Journal of Economic Behavior and Organization 248 (2026) 107627

Contents lists available at ScienceDirect

Journal of Economic Behavior and Organization

journal homepage: www.elsevier.com/locate/jebo

Add-on selling with context effects

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ARTICLE INFO

JEL classification:
D40
D90
L10
L50

Keywords:
Add-on selling
Context effects
Relative thinking
Reference dependence
Diminishing Sensitivity

ABSTRACT

A common practice is to offer optional extras or upgrades during the purchase process. This paper studies endogenous consumer insensitivity to such additional prices: we posit that consumers are more prone to buy these overpriced extras when they represent a smaller share of total expenditure. The presence of such context-sensitive consumers softens competition in the market for the base good, jeopardizing their own surplus but also that of consumers with standard preferences. Exploitation of context effects by firms reduces total welfare.

1. Introduction

The art of offering customers extra items or upgrades during the purchase is becoming ever more popular. Cars come with hundreds of extra options like park assist or battery upgrades, electronics retailers promote extended warranties, and self-service kiosks in restaurants advertise add-ons at checkout. Such practices are thought to be profitable by generating excess demand for the extra item (Morwitz et al., 1998; Rasch et al., 2020), and have become central to an active academic and policy debate on the regulation of add-on pricing (Mahoney, 2025).

This paper studies optional add-ons offered at the point of sale and their effect on competition and welfare. Our key mechanism is that consumers with context-dependent preferences become less sensitive to an add-on's price when it is small relative to the price of the base good, consistent with evidence that higher base good prices (causally) increase purchases of extras (Azar, 2011a; Lewis et al., 2019). We relate in particular to Ellison (2005) and Armstrong (2015), but in our model, the base good price itself shapes add-on demand. This endogeneity yields distinct implications relative to conventional add-on models with exogenous demand heterogeneity in the aftermarket.

Our analysis offers three insights. First, add-on selling may not only reduce the surplus of behavioral consumers who purchase overpriced extras, but can also harm classical consumers who act according to standard theory. Second, context effects create an endogenous price floor that sustains add-on profits and may soften the competition in the primary market. Third, the standard waterbed logic — regulating add-on prices may simply shift margins back into higher base good prices (Gabaix and Laibson, 2006; Armstrong and Vickers, 2012) — does not need to apply in our setting.

To set the scene, consider a consumer who chooses an airline carrier based on the price and itinerary. After proceeding to booking, the consumer is presented with additional options, such as seat selection, priority boarding, or extra legroom. Spending

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https://doi.org/10.1016/j.jebo.2026.107627
Received 2 November 2025; Received in revised form 4 May 2026; Accepted 20 May 2026

Available online 4 June 2026
0167-2681/

$10 on seat selection arguably feels less significant if the base fare is $300 rather than $50. In the former case, many of us may perceive that opting for seat selection will not put a dent in our wallets. In the latter case, the expense appears non-negligible.

This illustrates a context effect: the add-on's price is evaluated relative to the base good purchase, so that a higher base good price can make the same add-on feel cheaper. Such context-dependent preferences can be explained by relative thinking, diminishing sensitivity, or reference dependence (Bushong et al., 2021; Kahneman and Tversky, 1979; Kőszegi and Rabin, 2006). We model consumer behavior in a general reduced form to accommodate for these various microfoundations (provided in Appendix A).

Consider a Hotelling setting with two firms and two goods. Consumers first choose a seller for the base good and are then presented with the seller's offer for an optional add-on. The seller enjoys monopoly power in the aftermarket. Consumers can reject the extra offer at zero cost, and we focus on situations where the extra item costs less than the base good.

Classical consumers coexist with *behavioral consumers* in our economy. Behavioral consumers exhibit context-dependent preferences: their willingness-to-pay for the add-on is a function of the price of the base good. Firms observe the distribution of types, but cannot identify an individual consumer's type. Faced with a heterogeneous consumer population, firms must decide on their pricing strategy. In what we refer to as the rational benchmark economy, the entire population consists of classical consumers with standard preferences, yielding a canonical Hotelling outcome.

In equilibrium, firms either set an add-on price to serve both types (a non-exploiting strategy) or set a higher add-on price that only behavioral consumers accept (an exploiting strategy). Which strategy is optimal in equilibrium depends on the share of behavioral consumers and the intensity of competition. If the share of behavioral consumers is small, firms choose the non-exploiting strategy and price as if all consumers were classical, leading to the same outcome as in the benchmark economy without context effects.

If the share of behavioral consumers is sufficiently large, firms exploit behavioral consumers and face a trade-off when setting the optimal base good price: raising it increases behavioral consumers' add-on demand due to context effects; lowering it attracts more consumers that can be exploited. The first incentive creates the endogenous price floor, the second determines whether this floor is above or below the benchmark price.

