Management turnover, strategic ambiguity and supply incentives

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Abstract

When a firm appoints a new manager, it reopens the possibility of new contractual friction with its partners. We explore *strategic ambiguity* as a potential for friction with a supplier. The firm's new manager probably has fuzzy expectations about the supplier's strategy. An optimistic manager weights favorable strategies more heavily than detrimental ones, whereas a pessimistic manager does the opposite. We show that the manager's degree of optimism is critical: above a threshold, it can cause the supplier to change the timing of its contracting and increase its profits. We also find that this threshold degree of optimism depends on the degree of product substitution: it is more stringent with imperfect substitutes than with perfect substitutes or unrelated goods.

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, there is likely to be management turnover in a downstream firm (e.g., succession, resignation), implying that the monopolist now has to deal with a new manager. This new relationship revives the possibility of contractual friction and potentially threatens the monopolist's profits.

In this paper, we consider that contractual friction takes the form of *strategic ambiguity*: the new manager has fuzzy expectations about the monopolist's strategy. For example, the new manager is hired from outside the firm and mistrusts the supplier. Experimental evidence shows that individuals exhibit strategic ambiguity towards other players' choices in games (Eichberger *et al.*, 2007). The new manager therefore has an objective function that differs from one with rational expectations.

In addition to strategic ambiguity, the manager has attitude towards this ambiguity. We say a manager is optimistic when they are comfortable with ambiguity, and pessimistic when they are averse to it. Optimism leads a manager to weight favorable monopolist strategies more heavily than detrimental ones, whereas pessimism does the opposite. Again, experimental evidence shows that individuals exhibit both optimism and pessimism in games (Ivanov, 2011). Armstrong and Huck (2010) points out that entrepreneurs are even more prone to optimism about their abilities or the probability of favorable outcomes than are other individuals.

Our paper theoretically demonstrates that the monopolist can benefit from contractual friction when it takes the form of strategic ambiguity. Provided the new manager is sufficiently optimistic, the monopolist generates 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 finding is as follows.

When there is management turnover, the monopolist approaches the new manager first, so that the manager cannot fulfil their contract with the remaining firm. This leads to strategic ambiguity.

Optimism causes the new manager to expect exclusivity and, therefore, to monopolize the market. Under perfect substitutes, pessimism leads the new manager to expect a nil profit (due to too many rivals). The monopolist can offer the manager close to the monopoly quantity, provided it is sufficiently optimistic, and then let the rival firm serve the residual demand. The monopolist is thus better off than under simultaneously observable offers, only when optimism is high. Imperfect substitutes mitigate this result by acting on the manager's pessimistic scenario. The manager will then depend on the monopolist's quantity offer, which may trigger positive profits when it is sufficiently low, compared to the product substitution. This implies that the effect of product substitution on the monopolist's profit is non-monotonic.

Our paper contributes to the flourishing literature that investigates 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, in a Cournot duopoly, firms have a unilateral incentive to hire an optimistic manager who feels ambiguous about the rival's strategy. To the best of our knowledge, this literature does not discuss 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). This is not possible in the standard literature on 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 firm makes the manager interact with a monopolist supplier. We nonetheless discuss the fact that this would depend on the monopolist's bargaining power.

Our paper also relates, but to a lesser extent, to the literature on hiring managers. In this literature, Englmaier and Reisinger (2014) shows that firms hire over-confident managers in a Cournot setting, to commit to being 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 Eichberger *et al.* (2009) study the same issue, i.e. the incentive to hire an optimistic/over-confident manager, the source of uncertainty differs. The closest paper to ours in this literature with demand uncertainty is Meccheri (2021). It points out that the incentive to hire an over-confident manager in a Cournot duopoly depends on the degree of product substitution when a monopolist supplies firms. In our setting with strategic ambiguity towards the monopolist supplier, we show that hiring a very optimistic manager is not profitable for a firm irrespective of product substitution.

The paper is organized as follows. Section 2 presents the benchmark situation without management turnover. Section 3 introduces the model with management turnover. Section 4 states the new equilibrium strategies consecutive to management turnover and underlines the role of product substitution. Section 5 compares the result with the benchmark situation and provides comparative statics on the effect of product substitution. Section 6 discusses two alternative model specifications. Finally, section 7 concludes. All proofs are relegated to the Appendix.

2 The benchmark model

2.1 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:

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

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

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

Once a contract is accepted or rejected, it is transparently disclosed to the firms. The firms transform the inputs into (potentially) differentiated outputs on a one-to-one basis, and sell the final goods to consumers.[2] The inverse demand is $p_i(q_i, q_j) = 1 - q_i - \gamma q_j$ with $j \neq i$ and where γ refers to the level of product substitution. When $\gamma = 0$, goods are unrelated whereas as γ tends towards 1, goods become more and more substituable until they reach perfect substitution $\gamma = 1$. Thus, firm i's 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^B:

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

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, and (ii) the firms consider the offers and decide whether to accept. Profits are made.

2.2 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). To summarize, in the benchmark situation the symmetric SPNE in pure strategy implies the following equilibrium

[2] 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.

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

3 Management turnover and strategic ambiguity

In this section we suppose that downstream firm D_1 changes its manager.[3] It then gives to the monopolist the opportunity to create *strategic ambiguity* by adopting sequential rather than simultaneous contracting.

3.1 Sequential versus simultaneous contracting

If the monopolist supplier continues to make simultaneous offers, then observability and non-renegotiation mute strategic ambiguity: the new manager is able to fulfill the entire contract when they have to choose whether to accept it or not. Consequently, the result would be the same as in the benchmark situation.

When the monopolist sequences the timing of its contracting and enters first into contracts with the new manager, this leads to strategic ambiguity.[4] Under sequential contracting, the timing of the game is as follows:

1. The monopolist makes an offer c_1 to the new manager of firm D_1.

[3]We choose firm D_1 without loss of generality. The symmetric result would occur if we supposed that firm D_2 changes its manager instead.

[4]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 consider the contract between the supplier and D_2 upon deciding whether to accept the supplier's contract offer.

