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THE BUYER POWER OF MULTIPRODUCT RETAILERS: COMPETITION WITH ONE-STOP SHOPPING.

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The buyer power of multiproduct retailers: Competition with one-stop shopping[*]

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Abstract

This paper illustrates how, in local retail markets, a multiproduct retailer may gain buyer power when some consumers are one-stop shoppers (multi-product shoppers). We consider a model where independent suppliers negotiate terms of trade with a large multiproduct retailer and a group of smaller single product retailers, respectively. We find that an increase in the share of one-stop shoppers intensifies the degree of competition between the retailers, and hence reduces the overall industry profit – while at the same time enabling the multiproduct retailer to obtain discounts from its suppliers, in the form of lower fixed fees. We also show that the presence of a large retailer may positively affect the suppliers' incentives to invest in product quality or cost reductions.

1   Introduction

The increased supply and demand for one-stop shopping opportunities is one of the important changes in retailing over the recent decades. In the presence of shopping costs, and with growing opportunity costs of time, consumers increasingly prefer to fix all their purchases to a single weekday – to reduce both the number of shopping trips and the amount of time spent shopping (OECD, 1999; UK Competition Commission, 2000). Alongside this development in consumer behaviour, or as a consequence of it, many retailers have drastically increased their size and assortment of products.[1] We have seen the success of large, "big-box" retailers, such as Wal-Mart, Carrefour, and Tesco, who stock tens of thousands of products lines under one roof.

In light of these trends, there has been a growing concern among policy makers and competition authorities that manufacturers may have become adversely affected. A sometimes expressed view is that the growing size of retail outlets, together with the trend towards one-stop shopping behaviour, where consumers purchase a whole basket of goods at each shopping trip, has contributed to the buyer power of retailers' against their manufacturers (Inderst and Mazorotto, 2006).[2] The fear is that, as retailers capture a bigger share of the total profit, manufacturers will respond by cutting back on innovation and product development, and that consumers will suffer as a result.

Despite the great public interest, to our knowledge there is no formal theory that relates the one-stop shopping phenomenon to the bargaining power of multiproduct retailers. Moreover, the existing literature says little or nothing about how, in one-stop shopping markets, the "polarization in store size", in Chen's (2003) words, affects buyer power. This paper aims to fill this gap, by analysing the balance of power among manufacturers and multiproduct retailers that operate in the presence of one-stop shopping, and the welfare and public policy implications of increasing retailer size and the one-stop shopping phenomenon.

Large retailers have in part replaced and in part come in addition to smaller conve-

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[1] The UK Competition Commission (2000) found that the average supermarket store size in 1997-98 was around 2.325 square metres compared with an average of less than 1.860 square metres five years earlier.

[2] This concern is clearly expressed e.g. the OECD (1999) report on the buying power of multiproduct retailers: "Because of significant economies of scope in shopping, many consumers prefer infrequent, one-stop shopping [...] If consumers preferring fewer, one-stop shopping trips find that their primary store is no longer carrying a specific good, they may be more willing to substitute a similar good than eventually to change stores to find the missing product. Where a sufficient number of consumers display that behaviour, the result will be significant buyer power..." (p. 8) Similar concerns are expressed in European Comission (1999).

nience stores and specialised corner shops, who offer a more limited variety. However, in many countries, public policy puts restrictions on both the number and size of large outlets. This is due to both local planning restrictions and/ or policies that more intentionally seek to protect smaller retailers. The mode of competition has therefore become one where a few very large retail outlets (out-of-town or edge-of-town superstores) compete against groups of smaller retailers (e.g. a shopping street), each carrying a narrower range of products. In line with this, we consider a downstream market where a multiproduct retailer competes against a group of single-product retailers in the presence of one-stop shopping. The upstream market consists of a number of (monopolist) suppliers that manufacture independent products. Each manufacturer negotiate a bilateral efficient (two-part) contract with both a single-product retailer and the multiproduct retailer, before competition takes place in the downstream market. To model the increase in one-stop shopping behaviour, we consider two types of consumers; one-stop shoppers, who buy all products, and top-up (single product) shoppers, each buying one specific product only.

We find that as the share of one-stop shoppers increases, holding total demand for each product constant, a multiproduct retailer chooses to reduce its prices to internalise the demand externalities created by the consumers that bundle their purchases. As a result, single-product retailers have to reduce their prices as well. Hence, as more and more consumers bundle their purchases, downstream competition becomes tougher, and total industry profit falls. In turn this affects the negotiations between the large retailer and its manufacturers. We find that when the share of one-stop shoppers grows, at first the incremental gains from trade between a manufacturer and a large retailer, are reduced. When the number of one-stop shoppers is not too high, the multiproduct retailer is therefore able to extract more rent from each of its manufacturers, and, as a result, earns a larger share of a smaller overall profit. The manufacturers, on the other hand, in addition to being squeezed by the multiproduct retailer, earn less profit from their small retailers, who have difficulty competing against the large retailer in the presence of one-stop shopping. The latter result provides some support for the claim that "the combined trend towards larger outlets and all-in-oneshopping trips", in the words of Inderst and Mazarotto (2006 p. 14), has contributed to a shift in power towards large retailers – to the detriment of both manufacturers and smaller shops.

However, we also find that when the share of one-stop shoppers becomes sufficiently high, and competition for these consumers becomes fierce, it becomes more and more costly for a large retailer to delist a product. The reason is that when competition is though, by delisting one product the retailer risks losing demand also for the rest of its products; if prices are low enough, some one-stop shoppers will shift their attention to the

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smaller retailers to obtain the full assortment of goods – and in doing so they take all their demand with them. When there is a significant number of one-stop shoppers, the retailers' assortment is therefore of greater importance when it comes to bringing consumers to the store. The incremental gain to the multiproduct retailer from stocking a manufacturer's product may be higher in this case, which implies that the manufacturer can extract more profit in negotiations with the large retailer. A manufacturer's profit may therefore be a non-monotonic function of the number of one-stop shoppers; decreasing for low numbers of one-stop shoppers, and then increasing, for higher numbers of one-stop shoppers.

We also analyse the effect that the large retailer may have on the manufacturers incentives to innovate. Specifically, we consider the incentives of manufacturers to further increase the quality of their products (increasing consumers' willingness to pay) or to further reduce their marginal production costs. We find that, even if manufacturers earn lower profits, they can counteract the power of the large retailer by making an effort to become more efficient or to improve the quality of their products. By offering their products at lower costs (or higher quality), the manufacturers are able to "tempt" more one-stop shoppers to switch shopping location should the large retailer delists one of their products. In turn, this undermines the value of the large retailer's disagreement payoff, and increases the fixed fee that the manufacturer can charge in the negotiations with the retailer.

We also briefly explore possible effects on product entry. The results here are less clear; the conclusion largly depends on assumptions about the distribution of fixed entry costs between different types of manufacturers. However, with a uniform entry cost, under certain conditions it can be shown that the number of manufacturers that enter the upstream market is always weakly smaller when facing a multiproduct retailer, compared to the case with only single-product retailers.

Hence, according to our model, the presence of a larger retailer contributes to more competition and lower prices for consumers in the short run, and may stimulate manufacturers to produce their products at lower costs (or higher qualities) in the long run. The effect on product variety is less clear. It may be that, by squeezing the profits of its manufacturers, a multiproduct retailer reduces the incentives for new manufacturers to enter the industry. The long-run implications are therefore unclear.

Related Literature   This paper relates to the growing literature that analyse the effects of buyer power on both short-term and long-term welfare.[3] Much of the early work

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[3]See Inderst and Mazorotto (2006, 2008) and Inderst and Shaffer (2008). They discuss the welfare implications of buyer power, and give a thorough review of the literature.

focus on short term effects, i.e. the incentives of strong retailers to pass on discounts from their manufacturers to their consumers. See e.g. von Ungern-Sternberg (1996), Dobson and Waterson (1997) and Chen (2003). Since we assume that manufacturers and retailers use secret and non-linear (two-part) tariffs, we largely ignore these effects in our paper. However, there is a competition effect in our model, in that the presence of multiproduct retailers creates tougher competition in the downstream market, which in turn yields lower prices for the consumer.

There are also a number of papers that analyse how buyers may obtain discounts due to their size. This branch of the literature mainly focuses on cross-border mergers between retailers (i.e., the creation of retail chains). See e.g. the seminal work by Katz (1987), Inderst and Wey (2003, 2007, 2011), Vieira-Montez (2007) and Inderst and Shaffer (2007). In contrast, we formalise the buyer power that may arise from the size of local retail outlets, measured as the number of independent products (or product lines) that the retailer stocks under one roof.

Of the papers that focus on buyer power and dynamic efficiency, it is interesting to note the very different results obtained by e.g. Battigalli et al. (2007) and Inderst and Wey (2011) respectively, although in two very different models. Battigalli et al. find that an increase in buyer power, measured as an increase in the degree of differentiation between the retailers (less downstream rivalry), aggravates the hold-up problem and thus reduces the manufacturers investments in quality improvements. Inderst and Wey, on the other hand, building on the work by Katz (1987), show that large buyers have more credible outside options, which means that they can extract more of the total surplus in the negotations with the manufacturer. However, even though the buyer extracts more of the total surplus, Inderst and Wey are able to show that large buyers may provide the manufacturer with stronger incentives to innovate, since investing in e.g. lower marginal costs contributes to reducing the value of the buyer's outside option. Our result resembles that of Inderst and Wey. When a manufacturer reduces his marginal cost, he is able to sell to retailers at a lower wholesale price – which in turn is passed on to consumers in the form of lower prices. In this situation (with sufficiently low retail prices), a one-stop shopper is more inclined to switch shopping location to obtain the manufacturer's product, in the event that the product can not be obtained from the multiproduct retailer. Because one-stop shoppers are extra valuable, a reduction in the manufacturer's marginal cost thus undermines the value of the the large retailer's disagreement payoff, and increases the surplus that the manufacturer can extract in the negotiations with the multiproduct retailer – provided there are sufficiently many one-stop shoppers. The combination of one-stop shopping behaviour and large retail outlets may therefore increase the manufacturer's

incentives to invest in our model.

Our paper also relates to the literature that investigate consumers' one-stop shopping behaviour. See e.g. the seminal paper by Bliss (1988), Lal and Matutes (1989, 1994), Beggs (1994), Smith and Hay (2005) and Chen and Rey (2011). This literature focuses, among other things, on retailers incentives for loss-leading, on the retailers ability to discriminate between different types of consumers (i.e., one-stop shoppers vs. multi-stop shoppers), and on how the specific form of organisation at the retail level affects both the product assortment, the internalisation of pricing decisions, etc.[4] This literature mostly ignore the vertical relations aspect, however.

There is some new theory that tries to link one-stop shopping to the problem of buyer power, but the literature is yet scarce. See Schlippenbach and Wey (2011), who, in a similar model to ours (but with a monopolist retailer), analyse the incentives of two manufacturers to merge, depending on the share of one-stop shoppers. They find that an increase in the retailer's (exogenous) bargaining power may prevent welfare improving mergers between manufacturers.

The rest of the paper is organised as follows. Section 2 presents the basic framework and provides a benchmark. Section 3 analyses equilibrium outcomes when the manufacturers face both a multiproduct retailer as well as a group of single-product retailer. Section 4 analyse respectively the manufacturers incentives to invest and the incentives for product entry. Section 5 concludes.

2   The model

2.1 The economy

The market consists of $n \geq 2$ monopolist manufacturers, denoted by subscript $i \in \{1, ..., n\}$, each producing its own product, which is then sold through competing retailers to final consumers. We first consider the number of manufacturerers as fixed. In Section 3, where we analyse implications for dynamic efficiency, we will endogenise the number of upstream firms (or products).