With an intermediate share of behavioral consumers, higher prices and mark-ups in both markets outweigh the loss of demand, and the base good becomes more expensive. This reduces the surplus of behavioral consumers, who buy both products at a higher price than in the non-exploiting equilibrium. But also classical consumers are worse off: while they opt out in the aftermarket, they pay more for the base good than in the benchmark economy. In sum, total consumer surplus is lower.

With a large share of behavioral consumers, firms cut the base good price below the benchmark price. While the overpriced extra is still purchased by behavioral consumers only, those are now so prevalent that it is optimal for firms to compete more fiercely for them in the base good market, pushing the endogenous price floor below the benchmark price. Although all consumers benefit from a lower base good price, in the aggregate these gains are smaller than behavioral consumers' losses from the add-on overpayment, so total consumer surplus is still lower than in the benchmark. Welfare is also lower than in the benchmark due to lost gains from trade: classical consumers underpurchase the add-on whose price exceeds their valuation, even though purchases would be socially efficient since their valuation exceeds marginal cost.

More competitive markets mitigate these losses, but do not eliminate them. Even under perfect competition, when the base good is homogeneous and firms compete à la Bertrand, total consumer surplus is weakly lower than in the benchmark economy. This result implies that the safety-in-markets principle, which states that in a perfectly competitive economy, aggregate consumer surplus remains unaffected by the presence of consumers who make mistakes, does not hold in our case (Gabaix and Laibson, 2006; Heidhues and Kőszegi, 2018). Nevertheless, strengthening competition is helpful: aggregate consumer surplus is always higher in more competitive markets, and welfare is at least weakly higher.

We contribute to an ongoing policy discussion: add-on price caps.[1] A common objection to regulating ancillary prices is the waterbed logic (Lal and Matutes, 1994; Verboven, 1999; Ellison, 2005; Armstrong and Vickers, 2012; Gabaix and Laibson, 2018): in a competitive base good market, add-on markups do not translate into higher profits because firms compete fiercely for consumers by lowering base good prices. Accordingly, capping add-on prices may be ineffective because it triggers higher base good prices. Our framework breaks that logic because the base good price is also a strategic tool that influences demand and profitability of the aftermarket through context effects. Consequently, capping add-on prices can reduce firms' incentives to manipulate add-on demand by maintaining high base good prices. That is why a price cap on the add-on can have a multiplier effect in our setting and even reduce the base good price. Indeed, we find that an add-on price cap always increases behavioral and aggregate consumer surplus and sometimes even benefits classical consumers.

Our analysis relates to the fairly extensive literature on add-on pricing (Spiegler, 2011; Grubb, 2015; Heidhues and Kőszegi, 2017). In canonical models, behavioral consumers purchase overpriced ancillary charges because of myopia, naïvité, or hidden attributes of the base product.[2] Two features distinguish our mechanism: (i) our extra item is optional and can always be rejected at zero cost, (ii) consumer insensitivity in the aftermarket arises endogenously as a function of the price of the base good due to context-dependent preferences. Exactly this mechanism can soften competition in the base good market and is responsible for creating our distinct results, such as the non-monotonicity in optimal base good prices and the emergence of an endogenous base good price floor.

[1] Add-on caps are frequently discussed among scholars (see Gomes and Tirole, 2018, for example) and policy-makers (see UK Consumer Rights (Payment Surcharges) Regulations, 2012; The White House, 2022, for example).

[2] Typical examples include ATM fees, credit card late fees, resort fees, taxes and surcharges, or any other hidden feature of the base product.

Insofar, our paper also relates to the literature on base good price floors. Such price floors can arise because of a variety of reasons, for instance, due to infeasible negative base good price (Armstrong and Vickers, 2012), substitution (Miao, 2010; Michel, 2017), consumer procrastination (Heidhues et al., 2024), consumer type identification by firms (Johnen, 2020), and consumer suspicion (Heidhues et al., 2016; Shulman and Geng, 2019; Fehr and Wu, 2023).

As previewed earlier, the endogenous insensitivity to add-on prices distinguishes our mechanism from Ellison (2005) and Armstrong (2015). In the former, rich consumers not only "unintentionally buy overpriced add-ons" (Ellison, 2005, p. 587), but are also exogenously less price-sensitive in the base good market than poor consumers. This creates an adverse selection problem when competition is sufficiently intense: firms face lower incentives to undercut on the base good price, creating a price floor. Our result on lower competition in the primary market is consistent, but differs in that it also holds in uncompetitive settings. Armstrong (2015) emphasizes that in add-on markets, firms may cross-subsidize the base good using add-on revenue extracted from non-savvy consumers, generating a "ripoff externality" in which non-savvy consumers can fund better base good deals for savvy consumers. Our model shares this standard cross-subsidy channel but adds a countervailing force: firms incentives to compete in the primary market are softened by context-dependent preferences. As a result, unlike the canonical ripoff-externality intuition, the presence of behavioral consumers need not translate into a lower base good price and can instead even harm classical consumers.