2. D_1 decides whether to accept.

3. The monopolist makes an offer c_2 to D_2.

4. D_2 observes the two offers and decides whether to accept its offer. Profits are realized.

Under sequential contracting, strategic ambiguity is introduced on the upstream market. The downstream market remains unambiguous. In particular, D_1 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. Also, U knows the D_1's ambiguity attitude (level of pessimism/optimism). This could happen because the monopolist has time to monitor the new manager before making its offer.

3.2 Ambiguous belief and preference

At stage 2, D_1 now fully has no idea which offer c_2 will be made to D_2 by U, given c_1. D_1 takes decision a_1, weighting the best and worst profits it can get given its expectation about the future strategies available to the monopolist, c_2, and given the rival best response, $a_2(c)$.

The new manager's preference in the face of strategic ambiguity is represented by an $\alpha-$ MaxMin Expected Utility ($\alpha-$MEU) denoted as $E_{c_2}\pi_1$. In our case, this utility function boils down to the Hurwicz criterion (Hurwicz, 1951; Arrow and Hurwicz, 1972), axiomatically characterized by Chateauneuf *et al.* (2020). The expected profit of the manager for choosing action a_1 is then defined as:

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

The degree of pessimism α reflects D_1's belief in the best profit whereas the degree of optimism $1-\alpha$ denotes its belief in the worst profit.

4 Monopoly profit and product substitution

As stated by Lemma 1 in appendix A.2, the monopolist's simplified program depends on the product differentiation. We develop first the two extreme cases, namely perfect substitutes $\gamma = 1$

and unrelated products $\gamma = 0$. We then study the intermediate case of imperfect substitutes $\gamma \in (0,1)$. Last, we summarize the three cases in a graph.

4.1 Perfect substitutes

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 to the rival. Given the level of pessimism α, the monopolist's 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 α.

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

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

Because the new manager believes that the market price in the worst scenario is nil, as 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.*

4.2 Unrelated products

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 α. 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.

4.3 Imperfect substitutes

With imperfect substitutes, the new manager's expectation about the market price - and hence the profit - in the worst scenario depends on the monopolist's 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 - even in the worst case. Given a level of pessimism α, the monopolist program is

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

The optimal choice depends on the values of parameters α and γ. For $\gamma > (\sqrt{5}-1)/2$, let $\bar{\alpha}(\gamma) \leq 1/2$ be the pessimism level for which the monopolist offers a quantity $q_1 = 1-\gamma$. An increase in α decreases q_1 whereas $\alpha < \bar{\alpha}(\gamma)$ implies $q_1 > 1-\gamma$. For $\gamma > 2/3$, let $\bar{\bar{\alpha}}(\gamma) \geq 1/2$ be the pessimism level that makes D_1 indifferent between the acceptance or the rejection of the monopolist's offer. Specifically, D_1 accepts the offer when $\alpha < \bar{\bar{\alpha}}(\gamma)$ but rejects it when $\alpha > \bar{\bar{\alpha}}(\gamma)$. Finally, perfect substitution $\gamma = 1$ implies $\bar{\alpha}(\gamma) = \bar{\bar{\alpha}}(\gamma) = 1/2$.

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, 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 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 emboldens the monopolist to increase the quantity of the offer to the first firm ($\partial q_1^{T_{A'}}/\partial\gamma < 0$) and the manager has to have 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 in the worst scenario the market price and the profits remain positive. 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.

Note once again that the substitution degree affects this acceptance threshold $\bar{\bar{\alpha}}(\gamma)$. 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 emboldens 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 have 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, note that when the new manager prefers to reject the offers, the monopolist obviously offers them nothing 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 the degree of substitution decreases ($\partial q_1^{T_{C'}} / \partial\gamma < 0$).

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

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

4.4 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 generalize 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 is to consider, depending on the substitution degree and the firm's level of pessimism. Note that $\bar{\alpha}(\gamma) \geq 1/2$ and $\bar{\bar{\alpha}}(\gamma) \leq 1/2$.

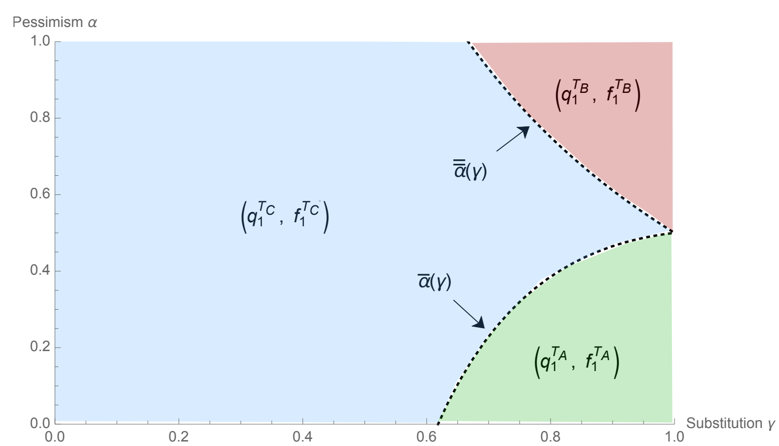

Figure 1: Graph of solution partition

5 Comparative statics of ambiguity attitude

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

5.1 Monopolist's profit

From proposition 1 and 2 joint with eq. (5), we first obtain the following statement:

Corollary 1. *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, the monopolist 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, in which $\tilde{\alpha}(\gamma)$ is the level of pessimism that makes the monopolist indifferent to the benchmark situation or the situation with strategic ambiguity.

Proposition 4. *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.*

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. Note that $\tilde{\alpha}(1) = 1/2$ and $\tilde{\alpha}(0) = 1$ so that Proposition 4 also points out that the sufficient level of optimism $1 - \tilde{\alpha}(\gamma)$, which makes management turnover profitable for the monopolist, is more stringent under imperfect substitutes than with perfect substitutes or unrelated goods. The intuition is as follows.