There are two types of retailers; single-product retailers (small retailers), who stock different products but only one product each, and a multiproduct retailer (large retailer), who is assumed to stock all of the n products. The two types of retailers are located at opposite ends of a Hotelling line of unit length, the large retailer at address 0 and all the

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[4]The effects of one-stop shopping on the retailers' promotion and pricing strategies have been widely explored in the marketing literature. See e.g. Messinger and Narasimhan (1997).

single-product retailers at address 1. We denote the large retailer by subscript L, and the group of small retailers by subscript S. Similarly, we denote the small retailer selling product i by subscript $iS \in \{1S, ..., nS\}$. Each manufacturer i is assumed to produce its product at constant marginal costs c_i. The retailers have no costs other than those charged by manufacturers.

The consumers that buy product i are uniformly distributed with density one along the Hotelling line. Each consumer has inelastic demand for one unit of the product, with a reservation price v_i. The consumers' reservation price may among other things reflect the quality of the manufacturer's product. We later endogenise both c_i and v_i by allowing the manufacturer to make an effort to become more efficient/ produce at higher quality before competition takes place in the downstream market. For each product i, there are two types of consumers buying the product; one-stop shoppers and top-up shoppers (single shoppers). A one stop-shopper buys all n products, whereas a top-up shopper buys product i only. Both types are assumed to be fully informed about the prices and the product assortment at each location.[5] We let $\sigma \in [0, 1]$ be the share of one-stop shoppers, and $1 - \sigma$ the share of top-up shoppers for each product $i \in \{1, ..., n\}$.[6]

We denote by $x \in [0, 1]$ the consumer's address on the Hotelling line. The consumer incurs a transportation cost $\tau > 0$ per unit travelled to visit a retail location. Hence, the consumer's total cost (shopping cost) of visiting a small retailer is $\tau (1 - x)$, and the cost of visiting the large retailer is τx. We can then write the utility of a one-stop shopper at address x as

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U_O(x) = \begin{cases} u_0 + \sum_{i=1}^{n} (v_i - P_{iL}) - \tau x & \text{if buying from } L \\ u_0 + \sum_{i=1}^{n} (v_i - P_{iS}) - \tau (1 - x) & \text{if buying from } S \end{cases}, \tag{1}
$$

where P_{iL} and P_{iS} are the prices of product i charged by the large retailer and the small

[5] Realistically, consumers do not have perfect information about the availability and prices of all goods. To what extent there should be any systematic differences one way or the other between different types of consumers , such as one-stop shoppers and top-up shoppers, is to us not obvious. To keep the analysis tractable, we therefore assume that all consumers have the same information.

[6] The total mass of consumers that buy at least one product is therefore $\sigma + (1 - \sigma) n$. This secures that the total demand for each product is independent of the share of one-stop shoppers. We think of an increase in one-stop shopping as consumers taking fewer shopping trips (which reduces the mass of consumers at any given point in time) but buying more products on each trip (which keeps total demand for each product constant).

retailer respectively. Similarly, we can write the utility of a top-up shopper as

$$U_T^i(x) = \begin{cases} u_0 + v_i - P_{iL} - \tau x & \text{if buying from } L \\ u_0 + v_i - P_{iS} - \tau(1-x) & \text{if buying from } iS \end{cases}, \qquad (2)$$

for $i \in \{1, ..., n\}$. In both (1) and (2), we include $u_0 > \tau$, which represents the consumer's utility from visiting one of the locations (without buying). This can be viewed as the consumer's utility from enjoying other services at the retail location, which are assumed to be exogenous to the retailers in our model.[7] We assume that the consumer incurs u_0 only once, and that she receives no additional utility on the second visit, or by visiting multiple locations. Importantly, this ensures that in our subgame-perfect equilibrium, the market is covered as long as P_{iL} and P_{iS} are equal or below the monopoly price, $P_i^M = v_i$. This assumption is not critical, but helps to keep the model tractable. We also make the following two assumptions about consumer behaviour "out-of-equilibrium":

Assumption 1. *If a product is not stocked at both locations, a one-stop shopper does not visit both locations to obtain all products.[8]*

Assumption 2. *If a top-up shopper finds that her product is not stocked at both locations, she always visits the location where the product is stocked – given that the price for the product is not higher than her reservation price.[9]*

Using this we find that, in equilibrium, when all products are stocked at both locations, the one-stop shopper that is indifferent between buying from the large retailer and the small retailers, is located at

$$x_O^* = \frac{1}{2} - \frac{1}{2\tau} \sum_{i=1}^n (P_{iL} - P_{iS}), \qquad (3)$$

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[7]This could be, e.g., a gas station at the location, or the utility that accrues from browsing the product assortment without buying anything.

[8]This assumption does not have any effect on equilbrium prices in our subgame-perfect equilibrium, i.e. when all products are sold at both locations. Due to consumers' shopping costs, it is then always optimal for a one-stop shopper to visit only one location. However, it may affect pricing out-of-equilibrium, when the large retailer delists one of its products. If prices are low enough, some one-stop shoppers may find it optimal to visit the large retailer to obtain most products at low prices, and then visit a small retailer to obtain the missing product. Allowing for this kind of behaviour complicates the analysis without affecting our qualitative results.

[9]This assumption is admittedly ad hoc, but it does not affect our qualitative results. It affects some of the critical values in our propositions and lemmas, however. We briefly discuss the implications of this assumption later in the analysis.

whereas the indifferent top-up shopper is located at

$$x_{Ti}^* = \frac{1}{2} - \frac{1}{2\tau}\left(P_{iL} - P_{iS}\right). \tag{4}$$

Consumers' utility maximisation therefore yields the following demand for product $i \in \{1, ..., n\}$ at the large retailer,

$$Q_{iL} = \sigma x_O^* + (1 - \sigma)\, x_{iT}^*, \tag{5}$$

and the following demand at the single-product retailer,

$$Q_{iS} = \sigma\left(1 - x_O^*\right) + (1 - \sigma)\left(1 - x_{Ti}^*\right). \tag{6}$$

The game consists of two stages. At stage 1, each manufacturer $i \in \{1, ..., n\}$ engage in simultaneous bilateral negotiations with each of its two buyers, L and iS. We assume that the manufacturer has two agents, each negotiating with a retailer on the manufacturer's behalf. Similarly, we assume that the large retailer has n agents, each negotiating with a manufacturer on the retailer's behalf.[10] We assume that each agent forms rational expectations about the outcome in all other bilateral negotiations.[11] The contracts between the manufacturer and the retailers are assumed to be in two-part tariffs, (w_{iL}, F_{iL}) and (w_{iS}, F_{iS}), where w_{iL} and w_{iS} are (linear) wholesale prices, and F_{iL} and F_{iS} are fixed fees, paid by the large retailer and the single-product retailer respectively.

At stage 2, the retailers simultaneously set prices to compete in the downstream market. We assume that the retailers learn which negotiations have been (un)successful before competing, and therefore know whether their rival is carrying a specific product. The supply terms, on the other hand, are assumed to be secret (i.e., retailers do not learn their rivals' wholesale prices before competing in the downstream market).

In each manufacturer-retailer negotiation, we assume that the agents maximise the manufacturer's and the retailer's joint profit, taking as given their expectations about the outcome of the other negotiations. They then divide the surplus so that each receives its diagreement profit plus a fixed (exogenous) share of the incremental gains from trade, with

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[10] An implicit assumption is here that the manufacturer is unable to commit to distributing its product through one retailer exclusively. Exclusive selling could be deemed unlawful by competition authorities. In this case, the manufacturer is unable to credibly commit to exclusivity, since it is without an enforcable contract; if each retailer believes that the manufacturer is simultaneously negotiating a contract with the rival, then the manufacturer is effectively precluded from obtaining higher compensation from the retailer in exchange for a promise of exclusivity. The same restriction occurs in e.g. Hart and Tirole (1990) and O'Brien and Shaffer (1994).

[11] See also Inderst and Wey (2011), who use the same assumption.

a portion $\lambda \in (0,1)$ going to the manufacturer and a portion $1 - \lambda$ going to the retailer.[12] We assume that both the large and small retailers have the same exogenous bargaining power $1 - \lambda$ against their manufacturers, and conversely that all manufactureres hold the same bargaining power λ against both of their retailers.[13]

2.2 A benchmark: All retailers are single-product retailers

Before we look at the case with a multiproduct retailer, we consider as our benchmark case a situation where there are only single-product retailers at both locations. Hence, there is one single-product retailer that sells product $i \in \{1, ..., n\}$ at each location, and $2n \geq 4$ retailers total. We denote retailers with subscript il, where $i \in \{1, ..., n\}$ is the retailer's product, and $l \in \{0, 1\}$ is the retailer's location. As specified above, if all products are sold at both locations, the indifferent one-stop shopper is located at

$$x_O^* = \frac{1}{2} - \frac{1}{2\tau} \sum_{i=1}^{n} (P_{i0} - P_{i1}) \tag{7}$$

(where we have replaced the subscripts on the prices) and the indifferent top-up shopper at

$$x_{iT}^* = \frac{1}{2} - \frac{1}{2\tau} (P_{i0} - P_{i1}). \tag{8}$$

Accordingly, the demand function (as specified above) is equal to $Q_{i0} = \sigma x_O^* + (1 - \sigma) x_{iT}^*$ for the single-product retailer selling product i at location 0, and $Q_{i1} = 1 - Q_{i0}$ for the single-product retailer at location 1.

Consider the maximisation problem for a retailer at stage 2, assuming all negotiations at stage 1 have been successful.

$$\pi_{il}^r = \max_{P_{il}} (P_{il} - w_{il}) Q_{il} - F_{il}. \tag{9}$$

This gives $2n$ first-order maximising conditions, one for each retailer, of the type

$$\frac{\partial \pi_{il}^r}{\partial P_{il}} = (P_{il} - w_{il}) \frac{\partial Q_{il}}{\partial P_{il}} + Q_{il} = 0 \tag{10}$$

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[12] These assumption are consisten with for example the generalised Nash bargaining solution.

[13] It is perfectly conceivable that different manufacturers have different bargaining powers towards their respective retailers, and, conversely, that different types of retailers have different bargaing powers towards their respective manufacturers. However, given that we are interested in how consumer behaviour and retailer size affects the bargaining outcome, we let the (exogenous) bargaining power be symmetric across different retailers and different manufacturers. The same approach is used in e.g. Inderst and Shaffer (2007) and Inderst and Wey (2011).