Section 2 defines the model setup. Section 3 provides the equilibrium analysis. Section 4 analyzes the policy implications. Section 5 concludes. Consumer preferences are microfounded in Appendix A. All proofs are presented in Appendix B.

2. The model

We study a market in which consumers choose a seller based on a base good and then decide whether to buy an optional add-on that can be declined at no cost.[3] We implement context effects in a reduced-form manner into a standard add-on model within a Hotelling framework,[4] and provide the psychological microfoundations in Appendix A.

2.1. Setup

Consumers with taste x are uniformly distributed on $[0, 1]$ and buy at most one unit of a base good with valuation v_1. We suppose that v_1 is sufficiently large such that the market is covered in equilibrium. After buying the base good, all consumers can purchase one unit of an upgrade with consumption utility v_2.

Two firms, located at $l = 0$ and $l = 1$, respectively, offer each a base good at price $p_{1,l} \in \mathbb{R}$ and an upgrade at price $p_{2,l} \in \mathbb{R}$, and have identical marginal production costs $0 \leq c_1 < v_1$ and $0 \leq c_2 < v_2$. We will suppress the firm index l when it is not necessary to ease notation. Buying a base good imposes transportation costs of $t|x - l|$ on the consumer, where $t \geq 0$ captures product differentiation and competition intensity. Our main analysis assumes $t > 0$ but the case $t = 0$, in which the base good is homogeneous and competition is à la Bertrand, is treated in Section 3.6. Upgrades are homogeneous across firms and consumers are locked-in in the aftermarket. That is, consumers can only purchase the upgrade from the same firm where the base good was purchased, implying monopolistic power for firms in the aftermarket.

The main feature of the model is that some consumers may exhibit context-dependent preferences when evaluating the additional offer. In this case, they consider the price of the add-on in the context of the cost of the base good, temporarily increasing their (perceived) utility of the add-on. We capture this behavioral effect formally with $\tilde{\Delta}(\beta_i, \Delta_p)$, where $\beta_i \in [0, 1]$ represents the strength of context effects and $\Delta_p = p_1 - p_2$ is the price difference. We suppose that $\tilde{\Delta}(\beta_i, \Delta_p)$ is strictly increasing in β_i. Whether $\tilde{\Delta}(\beta_i, \Delta_p)$ is increasing or decreasing in Δ_p depends on the underlying mechanism. To relieve notation, we refer to $\tilde{\Delta} \equiv \tilde{\Delta}(\beta_i, \Delta_p)$ as the context effects that affect the perceived add-on utility. We focus on equilibria in which the base good is more expensive than the add-on, $p_1 > p_2$, such that $\Delta_p > 0$ in any equilibrium.[5]

The perceived utility for the add-on depends on the consumption utility v_2, and the context effects $\tilde{\Delta}$, and is represented in reduced form by $W(v_2, \tilde{\Delta})$, which is strictly increasing in both arguments, weakly concave, and $W(v_2, \tilde{\Delta}(0, \Delta_p)) = W(v_2, \tilde{\Delta}(\beta_i, 0)) = v_2$. Hence, when both products are equally costly, $p_1 = p_2$, or $\beta_i = 0$, the (perceived) utility is not affected by context effects. Consumer i purchases the extra item when the perceived net utility is non-negative

$$U_i(v_2, p_2, \tilde{\Delta}) = W(v_2, \tilde{\Delta}) - p_2 \geq 0,$$

Thus, some consumers accept a larger additional price due to context effects. The analytical outcome for the add-on purchase decision is independent of whether consumers overestimate the benefits or underweight the costs,[6] and depending on the microfoundation, context effects $\tilde{\Delta}$ can affect $W(v_2, \tilde{\Delta})$ in an additive or multiplicative way.

An intuitive and tractable microfoundation of context effects is a consumer with reference-dependence preferences, who anchors on the base good price when evaluating the add-on. Such a behavioral consumer takes the base good price p_1 as a reference price

[3] We use the terms extra item, additional item, add-on, and upgrade interchangeably for the aftermarket product.

[4] In the previous version of this paper (Brunner and Zihlmann, 2024), we allow for a more general reduced-form demand structure including non-linear demand functions. While the richer model permitted the characterization of additional equilibrium types, it reduced the intuitive ease of the Hotelling model, but economic insights remain the same.

