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Secret Two-Part Tariffs and Retailer Risk Aversion

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Abstract
This paper studies a manufacturer that offers secret two-part tariffs to multiple retailers that compete in prices. Prior work on this setting has shown that, in equilibrium, wholesale prices equal marginal cost and profits vanish as retailers become undifferentiated. I extend the prior work by introducing demand uncertainty and downstream risk aversion. I show that if merely *a single* retailer is risk averse, *all* wholesale prices will lie above marginal cost. Intuitively, the manufacturer provides insurance to the risk-averse retailer by reducing its fixed fee and increasing the wholesale price above cost. The positive upstream margin in turn induces the manufacturer to divert sales toward the risk-averse retailer, which it does by increasing wholesale prices for the risk-neutral retailers as well. Relatedly, downstream risk aversion can increase industry and upstream profits compared to risk neutrality if retailers are close substitutes.

Keywords Vertical contracting · Opportunism problem · Two-part tariffs · Risk aversion · Price competition

JEL Classification D81 · L11 · L14

1 Introduction

When a manufacturer sells to competing retailers, it has an incentive to restrict intrabrand competition so as to exploit its market power. A fundamental idea in the vertical contracting literature is that the manufacturer can achieve this by using two-part tariffs: The manufacturer can increase its per-unit wholesale prices to offset retail competition and extract any downstream rents by the means of fixed fees. With this strategy, an upstream monopolist can earn the monopoly profit on its product irrespective of the number of retailers and how close substitutes they are (see, e.g., Mathewson & Winter, 1984).

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This result, however, presumes that the manufacturer's contract offers are publicly observable, which gives retailers full information about each other's supply terms. Such a level of transparency appears to be rare in practice. Instead, it might be more reasonable to assume that offers are *secret*, whereby the terms of each contract are private information to the manufacturer and the retailer in question. Secret contracting captures the compelling idea that a manufacturer may not be able to assure the retailers—despite any public pronouncements—that it is not secretly favoring one of them, for example by offering a lower wholesale price.

In an influential paper, O'Brien and Shaffer (1992) studied a model in which a manufacturer makes secret offers to $n \geq 2$ retailers that compete by setting prices. Their analysis suggests that, when offers are secret, two-part tariffs are completely ineffective for controlling competition. Intuitively, once the manufacturer cannot commit to a set of public contracts, retailers become wary of accepting high wholesale prices. A key result of O'Brien and Shaffer (1992) is that, in equilibrium, all wholesale prices must in fact be set equal to upstream marginal cost.[1] As a result, profits vanish when retailers become very close substitutes.

In this paper, I revisit the setting of O'Brien and Shaffer (1992), and add two elements to their framework: First, I assume that there is uncertainty about consumer demand at the contracting stage. Second, I assume that one retailer is *risk averse*, while the other $(n - 1)$ retailers remain risk neutral. Intuitively, the retailer can behave as risk averse, for example, because it has a risk-averse manager or faces short-term credit constraints (Nocke & Thanassoulis, 2014).

My main result is that these seemingly minor changes have a drastic effect on the opportunism problem: First, in the contract with the risk-averse firm, it is bilaterally optimal to reduce the risk that is borne by the retailer by reducing the fixed fee and increasing the wholesale price above cost. From the manufacturer's perspective, sales through this channel are therefore directly profitable at the margin. This, in turn, gives the manufacturer a robust incentive to divert sales toward the risk averse retailer, which it does by increasing wholesale prices also for the risk neutral retailers. Thus, although just a single retailer is risk averse, *all* equilibrium wholesale prices are above marginal cost.

The remainder of the paper is structured as follows: Sect. 1.1 presents the related literature. Section 2 lays out the model. Section 3 analyzes the model and presents the main result with general functional forms. Section 4 provides an example and studies the effect of risk aversion on profits. Section 5 concludes. Proofs and some supplementary material are relegated to the Appendix.

[1] This result is known as the "opportunism problem" in the vertical contracting literature. The result was first shown by Hart and Tirole (1990) under downstream Cournot competition (see also McAfee & Schwartz, 1994). Moreover, the opportunism problem has become influential in antitrust policy as an explanation for vertical mergers and vertical restraints (see, e.g., Marx & Shaffer, 2004; Rey & Tirole, 2007; Petrakis & Skartados, 2022).

1.1 Related Literature

This paper is closely related to the literature on secret contracting and retail price competition, where O'Brien and Shaffer (1992) is the seminal work. In more recent contributions, Montez (2015) studied a setting in which retailers are capacity constrained by their stocks when competing, while Gabrielsen and Johansen (2017) incorporated retail sales effort. My contribution is to examine the effect of demand uncertainty and risk aversion, which has not been done before.