Consider first perfect product substitution ($\gamma = 1$), we have $q_1^T = q_1^{T_A} = (1 - 2\alpha)/(3 - \alpha)$, provided the manager's optimism is sufficiently high and $q_1^T = 0$ otherwise. At the threshold optimism level $1 - \tilde{\alpha}(1) = 1/2$, the equilibrium quantity is nil and the monopolist is indifferent to whether management turnover occurs or not, $\pi_U^T = \pi_U^B$. This is because perfect substitutes make

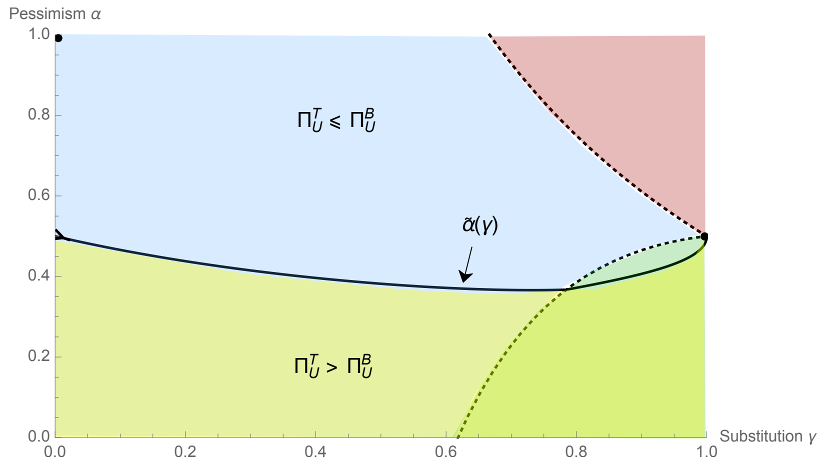

Figure 2: Comparison of the monopolist's profits

(Note that at $\gamma = 0$, we have $\tilde{\alpha} = 1$ while at $\gamma = 1$, we have $\tilde{\alpha} = 0.5$.)

the monopolist indifferent to the choice between letting both firms be downstream monopolists or letting D_2 be the downstream monopolist. In contrast, when the manager is sufficiently optimistic ($\alpha < \tilde{\alpha}(1) = 1/2$), the monopolist is clearly 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:

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

As products become less substitutable, the benchmark profit increases ($\partial \pi_U^B / \partial \gamma < 0$), implying that the turnover situation is profitable for smaller 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. Hence, the positive - but not that steep - slope of $d\tilde{\alpha}/d\gamma$ in area A.

When product substitution falls below a certain level, 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. Nonetheless, in the same time, this introduces a new effect linked to the pessimistic term that the new manager now accounts 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 the pessimistic manager now expects positive profits ($\partial f_1^T / \partial \gamma < 0$). This additional effect enables turnover profits to overcome the benchmark profit for higher levels of optimism. Hence the negative slope that appears at sufficiently low degrees of product substitution.

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

5.2 The downstream firms' profits

Proposition 5. *Provided the new manager is sufficiently optimistic ($\alpha < \tilde{\alpha}(\gamma)$), Firm 1 is worse off upon management turnover. By contrast, Firm 2 is indifferent between the two situations.*

In the absence of management turnover, Firm 1 and Firm 2 make nil profits. This happens for two reasons: the monopolist extracts the firms' expected revenues through the fixed fees; and the firms' expected revenues perfectly match the realized revenues because firms anticipate the future correctly.

With management turnover, the supplier continues to extract the firms' expected revenues. However, only firm 2 has correct anticipations about the future revenues. The manager of firm 1 feels ambiguous about what is going to occur between the supplier and Firm 2. The previous section has shown that the monopolist takes advantage of the ambiguity by proposing a positive quantity to Firm 1's manager when the latter is sufficiently optimistic ($\alpha \leq \tilde{\alpha}(\gamma)$). This case is represented by the yellow area in Figure 2. Note that the yellow area encompasses Area A where product substitution is great and Area C where product substitution is weaker. Formally, Firm 1's realized profit is

$$\pi_1^* = \begin{cases} (1 - q_1^{T_A} - \gamma q_2^{T_A})q_1^{T_A} - (1-\alpha)(1 - q_1^{T_A})q_1^{T_A} & \text{in Area A} \\ (1 - q_1^{T_C} - \gamma q_2^{T_C})q_1^{T_C} - [(1-\alpha)(1 - q_1^{T_C})q_1^{T_C} + \alpha(1 - q_1^{T_C} - \gamma q_2^{T_C})q_1^{T_C}] & \text{in Area C} \end{cases} \tag{12}$$

In brief, Firm 1's manager will think that they can release more quantity in the market than would actually be optimal for the firm without ambiguity. Therefore, Firm 1 makes losses on management turnover when the manager is sufficiently optimistic. This result is valid, irrespective of the product substitution. Nonetheless, section 6 shows that the result depends on the supplier's ability to extract Firm 1's expected revenues.

5.3 Consumer surplus

We now turn to the consumer surplus. To do that we replace the equilibrium outputs in the general consumer surplus function in Eq. (3). Let $\hat{\alpha}(\gamma)$ be the value of α for which the consumer surplus is the same with and without ambiguity. 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 degree of substitution.*

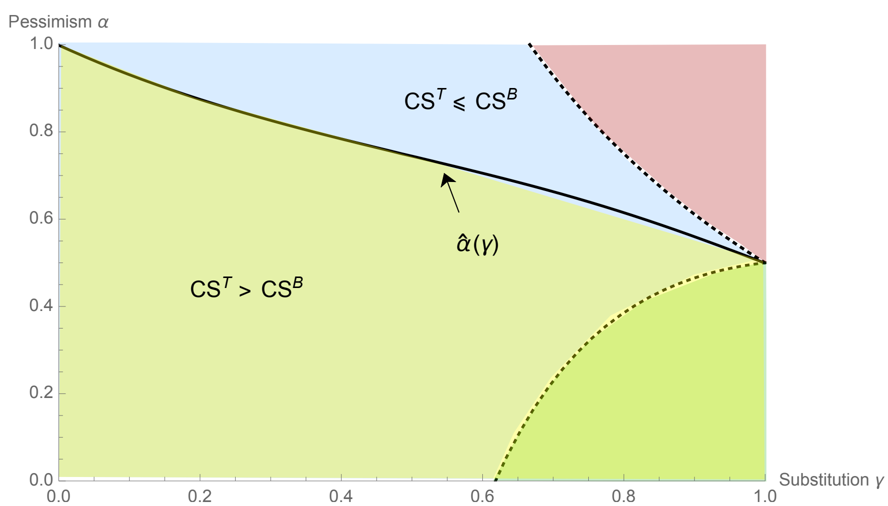

Figure 3: Comparison of the consumer surplus

We find that for any $\gamma \in [0, 1]$, $\hat{\alpha}(\gamma) \geq \tilde{\alpha}(\gamma)$, which means that consumers overall benefit from management turnover for a wider range of optimism levels than the monopolist.