[5] We rule out the corner solution $p_1 = p_2$, which implies $\Delta_p = 0$ and thus, $W(v_2, \tilde{\Delta}(\beta_i, 0)) = v_2$ for all consumers. Therefore, we focus on interior solutions. For instance, sufficiently large marginal costs c_1 and c_2 ensure $p_1 > p_2$ in equilibrium as shown in Lemma 1.

[6] For analytical reasons, we impose the behavioral effects on the (perceived) gross utility of the extra item instead of the price.

$\tilde{p}$, and gains additional utility from the perception of obtaining a "good deal" when $p_2 < p_1$ (see Wenner, 2015, based on Kőszegi and Rabin, 2006). The perceived net utility from the add-on is

$$U_i(v_2, p_2, \tilde{\Delta}) = v_2 - p_2 + \gamma(\tilde{p} - p_2),$$

where $\gamma(\cdot)$ captures the gain–loss utility from reference dependence, with $\gamma(0) = 0$ and γ strictly increasing and weakly concave. Given our focus on equilibria with $p_1 > p_2$, we can abstract from loss aversion. Setting $\tilde{p} = p_1$ and accounting for consumer heterogeneity β_i yields

$$U_i(v_2, p_2, \tilde{\Delta}) = v_2 - p_2 + \gamma(\beta_i \Delta p) = W(v_2, \tilde{\Delta}) - p_2,$$

with $\tilde{\Delta} = \gamma(\beta_i \Delta p)$. Thus, any weakly concave $\gamma(\cdot)$ satisfies our model assumptions. For instance, one can take $\tilde{\Delta} = \beta_i (p_1 - p_2)^y$ with $y \in (0, 1]$. Other behavioral mechanisms — relative and proportional thinking, diminishing sensitivity, and anchoring-and-adjustment — yield analogous reduced-form structures and are discussed in Appendix A.

The population consists of potentially two types, $i \in \{c, b\}$, classical and behavioral consumers, determined by the parameter β_i. A $\beta_i = \beta_b > 0$ characterizes a behavioral consumer with context-dependent preferences, while $\beta_i = \beta_c = 0$ implies a classical consumer who is not subject to any context effects and whose valuation depends only on the consumption utility, v_2. Thus, behavioral consumers have a strictly larger perceived add-on utility than classical consumers. For now, we remain agnostic about whether context effects only increase the perceived add-on utility at the time of purchase or if they also generate consumption utility, so whether $\tilde{\Delta}$ generates consumption utility or not. Our main results are robust to this choice.

With probability $\alpha \in [0, 1]$, a consumer exhibits context-dependent preferences when observing the additional offer after buying the base good. Firms cannot identify a consumer's type, making price discrimination impossible, but α is common knowledge and thus corresponds to the expected share of behavioral consumers in the market.

We solve the game for Nash equilibria in symmetric pure strategies. The timing of the game is as follows[7]:

- Period 0: Firms simultaneously choose the prices $p_{1,l}$ and $p_{2,l}$.
- Period 1: Demand for the base good realizes.
- Period 2: Each firm offers an add-on to its base good consumers. Consumers observe the additional offer and either accept or reject it at zero costs.

Lastly, we assume that the extra item does not affect consumer choice in the base good market, including the store location. Consumers select a firm solely because of the surplus provided by the base good.[8] Following Apffelstaedt and Mechtenberg (2021), preferences are context-sensitive only at the final point of sale and do not affect expectations ex-ante. Thus, consumers have rational expectations of obtaining zero surplus from the extra purchase when choosing the base good seller, as they (correctly) anticipate that firms extract all aftermarket rents due to lock-in.

3. Equilibrium pricing

3.1. Aftermarket

In period 2, after the purchase of the base good, consumers decide whether to buy an extra item at price p_2. Classical consumers ($\beta_c = 0$) purchase the upgrade when $v_2 \geq p_2$. Behavioral consumers ($\beta_b \in (0, 1]$) buy when $W(v_2, \tilde{\Delta}) \geq p_2$. Therefore, the demand for the upgrade of firm l is given by

$$Q_l(p_{2,l}, D_l(p_{1,l}, p_{1,-l})) = \begin{cases} D_l(p_{1,l}, p_{1,-l}) & \text{if } p_{2,l} \leq v_2, \\ \alpha D_l(p_{1,l}, p_{1,-l}) & \text{if } v_2 < p_{2,l} \leq W(v_2, \tilde{\Delta}), \\ 0 & \text{if } p_{2,l} > W(v_2, \tilde{\Delta}), \end{cases}$$

where $D_l(p_{1,l}, p_{1,-l})$ is the base good demand firm l obtains. Note that the upgrade demand also depends indirectly on p_1, because only base good buyers proceed to the aftermarket and can purchase the upgrade from this firm.