Maximisation by the retailers results in prices $P_{i0}^* \left(w_{i0}, \mathbf{w}_{-i0}^* \right)$ and $P_{i1}^* \left(w_{i1}, \mathbf{w}_{-i0}^* \right)$ for product i at each location, 0 and 1. In $P_{il}^* \left(w_{il}, \mathbf{w}_{-il}^* \right)$, w_{il} is the wholesale price of retailer $il \in \{i0, i1\}$, whereas $\mathbf{w}_{-il}^*$ represents the retailer's rational expectations about the wholesale prices of the $2n - 1$ other retailers. Turning to the negotiations at stage 1, we can write the joint profit between retailer $i0$ and manufacturer i (symmetric for $i1$ and i) as

$$\Pi_{i-i0} = \pi_{i0}^r \left(\mathbf{P}^* \right) + \left(w_{i0} - c_i \right) Q_{i0} \left(\mathbf{P}^* \right) + \left(w_{i1}^* - c_i \right) Q_{i1} \left(\mathbf{P}^* \right) + F_{i0} + F_{i1}, \qquad (11)$$

where $\mathbf{P}^* = \left(P_{10}^* \left(w_{10}, \mathbf{w}_{-10}^* \right), ..., P_{n0}^* \left(w_{n0}, \mathbf{w}_{-n0}^* \right), P_{11}^* \left(w_{11}, \mathbf{w}_{-11}^* \right), ..., P_{n1}^* \left(w_{n1}, \mathbf{w}_{-n1}^* \right) \right)$. Using the envelope theorem, we obtain the following first-order condition for joint profit maximisation between manufacturer i and retailer $i0$[14]

$$\frac{\partial \Pi_{i-i0}}{\partial w_{i0}} = \left[\left(w_{i0} - c_i \right) \frac{\partial Q_{i0}}{\partial P_{i0}} + \left(w_{i1}^* - c_i \right) \frac{\partial Q_{i1}}{\partial P_{i0}} \right] \frac{\partial P_{i0}^*}{\partial w_{i0}} = 0, \qquad (12)$$

and symmetric for i and $i1$. Notice that we have $\partial P_{i0}^* / \partial w_{i0} > 0$ and $\partial P_{i1}^* / \partial w_{i1} > 0$, but $\partial P_{i1}^* / \partial w_{i0} = \partial P_{i0}^* / \partial w_{i1} = 0$, since contracts are unobservable. From condition (12) it is easy to see that wholesale prices have to be uniform, $w_{i0}^* = w_{i1}^*$, in equilibrium. Moreover, we have proved the following result.

Lemma 1. *Under the assumption that a manufacturer and a retailer maximises their joint profit in pairwise, secret negotiations, there exists an infinite number of equilibria of the type $w_{i0}^* = w_{i1}^* = w_i^* \geq 0$.*

Hotelling competition is a special case, in the sense that own-price and cross-price effects cancel out ($\partial Q_{i0} / \partial P_{i0} = -\partial Q_{i1} / \partial P_{i0}$). Hence, as long as the wholesale price for product i is equal for the retailers at location 0 and 1, $w_{i0}^* = w_{i1}^* = w_i^*$, and $w_i^* \geq 0$, there is no incentive for any pair, $i - i0$ or $i - i1$, to deviate to a lower (higher) wholesale price – even if $w_i^* > c_i$.[15] This holds because for any small reduction in the wholesale price w_{i0} (repectively w_{i1}), the corresponding increase in downstream profit π_{i0}^r (respectively π_{i1}^r) is offset by an equal reduction in manufacturer i's upstream profit. Because this is a special case, in the following we will use the convention that wholesale prices equal marginal costs:

Assumption 3. *We restrict attention to equilibria where the wholesale prices are set*

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[14] The envelope theorem implies that $\frac{\partial \pi_{i0}^r (\mathbf{P}^*)}{\partial w_{i0}} = -Q_{i0}$.

[15] If own-price and cross-price effects do not cancel out, i.e., $\partial Q_{i0} / \partial P_{i0} < -\partial Q_{i1} / \partial P_{i0}$, then there is a unique equilibrium where wholesale prices equal marginal costs. This is a standard result in models with unobservable two-part tariffs.

equal to marginal cost.[16]

With wholesale prices $w_{i0}^* = w_{i1}^* = c_i$ for all $i \in \{1, ..., n\}$, the equilibrium in the retail market has a very simple solution where $P_{i0}^* = P_{i1} = \tau + c_i$, for $i \in \{1, ..., n\}$. Hence, we obtain the standard Hotelling prices. We now make the following assumption.

Assumption 4. *The inequality $\tau \leq \upsilon_i - c_i \equiv \Delta_i$ holds for all $i \in \{1, ..., n\}$.*

Assumption 4 requires that there is sufficient competition at the retail level, in the sense that retail prices are always below the monopoly level in equilibrium. Assumptions 3 and 4 ensures that our model has a very simple solution: In our benchmark, since each retailer only sells one product, and since the manufacturers earns their profit through fixed fees only ($w_i^* = c_i$), we do not need to specify what happens out of equilibrium, when negotiations break down between a retailer and a manufacturer. If all negotiations are successful, which they are in equilibrium, each retailer then earns the profit $\pi_{il}^r = \tau/2 - F_{il}$, whereas each manufacturer earns the profit $\pi_i^m = F_{i0} + F_{i1}$. The retailer and the manufacturer therefore negotiate over the (incremental) profit $\tau/2$. We therefore get fixed fees equal to $F_{i0} = F_{i1} = F^B = \lambda\tau/2$ in equilibrium. We have the following result.

Proposition 1. *When all retailers are single-product retailers, equilibrium retailer prices at both locations are equal to $P_i^* = \tau + c_i$ for $i \in \{1, ..., n\}$. Moreover, in equilibrium, each retailer and manufacturer earns the profits $\pi_B^r = (1 - \lambda)\tau/2$ and $\pi_B^m = \lambda\tau$ respectively.*

When all retailers are single-product retailers, each of them ignores the positive externality on nearby retailers (at the same location) of setting a lower retail price. We therefore get the standard Hotelling prices and profits in equilibrium, irrespective of the share σ of one-stop shoppers.

3 Equilibrium analysis and main results

We now turn to the case when there is a multiproduct retailer at location 0. This retailer is assumed to have the capacity distribute all $n \geq 2$ products. If all the negotiations at stage 1 are successful, then the multiproduct retailer's flow payoff (profit gross of fixed

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[16]Note that Assumption 3 can be obtained as a unique equilibrium if we assume that the manufacturer and the retailer maximise their total channel profit only, instead of maximising their total joint profit. In this case, the manufacturer and the retailer ignore the manufacturer's contract with the rival retailer. See e.g. Chen (2003, 2004) who use this assumption.

fees) at stage 2 is equal to

$$r_L = \sum_{i=1}^{n} (P_{iL} - w_{iL}) Q_{iL} \tag{13}$$

whereas the flow payoff of a small retailer is equal to

$$r_{iS} = (P_{iS} - w_{iS}) Q_{iS} \tag{14}$$

subject to $w_{iL} \leq P_{iL} \leq v_i$, $w_{iS} \leq P_{iS} \leq v_i$ for all $i \in \{1, ..., n\}$. Differentiating the profit functions with respect to the prices P_{iL} and P_{iS}, respectively, gives us the following first-order conditions for profit maximisation for the large retailer with respect to the price for product i,

$$\frac{\partial r_L}{\partial P_{iL}} = 0 \iff \frac{\partial Q_{iL}}{\partial P_{iL}} (P_{iL} - w_{iL}) + Q_{iL} = -\sigma \frac{\partial x_O^*}{\partial P_{iL}} \sum_{j \neq i} (P_{jL} - w_{jL}) \tag{15}$$

and for the small retailer iS with respect to its price P_{iS},

$$\frac{\partial r_{iS}}{\partial P_{iS}} = 0 \iff \frac{\partial Q_{iS}}{\partial P_{iS}} (P_{iS} - w_{iS}) + Q_{iS} = 0 \tag{16}$$

Because the large retailer sells more than one product, it takes into account the revenue from the rest of its assortment when setting the price P_{iL}. This is reflected in the right-hand side of eq. (15), which is positive as long as $\sigma > 0$ and $P_{jL} > w_{jL}$ for $j \neq i \in \{1, ..., n\}$. It follows that, when some consumers bundle their purchases, i.e. $\sigma > 0$, the profit maximising price for the large retailer is below the equilibrium price when all consumers are top-up shoppers, and hence below the equilibrium price in our benchmark. On the other hand, a small retailer only takes into account the effect on its own sales when setting the price P_{iS}. It follows that, as long as $\sigma > 0$, the price of each small retailer is above the level that is jointly optimal for the group of small retailers as a whole (as in our benchmark).

In solving the retailer's first-order conditions, and defining $k \equiv n - 1$, we obtain the following best response function for the large retailer for product i,

$$P_{iL}^b (P_{iS}) = \frac{P_{iS} + w_{iL}}{2} + \frac{\tau}{2 (1 + \sigma k)} \tag{17}$$

and the best response function

$$P_{iS}^b (P_{iL}) = \frac{(1 - \sigma) P_{iL} + w_{iS}}{2 - \sigma} + \frac{\tau}{2 + \sigma k} + \sigma \delta_S, \tag{18}$$
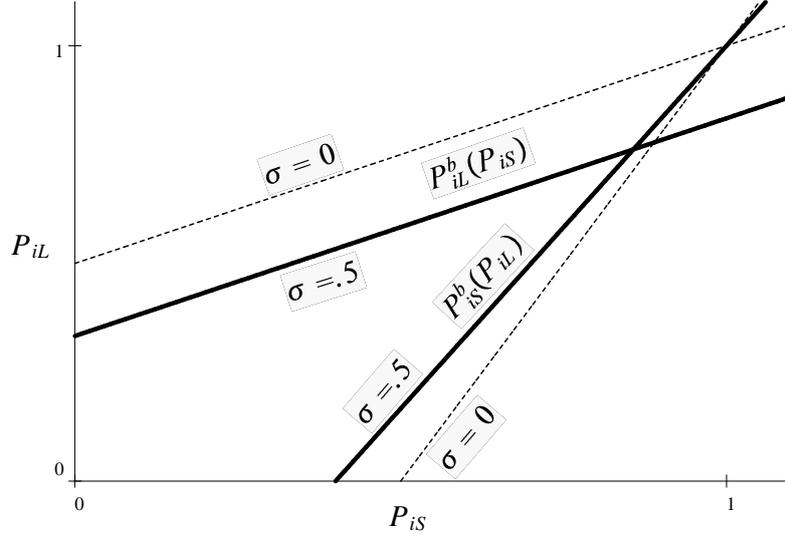
Figure 1: Best-response functions.

for each of the small retailers, $iS \in \{1S, ..., nS\}$, where[17]

$$\delta_S = \frac{\sum_{i=1}^n (P_{iL} - w_{iS})}{(2 - \sigma)(2 + \sigma k)} \tag{19}$$

Notice that as $\sigma \to 0$, the two functions converge to $P_{iL}^b = \frac{1}{2}(P_{iS} + w_{iL} + \tau)$ and $P_{iS}^b = \frac{1}{2}(P_{iL} + w_{iS} + \tau)$, in which case we obtain standard Hotelling prices $P_{iL}^* = \tau + \frac{2}{3}w_{iL} + \frac{1}{3}w_{iS}^*$ and $P_{iS}^* = \tau + \frac{2}{3}w_{iS} + \frac{1}{3}w_{iL}^*$. However, as the the share of one-stop shoppers σ increases, the best response function of the large retailer shifts down – which in turn forces the small retailers to reduce their prices. This effect is illustrated in Fig. 1, for the case $n = 2$ and $\tau = 1$ (and assuming $w_{iS} = w_{iL} = c_i = 0$ for $i \in \{1, 2\}$).

At stage 1, the manufacturers and the retailers engage in pairwise negotiations over two-part tariffs. We can write the joint profit between manufacturer $i \in \{1, ..., n\}$ and the multiproduct retailer as

$$\Pi_{L-i} = r_L^* (\mathbf{P}^*) + (w_{iL} - c_i) Q_{iL} (\mathbf{P}^*) + (w_{iS}^* - c_i) Q_{iS} (\mathbf{P}^*) + F_{iS} - \sum_{j \neq i} F_{jL}, \tag{20}$$

where $\mathbf{P}^* = (P_{1L}^* (\mathbf{w}_L, \mathbf{w}_S^*), ..., P_{nL}^* (\mathbf{w}_L, \mathbf{w}_S^*), P_{1S}^* (w_{1S}, \mathbf{w}_{-1S}^*), ..., P_{nS}^* (w_{nS}, \mathbf{w}_{-nS}^*))$ is the vector of prices that solves the retailers' maximisation problems (15) and (16) at stage 2.