The mechanism in my paper is also closely related to the mechanism in Gaudin (2019). He studies the opportunism problem when fixed fees are infeasible—that is, when contracts are linear. In my model, fixed fees are feasible but the extent to which they are used depends on risk preferences: If the retailer is very risk averse, the manufacturer may want to set a very small fixed fee and instead rely mostly on the per-unit price. My approach can thus be seen as providing a middle ground between the (exogenously) inefficient linear contracts in Gaudin (2019) and the perfectly efficient non-linear contracts in O'Brien and Shaffer (1992).[2]

Finally, my paper contributes to the literature on risk aversion and uncertainty in vertical relationships (e.g., Rey & Tirole, 1986; Nocke & Thanassoulis, 2014; Hansen & Motta, 2019; Ma & Tauman, 2021). Here, the conventional wisdom is that downstream risk aversion and uncertainty reduce the upstream firm's profit.[3] However, prior work has examined only public contracts. I show that when contracts are secret, risk aversion and uncertainty can mitigate the opportunism problem and thereby instead increase upstream profits (see Sect. 4 for an illustration).

2 Model

There is one manufacturer, M, and $n \geq 2$ differentiated retailers that are indexed by $i = 1, 2, \dots, n$. M has a constant marginal cost, $c \geq 0$. All other costs are set to zero. Retailer i's direct demand is $D_i(\mathbf{p}, \theta)$, where $\mathbf{p} = \left(p_1, \dots, p_n\right)$ and θ is a stochastic variable with bounded support that captures the state of demand. The demand system is symmetric. D_i is smooth whenever positive, downward-sloping in p_i, upward-sloping in θ and p_k, $\forall k \neq i$, and satisfies $\partial^2 D_i / \partial p_i \partial \theta > 0$, $\forall i$.

The timing is as follows. At $t = 1$, M makes simultaneous contract offers to the retailers. Each retailer then accepts or rejects. At $t = 2$, retailers compete in the

[2] Moreover, both Gaudin (2019) and the present paper obtain results that suggest that the manufacturer's opportunism problem may be less severe when retailers compete in prices, as opposed to competing in quantities. Gaudin (2019) finds that secret contracting yields higher (respectively, lower) wholesale prices than does public contracting when retailers compete in prices (resp., quantities). I find that, when one retailer is risk averse, all of the risk-neutral retailers are charged wholesale prices that are above marginal cost when retailers compete in prices; whereas these retailers would be charged wholesale prices equal to marginal cost if competition takes place in quantities (see Sect. 3.3 for further discussion).

[3] For example, Rey and Tirole (1986, p.928) state that *"The manufacturer has two objectives: 1) To ensure an optimal exploitation of monopoly power by the vertical structure; and 2) To provide adequate insurance to his retailers. These two objectives [...] conflict."*.

downstream market by setting prices. There are two key informational assumptions: First, contracts are secret: Terms that are offered to one retailer are never observed by any of its rivals. Second, there is demand uncertainty: θ is unknown to all firms at $t = 1$ (but becomes observable to retailers before they choose prices at $t = 2$).[4]

Following the literature on secret contracting with retail price competition (see Sect. 1.1), I adopt Crémer and Riordan 's (1987) *contract equilibrium* as the solution concept. In a contract equilibrium: 1) each retailer chooses its price while assuming that all its rivals choose their equilibrium prices; and 2) M offers retailer i the contract that maximizes M's (expected) profit, subject to retailer i's participation constraint, taking as fixed the equilibrium contracts of all other retailers, and the resulting retail pricing behavior. These properties are formalized in the analysis in Sect. 3.

The firms sign two-part tariffs, where w_i denotes the per-unit wholesale price and f_i denotes the fixed fee.[5] Profits can thus be written as $\pi_M = \sum_i^n \left[\left(w_i - c\right)D_i + f_i\right]$ and $\pi_i = \left(p_i - w_i\right)D_i - f_i$. I assume that all profit functions are concave in the relevant strategic variables, and that there exists a unique and stable equilibrium in retail prices at $t = 2$ for any vector of wholesale prices.

Without loss of generality, I assume that it is retailer 1 that is risk averse and that the $(n-1)$ retailers in the set $\{2, \dots, n\}$ are risk neutral. Formally, let $u_i\left(\pi_i\right)$ be a von Neumann-Morgenstern utility function that is defined over monetary outcomes, where $u_i' > 0$, $\forall i$. For retailer 1, this function is concave (or, equivalently, marginal utility is diminishing): $u_1'' = \left(u_1'\right)' < 0$. By contrast, for the other retailers, utility functions are linear (and marginal utility constant). M is also risk neutral. Risk preferences are assumed to be common knowledge.

3 Analysis

3.1 Retail Pricing

Starting at $t = 2$, the first-order condition for p_i, $\partial \pi_i / \partial p_i = 0$, is

$$D_i\left(p_i, \mathbf{p}_k^*, \theta\right) + \left(p_i - w_i\right) \frac{\partial D_i\left(p_i, \mathbf{p}_k^*, \theta\right)}{\partial p_i} = 0, \tag{1}$$

where $\mathbf{p}_k^*$ denotes the vector of equilibrium prices $\forall k \neq i$. This equation implicitly defines retailer i's optimal price response as a function of w_i and θ. I denote this price by $p_i^R(w_i, \theta)$.

It will also be useful to derive the pass-through rate of w_i to p_i^R. First, note that retailer i's marginal revenue can be defined as $MR_i(\mathbf{p}, \theta) := p_i + D_i / \left(\partial D_i / \partial p_i\right)$.

[4] Whether or not θ can be observed at $t = 2$ before prices are set is not critical. My assumption here is in line with, for example, Rey and Tirole (1986) and Nocke and Thanassoulis (2014).

