma - \frac{2}{\gamma+1} + 3\right) \leq 1/2$, we have $\left(-\sqrt{\frac{(\gamma-2)\gamma^3+1}{(\gamma+1)^2}} - \gamma - \frac{2}{\gamma+1} + 3\right) \leq 1 \Rightarrow -\gamma - \frac{2}{\gamma+1} + 3 - 1 \leq \sqrt{\frac{(\gamma-2)\gamma^3+1}{(\gamma+1)^2}} \Rightarrow \frac{\gamma-\gamma^2}{\gamma+1} \leq \sqrt{\frac{(\gamma-2)\gamma^3+1}{(\gamma+1)^2}} \Rightarrow \gamma - \gamma^2 \leq \sqrt{(\gamma-2)\gamma^3+1} \Rightarrow (\gamma-\gamma^2)^2 \leq 1 + \gamma^4 - 2\gamma^3 \Rightarrow \gamma^2 - 2\gamma^3 + \gamma^4 \leq 1 - 2\gamma^3 + \gamma^4$ which is true for $\gamma \in (0,1)$.

□

**Proof of Equation 11** From $\pi_U^T(\tilde{\alpha}(\gamma),\gamma) - \pi_U^B(\gamma) = 0$, we get:

$$\frac{d\tilde{\alpha}}{d\gamma}(\gamma) = -\frac{\frac{\partial \pi_U^T}{\partial \gamma} - \frac{\partial \pi_U^B}{\partial \gamma}}{\frac{d\pi_U^T}{d\alpha}}$$

We can then decompose the profits. First, using $\pi_U^T(q_2^*(q_1), q_1)$ at $q_1^T(\alpha,\gamma)$, we have

$$\frac{\partial \pi_U^T}{\partial \gamma} = \frac{\partial \pi_U^T}{\partial q_1}\frac{\partial q_1^T}{\partial \gamma} + \frac{\partial \pi_U^T}{\partial \gamma}|_{q_1=q_1^T}$$

At this point $(\partial \pi_U^T/\partial q_1)(q_1^T) = 0$, the expression simplifies to

$$\frac{\partial \pi_U^T}{\partial \gamma} = 0 + \frac{\partial f_1}{\partial \gamma}|_{q_1=q_1^T} + \frac{\partial f_2}{\partial \gamma}|_{q_1=q_1^T}$$

Because $f_1(q_1^T) = (1-\alpha)(1-q_1^T)q_1^T + \mathbb{1}_{[q_1^T<1-\gamma]}\alpha(1-\gamma-q_1^T)q_1^T$ and $f_2(q_1^T) = (1/4)(1-\gamma q_1^T)^2$, we find

$$\frac{\partial \pi_U^T}{\partial \gamma} = -\mathbb{1}_{[q_1^T<1-\gamma]}\alpha.q_1^T - \frac{1}{2}q_1^T(1-\gamma q_1^T) < 0 \tag{21}$$

By the same process, we obtain

$$\frac{\partial \pi_U^T}{\partial \alpha} = -(1-q_1^T)q_1^T + \mathbb{1}_{[q_1^T<1-\gamma]}(1-\gamma-q_1^T)q_1^T < 0 \tag{22}$$

Finally, it is easy to see that $\pi_U^B(q_1^*, q_2^*)$ implies the same derivative irrespective of the area considered. We get

$$\frac{\partial \pi_U^B}{\partial \gamma} = -\frac{1}{2(1+\gamma)^2} < 0 \tag{23}$$

From Eq. (21), Eq. (22) and Eq. (23), we find that:

$$\begin{aligned}
\text{sign}[\frac{d\tilde{\alpha}}{d\gamma}] &= \text{sign}[\frac{\partial \pi_U^T}{\partial \gamma} - \frac{\partial \pi_U^B}{\partial \gamma}] \\
&= \text{sign}\left[\frac{\partial f_2}{\partial \gamma}(q_1^T) - \mathbb{1}_{[q_1^T<1-\gamma]}\frac{\partial f_1}{\partial \gamma}(q_1^T) - \frac{\partial \pi_U^B}{\partial \gamma}\right]
\end{aligned}$$

This is Equation 11 in our main text.