7 Sequential price setting of p_1 and p_2 does not change the results qualitatively because firms are still unable to identify a consumer's type after the base good purchase. Further, as we show in Section 3.2, firms choose p_1 given p_2 also in the simultaneous case. If changing p_2 after selling the base good is profitable, then p_1 was not optimally chosen.

8 This assumption is quite reasonable in our setting since upgrades are offered only after the base good purchase, and aligns with existing models considering add-on pricing (Shapiro, 1994; Ellison, 2005; Gabaix and Laibson, 2006; Spiegler, 2006; Gamp, 2015; Spiegler, 2016; Rasch et al., 2020; Heidhues et al., 2021; Johnen and Somogyi, 2024).

3.2. *Firms' strategies*

The profit function of firm l is given by

$$\pi_l(p_{1,l}, p_{1,-l}, p_{2,l}) = (p_{1,l} - c_1)D_l(p_{1,l}, p_{1,-l}) + (p_{2,l} - c_2)Q_l(p_{2,l}, D_l(\cdot)). \tag{1}$$

Since firms have monopolistic power in the aftermarket, they make either of the two consumer types indifferent in buying the extra product. Two possible add-on prices emerge in equilibrium, (implicitly) defined by $p_2^* \in \{v_2, W(v_2, \tilde{\Delta})\}$.

If $p_2^* = v_2$, firms do not exploit behavioral consumers' context-dependent preferences. All consumers accept the additional offer, which we refer to as the *non-exploiting strategy*. However, if $p_2^* = W(v_2, \tilde{\Delta})$, firms set a higher price for the upgrade than in the non-exploiting strategy, aiming to exploit behavioral consumers' increased willingness-to-pay for the extra item. Consequently, classical consumers no longer accept the additional offer. We refer to this as the *exploiting strategy*.

Selecting one strategy determines $p_{2,l}$ and $Q_j(p_{2,l}, D_l(\cdot))$ in Expression (1), while the base good demand $D_l(p_{1,l}, p_{1,-l})$ is determined by the indifferent consumer $\bar{x} = \frac{1}{2} + \frac{p_{1,-l} - p_{1,l}}{2t}$ such that $D_l(p_{1,l}, p_{1,-l}) = \bar{x}$ and $D_{-l}(p_{1,-l}, p_{1,l}) = 1 - \bar{x}$. Given a chosen strategy, firm l maximizes its profits by choosing the base good price $p_{1,l}$, which yields the implicitly defined best response functions for any $p_{1,-l}$.

3.3. *Market outcome*

We define the rational benchmark economy as an economy in which only classical consumers exist ($\alpha = 0$). This allows us to identify how the presence of consumers with context-dependent preferences affects the market outcome. We define the profit threshold

$$\bar{\alpha}_\pi \in \left(\frac{v_2 - c_2}{W(v_2, \tilde{\Delta}) - c_2}, \frac{v_2 - c_2}{W(v_2, \tilde{\Delta}) - c_2 - tW'(v_2, \tilde{\Delta})} \right)$$

to characterize the symmetric exploiting equilibrium.[9] The expression $W'(v_2, \tilde{\Delta}) = \frac{\partial W(v_2, \tilde{\Delta})}{\partial p_{1,l}} > 0$ captures the marginal effect of a more expensive base good on the willingness-to-pay for the extra item.

Lemma 1.

(i) *Suppose $\alpha = 0$. In the rational benchmark, both firms set $p_1^{BM} = t + c_1 + c_2 - v_2$ and $p_2^* = v_2$, and earn $\pi^{BM} = \frac{t}{2}$.*
(ii) *The symmetric non-exploiting equilibrium exists for $0 < \alpha \le \frac{v_2 - c_2}{W(v_2, \tilde{\Delta}) - c_2}$ and is identical to the benchmark outcome.*
(iii) *The symmetric exploiting equilibrium exists when $\alpha \ge \bar{\alpha}_\pi$ and $t \le \frac{W(v_2, \tilde{\Delta}) - v_2}{W'(v_2, \tilde{\Delta})}$. Firms set $p_1^e(\alpha) = t(1 + \alpha W'(v_2, \tilde{\Delta})) + c_1 + \alpha(c_2 - W(v_2, \tilde{\Delta}))$ and $p_2^* = W(v_2, \tilde{\Delta})$, and earn $\pi^e = \frac{t(1 + \alpha W'(v_2, \tilde{\Delta}))}{2}$.*
(iv) *In a symmetric exploiting equilibrium, profits π^e are strictly increasing in α and the optimal base good price $p_1^e(\alpha)$ is monotonically decreasing in α.*

With $\alpha = 0$, we obtain the standard Hotelling outcome: firms use the aftermarket earnings, $v_2 - c_2$, to cross-subsidize and lower the base good price p_1^{BM}. This is to attract and lock in more consumers, known from the classical add-on pricing literature (Holton, 1957; Diamond, 1971).