[5] There is substantial empirical evidence that two-part tariffs are used in real-world markets, see, e.g., Lafontaine and Slade (2012) and Bonnet and Réquillart (2013).

Using this, we can rewrite (1), evaluated at $p_i = p_i^R$, as $MR_i\left(p_i^R, \mathbf{p}_k^*, \theta\right) = w_i$. By differentiating the latter equation with respect to w_i, we obtain

$$\frac{dp_i^R}{dw_i} = \left(\frac{\partial MR_i\left(p_i^R, \mathbf{p}_k^*, \theta\right)}{\partial p_i}\right)^{-1} > 0, \tag{2}$$

where the inequality follows from the concavity of retailer profits.[6]

3.2 Supply Contracting

Continuing at $t = 1$, let $\left(w_k^*, f_k^*\right)$ denote the equilibrium contract of any $k \neq i$, and let $\mathbf{p}_j^*$ denote the vector of retail prices $\forall j \neq i, k$. In the bilateral relationship with retailer i, M's problem can then be written as

$$\max_{w_i, f_i} \left\{ \mathbb{E}_\theta \left[\left(w_i - c\right) D_i\left(p_i^R, \mathbf{p}_k^*, \theta\right) + f_i + \sum_{k \neq i}^{n-1} \left[\left(w_k^* - c\right) D_k \left(p_k^*, p_i^R, \mathbf{p}_j^*, \theta\right) + f_k^* \right] \right] \right\},$$

subject to

$$\mathbb{E}_\theta \left[u_i\left(\left(p_i^R - w_i\right) D_i\left(p_i^R, \mathbf{p}_k^*, \theta\right) - f_i \right) \right] \geq 0.$$

Intuitively, retailer i will accept its offer if and only if it provides a non-negative expected utility of profits (taking as given the contracts of retailers $k \neq i$), where the utility function can be concave or linear depending on the retailer's risk preferences.

The manufacturer's problem can be solved with Lagrange's method. Denote the multiplier on retailer i's participation constraint by λ_i. The first-order condition for f_i is then simply

$$\mathbb{E}_\theta \left[1 + \lambda_i u_i' \right] = 0, \tag{3}$$

which implies $\lambda_i = -\left[\mathbb{E}_\theta\left[u_i'\right]\right]^{-1}$. Furthermore, the first-order condition for w_i can be written as

$$\begin{aligned} \mathbb{E}_\theta \Bigg[D_i + \left(w_i - c\right) \frac{\partial D_i}{\partial p_i} \frac{dp_i^R}{dw_i} + \sum_{k \neq i}^{n-1} \left(w_k^* - c\right) \frac{\partial D_k}{\partial p_i} \frac{dp_i^R}{dw_i} \\ - \lambda_i \left[u_i' \times \left(\left(\frac{dp_i^R}{dw_i} - 1 \right) D_i + \left(p_i^R - w_i\right) \frac{\partial D_i}{\partial p_i} \frac{dp_i^R}{dw_i} \right) \right] \Bigg] = 0. \end{aligned} \tag{4}$$

By using (1), (2), and substituting for λ_i, (4) can be simplified and rewritten as

[6] Using (1), we obtain $\partial^2 \pi_i / \partial p_i^2 = 2\left(\partial D_i / \partial p_i\right) - \left[D_i / \left(\partial D_i / \partial p_i\right)\right]\left(\partial^2 D_i / \partial p_i^2\right)$. We also have $\partial MR_i / \partial p_i = 2 - \left[D_i / \left(\partial D_i / \partial p_i\right)^2\right]\left(\partial^2 D_i / \partial p_i^2\right)$. Thus, $\partial^2 \pi_i / \partial p_i^2 < 0 \implies \partial MR_i / \partial p_i > 0$.

$$\mathbb{E}_\theta\left[\left(w_i - c\right)\frac{\partial D_i}{\partial p_i} + \sum_{k\neq i}^{n-1}\left(w_k^* - c\right)\frac{\partial D_k}{\partial p_i}\right] + \mathbb{E}_\theta\left[\frac{\partial MR_i}{\partial p_i}\right]\mu_i = 0, \tag{5}$$

where

$$\mu_i := \frac{\operatorname{cov}\left(u_i', D_i\right)}{-\mathbb{E}_\theta\left[u_i'\right]}$$

and $\operatorname{cov}\left(u_i', D_i\right) := \mathbb{E}_\theta\left[u_i' D_i\right] - \mathbb{E}_\theta\left[u_i'\right]\mathbb{E}_\theta\left[D_i\right]$.

The term μ_i is known in the literature on risk-averse firms as the "marginal risk premium." Its value depends on the firm's risk preferences. For the risk averse retailer 1, we have $\mu_1 > 0$. Intuitively, under risk aversion, the covariance between quantity demanded and marginal utility is negative (i.e., $\operatorname{cov}\left(u_i', D_i\right) < 0$), because a better demand state increases flow profits and reduces marginal utility. By contrast, for a risk neutral retailer, marginal utility is constant, and the covariance, and thereby also the risk premium, equals zero (i.e., $\mu_2 = \mu_3 = \cdots = \mu_n = 0$).