In area A, where $q_1^T = q_1^{T_A}$ we have:

$$\text{sign}[\frac{d\tilde{\alpha}}{d\gamma}] = \text{sign}[\frac{(1-\alpha)(2-\gamma)(2\alpha+\gamma-2)}{(4\alpha+\gamma^2-4)^2} + \frac{1}{2(\gamma+1)^2}]$$

And the sign is positive.

In area C, where $q_1^T = q_1^{T_C}$ we have:

$$\text{sign}[\frac{d\tilde{\alpha}}{d\gamma}] = \text{sign}[\frac{\alpha^2}{(\gamma-2)^2} - \frac{(\alpha+1)^2}{(\gamma+2)^2} + \frac{1}{2(\gamma+1)^2}]$$

And the sign can be positive or negative. However, evaluating the sign at $\alpha = \tilde{\alpha}^c(\gamma)$ we get that

$$\text{sign}[\frac{d\tilde{\alpha}}{d\gamma}] = \text{sign}[\frac{2\left(\sqrt{\gamma^4-5\gamma^2+4}-2\right)+\gamma\left(\gamma^2+2\sqrt{\gamma^4-5\gamma^2+4}+4\gamma-4\right)}{2\gamma(\gamma+1)^2\left(\gamma^2-4\right)}]$$

which is negative provided $0 < \gamma < -1+\sqrt{3} \approx 0.730$. This threshold is lower than the threshold at which $\tilde{\alpha}$ intersects area A, $\gamma \approx 0.784$. Therefore, the slope is slightly positive above $\gamma = -1+\sqrt{3}$ and negative below. $\square$

**Proof of proposition 6** Let $CS$ denote the consumer surplus. With a linear demand, the consumer surplus simplifies to:

$$CS(q_1, q_2) = \frac{(q_1)^2 + (q_2)^2 + 2\gamma q_1 q_2}{2}$$

From the benchmark optimal quantity we find that the consumer surplus without management turnover is $CS^B = 1/(4(1+\gamma))$. Let $CS^T$ denote the consumer surplus with management turnover.

By lemma 2, we have:

**Lemma 4.** *With management turnover, the consumer surplus is:*

$$CS^T(\alpha,\gamma) = \begin{cases} \frac{\alpha^2((4-3\gamma)\gamma+8)-2\alpha(\gamma-4)(\gamma-2)(\gamma+1)+2(\gamma-3)\gamma^2+8}{2(4\alpha+\gamma^2-4)^2} & \textit{if } (\alpha,\gamma) \in AreaA \\ 1/8 & \textit{if } (\alpha,\gamma) \in AreaB \\ \frac{\gamma\left(\alpha^2\gamma\left(4-3\gamma^2\right)-2\alpha(\gamma-2)^2(\gamma+1)+2(\gamma-3)\gamma\right)+8}{2(\gamma^2-4)^2} & \textit{otherwise} \end{cases} \tag{24}$$

We then get (omiting writing CS as functions):

$$CS^T - CS^B = \begin{cases} \frac{\alpha^2((4-3\gamma)\gamma+8)-2\alpha(\gamma-4)(\gamma-2)(\gamma+1)+2(\gamma-3)\gamma^2+8}{2(4\alpha+\gamma^2-4)^2} - \frac{1}{4(1+\gamma)} & \text{if } (\alpha,\gamma) \in AreaA \\ -\frac{1-\gamma}{8(\gamma+1)} & \text{if } (\alpha,\gamma) \in AreaB \\ \frac{\gamma\left(\alpha^2\gamma\left(4-3\gamma^2\right)-2\alpha(\gamma-2)^2(\gamma+1)+2(\gamma-3)\gamma\right)+8}{2(\gamma^2-4)^2} - \frac{1}{4(1+\gamma)} & \text{otherwise} \end{cases} \tag{25}$$

which is always positive in area A, always negative in area B and positive if $\alpha < \frac{(\gamma-2)^2(\gamma+1)}{4\gamma-3\gamma^3} - \frac{\sqrt{\frac{(\gamma^2-4)^2(2\gamma^3-\gamma^2-2\gamma+2)}{\gamma^2(\gamma+1)(3\gamma^2-4)^2}}}{\sqrt{2}} \equiv \hat{\alpha}(\gamma)$ while negative otherwise in area C. Figure 3 summarizes our findings and is redisplayed below.