With $\alpha > 0$, firms face a trade-off in the aftermarket between selling the upgrade to every customer or at a higher price to behavioral consumers only. The symmetric non-exploiting equilibrium exists when the share of behavioral consumers is sufficiently low.[10] When only a few consumers have context-dependent preferences, a firm loses a substantial amount of the upgrade demand when exploiting, making it unprofitable. In a non-exploiting equilibrium, firms price as if in the benchmark economy, and the presence of behavioral consumers does not affect the market outcome. For this reason, the remainder of the analysis focuses on the symmetric exploiting equilibrium.

A symmetric exploiting equilibrium exists when sufficiently many behavioral consumers are in the market, $\alpha \ge \bar{\alpha}_\pi$.[11] The additional condition, $t \le \frac{W(v_2, \tilde{\Delta}) - v_2}{W'(v_2, \tilde{\Delta})}$, guarantees that the profit threshold exists, $\bar{\alpha}_\pi \le 1$, and implies that competition in the base good market must be sufficiently strong.[12] When firms exploit context effects in equilibrium, consumers with context-dependent preferences introduce a distinct incentive concerning the optimal price for the base good, which is absent in the standard pricing game with add-ons: firms have an incentive to *raise the base good price*.

A higher-priced base good amplifies behavioral consumers' distortion, increasing the perceived utility of the extra. This enables firms to expand the value of the aftermarket and extract greater mark-ups from it. Consequently, firms avoid pricing the base good too cheaply, creating an endogenous price floor, which is displayed by the additional term in $p_1^e(\alpha)$: $t\alpha W'(v_2, \tilde{\Delta})$. Thus, context effects soften competition in the primary market. At the same time, firms must still first attract and lock in consumers to extract rents in

[9] We show in the proof of Lemma 1 that $\bar{\alpha}_\pi \le 1$ and uniqueness.

[10] We show in the proof of Lemma 1 that the symmetric non-exploiting equilibrium may also exist for larger values of α. However, characterizing the region of the non-exploiting equilibrium precisely would require much more structure on the model without providing further insights.

[11] Otherwise, there exists a profitable deviation by selling the upgrade at $p_2 = v_2$ to capture the additional demand of classical consumers.

[12] In the previous version of this paper (Brunner and Zihlmann, 2024), which employs a more general base good demand structure, we show that our results hold qualitatively also in less competitive markets, including a monopoly setting.

the aftermarket, which prevents the base good from being overly expensive. For this reason, similar to the benchmark, firms use the aftermarket earnings, $\alpha(W(v_2,\tilde{\Delta})-c_2)$, to cross-subsidize $p_1^e(\alpha)$. Despite that, profits are strictly larger in an exploiting equilibrium, as shown in Lemma 1 (iii).

Whether the optimal base good price $p_1^e(\alpha)$ is a decreasing or increasing function in α, depends on whether the endogenous price floor or the cross-subsidy from the aftermarket grow stronger when the share of behavioral consumers rises. The condition $t \leq \frac{W(v_2,\tilde{\Delta})-v_2}{W'(v_2,\tilde{\Delta})}$ ensures that competition is sufficiently intense such that the latter effect dominates, $W(v_2,\tilde{\Delta})-c_2 \geq tW'(v_2,\tilde{\Delta})$, implying that firms compete more fiercely when α increases. The optimal base good price $p_1^e(\alpha)$ in the symmetric exploiting equilibrium is thus a decreasing function in α,

$$\frac{\partial p_1^e(\alpha)}{\partial \alpha} = \frac{tW'(v_2,\tilde{\Delta}) - W(v_2,\tilde{\Delta}) + c_2}{1+\alpha W'(v_2,\tilde{\Delta}) - \alpha t W''(v_2,\tilde{\Delta})} \leq 0,$$

where $W''(v_2,\tilde{\Delta}) = \frac{\partial^2 W(v_2,\tilde{\Delta})}{\partial p_{1,l}^2} \leq 0$. Hence, more behavioral consumers in the population make the base good cheaper.