3.3 Main Result

In the following, I use the subscript k to refer to any retailer in the set $\{2, \dots, n\}$. I denote equilibrium wholesale prices by w_1^* and w_k^*, $\forall k$. Moreover, I denote the resulting retail prices by $p_1^* = p_1^R\left(w_1^*, \theta\right)$ and $p_k^* = p_k^R\left(w_k^*, \theta\right)$, and the equilibrium price vector by $\mathbf{p}^* = (p_1^*, \dots, p_n^*)$.

In a contract equilibrium, w_1^* and w_k^* will be determined through (5). This system of equations can be written in matrix form as $(\mathbf{w} - \mathbf{c})\mathbb{E}_\theta[\mathbf{D}] = \mathbf{m}$, where $\mathbf{w} = \left(w_1^*, \dots, w_n^*\right)$; $\mathbf{c} = (c, \dots, c)$; $\mathbf{m} = \left(-\mathbb{E}_\theta\left[\partial MR_1/\partial p_1\right]\mu_1, 0, \dots, 0\right)$; $\mathbf{D}$ is an n-by-n Jacobian matrix; and $\mathbf{m}$ and $\mathbf{D}$ are evaluated at $\mathbf{p}^*$. By the invertible matrix theorem, the equation $(\mathbf{w} - \mathbf{c})\mathbb{E}_\theta[\mathbf{D}] = \mathbf{m}$ has a unique solution in wholesale prices if $\det(\mathbf{D}) \neq 0$.

It can be shown (see the proof of Proposition 1 in the Appendix) that a sufficient condition for $\det(\mathbf{D}) \neq 0$ is

$$\mathbb{E}_\theta\left[\Delta(\mathbf{p})\right] > 0, \tag{6}$$

where

$$\Delta(\mathbf{p}) := \frac{\partial D_1}{\partial p_1}\left[\frac{\partial D_k}{\partial p_k} + (n-2)\frac{\partial D_k}{\partial p_j}\right] - (n-1)\frac{\partial D_1}{\partial p_k}\frac{\partial D_k}{\partial p_1}, \quad j \neq k.$$

It is important to note that there may exist circumstances under which (6) does *not* hold. In such cases, a contract equilibrium may *not* exist. In particular, the condition may be violated if retailers are sufficiently close substitutes, that is, when the cross-partial derivatives of demand are sufficiently large. I will analyze and discuss this potential non-existence problem further in the example in Sect. 4. In the remainder of this section, however, I assume that (6) is satisfied, $\forall\,\mathbf{p}$.

The main result can now be stated as follows:

Proposition 1 *Suppose that* (6) *holds. Then, in any contract equilibrium, wholesale margins are given by*

$$w_1^* - c = \mathbb{E}_\theta \left[\frac{-\left(\frac{\partial D_k}{\partial p_k} + (n-2) \frac{\partial D_k}{\partial p_j} \right)}{\Delta \left(\frac{\partial MR_1}{\partial p_1} \right)^{-1}} \right] \mu_1 > 0 \tag{7}$$

for the risk averse retailer 1, *and by*

$$w_k^* - c = \mathbb{E}_\theta \left[\frac{\frac{\partial D_1}{\partial p_k}}{\Delta \left(\frac{\partial MR_1}{\partial p_1} \right)^{-1}} \right] \mu_1 > 0 \tag{8}$$

for any risk neutral retailer $k \in \{2, \dots, n\}$, *where all functions are evaluated at* $\mathbf{p}^*$.

Proof See the Appendix. □

This result shows that, when demand is uncertain, the presence of a single risk averse retailer has a striking effect on M's opportunism problem. Indeed, if none of the retailers were risk averse—if also $\mu_1 = 0$—no wholesale price would exceed marginal cost, as is typically found in prior work. By contrast, when just a single retailer is risk averse—when $\mu_1 > 0$—*all* wholesale prices exceed marginal cost.

Intuitively, demand uncertainty and risk aversion create a countervailing effect that mitigates the opportunism problem. First, in the relationship with retailer 1, M reduces the fixed fee (compared to under risk neutrality) and increases the wholesale price above marginal cost so as to reduce the retailer's exposure to downside risk. In essence, M is engaging in risk-sharing with retailer 1. This contract then has a ripple effect throughout the supply network: The positive margin that is earned on sales to retailer 1 gives M a robust incentive to divert more sales to this retailer. This is done by increasing the wholesale prices also for retailers $\{2, \dots, n\}$, which induces them to increase their retail prices, and in turn induces consumers to substitute toward retailer 1.

While the opportunism problem is less extreme here than in O'Brien and Shaffer (1992), note that the lack of commitment power brought about by secret contracting remains a disadvantage for M. First, the equilibrium wholesale prices here cannot be fine-tuned to the monopoly level as under public contracting. Moreover, M's equilibrium choice of w_k does not take account of diversion from other retailers to k, since there is no bilaterally robust incentive to have a positive upstream margin with retailer k. Yet, as long as such an incentive exists with retailer 1, M can sustain $w_k^* > c$ to internalize some competitive pressure from k to 1.