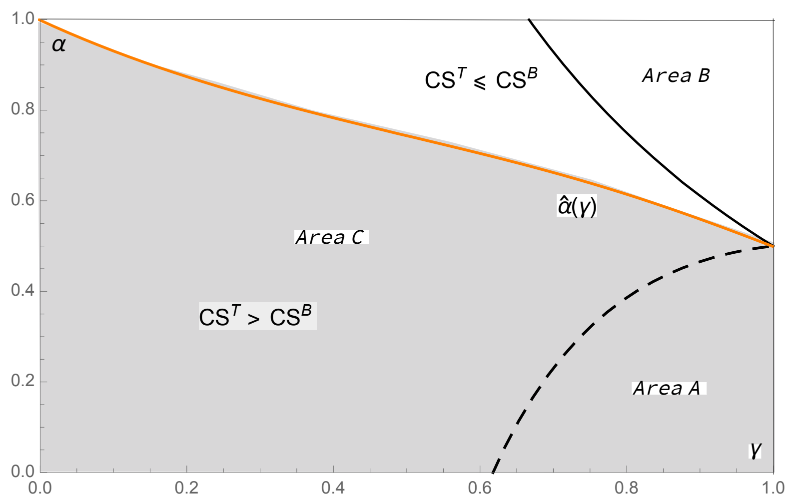


Figure 8: (Equiv. Fig 3) The consumer surplus

□

**Equilibrium with $q_2 \in [0, +\infty)$.** When $q_2 \in [0, +\infty)$, the new manager expects the following profit upon contracting with the monopolist : $E\pi_1 = (1-\alpha)(1-q_1)q_1 - f_1$. The monopolist captures all the rent and maximizes the following profit function : $\pi_U = \left(\frac{1-\gamma q_1}{2}\right)^2 + (1-\alpha)(1-q_1)q_1$ with respect to $q_1$. This gives the following first order condition : $FOC_{q_1} : -\gamma(1-\gamma q_1)+2(1-\alpha)(1-2q_1) = 0$. The latter condition implies the following equilibrium offer: $q_1^* = \frac{2(1-\alpha)-\gamma}{4(1-\alpha)-\gamma^2}$. Note that we retrieve the extreme values under perfect substitutes, $\gamma = 1$, and unrelated products, $\gamma = 0$.

Substituting the above equilibrium value, we find $q_2^* = \frac{(1-\alpha)(2-\gamma)}{4(1-\alpha)-\gamma^2}$ and $f_1^* = \frac{(1-\alpha)(2(1-\alpha)-\gamma)(2(1-\alpha)+\gamma-\gamma^2)}{(4(1-\alpha)-\gamma^2)^2}$. Finally, we find $f_2^* = \frac{(1-\alpha)^2(2-\gamma)^2}{(4(1-\alpha)-\gamma^2)^2}$ and $\pi_U^* = \frac{(1-\alpha)(-\alpha-\gamma+2)}{4(1-\alpha)-\gamma^2}$.

We now just have to compare $\pi_U^*$ to $\pi_U^B$. The following graph summarizes the findings with the optimism threshold $1 - \tilde{\alpha}(\gamma)$.

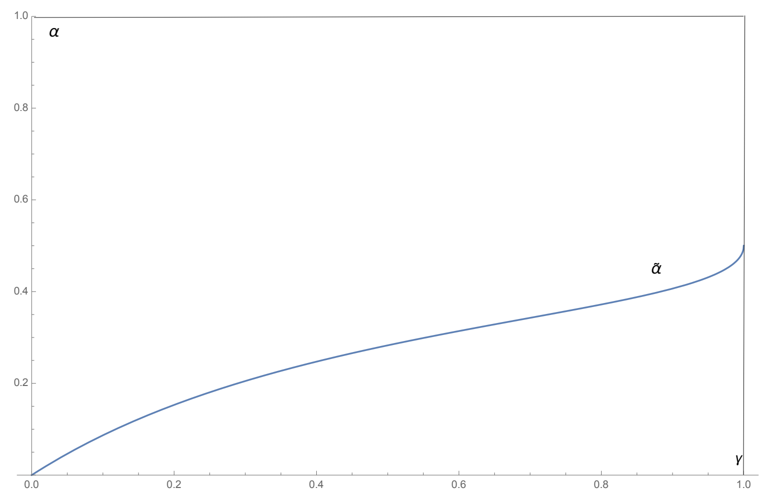


Figure 9: Comparison of the monopolist's profits with imperfect substitutes

□