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[17]We have solved for retailer iS's best-response assuming that all the other small retailers play their best reponse – i.e., assuming that $P_{jS} = P_{jS}^b$ for all $j \in \{1, ..., n\}$, $i \neq j$.

In $P_{iL}^* (\mathbf{w}_L, \mathbf{w}_S^*)$, $\mathbf{w}_L$ represents the vector of the wholesale prices for the large retailer, whereas $\mathbf{w}_S^*$ is the large retailer's rational expectation about the wholesale prices of the small retailers. Similarly, in $P_{iS}^* (w_{iS}, \mathbf{w}_{-iS}^*)$, w_{iS} is the wholesale price of retailer iS, whereas $\mathbf{w}_{-iS}^*$ represents retailer iS' rational expectations about the wholesale prices of both the large retailer and the other small retailers.

In the same way we can write the joint profit between the manufacturer and the small retailer as

$$\Pi_{S-i} = r_{iS} (\mathbf{P}^*) + (w_{iL}^* - c_i) Q_{iL} (\mathbf{P}^*) + (w_{iS} - c_i) Q_{iS} (\mathbf{P}^*) + F_{iL}. \tag{21}$$

Using the envelope theorem, we obtain the following first-order conditions for joint profit maximisation between the large retailer and manufacturer i, and between the small retailer and manufacturer i

$$\frac{\partial \Pi_{L-i}}{\partial w_{iS}} = \sum_{j=1}^{n} \left\{ \frac{\partial P_{jL}^*}{\partial w_{iL}} \left[(w_{iL} - c) \frac{\partial Q_{iL}}{\partial P_{jL}} + (w_{iS}^* - c) \frac{\partial Q_{iS}}{\partial P_{jL}} \right] \right\} = 0, \tag{22}$$

$$\frac{\partial \Pi_{S-i}}{\partial w_{iS}} = \left[(w_{iL}^* - c_i) \frac{\partial Q_{iL}}{\partial P_{iS}} + (w_{iS} - c_i) \frac{\partial Q_{iS}}{\partial P_{iS}} \right] \frac{\partial P_{iS}^*}{\partial w_{iS}} = 0. \tag{23}$$

Notice that these are equivalent to the first-order conditions in our benchmark, (12).[18] Hence, we can rely on Assumption 3, which says that $w_{iL}^* = w_{iS}^* = c_i$ in equilibrium. The solution to our model then has a relatively simple characterisation, in which the unique equilibrium prices are equal to

$$P_{iL}^* = \tau + c_i - \sigma \frac{\tau k (2 + k\sigma)}{(1 + k\sigma)(3 + k\sigma)} \quad \text{and} \quad P_{iS}^* = \tau + c_i - \sigma \frac{\tau k}{3 + k\sigma}, \tag{24}$$

for $i \in \{1, ..., n\}$. Using this, we can write the retailers' equilibrium flow profits as

$$r_L^* = \frac{\tau (k + 1)(3 + 2k\sigma)^2}{2 (3 + k\sigma)^2 (1 + k\sigma)} \tag{25}$$

for the large retailer, and

$$r_S^* = \frac{9\tau}{2 (3 + k\sigma)^2} \tag{26}$$

for each small retailer. Notice that both $\partial r_L^*/\partial \sigma < 0$ and $\partial r_S^*/\partial \sigma < 0$. Hence, as the share of one-stop shoppers increases, downstream competition gets tougher, and both types of

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[18]In (22) and (23), the price effects cancel out: We have $\partial Q_{iL}/\partial P_{jL} = -\partial Q_{iS}/\partial P_{jL}$ and $-\partial Q_{iL}/\partial P_{iS} = \partial Q_{iS}/\partial P_{iS}$.

retailers (large and small) earn lower flow payoffs. The overall industry profit therefore falls as the share of one-stop shoppers increases.

As in our benchmark, the disagreement profit of a small retailer is always zero. We therefore have $F_{iS}^* = F_S^* = \lambda r_S^*$ for all $i \in \{1, ..., n\}$ in equilibrium. The disagreement profit of the multiproduct retailer, on the other hand, is non-zero. To determine the distribution of profits between manufacturer i and the large retailer we therefore have to specify the large retailer's flow payoff r_L^{-i} in the subgame where negotiations break down between L and i:

When the large retailer is not stocking product i, the marginal one-stop shopper is located at

$$x_O^{**} = \frac{1}{2} - \frac{1}{2\tau} \left[\sum_{j \neq i} (P_{jL} - P_{jS}) + v_i - P_{iS} \right], \tag{27}$$

where $P_{iS} \leq v_i$. In this case there is a trade-off for the one-stop shopper between visiting the small retailers, to obtain all products (at possibly higher prices), and visiting the large retailer, to obtain all products but product i (at possibly lower prices). As before, product $j \in \{1, ..., n\}$, $i \neq j$, can still be obtained at both locations. The marginal top-up up shopper who is buying product j is therefore located at

$$x_{jT}^* = \frac{1}{2} - \frac{1}{2\tau} (P_{jL} - P_{jS}) \tag{28}$$

Hence, we write the demand for product j at the multiproduct retailer as

$$\widehat{Q}_{jL} = \sigma x_O^{**} + (1 - \sigma) x_{jT}^*, \tag{29}$$

and as $\widehat{Q}_{jS} = 1 - \widehat{Q}_{jL}$ the demand for product j at the small retailer jS. Given that $P_{iS} \leq v_i$, under Assumption 2 all the top-up shoppers that are after product i now shop from the small retailer iS. The demand at retailer iS, who in this case has monopoly on the sales of product i, is therefore

$$\overline{Q}_{iS} = \sigma (1 - x_O^{**}) + 1 - \sigma, \tag{30}$$

for $P_{iS} \leq v_i$, and zero otherwise. We write the equilibrium (gross) profit of retailer iS in this case as $\overline{r}_{iS} = (\overline{P}_{iS} - c_i) \overline{Q}_{iS}$, where $\overline{P}_{iS}$ is the equilibrium price. It can be shown that the price $\overline{P}_{iS}$ satisfies $\overline{P}_{iS} < v_i$ only as long as

$$\Delta_i > \tau \frac{6 + (8k - 11)\sigma + (k-1)(k-6)\sigma^2 - (k-1)^2 \sigma^3}{(3 + k\sigma - \sigma)(1 + k\sigma - \sigma)\sigma} \equiv \Delta(\sigma, n, \tau) \tag{31}$$

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We denote by P_{jL}^{**} and P_{jS}^{**} the subgame-equilibrium prices for product $j \in \{1, ..., n\}$, $i \neq j$. (The derivation of the equilibrium values, and the condition in (31), are detailed in the appendix.) We have the following result.

Lemma 2. *Suppose there is disagreement in the negotiations between the multiproduct retailer and manufacturer i. In this subgame there exist a function $\widehat{\sigma}_i (\Delta_i, n, \tau) > 0$, such that the price for product i at the small retailer iS is equal to*

$$\overline{P}_{iS} = \begin{cases} v_i & if & \sigma \leq \widehat{\sigma}_i \\ \rho_i (\Delta_i, \sigma, n) & < v_i & otherwise \end{cases}$$

where $\partial \rho_i / \partial \sigma < 0$. Moreover, we have $\partial \widehat{\sigma}_i / \partial \Delta_i < 0$ and $\partial \widehat{\sigma}_i / \partial n < 0$.

Proof. See Appendix A.

The function $\widehat{\sigma}_i (\Delta_i, n, \tau)$ in Lemma 2, is the unique value of σ for which the condition in (31) holds with equality. Lemma 2 states that as long as the share of one-stop shoppers is not too high, $\sigma < \widehat{\sigma}_i$, the small retailer sets the price for product i equal to the (monopoly) reservation price, $\overline{P}_{iS} = v_i$, and then free-rides on the demand from the one-stop shoppers created by the other single-product retailers. With a sufficiently high number of one-stop shoppers, however, retailer iS will find it optimal to set a lower price, $\overline{P}_{iS} < v_i$ – despite having a monopoly on the sales of product i – to attract more one-stop shoppers to its location.[19] Hence, in one sense, there may be competition "for the manufacturer's product" also out-of-equilibrium (when the large retailer delists product i), which is created by consumers' one-stop shopping behaviour.

Lemma 2 also states that for a higher "quality/cost gap" for product i, $\Delta_i \equiv v_i - c_i$, it is more likely that $\sigma > \widehat{\sigma}_i$ holds, and that $\overline{P}_{iS} < v_i$. The result is illustrated in Figure 2 for the case $n = 2$.

The implications of Assumption 2 are perhaps already obvious to the reader: If not all top-up shoppers were to visit the small retailer iS to obtain product i, which in this case is not stocked by L, then this would imply lower demand for the small retailer; ceteris paribus, this could give a lower price $\overline{P}_{iS}$. Hence, under Assumption 2, the model is biased in favour of weaker retail competition in the subgame where iS has monopoly on the sales of product i. The critical number of one-stop shoppers $\widehat{\sigma}_i$ is therefore biased upwards under Assumption 2.

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[19]If the share of one-stop shoppers is very low, e.g. $\sigma = 0$, then $P_{iS} < v_i$ is clearly not optimal, in which case the price will be equal to the monopoly price.
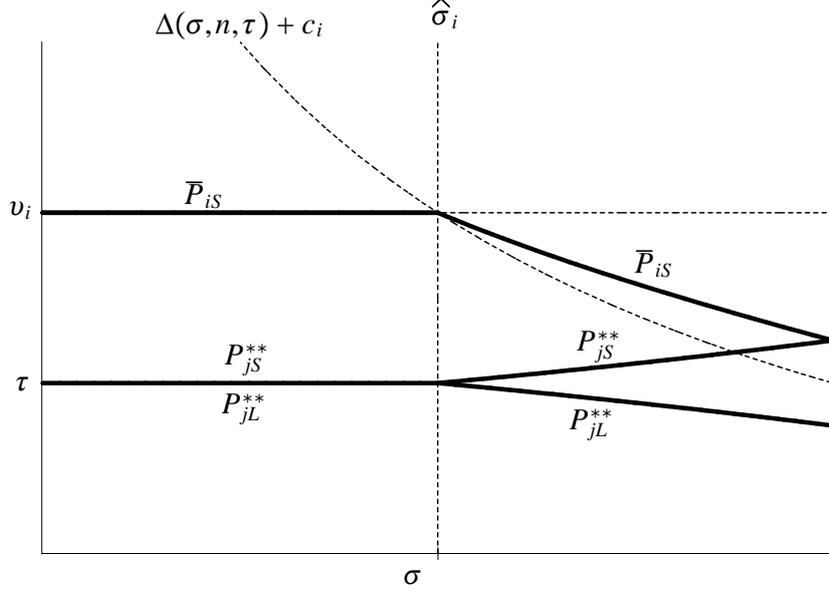
Figure 2: Equilibrium prices for products $i, j \in \{1, 2\}$ when the large retailer is not selling product i. $(n = 2)$.