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 for 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 the 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 decrease, 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 for 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.

6 Discussion

This section discusses two hypotheses of our model. On the one hand, we suppose that the supplier makes take-or-leave-it offers to the firm, and finds that with the new manager the firm makes losses. Intuitively, bargaining power may alleviate this result, and we discuss a simple setting where this is the case. On the other hand, we suppose that the new manager has time to monitor only one firm and the rival. As this is fundamental, it makes the manager feel ambiguity towards the supplier. We discuss what would happen when the manager decided to monitor the supplier instead of the rival, and therefore felt ambiguous.

Bargaining power can alleviate losses We assume that the supplier has all the bargaining power when deciding on the offers. It especially implies that the supplier extracts all the surplus of the firms through the fixed fees. This is, of course, the main problem of D_1 with its optimistic manager who accepts too high a fixed payment, given the firm's future revenues and thus losses. Bargaining power may alleviate this result.

Instead, let us suppose the firm can bargain on the fixed fees, in the sense that they can propose their offers with probability $1-\theta$ (Munster and Reisinger, 2017). When the firms decide on the fixed fee, they set it at nil because their respective profits decrease with their fixed fees. Therefore, the probability acts as if the monopolist can capture only a share θ of each firm's expected revenues. Formally, $f_i = \theta E_i R_i + (1-\theta)0$, where $R_i = (1 - q_i - \gamma q_j)q_i$ denotes firm i's revenues and $E_i R_i$ denotes firm i's expected revenues upon acceptance of the decision.

Given this neat parameterization, the quantity results remain the same because the supplier still sets the quantity offers and the additional probability appears only as a constant before each firm's fixed fee (by backward induction, q_2^* is not affected because the supplier's objective function is $\pi_U = f_1 + \theta E_2 R_2$ and then q_1^* is not affected because the objective function is $\pi_U = \theta E_1 R_1 + \theta E_2 R_2$). However, the equilibrium fixed fees differ depending on the value of θ. The latter decrease as the probability of the supplier to decide the fixed fees diminishes, i.e. θ decreases: $f_i^* = \theta E_i R_i(q_1^*, q_2^*)$.

Consider the simple case of perfect substitutes, then D_1 can hire an optimistic manager without making losses, as long as the monopolist's bargaining power is sufficiently weak:

$$\theta \leq \frac{R_1(q_1^*, q_2^*)}{E_1 R_1(q_1^*)} = \frac{1}{2(1-\alpha)} \equiv \bar{\theta}(\alpha) \in [0, 1]$$

We observe that a rise of optimism (an increase of $1-\alpha$) shrinks the range of the monopolist's bargaining power that enables the firm to make positive profits.

Ambiguity towards the other firm We assume that the manager has time to monitor the rival but not the supplier. Alternatively, we could suppose that they use that time to monitor the supplier but not the rival. In this situation, the manager thus becomes ambiguous regarding the rival's strategy. Note that the rival's strategy boils down to accepting or rejecting the supplier's proposal. Therefore, in contrast to Eichberger *et al.* (2009)'s framework, the manager does not hold ambiguous beliefs regarding the rival's outcome decision.

We focus on the simpler situation with perfect substitutes. Intuitively, ambiguity arises again only when the supplier meets the firm that hires a new manager, say Firm 1, first. Appendix details the computations. To sum up, by backward induction, at stage 2, everything remains the same, and we find the same continuation contract offer. At stage 1, however, firm 1 now expects to be a monopoly in the best scenario (the rival rejects the offer) while it expects the rival to set the continuation quantity $q_2^*(q_1)$ in the worst scenario (the rival accepts the offer). The manager accepts whenever $f_1 \leq (1 - q_1 - \alpha q_2^*(q_1))q_1$. Note that, in contrast to our model, the worst scenario is far from being nil. Additionally, the manager anticipates the effect of q_1 on the rival's offer $q_2^*(q_1)$ and so on its revenues. We find that the monopolist supplies firm 1 and earns a profit strictly greater than the monopoly profit whenever the ambiguity attitude is not extreme $(1 > \alpha > 0)$[5]. The monopolist supplies greater quantities to the manager in this setting than in our model, and it does so for a larger interval of ambiguity attitude.

Upstream competition It is difficult to speculate about the robustness of our results with upstream competition because that competition can take various forms and raises new questions, such as whether to allow exclusivity or to let a rival supplier meet with a rival firm whenever a supplier meets with a firm (in the sequential contracting situation). Still, it is possible to speculate that upstream competition with non-exclusive contracts will generally diminish the fixed fees as suppliers compete to poach the firms (see appendix for an illustration).

7 Conclusion

When a firm changes its manager, it reopens room for contractual frictions with its partners. In this paper, we explore *strategic ambiguity* as 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 it causes the supplier to change its timing of contracting and increase its profits above a certain threshold. 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

[5] When $\alpha = 1$, the monopolist does not serve firm 1. When $\alpha = 0$, the profits under the two situations are the same (no differentiation).

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 of ambiguity concepts (Eichberger *et al.*, 2009; Król, 2012; Kauffeldt and Wiesenfarth, 2018). To the best of our knowledge, this literature does not include 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. This result depends on product substitution.