The equilibrium wholesale prices depend on model parameters in intuitive ways. For example, w_1^* increases with retailer 1's risk aversion level, which is given by the degree of concavity of u_1, and decreases with the pass-through rate, which is given by $\left(\partial MR_1/\partial p_1\right)^{-1}$.[7] It is also intuitive that these properties carry over to w_k^*. Indeed, a higher (lower) margin with retailer 1 gives M a stronger (weaker) incentive to divert customers away from the other retailers, ceteris paribus.

With respect to the comparison of w_1^* and w_k^*, (7) and (8) yield[8]

$$w_1^* > w_k^* \iff \frac{\frac{\partial D_1}{\partial p_k}}{-\frac{\partial D_k}{\partial p_k}} + (n-2)\frac{\frac{\partial D_j}{\partial p_k}}{-\frac{\partial D_k}{\partial p_k}} < 1. \tag{9}$$

Starting with the duopoly case ($n = 2$), we see that $w_1^* > w_2^*$, since the diversion ratio from retailer 2 to retailer 1, that is $\left(\partial D_1/\partial p_2\right)/\left(-\partial D_2/\partial p_2\right)$, is typically below one. (See also (11) for an illustration.) Interestingly though, when $n \geq 3$, the ranking may be reversed to $w_1^* < w_k^*$ if the cross-price effect among the risk-neutral retailers k and j is particularly large when evaluated at $\mathbf{p}^*$.[9]

Since the presence of a risk averse retailer increases all wholesale prices, it also softens competition in the downstream market. Consequently, one may suspect that this risk aversion can also increase profits, compared to the standard opportunism outcome where wholesale prices equal marginal cost and competition is unchecked. However, from the manufacturer's perspective, there is also a downside to dealing with a retailer that is risk averse: This limits the rent that can be extracted through the fixed fee. In Sect. 4, I analyze these and other issues with the use of a more specific example.

I close this section with two remarks about Proposition 1: First, the logic that retailer 1's contract can have a ripple effect onto the other contracts holds irrespective of *why* $w_1 > c$ is bilaterally optimal. Thus, results similar to Proposition 1 would hold also for contractual frictions other than risk sharing.[10] Second, the result is specific to retail *price* competition. Indeed, under *quantity* competition, the wholesale prices of retailers $k \neq 1$ would not affect the revenue from retailer 1 in M's profit function at $t = 1$ (see Rey & Vergé, 2004) and the ripple effect would not occur. Thus, in that case, we would have $w_k^* = c$ even though $w_1^* > c$.[11]

[7] Intuitively, a higher pass-through rate means that the manufacturer faces a more elastic derived demand curve, which incentivizes it to set a lower input price, ceteris paribus.

[8] Note that, by symmetry, $\partial D_j/\partial p_k = \partial D_k/\partial p_j$.

[9] For example, if $n = 3$, we have $w_1^* < w_2^* = w_3^*$ if $\partial D_3/\partial p_2 > -\left(\partial D_1/\partial p_2 + \partial D_2/\partial p_2\right)$ at $\mathbf{p}^*$, which is feasible under (6).

[10] In the Appendix I illustrate this point formally by using the reduced-form approach that was recently proposed by Calzolari et al. (2020).

[11] See Lømo (2020) for an analysis of secret contracting with quantity competition and (symmetric) risk aversion.

4 Example

I now consider an example with $n = 2$ and inverse demand $p_i = a + \theta - q_i - bq_k$, $i \neq k \in \{1, 2\}$, where a is base demand and $b \in (0, 1)$ measures the willingness of a representative consumer to substitute between retailers. This system of inverse demands gives rise to linear direct demand functions:

$$D_i(\mathbf{p}, \theta) = \frac{a + \theta - p_i - b\left(a + \theta - p_j\right)}{(1 - b)(1 + b)}. \tag{10}$$

Further, I assume now that θ can take two values, H ("high") or L ("low"), with equal probabilities, where $H > L$ and $a + L > c$. Finally, I assume that retailer 1 is "infinitely" risk averse in the sense that it requires a non-negative payoff in the worst-case scenario $\theta = L$. Retailer 2 is risk neutral.

Under these assumptions, it can be shown that, if a contract equilibrium exists, the wholesale prices will be

$$w_1^* = c + \frac{(H - L)}{2(1 + b)} \qquad \text{and} \qquad w_2^* = c + \frac{b(H - L)}{2(1 + b)}. \tag{11}$$

Given these wholesale prices, retail quantities will be non-negative in both demand states if H is not too large, that is, $H \leq \beta := (2 + b)(a - c) + (3 + b)L$.

Moreover, it can be shown that the corresponding fixed fees are

$$F_1^* = \frac{(1 - b)(\beta - H)^2}{(1 + b)\left(4 - b^2\right)^2} \qquad \text{and} \qquad F_2^* = \frac{(1 - b)^2\phi}{\left(1 - b^2\right)\left(4 - b^2\right)^2}, \tag{12}$$

where $\phi := \frac{1}{32}\left[\left(4(\beta - L) + b^2(H - L)\right)^2 + \left(4(\beta + 2H - 3L) - b^2(H - L)\right)^2\right] > 0$.