If $\sigma \leq \widehat{\sigma}_i$, then the equilibrium in this subgame is very simple. The large retailer's (out-of-equilibrium) flow payoff, when in disagreement with manufacturer i, is then equivalent to its equilibrium flow payoff r_L^* from above, but with $n - 1$ instead of n products. I.e., the large retailer and the group of $n - 1$ small retailers (excluding iS) compete as though product i does not exist, since its price P_{iS} is set equal to the consumers' reservation price v_i. When $\sigma > \widehat{\sigma}_i$, on the other hand, the price for product i is below v_i, which (ceteris paribus) will cause more one-stop shoppers to buy from the single-product retailers. The large retailer may therefore have to reduce its prices to compensate. In this case, the large retailer's flow payoff when in disagreement with i, is partially determined by the quality/cost gap Δ_i on manufacturer i's product. By solving for the optimal prices in both cases, $\sigma \leq \widehat{\sigma}_i$ and $\sigma > \widehat{\sigma}_i$, we find that the large retailer's flow payoff when not selling product i, is equal to

$$
r_L^{-i} = \begin{cases} \dfrac{\tau k \left(3 + 2 \left(k - 1\right) \sigma\right)^2}{2 \left(3 + (k-1) \sigma\right)^2 \left(1 + (k-1) \sigma\right)} & \text{if} \quad \sigma \leq \widehat{\sigma}_i \\[4mm] \dfrac{k \left(1 + (k-1) \sigma\right) \left(8\tau + 2k\sigma\tau - 5\sigma\tau - \sigma\Delta_i\right)^2}{2\tau \left(6 + 6k\sigma - 8\sigma + 2\sigma^2 - 3k\sigma^2 + k^2\sigma^2\right)^2} & \text{otherwise} \end{cases} \tag{32}
$$

In equilibrium, the incremental gains from trade between manufacturer i and the multi-product retailer are equal to $r_L^* - r_L^{-i} \geq 0$. The fixed fee agreed between manufacturer

i and the large retailer is therefore equal to $F_{iL}^* = \lambda \left(r_L^* - r_L^{-i} \right)$. Accordingly, we can write manufacturer i's equilibrium profit as $\pi_i^* = \lambda \left(r_L^* - r_L^{-i} \right) + \lambda r_S^*$, and the profit of the multiproduct retailer as[20]

$$\pi_L^* = r_L^* - \lambda \sum_{i=1}^{n} \left(r_L^* - r_L^{-i} \right) \tag{33}$$

Notice that, as $\sigma \to 0$, $\pi_L^* \to n\pi_B^r$ and $\pi_i^* \to \pi_B^m$. I.e., as the share of one-stop shoppers approaches zero, the *per-product* profit of the large retailer becomes equal to the benchmark profit of a small retailer, π_r^B. In the same way, the profit of each manufacturer approaches the benchmark profit π_B^m.

We now make the following assumption.

Assumption 5. *We restrict attention to parameter values such that F_{iL}^* is increasing in σ over the interval $\sigma \in (\widehat{\sigma}_i, 1)$.*

Assumption 5 holds for a range of parameter values and makes it easier to prove our remaining results. Specifically, the assumption requires that Δ_i is not too high relative to the number of upstream firms n and the transportation cost τ. Note that the assumption that Δ_i (and/or λ) is not too high, is necessary also to ensure that the large retailer's profit in (33) is non-negative. We can derive the following results.

Lemma 3. *If $\sigma < \widehat{\sigma}_i$, then $F_{iL}^* \leq F^B$. Moreover, we have $F_{iL}^* < F^B$ everywhere on $\sigma \in (0, 1)$ as long as $\Delta_i < \tau \left(3 + 2k - \sqrt{(2 + k)\, 3k} \right) \equiv \Delta^*$.*

Proof. See Appendix B.

Proposition 2. *Assume $\sigma > 0$. A manufacturer is then strictly worse off when facing a multiproduct retailer as long as the manufacturer's quality/cost gap Δ_i is not too high; a sufficient condition is that $\Delta_i < \Delta^*$. The multiproduct retailer is strictly better off following an increase in the share of one-stop shoppers, as long as σ is not too high, and λ is not too low; a necessary condition is that $\lambda > 1/2$. More specifically, we have*

- *$\lim_{\sigma \to 0} \partial \pi_i^* / \partial \sigma < 0$ for all $i = 1, ..., n$, and*

- *$\lim_{\sigma \to 0} \partial \pi_L^* / \partial \sigma > 0$ as long as $\lambda > 1/2$.*

Proof. See Appendix B.

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[20]It is assumed that the multiproduct retailer's profit in (33) is non-negative.

With a positive share of one-stop shoppers ($\sigma > 0$), the equilibrium flow payoff r_L^* of the large retailer becomes concave in the number of firms n. Loosely speaking: Starting at $\sigma = 0$, in the eyes of the large retailer, the manufacturers' products become "more substitutable" when increasing σ, in the sense that, when delisting a product, the multi-product retailer will increase prices and earn more revenue on its other products. As each manufacturer negotiates on the retailer's margin – i.e., a manufacturer negotiates over its incremental contribution $r_L^* - r_L^{-i}$ to the retailer's profit taking as given the retailer's contracts with other manufacturers – each of them captures a smaller share of the profits as σ increases and r_L^* becomes concave. By the same token, there are two opposing forces affecting the large retailer's profit as the share of one-stop shoppers increases. On one hand, the retailer may be paying a smaller fixed fee to at least some of its manufacturers, i.e. $F_{iL}^* = \lambda \left(r_L^* - r_L^{-i} \right) < F^B$ for some $i \in 1, ..., n$, which affects the retailer's profit positively, ceteris paribus. On the other hand, as σ increases, the multiproduct retailer is unable to commit not to reduce its prices, and downstream profits is reduced as a result. Hence, the multiproduct retailer may benefit from an increase in the degree of one-stop shopping, but only as long as the decrease in the manufacturers' fixed fees is large enough – which implies that λ has to be sufficiently high.

Notice that Proposition 2 does not rule out $F_{iL}^* > F^B$ for some $i \in \{1, ..., n\}$. For a multiproduct retailer, it may be particularly important to get access to so-called must-carry brands, i.e. products with strong brand names. We may interpret this as products with a high quality/cost gap Δ_i in our model. When the multiproduct retailer lose access to such products (with high Δ_i), its total demand falls "over-proportionally", in the sense that a high portion of one-stop shoppers will switch shopping location to get hold of the delisted product, and in doing so they take all of their demand (for the rest of the products) with them. If Δ_i is high enough, this effect may even dominate the reduction in surplus that the manufacturer extracts from its small retailer (the competition effect). In this case, the manufacturer earns a strictly higher profit when facing a multiproduct retailer, compared to in our benchmark. We have the following result.

Proposition 3. *Assume $\sigma > 0$. Manufacturer $i = 1, ..., n$ may earn strictly higher profit when facing a multiproduct retailer. A necessary condition is that $\Delta_i > \tau \left(3 + 2k - k\sqrt{2} \right) \equiv \underline{\Delta} > \Delta^*$. (Under Assumption 5, $\Delta_i > \underline{\Delta}$ is a sufficient condition only when $\sigma = 1$.)*

Proof. See Appendix B.

Our model is similar in spirit, but the mirror image when it comes to market structure, to the model of Inderst and Wey (2007), who assume that a monopolist manufacturer is

supplying a number of downstream firms that operate in separate markets. Inderst and Wey assume that the total surplus function is concave in the quantity supplied, and hence also concave in the number of buyers (or markets) served. This could for example be due to the supplier's cost function being convex (i.e., increasing marginal costs). Since small buyers negotiate more "on the seller's margin", where incremental contributions are small, a small buyer also captures a smaller portion of the total surplus relative to a large buyer, who negotiate over a large number of units (where incremental contributions are high). Horizontal cross-border mergers (i.e., forming a retail chain/ buyer cooperative) may therefore be profitable for the buyers in these models.[21] In our model, on the other hand, consumers' one-stop shopping behaviour makes the multiproduct retailer's flow profit concave in the number of upstream firms, n. Consequentially, each individual manufacturer may capture a smaller portion of the large retailer's total surplus, even though the manufacturers are not in direct competition with each other. This observation brings us to our next result.

Proposition 4. ($\sigma > 0$) *When facing a multiproduct retailer, it may sometimes be jointly profitable for a subset $M_S \subset \{1, .., n\}$ of manufacturers to form a cooperative (e.g., merging) before they enter into negotiations with the retailers.*

Proof. See Appendix B.

Proposition 4 states that one way for (otherwise independent) manufacturers to counter the buyer power of multiproduct retailers, is to form a sellers' cooperative before negotiations with the retailers take place. For example through a merger. (This follows directly from the concavity of the large retailer's equilibrium flow payoff.) This result is fully independent of the initial distribution of bargaining power, with the only condition that $\lambda > 0$. I.e., we only require that manufacturers always earn some positive profits. However, often the manufacturers will never be able to fully restore their benchmark profits. The reason for this is that, in a market with one-stop shopping, the overall industry profit is smaller when there is a multiproduct retailer, compared to in our benchmark situation with only single-product retailers. Hence, a merger for example between all n manufacturers, would only give the new sellers' cooperative a joint profit of λ times the overall industry profit, which is strictly smaller compared to in our benchmark.[22]

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[21]See also Chipty and Snyder (1999) and Raskovich (2003). Horn and Wolinsky (1988) and Stole and Zwiebel (1996) make the same point, but in models of wage negotiations between firms and their employees. Similar effects emerge in DeGraba (2003) and Chae and Heidhues (2004), where the surplus function is concave due to either seller's or buyers' risk aversion.

[22]See also Schlippenbach and Wey (2011). In a model where two independent manufacturers negoti-

4 Dynamic efficiency

4.1 Investments in technology or product improvements

We have seen that in the short run, as long as some consumers are one-stop shoppers, the presence of a large retailer leads to lower retail prices for all products at all retail outlets. Which (trivially) gives a higher consumers' surplus. We have also seen that the retailer may benefit from being large, in the sense that the multiproduct retailer may be paying a lower fixed fee for at least some the products, and hence extracts a higher share of an otherwise smaller total profit. Manufacturers, on the other hand, may be adversely affected, in the sense that each of them receives a smaller share of a strictly smaller industry profit.

In the short run, however, the distribution of profits between manufacturers and retailers does not have any welfare consequences. It may, however, affect efficiency in the long run. Suppose we add a stage 0 to our model, where manufacturers are allowed to make some effort to become more efficient (reduce their unit cost c_i) or produce a higher quality (inrease υ_i). I.e., we consider the incentives of a manufacturer to further increase its initial quality/cost gap Δ_i. We define as $\varphi_i \equiv \Delta_i + s_i$ the new quality/cost gap after the manufacturer has made an effort to increase it by s_i, where $0 \leq s_i \leq c_i$.[23] Let $C_I(s_i)$ be the manufacturer's total cost of increasing the quality/ cost gap by s_i, where $C_I(0) = C_I'(0) = 0$, $C_I'(s_i) > 0$ for all $s_i > 0$, and $C'(s_i) \to \infty$ for $s_i \to c_i$.

Consider first the manufacturers' incentives when facing only single-product retailers. In this case we have $\pi_B^m = \lambda\tau - C_I(s_i)$. The manufacturer's incentives at the margin are then equal to $\partial\pi_B^m/\partial s_i = -C_I'$. We therefore get a corner solution where each manufacturer invests nothing in neither cost reductions nor quality improvements:

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ate with a monopolist multiproduct retailer, they find that, with one-stop shopping, more (exogenous) bargaining power to the retailer (a smaller λ in our model), or a smaller number of one-stop shoppers (σ in our model), may cause manufacturers to prefer separation to merger. In their model, separation between the manufacturers is inefficient due to the assumption that retailers and manufacturers use linear wholesale contracts; a merger will then induce manufacturers to internalise the demand externalities (due to consumers' one-stop shopping behaviour) by reducing their wholesale prices, which ultimately causes lower retail prices for consumers. In our model, on the other hand, there is no (short-run) efficiency gain from an upstream merger; it only affects the overall distribution of surplus. This is due to the assumption that manufacturers and retailers use bilateral efficient (two-part) tariffs, and that wholesale prices always equal marginal costs. Hence, there is no double marginalisation problem to rectify.