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Appendix A Subgame perfect Nash Equilibrium

A.1 SPNE without ambiguity

We look for the symmetric SPNE where the two firms accept their contracts. By backward induction, we find that firms accept contracts 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' rents 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 $\pi_U = 1/[2(1 + \gamma)]$. Symmetrically, the consumer surplus can be rewritten as: $CS = (1 + \gamma)q^2$ which gives $CS = 1/[4(1 + \gamma)]$. □

A.2 SPNE with strategic ambiguity and sequential contracting

We look for the SPNE in pure strategies of the game and thus solve the game using backward induction. We now refer to the new manager and D_1 as the same entity to ease the explanation and notations. For the same reason we also do not write the history of strategies as functions of the history of past strategies.

When D_2 observes its offer, it also observes the previous contract offer and D_1's decision. D_2 accepts the contract whenever its profit is positive. Formally, this 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, which 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 that of D_1. 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 up 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), the result is 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 from them (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 for 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 at worst a positive market price and hence positive profits.

We focus on equilibria where the firms accept the contract, 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 on 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 α, the monopolist extracts all the rent.

A.2.1 Perfect substitutes

SPNE with perfect substitutes and strategic ambiguity is characterized by Eq. (8).

At the time the monopolist enters into a 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:

$$\frac{\partial \pi_U}{\partial q_1} = 0 \quad \Leftrightarrow \quad (1-2\alpha) - (3-4\alpha)q_1 = 0 \tag{13}$$

$$\frac{\partial^2 \pi_U}{\partial^2 q_1} \leq 0 \quad \Leftrightarrow \quad (1-\alpha)(-2) + (1/2) \leq 0 \tag{14}$$

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. (13) and eq. (14) 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 $0 \leq \alpha \leq 1/2$.

When $\alpha > 1/2$, the SOC becomes positive (eq. (14)). 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 $q_1(\alpha) = (1 - 2\alpha)/(3 - 4\alpha) \geq 0$ and positive above that. This time $q_1(\alpha) = (1 - 2\alpha)/(3 - 4\alpha)$ is thus a minimum. By computing the profit value at the extreme of 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 reached 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. □

A.2.2 Imperfect substitutes

At the time the monopolist enters into contract with the first firm, it maximizes

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

We have two cases to consider, depending on if $q_1 \leq 1 - \gamma$ or $q_1 \geq 1 - \gamma$.

Case 1 $q_1 \leq 1 - \gamma$.

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 π_U. When

$\alpha \leq \bar{\bar{\alpha}}(\gamma) \equiv \frac{1}{\gamma} - \frac{1}{2}$, we have $q_1^L(\alpha, \gamma) \geq 0$. $q_1^L(\alpha, \gamma)$ is 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 $\frac{1}{2}\left(-\gamma^2 + \gamma - \frac{2}{\gamma} + 3\right)$.

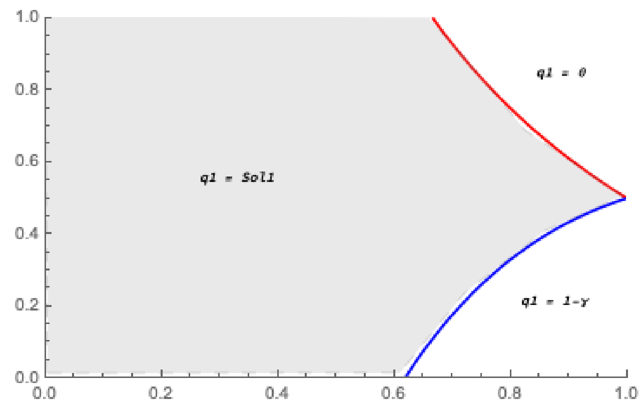

Figure 4: The solution for $q_1 < 1 - \gamma$

Case 2 $\quad q_1 \geq 1 - \gamma$.

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

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

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

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 π_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 $\frac{(\gamma-2)\left(\gamma^2+\gamma-1\right)}{2-4\gamma}$.

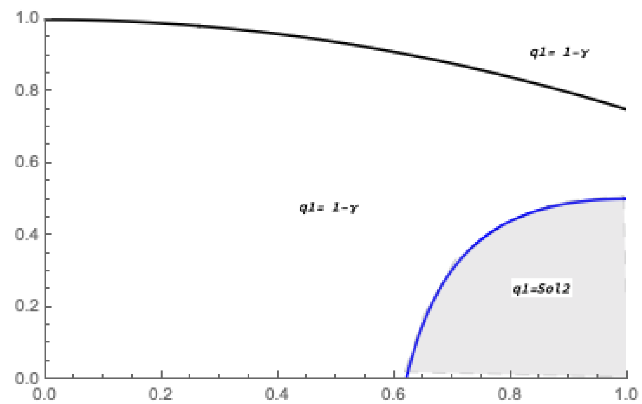

Figure 5: The solution for $q_1 \geq 1-\gamma$

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

◇ *Maximum profit at optimum solutions.*

Let us denote by π_U^L the profit function when $q_1 \leq 1-\gamma$ and π_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 the 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 in this region is $q_1(\alpha,\gamma) = 0$.

(iv) 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 in 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 $q_1^{T_{C'}} = q_1^L(\alpha,\gamma)$.

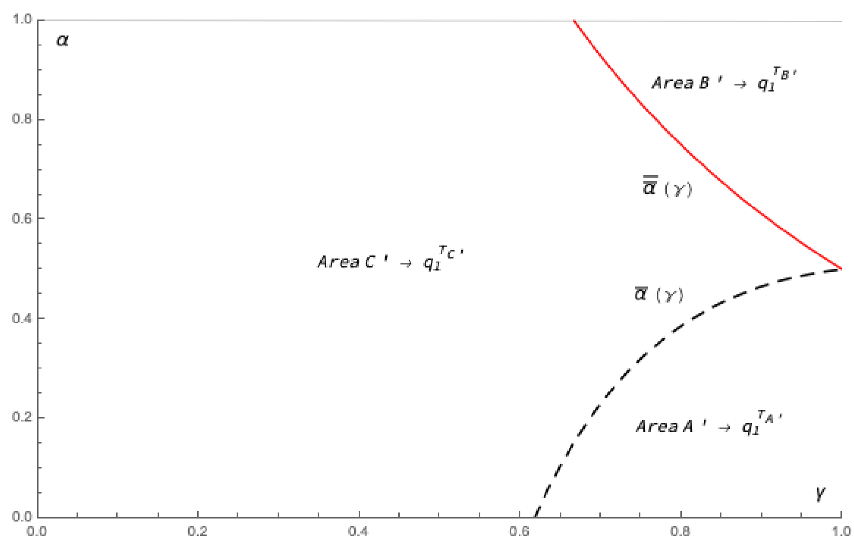

Figure 6: (Equiv. fig 1) Graph of solution partition

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. □

Appendix B Proofs

B.1 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 4), we have:

$$\pi_U(\alpha)=f_1(\alpha)+f_2(\alpha)=\frac{(1-\alpha)^2}{3-4\alpha}, \tag{19}$$

as long as $\alpha \leq 1/2$. For higher values of α, π_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. □