Before analyzing the profit effects of risk aversion, I address further the potential non-existence problem that was noted in Sect. 3.3. The underlying reason for this issue is the asymmetry of risk preferences: that one retailer is risk averse and the other retailer(s) is (are) risk neutral. In particular, a (candidate) contract equilibrium may be vulnerable to deviations where M offers a very low wholesale price to retailer 2. This can be profitable for M since retailer 2 then can outcompete retailer 1 (who's wholesale price is higher for insurance purposes) and pay a high fixed fee. If such a profitable deviation exists, the candidate is not, in fact, an equilibrium.

As was noted in Sect. 3.3, it is when retailers are close substitutes that a contract equilibrium may fail to exist. The intuition for this is two-fold: First, when retailers are close substitutes, retailer 2 would be able to steal a large quantity of sales from retailer 1 if the former were to receive a lower wholesale price. This increases the potential upside from a deviation. Second, a high level of substitution means that not much variety would be lost if retailer 1's market share were to become very small. This decreases the potential downside from a deviation.

In addition, the scope for profitable deviations may depend on other factors. In the current example, profitable deviations are more likely to exist if the gap between demand states, that is $(H - L)$, is larger. Intuitively, if this gap is larger,

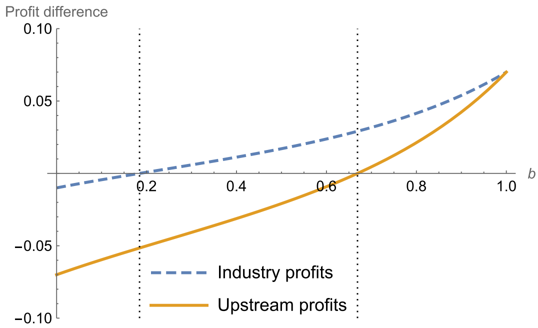

Fig. 1 The effect of risk aversion on upstream profits (M's profit) and industry profits (the combined profit of M and both retailers)

there is more uncertainty about demand at $t = 1$, and retailer 1 should therefore pay a higher wholesale price, ceteris paribus (see (11)). In that case, it is relatively easier for retailer 2 to outcompete retailer 1, in the sense that the price cut that is required to do so becomes smaller. To summarize, the current example may have non-existence of contract equilibria when: i) b is high (i.e., close to 1); and ii) H is large relative to L.[12]

With this important caveat in mind, let us now examine the profit effects of retailer risk aversion, given that a contract equilibrium exists. Figure 1 illustrates the differences in profits between an equilibrium with risk aversion, where w_1^* and w_2^* are as given in (11), and the outcome under risk neutrality in which $w_1^* = w_2^* = c$ (the curves are plotted for $a = 1$, $c = 0.5$, $H = 0.5$, and $L = 0.1$).

The main takeaway from Fig. 1 is that risk aversion can provide higher profits than does risk neutrality when retailers are sufficiently close substitutes: Risk aversion raises the aggregate *industry* profits when b is higher than 0.18 (the left dashed line), and raises *upstream* profits when b is higher than 0.67 (the right dashed line).[13] The basic intuition is that, when downstream competition is fierce, profits under risk neutrality (with wholesale prices at marginal cost) are relatively small. Risk aversion can then yield higher profits by increasing wholesale prices and thereby softening competition.

Moreover, we see from Fig. 1 that the threshold level of substitution above which risk aversion is profitable is lower for industry profits than for upstream profits. This is also intuitive. Indeed, risk aversion can increase the aggregate industry profits and yet reduce upstream profits, as the manufacturer must give up a risk premium to retailer 1 through the fixed fee, and thus extract a smaller slice of a bigger pie. In Fig. 1, this happens in the intermediate region where $0.18 < b < 0.67$.

[12] To illustrate this formally, suppose (without loss of generality) that $a = 1$, $c = 0$, and $L = 0$, and consider the limiting case in which retailers become perfect substitutes: $b \to 1$. In this case, it can be shown that, starting from the wholesale prices in (11), M has profitable deviations with retailer 2 (which involve setting $w_2 = 0$) if $H > 2$. Conversely, if $H \leq 2$, such deviations will not be profitable. (Note that the upper bound for H for these parameter values is $\beta = 3$.) I am extremely grateful to an anonymous referee for highlighting the potential existence problems and providing these numerical examples.

[13] Moreover, risk aversion ensures that industry profits remain strictly positive even as retailers become undifferentiated. Indeed, if we assume that (11) constitute equilibrium prices in this limit, it can be shown that industry profits converge to $(1/16)[4(a-c) + H + 3L](H-L) > 0$ as $b \to 1$.

Finally, it is interesting to examine how each retailer contributes to M's profit in the risk aversion equilibrium vis-à-vis the risk neutrality benchmark. Note first that, in the benchmark, M earns the same profit from each retailer due to symmetry. By contrast, in the equilibrium with risk aversion, it can be shown that M earns strictly less from the risk-averse retailer than from the risk-neutral retailer. This holds irrespective of whether total upstream profits are higher or lower than in the benchmark. This result occurs because the risk-averse retailer purchases a smaller quantity, and because M must reduce its fixed fee so as to compensate the retailer for being exposed to downside risk.[14]

5 Conclusion

This paper has studied a model where a manufacturer offers secret two-part tariffs to several retailers that face demand uncertainty and compete in prices. The main result is that if *a single* retailer is risk averse, *all* wholesale prices exceed marginal cost in equilibrium. Using a linear demand example, I also find that downstream risk aversion can increase industry and upstream profits (compared to risk neutrality) if retailers are sufficiently close substitutes. These results stand in contrast to prior work on secret contracts and retail price competition, where wholesale prices equal marginal cost and profits vanish as retailers become undifferentiated.