[23]We put an upper bound on s_i to secure an interior solution. Our assumption implies that if c_i is "high", there is more scope for both cost reductions and quality improvements. We feel this is a realistic assumption; if the manufacturers costs are already high, there may be ways for the manufacturer to utilise its resources more efficiently, for example to produce more quality without increasing costs – or to reduce its costs without affecting the quality level.

Lemma 4. *In our benchmark with only single-product retailers, the manufacturers have no incentives to further increase their quality/cost gaps. I.e., in equilibrium we have $s_i^B = 0$ for all $i \in \{1, ..., n\}$.*

Hotelling competition is again a special case. With sufficient downstream competition, i.e., $\tau \le v_i - c_i$ for all $i = 1, ..., n$, we have zero investments at the upstream level. First, consumers' unit demand implies that retailers pass on all of their costs to consumers. Also, a *reduction* in prices has no effect on total demand. This means that there are no gains from further cost reductions. With the addition of retail competition, any rents that accrue from increasing consumers' willingness-to-pay, is competed away by the retailers. Hence, there is no gain from quality improvements either. Manufacturers therefore invest too little in our benchmark.

Now, consider instead a manufacturer's incentives when facing a multiproduct retailer. At stage 0, each manufacturer chooses s_i so as to maximise

$$\pi_i^* (\varphi_i) = \lambda \left(r_L^* - r_L^{-i} (\varphi_i) \right) + \lambda r_S^* - C_I (s_i), \qquad (34)$$

where we substitute Δ_i with $\varphi_i = \Delta_i + s_i$ in the manfuacturer's profit function. The manufacturer's incentives at the margin are then equal to

$$\mu_i (s_i) \equiv \begin{cases} -C' & \text{if} \quad \sigma < \widehat{\sigma}_i \\ \lambda \dfrac{\sigma k (1 + k\sigma - \sigma)(8\tau - 5\sigma\tau + 2k\sigma\tau - \sigma\varphi_i)}{\tau (6 + 6k\sigma - 8\sigma + 2\sigma^2 - 3k\sigma^2 + k^2\sigma^2)^2} - C' & \text{otherwise} \end{cases}, \qquad (35)$$

where $\mu_i (0) = 0$ if $\sigma < \widehat{\sigma}_i$ and $\mu_i (0) > 0$ if $\sigma \ge \widehat{\sigma}_i$. We thus have the following result.

Proposition 5. *When facing a multiproduct retailer, manufacturer i's marginal costs may be strictly lower in equilibrium, compared to the benchmark situation with only single-product retailers. Similarly, manufacturer i's choice of product quality may be strictly higher. A sufficient condition is that $\sigma \ge \widehat{\sigma}_i$.*

A manufacturer may be able to counteract the power of the large retailer by making an effort to become more efficient (or to improve its product quality): By supplying its small retailer at a lower per-unit cost (or by improving quality), the manufacturer may be able to tempt more one-stop shoppers to switch shopping location should the large retailer delist its product. Because one-stop shoppers are extra valuable to the large retailer, both cost reductions and quality improvements thus undermine the value of the large retailer's

flow payoff when in disagreement with the manufacturer, which in turn increases the profit that the manufacturer is able to extract in negotiations with the retailer – provided, of course, the share of one-stop shoppers is high enough. A manufacturer's incentives may therefore be strictly higher compared to in our benchmark, even if the manufacturer earns a strictly lower profit in equilibrium.[24]

Our result is similar to that of Inderst and Wey (2011). They consider a model where a single manufacturer supplies a number of markets, where, in each maret, two local retilers compete a-la Cournot. Inderst and Wey show that an increase in retailer size, measured as the number of markets the retailer, or retail chain (buyer group), operates in, may give rise to buyer power by creating a situation where the retailer can credibly threaten to integrate backwards into supply.[25] As in our model, this creates competition for the manufacturer's product both in and out of equilibrium; the ability to integrate backwards implies that a large retailer is active even if negotiations break down with the manufacturer. The disagreement profit (or outside option) of a large retailer is therefore partially determined by how efficiently the manufacturer can supply the retailer's (local) rival; by supplying its product at a lower marginal cost, the manufacturer intensifies out-of-equilibrium competition for the retailers. This reduces the value of the large retailer's outside option, and in turn enables the manufacturer to capture a higher share of the total surplus in the negotiations. This bargaining effect comes in addition to the standard effects that lower unit costs may have on the total surplus; hence, the presence of fewer but larger buyers increases the manufacturer's incentives to become more efficient in their model. Our result identifies another way in which this bargaining effect may materialise; namely through the combination of retailer size, measured here as the number of products the retailer stocks, and consumers' one-stop shopping habbits.

4.2 Product entry

Manufacturers' incentives for investments in respectively product improvements (e.g., brand building and quality improvements) and in new product introduction (entry), are generally not the same. Hence, it may very well be that more buyer power gives the

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[24]Notice also that, due to Assumption 2, Proposition 5 is biased in favour of weaker incentives for the manufacturers – since competition ("out-of-equilibrium") would be even tougher without Assumption 2. I.e., the condition $\sigma > \widehat{\sigma}_i$ would then be more likely to hold.

[25]Inderst and Wey (2011) follow the approach developed by Katz (1987), where, in case of disagreement with its manufacturer, a buyer is able to pay a fixed cost to integrate backwards into supply. When the buyer operates in several markets, the buyer is able to spread this fixed cost over a higher number of units produced. Hence, as the buyer grows, the threat to integrate backwards becomes more credible.

manufacturer incentives to exert more effort to improve its product, given that it has entered the upstream market, but at the same time provides the manfuacturer with weaker incentives to enter the market in the first place.

In the following we ignore investments to increase the quality and reduce costs, and assume instead that, at stage 0, each manufacturer i has to pay a fixed cost, which we denote $\theta > 0$, in order to enter the upstream market. Suppose that there is consumer demand for a predetermined number of products, $N \geq 2$, and that there is an equal number of manufacturers, $i \in \{1, ..., N\}$, each of them producing one product, and who are ready to enter the market. How many, and which manufacturers will enter?

In our benchmark, the condition for all N manufacturers to enter is simply $\lambda\tau > \theta$. Suppose this condition holds. When the manufacturers face a multiproduct retailer instead, the equilibrium number n^* that enters the market is in this case always $n^* \leq N$. This follows directly from Proposition 2. If, for some manufacturers, $\sigma < \widehat{\sigma}_i$, the following is a sufficient condition for $n^* < N$

$$
\begin{aligned}
\lambda\tau \;>\; \theta > \lambda\Bigg[& \frac{9\tau}{2\left(3 + K\sigma\right)^2} \\
& + \frac{\tau\left(K+1\right)\left(3 + 2K\sigma\right)^2}{2\left(3 + K\sigma\right)^2\left(1 + K\sigma\right)} - \frac{\tau K\left(3 + 2\left(K-1\right)\sigma\right)^2}{2\left(3 + \left(K-1\right)\sigma\right)^2\left(1 + \left(K-1\right)\sigma\right)} \Bigg]
\end{aligned}
\tag{36}
$$

where $K \equiv N - 1$. Hence, since some manufacturers may earn strictly lower profits when facing a multiproduct retailer, some of these manufacturers may choose not to enter the market at stage 0, provided that θ is sufficiently high. For $\tau = 1$, $K = 3$, and $\lambda = .65$, condition (36) reduces to

$$
.65 > \theta > \frac{.65\left(18 + 114\sigma + 257\sigma^2 + 227\sigma^3 + 48\sigma^4 - 16\sigma^5\right)}{2\left(1 + \sigma\right)^2\left(3 + 2\sigma\right)^2\left(1 + 3\sigma\right)\left(1 + 2\sigma\right)}.
\tag{37}
$$

We therefore have the following straightforward result.

Proposition 6. *Assume i) a uniform entry cost θ, and that ii) θ is such that all manufacturers enter the market in our benchmark, i.e. $\lambda\tau > \theta$. When facing a multiproduct retailer, the equilibrium number of manufacturers that enter the market satisfies $n^* \leq N$, where $n^* < N$ if θ is sufficiently close to $\lambda\tau$ and $\sigma < \widehat{\sigma}_i$ for some $i \in \{1, ..., N\}$.*

It is perhaps more realistic to assume that the manufacturers have different entry costs, and, moreover, that a manufacturer's entry cost depend on the type of product it sells. For example, it may be natural to assume that the entry cost of manufacturer i,

θ_i, is higher when the manufacturer produces a high-value product. I.e., if Δ_i is high, then θ_i is also high. Suppose that $\theta_i > \lambda\tau$ for some manufacturers with high Δ_i. Then things are less clear; some manufacturers who would not have entered in our benchmark, may enter instead when facing a multiproduct retailer – provided that Δ_i is high enough. This follows directly from Proposition 6. Suppose $\sigma = 1$ and $\theta_i = \theta + \varepsilon > \lambda\tau = \theta$, where ε is an infinitesimal value. Manufacturer i then does not enter in our benchmark. A sufficient condition that manufacturer i will enter when facing a multiproduct retailer instead, is then $\Delta_i > 3\tau + 2k\tau - k\tau\sqrt{2} \equiv \underline{\Delta}$. Hence, it is possible to construct scenarios where different manufacturers choose to enter in our benchmark compared to when facing a multiproduct retailer, and even scenarios where more manufacturers enter when facing a multiproduct retailer.

5 Conclusions

In this article we have analysed how buyer power relates to retailer size in markets with one-stop shopping behaviour. An often expressed view is that, in these markets, the trend where consumers reduce the number of weekly shopping trips, and hence bundle more of their purchases, has contributed to a shift in power towards large, multiproduct retailers. The fear is that, as the manufacturers earn a smaller share of the profits, they may respond by cutting back on innovation and product development.

We have contrasted two extreme cases: i) The case when all retailers are single-product retailers, and ii) the case where one retailer is a multiproduct retailer that competes against a group of single-product retailers. Our results confirm that large retailers may be able to obtain discounts, and therefore may be earning a higher profit (per product) than their smaller rivals. However, in contrast to some often expressed views, we do not find that large retailers harm supplier's incentives to innovate. On the contrary, we find that, if anything, large retailers tend to stimulate both product and process innovation at the upstream level, and that consumers, as a result, may benefit from both lower retail prices and higher quality on products.

By lowering its marginal cost, the manufacturer is able to offer its small retailer a lower wholesale price, which in turn translates into a lower final price for the consumers. By doing this, the manufacturer may be able to tempt more one-stop shoppers to switch shopping location should the multiproduct retailer delist its product. This undermines the value of the large retailer's disagreement payoff in the negotiations with the manufacturer – since one-stop shoppes, who buy many products, are more valuable to the large

retailer than top-up shoppers, who only buy one product. Cost reductions (or quality improvements) may therefore contribute to increasing the profit that the manufacturer can extract in negotiations with the multiproduct retailer.

We also briefly discussed the effect of multiproduct retailers on product entry. Our results are then unclear. Given that manufacturers often earn lower profits when facing a multiproduct retailer, it may be that some manufacturers will choose not to enter the market. However, depending on our assumptions about manufacturers entry costs, it is possible to contstruct scenarios where different manufacturers enter the market when facing a multiproduct retailer, compared to in our bencmark case with only single-product retailers. This is an issue that needs further investigation. In particular, we have only investigated the case with manufacturers that produce independent products (i.e., entry of all new product categories). The same dynamics may not apply when considering for example the incentives for manufacturers of introducing new products variants (substitutes) in their respective product categories.