B.2 Proof of proposition 3

Take for example $\alpha = 1$ and a sufficiently high γ, 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 $f_1^T + f_2^T = 1/4 < 1/(2+2\gamma) = \pi^M$. □

B.3 Proof of proposition 4

Remember that $\pi_U^B = 1/(2(1+\gamma))$ is the benchmark profit without management turnover. Let us now denote by π_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 α and the product substitution γ such that:*

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

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

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

where Area A denotes the subset $\{(\alpha,\gamma)\in[0,1]^2:\ \alpha<\bar{\alpha}(\gamma)$ *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* $\{(\alpha,\gamma)\in[0,1]^2:\ \bar{\bar{\alpha}}(\gamma)<\alpha<1$ *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 the contract, 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*

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

We then get:

$$\pi_U^T(\alpha,\gamma)-\pi_U^B(\gamma)=\begin{cases}\frac{(1-\alpha)(2-\alpha-\gamma)}{4(1-\alpha)-\gamma^2}-\frac{1}{2(1+\gamma)} & \text{if } (\alpha,\gamma)\in AreaA\\ -\frac{1-\gamma}{4(\gamma+1)} & \text{if } (\alpha,\gamma)\in AreaB\\ \frac{\gamma(-2\alpha(\gamma+1)(\alpha\gamma+\gamma-2)+\gamma-2)}{2(\gamma+1)(\gamma^2-4)} & \text{otherwise}\end{cases}\tag{21}$$

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.

⋄ Let's additionnally prove that the thresholds are inferior to 1/2 for $\gamma\in(0,1)$,
- Consider $\tilde{\alpha}^c(\gamma)=\frac{-\gamma^2-\sqrt{\gamma^4-5\gamma^2+4}+\gamma+2}{2(\gamma^2+\gamma)}\le 1/2$. It is equivalent to $2+\gamma-\gamma^2-\sqrt{4-5\gamma^2+\gamma^4}\le(1/2)2(\gamma+\gamma^2)\Rightarrow 2-2\gamma^2\le\sqrt{4-5\gamma^2+\gamma^4}\Rightarrow 4(1-\gamma^2)^2\le 4-5\gamma^2+\gamma^4\Rightarrow 4-8\gamma^2-4\gamma^4\le 4-5\gamma^2+\gamma 4$ which is true for $\gamma\in(0,1)$.
- For $\tilde{\alpha}^a(\gamma)=\frac{1}{2}\left(-\sqrt{\frac{(\gamma-2)\gamma^3+1}{(\gamma+1)^2}}-\gamma-\frac{2}{\gamma+1}+3\right)\le 1/2$, we have $\left(-\sqrt{\frac{(\gamma-2)\gamma^3+1}{(\gamma+1)^2}}-\gamma-\frac{2}{\gamma+1}+3\right)\le 1\Rightarrow -\gamma-\frac{2}{\gamma+1}+3-1\le\sqrt{\frac{(\gamma-2)\gamma^3+1}{(\gamma+1)^2}}\Rightarrow\frac{\gamma-\gamma^2}{\gamma+1}\le\sqrt{\frac{(\gamma-2)\gamma^3+1}{(\gamma+1)^2}}\Rightarrow\gamma-\gamma^2\le\sqrt{(\gamma-2)\gamma^3+1}\Rightarrow(\gamma-\gamma^2)^2\le 1+\gamma^4-2\gamma^3\Rightarrow\gamma^2-2\gamma^3+\gamma^4\le 1-2\gamma^3+\gamma^4$ which is true for $\gamma\in(0,1)$.

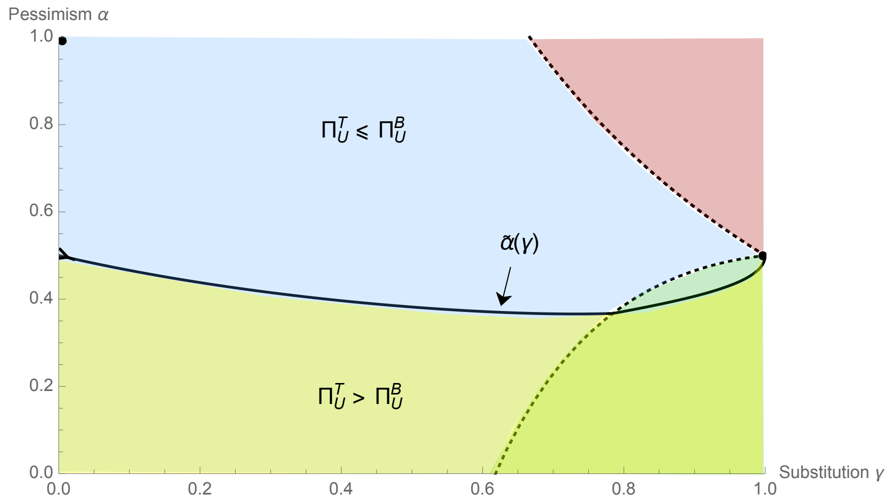

Figure 7: (Equiv. Fig 2) The monopolist's profits

□

B.4 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

$$\frac{\partial \pi_U^T}{\partial \gamma} = -\mathbb{1}_{[q_1^T < 1-\gamma]}\alpha . q_1^T - \frac{1}{2}q_1^T(1-\gamma q_1^T) < 0 \tag{22}$$

By the same process, we obtain

$$\frac{\partial \pi_U^T}{\partial \alpha} = -(1-q_1^T)q_1^T + \mathbb{1}_{[q_1^T<1-\gamma]}(1-\gamma-q_1^T)q_1^T < 0 \tag{23}$$

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

$$\frac{\partial \pi_U^B}{\partial \gamma} = -\frac{1}{2(1+\gamma)^2} < 0 \tag{24}$$

From Eq. (22), Eq. (23) and Eq. (24), 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 find 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. □

B.5 Proof of proposition 5

(i) It is straightforward to see that the firms make no profit in the case without management turnover.