Since a downstream imperfection (risk aversion) can increase upstream profits, this further raises the question of whether an upstream firm could artificially create such an imperfection. If so, the classic opportunism problem with two-part tariffs—whereby wholesale prices equal marginal cost—may be less relevant. For example, an upstream firm could create an imperfection by picking (at least) one risk-averse retailer to deal with or by unilaterally creating uncertainty about the demand for its product. Yet, endogenizing risk aversion or uncertainty in this way may also raise new and subtle issues—especially if risk preferences are the retailers' private information. Formally analyzing these questions stands out as an interesting avenue for future research.

Appendix

Proof of Proposition 1 Note first that, due to symmetry of the demand system, we can write $\partial D_k/\partial p_k$ for the own-price effect for any $k \in \{2, \dots, n\}$; $\partial D_k/\partial p_1$ for the cross-price effect from 1 to any k, $\partial D_1/\partial p_k$ for the cross-price effect from any k to 1, and $\partial D_k/\partial p_j$ for the cross-price effect between k and j, $\forall k \neq j$. Given this, we obtain the matrix equation $(\mathbf{w} - \mathbf{c})\mathbb{E}_\theta[\mathbf{D}] = \mathbf{m}$, where

[14] On the other hand, retailer 1 also pays a higher wholesale price (see (11)), but this effect is dominated by the effects on the quantity and the fixed fee.

$$\mathbf{w} := \begin{bmatrix} w_1^* \\ w_2^* \\ \vdots \\ w_n^* \end{bmatrix}, \quad \mathbf{c} := \begin{bmatrix} c \\ c \\ \vdots \\ c \end{bmatrix}, \quad \mathbf{D} := \begin{bmatrix} \frac{\partial D_1}{\partial p_1} & \frac{\partial D_k}{\partial p_1} & \cdots & \frac{\partial D_k}{\partial p_1} \\ \frac{\partial D_1}{\partial p_k} & \frac{\partial D_k}{\partial p_k} & \cdots & \frac{\partial D_k}{\partial p_j} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{\partial D_1}{\partial p_k} & \frac{\partial D_k}{\partial p_j} & \cdots & \frac{\partial D_k}{\partial p_k} \end{bmatrix}, \quad \mathbf{m} := \begin{bmatrix} -\frac{\partial MR_1}{\partial p_1}\mu_1 \\ 0 \\ \vdots \\ 0 \end{bmatrix},$$

and where the elements of $\mathbf{D}$ and $\mathbf{m}$ are evaluated at $\mathbf{p}^*$.

It is easily verified that

$$\det(\mathbf{D}) = \left(\frac{\partial D_1}{\partial p_1} - \frac{\partial D_k}{\partial p_j}\right)^{(n-2)} \times \Delta. \tag{13}$$

Note that $\mathbb{E}_\theta[\det(\mathbf{D})] \neq 0$ under (6) (as clearly $\partial D_1/\partial p_1 \neq \partial D_k/\partial p_j$). Thus, $\mathbf{D}$ is non-singular, and, by the invertible matrix theorem, $(\mathbf{w} - \mathbf{c})\mathbb{E}_\theta[\mathbf{D}] = \mathbf{m}$ has a unique solution.

Let $\mathbf{D}_i$ be the matrix where $\mathbf{m}$ replaces the i-th column of $\mathbf{D}$. For $i = 1$, we have

$$\det\left(\mathbf{D}_1\right) = -\left(\frac{\partial D_1}{\partial p_1} - \frac{\partial D_k}{\partial p_j}\right)^{(n-2)} \left(\frac{\partial D_k}{\partial p_k} + (n-2)\frac{\partial D_k}{\partial p_j}\right)\frac{\partial MR_1}{\partial p_1}\mu_1. \tag{14}$$

Using Cramer's rule with (13) and (14) yields (7). With the use of the fact that $\partial D_1/\partial p_1 < 0$, $\partial D_k/\partial p_1 > 0$, and $\partial D_1/\partial p_k > 0$, it is straightforward to show that the numerator of (7) is positive when (6) holds. Finally, $\forall k$, we have

$$\det\left(\mathbf{D}_k\right) = \left(\left(\frac{\partial D_1}{\partial p_1} - \frac{\partial D_k}{\partial p_j}\right)^{(n-2)} \frac{\partial D_1}{\partial p_k}\right)\frac{\partial MR_1}{\partial p_1}\mu_1. \tag{15}$$

Using Cramer's rule with (13) and (15) yields (8). □

Reduced-form approach. For this analysis, I remove risk aversion and uncertainty from the model: i) There is no state variable that affects demand, that is, demand is only a function of prices (the demand function is $D_i(\mathbf{p})$); and ii) retailers do not have utility functions over monetary outcomes; they simply care about profits.