Few papers in the economic literature analyse the effects of consumers' tendency to bundle their purchases. In particular, more work needs to be done to understand how this affects vertical relations. There are different ways to extend our model to gain additional insight. An interesting extension would be to allow both the retailers and the manufacturers to merge. The results could be interesting for competition policy, since the conclusion could have implications for how we should think of mergers between producers of seemingly independent products. Our model also contains some shortcomings that deserve future investigation. For example, even though we believe our qualitative results should still apply, it may be worth investigating the case when consumers' demand is elastic.[26] A possible extension could also be to investigate what happens when some of the manufacturers' products are substitutes. Or the situation where the retailers have access to an alternative source of supply for at least some of the products, for example a private label of inferior quality. We leave these questions for future research.

Appendix A: Retail market equilibria

Here we detail the retail market equilibrium when the large retailer sells all products, and every small retailer is active. According to (22) and (23), we have an equilibrium at stage 1 where each manufacturer $i \in \{1, ..., n\}$ and the retailers, L and iS, agree on

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[26]This may prove technically difficult, however.

$w_{iL}^* = w_{iS}^* = c_i$. The large retailer's profit at stage 2 is then

$$
\begin{aligned}
\pi_L &= \sum_{i=1}^{n} \left\{ (P_{iL} - c_i) Q_{iL} - F_{iL} \right\} \\
&= \sum_{i=1}^{n} \left\{ \left[\sigma \left(\frac{1}{2} - \frac{\sum_{i=1}^{n} (P_{iL} - P_{iS})}{2\tau} \right) \right. \right. \\
&\quad \left. \left. + (1 - \sigma) \left(\frac{1}{2} - \frac{P_{iL} - P_{iS}}{2\tau} \right) \right] (P_{iL} - c_i) - F_{iL} \right\},
\end{aligned}
\tag{38}
$$

and the profit of the small retailer selling product i, is

$$
\begin{aligned}
\pi_{iS} &= (P_{iS} - c_i) Q_{iS} - F_{iS} \\
&= \left[\sigma \left(\frac{1}{2} + \frac{\sum_{i=1}^{n} (P_{iL} - P_{iS})}{2\tau} \right) \right. \\
&\quad \left. + (1 - \sigma) \left(\frac{1}{2} - \frac{P_{iL} - P_{iS}}{2\tau} \right) \right] (P_{iS} - c_i) - F_{iS}
\end{aligned}
\tag{39}
$$

Taking the derivative of (38) w.r.t. the prices $P_{1L}, ..., P_{nL}$ yields n first-order conditions for the multiproduct retailer:

$$
-\frac{P_{1L} - c_1}{2\tau} + \sigma \left(\frac{1}{2} - \frac{\sum_{i=1}^{n} (P_{iL} - P_{iS})}{2\tau} \right) + (1 - \sigma) \left(\frac{1}{2} - \frac{P_{1L} - P_{1S}}{2\tau} \right)
$$
$$
= \frac{\sigma}{2\tau} \sum_{j \neq 1} (P_{jL} - c_j)
\tag{40}
$$
$$
\vdots
$$
$$
-\frac{P_{nL} - c_n}{2\tau} + \sigma \left(\frac{1}{2} - \frac{\sum_{i=1}^{n} (P_{iL} - P_{iS})}{2\tau} \right) + (1 - \sigma) \left(\frac{1}{2} - \frac{P_{nL} - P_{nS}}{2\tau} \right)
$$
$$
= \frac{\sigma}{2\tau} \sum_{j \neq n} (P_{jL} - c_j)
$$

Taking the derivative of the profit for each small retailer, $iS \in \{1S, ..., nS\}$, w.r.t its price P_{iS}, yields n first-order conditions (one for each retailer)

$$
-\frac{P_{1S} - c_1}{2\tau} + \sigma \left(\frac{1}{2} + \frac{\sum_{i=1}^{n} (P_{iL} - P_{iS})}{2\tau} \right) + (1 - \sigma) \left(\frac{1}{2} + \frac{P_{1L} - P_{1S}}{2\tau} \right) = 0
$$
$$
\vdots
\tag{41}
$$
$$
-\frac{P_{nS} - c_1}{2\tau} + \sigma \left(\frac{1}{2} + \frac{\sum_{i=1}^{n} (P_{iL} - P_{iS})}{2\tau} \right) + (1 - \sigma) \left(\frac{1}{2} + \frac{P_{nL} - P_{nS}}{2\tau} \right) = 0
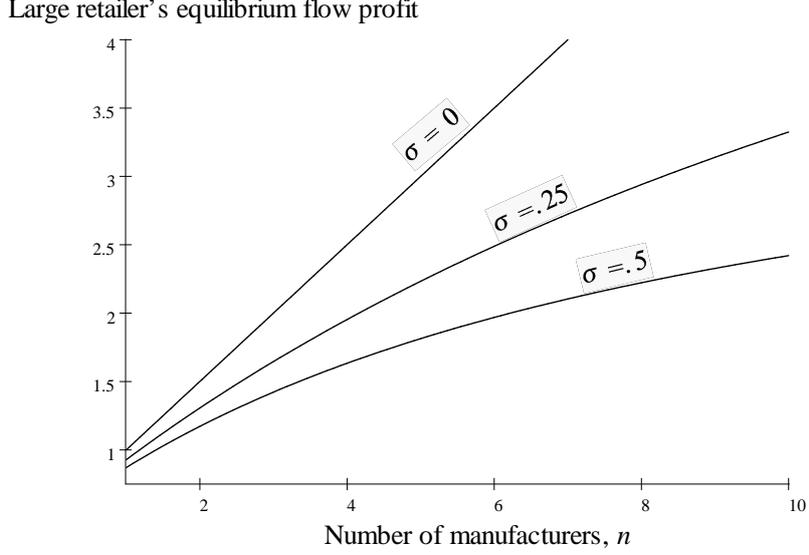$$

Figure 3: The multiproduct retailer's flow profit as a function of the number of products/ upstream firms.

Notice the symmetry. By imposing $P_{iL} = p_{iL} + c_i$ and $P_{iS} = p_{iS} + c_i$ for all $i \in \{1, ..., n\}$, setting $p_{1S} = ... = p_S$ and $p_{1L} = ... = p_L$, and defining $k \equiv n - 1$, we can write the first-order condtitions for the large retailer and each small retailer, respectively, as

$$-\frac{1}{2\tau}p_L + \sigma\left(\frac{1}{2} - \frac{(k+1)(p_L - p_S)}{2\tau}\right) + (1-\sigma)\left(\frac{1}{2} - \frac{p_L - p_S}{2\tau}\right) = \sigma\frac{1}{2\tau}kp_L \qquad (42)$$

and

$$-\frac{1}{2\tau}p_S + \sigma\left(\frac{1}{2} + \frac{(k+1)(p_L - p_S)}{2\tau}\right) + (1-\sigma)\left(\frac{1}{2} + \frac{p_L - p_S}{2\tau}\right) = 0. \qquad (43)$$

Solving these for $p_L = p_L^*$ and $p_S = p_S^*$, respectively, and setting $P_{iL}^* = p_L^* + c_i$ and $P_{iS}^* = p_S^* + c_i$ for all $i \in \{1, ..., n\}$, yields the prices in (24). Inserting these into the retailers' flow payoffs $r_L = \sum_{i=1}^{n}(P_{iL} - c_i)Q_{iL}$ and $r_{iS} = (P_{iS} - c_i)Q_{iS}$, yields the expressions in (25) and (26). r_L^* is plotted in Figure 3 for $\tau = 1$, and for different values on σ. Notice how, when increasing σ, r_L^* becomes concave in the number of firms $n = k + 1$.

Proof of Lemma 2. When not stocking product i, the large retailer has $n-1$ symmetric first-order conditions. By the same logic, the first-order conditions are symmetric also for the $n-1$ small retailers who are not selling product i. Using these symmetry properties, and setting $P_{jL} = p_L + c_j$ and $P_{jS} = p_S + c_j$ for all $j \in \{1, ..., n\}$, $j \neq i$, and $P_{iS} = p_{iS} + c_i$,

we can write the first-order conditions for the large retailer and the k small retailers who not selling product i, respectively, as

$$-\frac{p_L}{2\tau} + \sigma \left(\frac{1}{2} - \frac{k(p_L - p_S) + \Delta_i - p_{iS}}{2\tau} \right) + (1 - \sigma) \left(\frac{1}{2} - \frac{p_L - p_S}{2\tau} \right)$$
$$= \frac{\sigma}{2\tau} (k - 1) p_L \qquad (44)$$

$$-\frac{p_S}{2\tau} + \sigma \left(\frac{1}{2} + \frac{k(p_L - p_S) + \Delta_i - p_{iS}}{2\tau} \right) + (1 - \sigma) \left(\frac{1}{2} + \frac{p_L - p_S}{2\tau} \right) = 0 \qquad (45)$$

where $\Delta_i \equiv v_i - c_i$. Notice that if the price for product i is equal to the monopoly price, $p_{iS} + c_i = v_i$, then (44) and (45) are equivalent to (42) and (43), but with k instead of $n = k + 1$ products. The first-order condition for retailer iS, who has monopoly on the sales of product i, is

$$-\frac{\sigma}{2\tau} p_{iS} + \sigma \left(\frac{1}{2} + \frac{k(p_L - p_S) + \Delta_i - p_{iS}}{2\tau} \right) + (1 - \sigma) \geq 0. \qquad (46)$$

Assuming we have an interior solution (i.e., that $P_{iS} < v_i$, in which case (45) should hold with equality), the solutions to (44), (45) and (46), setting $p_L = p_L^{**}$, $p_S = p_S^{**}$ and $p_{iS} = \rho_i - c_i$, yields

$$P_{jL}^{**} = c_j + \frac{8\tau - \sigma(5\tau - 2k\tau + \Delta_i)}{6 + \sigma^2(k - 1)(k - 2) + 2(3k - 4)\sigma} \qquad (47)$$

$$P_{jS}^{**} = c_j + \frac{4\tau + \sigma(2k\tau - 3\tau + \Delta_i) + \sigma^2(k - 1)(\tau + \Delta_i)}{6 + \sigma^2(k - 1)(k - 2) + 2(3k - 4)\sigma} \qquad (48)$$

$$\rho_i = p_S^{**} + c_i + \frac{(1 - \sigma)[6\tau + \sigma^2(k - 1)(k\tau + 2\Delta_i) + \sigma(8k\tau - 9\tau + 3\Delta_i)]}{\sigma(6 + \sigma^2(k - 1)(k - 2) + 2(3k - 4)\sigma)} \qquad (49)$$

In solving $\rho_i = v_i$ for Δ_i, we find that ρ_i is below or equal to the reservation price v_i only as long as

$$\Delta_i \geq \tau \frac{6 + \sigma^2(k - 1)(k - 6) + \sigma(8k - 11) - \sigma^3(k - 1)^2}{(3 + k\sigma - \sigma)(1 + k\sigma - \sigma)\sigma} \equiv \Delta(\sigma, n, \tau). \qquad (50)$$

in which case we have an interior solution to (46). We can rewrite this constraint as $v_i \geq \Delta(\sigma, n, \tau) + c_i$. Taking the derivative of $\Delta(\sigma, n, \tau)$ w.r.t. σ, yields

$$\frac{\partial \Delta(\sigma, n, \tau)}{\partial \sigma} = -\tau \frac{\left\{ \begin{array}{c} 18 + (k - 2)(k - 1)^3 \sigma^4 + 16(k - 1)^3 \sigma^3 \\ + (47k - 44)(k - 1)\sigma^2 + 48(k - 1)\sigma \end{array} \right\}}{\sigma^2(3 + k\sigma - \sigma)^2(1 + k\sigma - \sigma)^2} < 0 \qquad (51)$$

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which is negative. Hence, as σ increases, the constraint, $v_i \geq \Delta(\sigma, n, \tau) + c_i$, becomes more relaxed. Hence, there exist a critical value $\widehat{\sigma}_i$, such that when $\sigma \leq \widehat{\sigma}_i$, the constraint binds and the equilibrium price for product i is $\overline{P}_{iS} = v_i$; if $\sigma > \widehat{\sigma}_i$, the constraint does not bind, and the equilibrium price is $\overline{P}_{iS} = \rho_i < v_i$. Taking the derivative of $\Delta(\sigma, n, \tau)$ w.r.t the number of firms, $n = k + 1$, yields

$$\frac{\partial \Delta(\sigma, n, \tau)}{\partial k} = -\tau \frac{(\sigma(4 - \sigma) k^2 + (1 - \sigma)(3 - \sigma)(2k - 1)) \sigma}{(3 + k\sigma - \sigma)^2 (1 + k\sigma - \sigma)^2} < 0, \quad (52)$$

which is negative. Hence, as the number of firms, $n = k + 1$, increases, the constraint, $v_i \geq \Delta(\sigma, n, \tau) + c_i$, becomes more relaxed, which means that the critical value $\widehat{\sigma}_i$ is a decreasing function of the number of upstream firms. Finally, it is straightforward to see that as either v_i increases and/ or c_i decreases, the constraint becomes more relaxed, which means that $\widehat{\sigma}_i$ is also a decreasing function of the quality/ cost gap, Δ_i.