(ii) With management turnover, the monopolist takes advantage of ambiguity when the manager is sufficiently optimistic ($\alpha \leq \tilde{\alpha}(\gamma)$). This area encompasses a sub-part of Area A and Area C. From Eq. (12), we find that:

- in the intersection of Area A with the area where $\alpha \leq \tilde{\alpha}(\gamma)$, the profit of Firm 1 is:

$$\begin{aligned} \pi_1 &= (1 - q_1^{T_A} - \gamma q_2^{T_A})q_1^{T_A} - (1-\alpha)(1 - q_1^{T_A})q_1^{T_A} && (25) \\ &= q_1^{T_A}\left(\alpha(1 - q_1^{T_A}) - \gamma q_2^{T_A}\right) && (26) \end{aligned}$$

It can be shown through Mathematica that $\alpha(1 - q_1^{T_A}) - \gamma q_2^{T_A} < 0$ in the area of interest. Therefore the profit is nil in this area.

- in the intersection of Area C with the area where $\alpha \leq \tilde{\alpha}(\gamma)$, the profit of Firm 1 is:

$$\begin{aligned} \pi_1 &= (1 - q_1^{T_C} - \gamma q_2^{T_C})q_1^{T_C} - (1-\alpha)(1 - q_1^{T_C})q_1^{T_C} - \alpha(1 - q_1^{T_C} - \gamma q_2^{T_C})q_1^{T_C} && (27) \\ &= (1 - q_1^{T_C})q_1^{T_C} - \gamma q_2^{T_C} q_1^{T_C} - (1 - q_1^{T_C})q_1^{T_C} + \alpha(1 - q_1^{T_C})q_1^{T_C} - \alpha(1 - q_1^{T_C})q_1^{T_C} + \alpha\gamma q_2^{T_C} q_1^{T_C} && (28) \\ &= -(1-\alpha)\gamma q_1^{T_C} q_2^{T_C} < 0 && (29) \end{aligned}$$

Overall, we indeed find that Firm 1's profit is negative in the region where the monopolist would take advantage of strategic ambiguity (i.e. $\alpha < \tilde{\alpha}(\gamma)$). It is obvious to compute that Firm 2 makes zero profit.

From (i) and (ii), we find that Firm 1 is worse off with management turnover whereas Firm 2 is indifferent.[6]

[6]Firm 1 is weakly worser off as than $\alpha > \tilde{\alpha}(\gamma)$, the monopolist does not take advantage of ambiguity and Firm 1 makes nil profits in this case. Firm 1 becomes indifferent between the situation with and without management turnover.

B.6 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:*

$$CS^T(\alpha,\gamma) = \begin{cases} \frac{\alpha^2((4-3\gamma)\gamma+8)-2\alpha(\gamma-4)(\gamma-2)(\gamma+1)+2(\gamma-3)\gamma^2+8}{2(4\alpha+\gamma^2-4)^2} & \textit{if } (\alpha,\gamma) \in \textit{AreaA} \\ 1/8 & \textit{if } (\alpha,\gamma) \in \textit{AreaB} \\ \frac{\gamma\left(\alpha^2\gamma\left(4-3\gamma^2\right)-2\alpha(\gamma-2)^2(\gamma+1)+2(\gamma-3)\gamma\right)+8}{2(\gamma^2-4)^2} & \textit{otherwise} \end{cases} \tag{30}$$

We then get (omiting writing CS as functions):

$$CS^T - CS^B = \begin{cases} \frac{\alpha^2((4-3\gamma)\gamma+8)-2\alpha(\gamma-4)(\gamma-2)(\gamma+1)+2(\gamma-3)\gamma^2+8}{2(4\alpha+\gamma^2-4)^2} - \frac{1}{4(1+\gamma)} & \text{if } (\alpha,\gamma) \in \textit{AreaA} \\ -\frac{1-\gamma}{8(\gamma+1)} & \text{if } (\alpha,\gamma) \in \textit{AreaB} \\ \frac{\gamma\left(\alpha^2\gamma\left(4-3\gamma^2\right)-2\alpha(\gamma-2)^2(\gamma+1)+2(\gamma-3)\gamma\right)+8}{2(\gamma^2-4)^2} - \frac{1}{4(1+\gamma)} & \text{otherwise} \end{cases} \tag{31}$$

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.

□

B.7 Proof of Extension 'Ambiguity towards the rival"

We suppose the manager feels ambiguity towards the rival and not the supplier. In addition, we focus on the case of perfect substitutes. We solve the sequential contracting game using backward

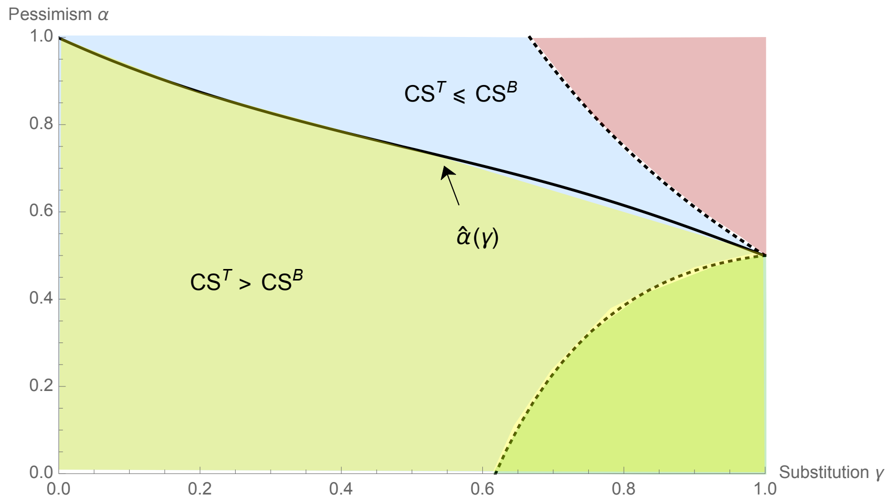

Figure 8: (Equiv. Fig 3) The consumer surplus

induction.