Instead, I now follow Calzolari et al. (2020) in assuming that fixed fees entail deadweight losses. Formally, for any payment $f_i > 0$ that is received by M, retailer i loses an amount $\left(1 + \alpha_i\right)f_i$, where $\alpha_i \geq 0$. The parameter α_i may capture distortions that are due to risk sharing (as above), or alternatively: adverse selection; upstream moral hazard; or managerial loss aversion (on the last, see Ho & Zhang, 2008). Furthermore, following the asymmetric set-up, I assume $\alpha_1 = \alpha > 0$ and $\alpha_k = 0$, $\forall k \in \{2, \dots, n\}$. All other features are the same as in the main model. (Note, however, that since demand is deterministic, (6) now simply becomes $\Delta(\mathbf{p}) > 0$.)

Given the above, the same approach as in Sect. 3 can be used to show that any contract equilibrium will have wholesale margins given by

$$w_1^* - c = \frac{-\left(\frac{\partial D_k}{\partial p_k} + (n-2)\frac{\partial D_k}{\partial p_j}\right)}{\Delta\left(\frac{\partial MR_1}{\partial p_1}\right)^{-1}}\left(\frac{\alpha}{1+\alpha}D_1\right), \tag{16}$$

and

$$w_k^* - c = \frac{\frac{\partial D_1}{\partial p_k}}{\Delta\left(\frac{\partial MR_1}{\partial p_1}\right)^{-1}}\left(\frac{\alpha}{1+\alpha}D_1\right), \tag{17}$$

where all functions are evaluated at $\mathbf{p}^*$.

Formulas (16) and (17) correspond to (7) and (8) in the main text. In line with Proposition 1, we see that all wholesale prices exceed marginal cost, even though the deadweight loss $\alpha > 0$ applies only to retailer 1's fixed payment. Intuitively, when $D_1 > 0$, the term $\left[\alpha/(1+\alpha)\right]D_1 > 0$ reflects the bilateral benefit of M and retailer 1 from marginally increasing w_1 above c—as opposed to M setting $w_1 = c$ and relying only on f_1 for extracting downstream rents.

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Declarations

Conflict of interest The authors declare no conflict of interest.

References

Bonnet, C., & Réquillart, V. (2013). Impact of cost shocks on consumer prices in vertically-related markets: The case of the French soft drink market. *American Journal of Agricultural Economics, 95*(5), 1088–1108.

Calzolari, G., Denicolò, V., & Zanchettin, P. (2020). The demand-boost theory of exclusive dealing. *RAND Journal of Economics, 51*(3), 713–738.

Crémer, J., & Riordan, M. H. (1987). On governing multilateral transactions with bilateral contracts. *RAND Journal of Economics, 18*(3), 436–451.

Gabrielsen, T. S., & Johansen, B. O. (2017). Resale price maintenance with secret contracts and retail service externalities. *American Economic Journal: Microeconomics, 9*(1), 63–87.

Gaudin, G. (2019). Vertical relations, opportunism, and welfare. *RAND Journal of Economics, 50*(2), 342–358.

Hansen, S., & Motta, M. (2019). Vertical exclusion with downstream risk aversion or limited liability. *Journal of Industrial Economics, 67*(3–4), 409–447.

Hart, O., & Tirole, J. (1990). 'Vertical integration and market foreclosure', Brookings papers on economic activity. *Microeconomics, 1990*, 205–286.

Ho, T.-H., & Zhang, J. (2008). Designing pricing contracts for boundedly rational customers: Does the framing of the fixed fee matter? *Management Science, 54*(4), 686–700.

Lafontaine, F. & Slade, M. (2012). *Inter-firm contracts: Evidence, handbook of organizational economics* (pp. 958–1013).

Lømo, T. L. (2020). Vertical control, opportunism, and risk sharing. *Economics Letters, 191*, 109114.

Ma, S., & Tauman, Y. (2021). Licensing of a new product innovation with risk averse agents. *Review of Industrial Organization, 59*(1), 79–102.

Marx, L. M., & Shaffer, G. (2004). Opportunism in multilateral vertical contracting: Nondiscrimination, exclusivity, and uniformity: Comment. *American Economic Review, 94*(3), 796–801.

Mathewson, G. F., & Winter, R. A. (1984). An economic theory of vertical restraints. *RAND Journal of Economics, 15*(1), 27–38.

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

Montez, J. (2015). Controlling opportunism in vertical contracting when production precedes sales. *RAND Journal of Economics, 46*(3), 650–670.

Nocke, V., & Thanassoulis, J. (2014). Vertical relations under credit constraints. *Journal of the European Economic Association, 12*(2), 337–367.

O'Brien, D. P., & Shaffer, G. (1992). Vertical control with bilateral contracts. *RAND Journal of Economics, 23*(3), 299–308.

Petrakis, E., & Skartados, P. (2022). Vertical opportunism, bargaining, and share-based agreements. *Review of Industrial Organization, 60*(4), 549–565.

Rey, P., & Tirole, J. (1986). The logic of vertical restraints. *American Economic Review, 76*(5), 921–939.

Rey, P., & Tirole, J. (2007). A primer on foreclosure. *Handbook of Industrial Organization, 3*, 2145–2220.

Rey, P., & Vergé, T. (2004). Bilateral control with vertical contracts. *RAND Journal of Economics, 35*(4), 728–746.