If $\sigma \leq \widehat{\sigma}_i$ and $\overline{P}_{iS} = v_i$, we can solve the first-order conditions (44) and (45) for $p_L = p_L^{**}$ and $p_S = p_S^{**}$ respectively, and set $P_{jL}^{**} = p_L^{**} + c_j$ and $P_{jS}^{**} = p_S^{**} + c_j$. We then obtain the prices

$$P_{jL}^{**} = \tau + c_j + \sigma \frac{\tau(2 + \sigma(k - 1))(k - 1)}{(3 + \sigma(k - 1))(1 + \sigma(k - 1))} \; ; \; P_{jS}^{**} = \tau + c_j - \sigma \frac{(k - 1)\tau}{(3 + \sigma(k - 1))}, \quad (53)$$

which are equivalent to the prices in (24), but with k instead of $n = k + 1$ products. It is easily checked that the prices in (53), and the prices in (47) and (48), are equal when $v_i = \Delta(\sigma, n, \tau) + c_i$. Inserting the equilibrium prices into the large retailer's flow payoff, $r_L = \sum_{j \neq i} (P_{jL} - c_j) Q_{jL}$, yields the expressions in (31). **Q.E.D.**

Appendix B

An example for Assumption 5   The fixed fee paid by the large retailer to manufacturer i, is $F_{iL}^* = \lambda(r_L^* - r_L^{-i})$. By setting $n = 3$, $\tau = 1$, $v_i = 2$, $\lambda = 1$ and $c_i = 0$, we obtain $\widehat{\sigma}_i \approx 0.62269$. The fixed fee is then equal to

$$F_{iL}^* = \begin{cases} \dfrac{81 + 297\sigma + 405\sigma^2 + 195\sigma^3 - 8\sigma^4 - 16\sigma^5}{2(1 + 2\sigma)(1 + \sigma)(3 + \sigma)^2(3 + 2\sigma)^2} & \text{if} \quad \sigma \leq 0.62269 \\ \dfrac{(69\sigma - 18\sigma^2 + 103)\sigma^2 - 10}{4(2\sigma + 3)^2(2\sigma + 1)} & \text{otherwise} \end{cases} \quad (54)$$

(53) is plotted in Figure 4. It is easy to see that F_{iL}^* is increasing in σ over the interval $(0.62269, 1)$.
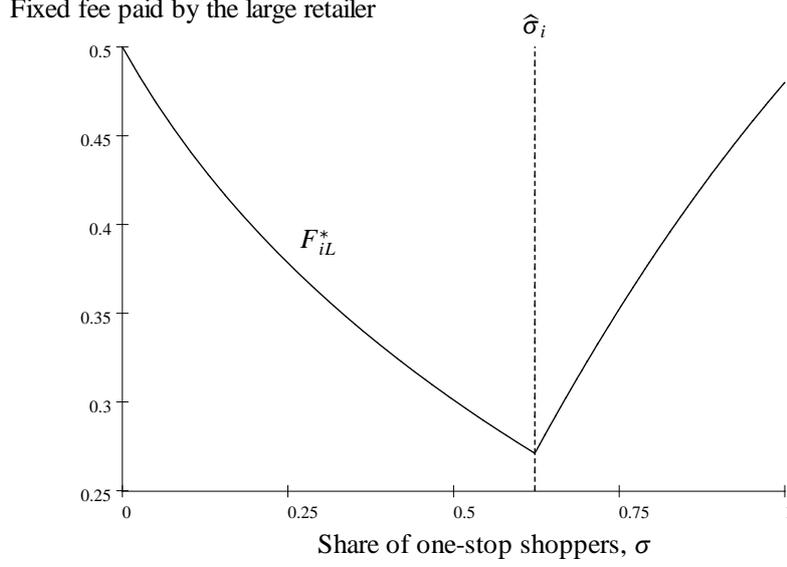
Figure 4: The fixed fee paid by the large retailer to manufacturer i.

Proof of Lemma 3. When $\sigma > 0$, it follows from the concavity of $r_L^*(n)$, that $F_{iL}^* = \lambda\left(r_L^* - r_L^{-i}\right) < F^B$ when $\sigma \in (0, \widehat{\sigma}_i)$ Let $g_r(k, \sigma)$ be the second order partial derivative of r_L^* w.r.t $k = n - 1$:

$$g_r = -\sigma\tau\frac{\left\{\begin{array}{c} 9\left(3 - 2\sigma\right) + k^4 4\sigma^4\left(4 - \sigma\right) + k^3 3\sigma^3\left(19 - 4\sigma\right) \\ + k^2 9\sigma^2\left(9 - 2\sigma\right) + k3\sigma\left(21 - 8\sigma\right) \end{array}\right\}}{\left(k\sigma + 3\right)^4\left(k\sigma + 1\right)^3} < 0 \qquad (55)$$

This is strictly negative as long as $\sigma > 0$. r_L^* is therefore concave in the number of upstream firms n. Under Assumption 5, $\lambda\left(r_L^* - r_L^{-i}\right)$ is strictly increasing in σ over the interval $\sigma \in (\widehat{\sigma}_i, 1)$. When $\sigma = 1$, we have

$$F_{iS}^* = \frac{\lambda\left(6\tau + 4k\tau - \Delta_i\right)\Delta_i}{2\left(k + 3\right)^2 \tau}, \qquad (56)$$

provided that $\widehat{\sigma}_i < 1$. In solving the following inequality

$$\frac{\lambda\left(6\tau + 4k\tau - \Delta_i\right)\Delta_i}{2\left(k + 3\right)^2 \tau} - \frac{\lambda\tau}{2} \leq 0 \qquad (57)$$

for Δ_i, we obtain $\Delta_i \leq \tau\left(3 + 2k - \sqrt{3}\sqrt{k\left(2 + k\right)}\right) \equiv \Delta^*$. **Q.E.D.**

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Proof of Proposition 2. Suppose $\sigma \in (0, \widehat{\sigma}_i)$ for all $i \in \{1, ..., n\}$. From the concavity of $r_L^*(n)$, it follows that manufacturer i earns strictly lower profits compared to in our benchmark. We can write the profit of the large retailer in this case as

$$\pi_L^* = r_L^*(n) - n\lambda \left[r_L^*(n) - r_L^*(k) \right], \tag{58}$$

where $k = n - 1$. Suppose $\lambda = 1$, then we have $\pi_L^* = 0$ when $\sigma = 0$. If $\sigma > 0$, then $\pi_L^* > 0$ iff

$$\frac{r_L^*(k)}{n-1} > r_L^*(n) - r_L^*(k), \tag{59}$$

which holds iff $r_L^*(n)$ is strictly concave. If $\lambda < 1$, then $\pi_L^* = n(1 - \lambda)\tau/2$ when $\sigma = 0$. The multiproduct retailer then earns strictly higher profit when $\sigma > 0$ iff

$$\frac{r_L^*(k)}{n\lambda - 1} - \frac{n\tau(1 - \lambda)}{2(n\lambda - 1)} > r_L^*(n) - r_L^*(k) \tag{60}$$

which holds iff $r_L^*(n)$ is strictly concave and λ is not too low. Taking the derivative of π_L^* as $\sigma \to 0$, yields

$$\lim_{\sigma \to 0} \frac{\partial \pi_L^*}{\partial \sigma} = \frac{1}{6}\tau k(k + 1)(2\lambda - 1), \tag{61}$$

which is positive as long as $\lambda > 1/2$. Taking the derivative of $\pi_i^* = \lambda \left(r_L^* - r_L^{-i} \right) + \lambda r_S^* = \lambda \left[r_L^*(n) - r_L^*(k) \right] + \lambda r_S^*$, as $\sigma \to 0$, yields

$$\lim_{\sigma \to 0} \frac{\partial \pi_i^*}{\partial \sigma} = -\frac{2}{3}\tau \lambda k, \tag{62}$$

which is negative. **Q.E.D.**

Proof of Proposition 3. The manufacturer earns strictly lower profit when $\sigma \in (0, \widehat{\sigma}_i)$, as shown above. Under Assumption 5, F_{iL}^* is increasing in σ over the interval $\sigma \in (\widehat{\sigma}_i, 1)$. Hence, we have to evaluate manufacturer i's profit π_i^* as $\sigma \to 1$. This yields

$$\lim_{\sigma \to 1} \pi_i^* = \lambda \frac{9\tau^2 + \Delta_i (6\tau + 4k\tau - \Delta_i)}{2\tau(k + 3)^2} \tag{63}$$

assuming $\widehat{\sigma}_i < 1$, which is strictly higher than $\pi_B^m = \lambda\tau$ iff $\Delta_i > \tau \left(3 + 2k - \sqrt{2}k \right) = \underline{\Delta}$.
Q.E.D.

Proof of Proposition 4. To demonstrate that a merger between manufacturers (before negotiations with the retailers take place) may be profitable, it is sufficient to give an example. Take the simplest case: Suppose $\sigma < \widehat{\sigma}_i$ for all $i \in \{1,...,n\}$, and that all n manufacturers decide to merge. Since the large retailer's disagreement payoff is zero in the negotiations with the merged manufacturer, the manufacturers' joint (post-merger) profit is simply $\Pi_M = \lambda \left(r_L^* \left(n \right) + n r_S^* \right)$. Their (joint) pre-merger profit is $n\pi_i^* = \lambda n \left(r_L^* \left(n \right) - r_L^* \left(k \right) + r_S^* \right)$. We then have

$$\Pi_M - n\pi_i^* = (k+1) \, k\sigma\tau\lambda \frac{\left\{ \begin{array}{c} 27 + 27 \left(2k - 1 \right) \sigma + 3 \left(17k^2 - 17k + 3 \right) \sigma^2 \\ + 12k \left(2k - 1 \right) \left(k - 1 \right) \sigma^3 + 4 \left(k - 1 \right)^2 k^2 \sigma^4 \end{array} \right\}}{2 \left(1 + k\sigma \right) \left(1 + k\sigma - \sigma \right) \left(3 + k\sigma \right)^2 \left(3 + k\sigma - \sigma \right)^2} > 0 \quad (64)$$

which is strictly positive as long as $\sigma, \lambda > 0$. **Q.E.D.**

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