Obviously, the interesting situation arises when the firm with the new manager, say firm 1, meets the supplier first. Otherwise, the firm knows about the rival decision before contracting with the supplier.

At stage 2, the supplier thus meets with firm 2. It sets (q_2, f_2) so as to maximize its expected profit $E\pi_U = f_1 + f_2$, given firm 2's acceptance decision $f_2 \leq (1 - q_2 - q_1)q_2$. This gives the same continuation contract offer as in our model $(q_2^*(q_1), f_2^*(q_1))$ where q_2^* is the Cournot best response to q_1 (i.e. $q_2^* = (1 - q_1)/2$).

At stage 1, the supplier meets with firm 1 and firm 1 forms expectations about firm 2's acceptance decision. In the worst case scenario, firm 2 accepts and firm 1 expects to find $q_2^*(q_1)$ on the market. In the best case scenario, firm 2 rejects and firm 1 expects to be a monopolist. Firm 1 accepts the supplier's offer whenever $f_1 \leq (1 - q_1 - \alpha q_2^*(q_1))q_1$. The supplier acknowledges this behavior and sets (q_1, f_1) so as to maximize its expected profit $E\pi_U = f_2^*(q_1) + f_1$. Due to the supplier's bargaining power, it simplifies to $E\pi_U = f_2^*(q_1) + (1 - q_1 - \alpha q_2^*(q_1))q_1$. The derivative writes $dE\pi_U/dq_1 = \frac{1}{2}(-\alpha + (2\alpha - 3)q_1 + 1)$ and gives $q_1^* = \frac{1-\alpha}{3-2\alpha}$ (SOC is $-(3/2) + \alpha < 0$). The monopolist does not serve firm 1 when $\alpha = 1$. We then find $q_2^* = \frac{2-\alpha}{6-4\alpha}$, $f_1^* = \frac{(2-\alpha)^2(1-\alpha)}{2(3-2\alpha)^2}$, and $f_2^* = \frac{(2-\alpha)^2}{4(3-2\alpha)^2}$. Finally, we compute the supplier's equilibrium profit $\pi_U^* = \frac{(2-\alpha)^2}{12-8\alpha}$ which is always greater than the monopoly profit (1/4) whenever $1 > \alpha > 0$ (i.e. the ambiguity attitude is not extreme). □

Appendix C Illustration upstream competition

Caprice (2006) is the closest framework to such an extension in our model. The author extends Rey and Tirole (2007)'s model with upstream competition by adding a competitive fringe in the upstream market.

Thus, we suppose there is a competitive fringe and rename the established supplier as the incumbent. Furthermore, we assume that all contracts are non-exclusive and perfectly observable by everyone. In particular, upon contracting with a supplier, each firm can observe any rival supplier's offer to the rival firm. Last, we assume the incumbent prefers to deter poaching, and the firms prefer to buy from the incumbent rather than from the fringe when they offer the same quantity and nil fixed fees.

C.1 The benchmark situation

Let us first study the benchmark situation without management turnover. We find that the symmetric equilibrium changes. Even though the incumbent still supplies both firms, the quantities increase, whereas the fixed fees decrease.

Intuition of the proof

Fixed fees Suppose the incumbent offers half the monopoly quantity to each firm in exchange for half monopoly profit. Then, the fringe can provide the same quantity in exchange for a lower fixed fee, which at best is nil. Therefore, the incumbent supplier prefers to quote a fixed fee equal to 0 so that the fringe cannot poach the firms by undercutting the fixed fee.

Quantities Regarding the quantities, suppose the incumbent freely offers half the monopoly quantity to each firm. The fringe can then freely offer more quantity, say up to the deviation quantity (i.e.), to at least one firm. The firm would accept, and the rival would still get input from the incumbent (the latter's expected profits remain positive). To avoid such poaching, the incumbent delivers half the Cournot quantity to the firms (which also leads us back to a symmetric equilibrium). Then, the fringe cannot offer more quantity to the firms.

C.2 Management turnover and optimism

Now let us consider the situation with management turnover when the manager is sufficiently optimistic so that a monopoly supplier prefers sequential contracting. The following additional assumptions are needed: (i) the manager is also ambiguous about what the fringe will offer in the future to D2 (but not in the present); (ii) the fringe can meet with D2 when the incumbent meets with D1, and this contract is observable.

The incumbent does not benefit from ambiguity anymore as it cannot extract the total expected revenues of D1. It is indifferent between sequential and simultaneous contracting.

Intuition of the proof

Fringe does not meet D2 while incumbent meets D1 We use backward induction. When the incumbent meets with D2, the fringe can propose the same offer but a nil fixed fee. The incumbent thus has to set a nil fixed fee as well. To prevent poaching, the incumbent also delivers the Cournot best response to D2. When meeting with D1, a similar behavior occurs. The incumbent freely provides the 'optimistic quantity'. At equilibrium, the incumbent quotes a nil fixed fee for the two firms and supplies the same quantities as in our previous setting.

Fringe meets D2 while incumbent meets D1 Suppose now that the incumbent wants to meet with D1 and the fringe decides to meet with D2 meanwhile. Then ambiguity is muted as D1 observes D2's offer. Therefore, there is no reason for the incumbent to meet D1 first. The incumbent turns back to simultaneously contracting with the two firms: it sets the same equilibrium as in the simultaneous contracting case to prevent the fringe from poaching.

Then if we compare both settings, the incumbent earns the same profit of zero in the two settings due to the presence of the fringe. It becomes indifferent between the two settings. In particular, upstream competition can mute ambiguity as the fringe can meet with the rival while the incumbent meets with D1.