Nevertheless, the base good can be more expensive in the exploiting equilibrium than in the benchmark outcome. We define the implicit price threshold

$$\bar{\alpha}_p \equiv \begin{cases} \dfrac{v_2 - c_2}{W(v_2,\tilde{\Delta}) - c_2 - tW'(v_2,\tilde{\Delta})} & \text{for} \quad tW'(v_2,\tilde{\Delta}) \neq W(v_2,\tilde{\Delta}) - c_2, \\ \infty & \text{for} \quad tW'(v_2,\tilde{\Delta}) = W(v_2,\tilde{\Delta}) - c_2, \end{cases}$$

which is positive under the condition $t \leq \frac{W(v_2,\tilde{\Delta})-v_2}{W'(v_2,\tilde{\Delta})}$. When $\alpha = \bar{\alpha}_p$, then the base good is equally costly in the benchmark and the exploiting equilibrium, $p^{BM} = p_1^e(\alpha)$. Note that the price threshold is strictly larger than the profit threshold, $\bar{\alpha}_p > \bar{\alpha}_\pi$, when $t \leq \frac{W(v_2,\tilde{\Delta})-v_2}{W'(v_2,\tilde{\Delta})}$, so the interval $[\bar{\alpha}_\pi, \bar{\alpha}_p)$ is non-empty.

Proposition 1 (*Price Effect*)**.**

(i) If $\alpha \in [\bar{\alpha}_\pi, \bar{\alpha}_p)$, then the base good is more expensive in a symmetric exploiting equilibrium than in the benchmark, $p_1^e(\alpha) > p_1^{BM}$.
(ii) If $\alpha > \bar{\alpha}_p$, then the base good is cheaper in a symmetric exploiting equilibrium, $p_1^e(\alpha) < p_1^{BM}$.

When the share of behavioral consumers is intermediate, $\alpha \in [\bar{\alpha}_\pi, \bar{\alpha}_p)$, it is optimal for firms to increase the price of the base good compared to the benchmark. In this case, the competition softening effect arising from context effects, $t\alpha W'(v_2,\tilde{\Delta})$, is larger than what firms earn by selling the upgrade to behavioral consumers, $\alpha(W(v_2,\tilde{\Delta})-c_2)$. Intuitively, exploitation leads to a substantial loss in the aftermarket demand as classical consumers do not accept the additional offer anymore, but this is (over)compensated by a higher base good price $p_1^e(\alpha)$.

When the share of behavioral consumers is large, $\alpha > \bar{\alpha}_p$, the loss from not selling the upgrade to classical consumers vanishes, and it is now profitable to attract and lock in more context-sensitive consumers. As a consequence, the optimal base good is priced lower than in the benchmark economy. Fig. 1 depicts the findings of Proposition 1.

3.4. Consumer surplus

By combining the results of Lemma 1 and Proposition 1, we establish that the presence of behavioral consumers leads to non-monotonic effects on the surplus of classical consumers. Formally, we define the classical consumer surplus as $CS_c^s = v_1 - p_1^s + \max\{v_2 - p_2^s, 0\}$ with $s \in \{e, BM\}$.

Proposition 2 (*Classical Consumer Surplus*)**.**

(i) The presence of behavioral consumers harms classical consumers in a symmetric exploiting equilibrium if $\alpha \in [\bar{\alpha}_\pi, \bar{\alpha}_p)$.
(ii) The presence of behavioral consumers benefits classical consumers in a symmetric exploiting equilibrium if $\alpha > \bar{\alpha}_p$.

The non-monotonic effect depends on the proportion of behavioral consumers. For an intermediate share of behavioral consumers, as in case (i), it is optimal for firms to exploit context-dependent preferences in the aftermarket and set a larger base good price than in the benchmark economy. The surplus loss arises through the base good market as classical consumers avoid the overpriced upgrade with zero effort costs.[13] When the share of behavioral consumers is large, as in case (ii), firms price the base good cheaper than in the benchmark, which increases the surplus of classical consumers. These findings imply that classical consumers, who behave perfectly in line with canonical economic theory, do not always benefit from the presence of behavioral or "naïve" consumers. In our model, classical consumers can be harmed because base good prices may go up.

We continue to analyze the surplus of behavioral consumers, along with total consumer surplus. We define behavioral consumers' surplus as $CS_b^s = v_1 - p_1^s + v_2 - p_2^s$ and total consumer surplus as the weighted sum $CS^s = \alpha CS_b^s + (1-\alpha)CS_c^s$.[14] Exploitation by firms has the following effects on consumer welfare:

[13] The aftermarket surplus in the benchmark is also zero since $p_2 = v_2$.

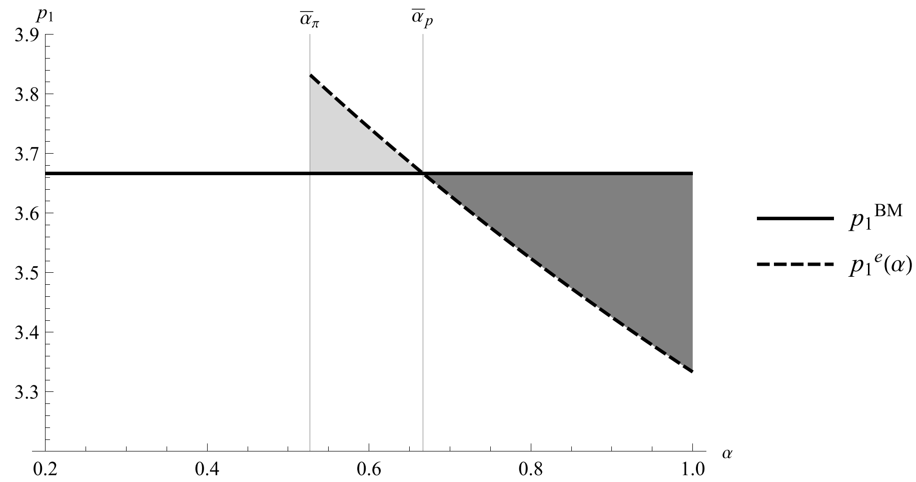

Fig. 1. Optimal pricing: Base good.
Note: The figure depicts Proposition 1, using $W(v_2, \tilde{\Delta}) = v_2 + \beta_i(p_1 - p_2)$ with $\beta_b = 1$ and $\beta_c = 0$. The parameter specifications are $t = \frac{2}{3}$, $v_1 = 7$, $v_2 = 2$, $c_1 = 4$, and $c_2 = 1$. The solid line represents the optimal base good price in the benchmark, which is independent of α. Once the share of behavioral consumers is sufficiently large, $\alpha \geq \bar{\alpha}_\pi$, the exploiting equilibrium exists. The optimal base good price under exploitation is given by the dashed line. The light gray region captures how much the exploiting firms should increase the base good price compared to the benchmark. Similarly, the dark gray shows how much the base good price should be reduced.

Proposition 3 (*Behavioral and Total Consumer Surplus*).

(i) Behavioral consumers are worse off when firms adopt the exploiting strategy.
(ii) Exploitation strictly reduces total consumer surplus.

Behavioral consumers always prefer to not be exploited by firms. Even when the exploiting strategy results in a lower base good price (when $\alpha > \bar{\alpha}_p$), the negative surplus consumed in the aftermarket caused by context effects exceeds the positive surplus gained in the base good market.

Proposition 3 concludes that total consumer surplus must be strictly less than in the benchmark economy. When the share of behavioral consumers is intermediate, $\alpha \in [\bar{\alpha}_\pi, \bar{\alpha}_p)$, both types of consumers are worse off when firms exploit context effects, and the conclusion becomes obvious. When $\alpha > \bar{\alpha}_p$, however, classical consumers benefit when firms adopt the exploiting strategy, as they enjoy a cheaper base good relative to the benchmark. Nonetheless, this increase in classical consumers' surplus does not compensate for the loss of behavioral consumers' surplus, leading overall to a lower consumer surplus since the majority of consumers are behavioral consumers in this case.

Fig. 2 illustrates the findings of Propositions 2 and 3. Since consumer surplus is identical across types in the benchmark, the solid line represents individual and total consumer surplus in the benchmark. Observe that classical consumer surplus in the exploiting equilibrium exceeds the benchmark when $\alpha > \bar{\alpha}_p$ and is lower otherwise. Behavioral and total consumer surplus are lower than the benchmark in any case. The individual surplus of both types strictly increases in α since the base good and the upgrade become cheaper. While more behavioral consumers are being exploited, each individual is less exploited. Despite that, the total consumer surplus can fall or rise in α because the classical surplus is substituted with a lower behavioral surplus. Depending on how strong the substitution effect is, the total consumer surplus may increase with more behavioral consumers in the market.

3.5. Producer surplus and welfare

Next, we analyze how the presence of behavioral consumers alters producer surplus and welfare by comparing the symmetric exploitation equilibrium with the benchmark economy. Producer surplus is defined as the sum of profits, and welfare is defined as the sum of producer and total consumer surplus, $\omega^s = 2\pi^s + CS^s$.[15]

[14] We assume context-dependent preferences that increase the perceived utility of the add-on at the time of purchase, but not the actual consumption utility — and therefore not the consumer surplus — of behavioral consumers. As elaborated earlier, one could argue that context-dependent preferences also increase the consumption utility itself. Proposition 3 is robust to such a definition of the surplus, in which we would need to replace v_2 with $W(v_2, \tilde{\Delta})$ such that $\tilde{CS}^s_b = v_1 - p^s_1 + W(v_2, \tilde{\Delta}) - p^s_2$ and $\tilde{CS}^s = \alpha\tilde{CS}^s_b + (1-\alpha)CS^s_c$.

[15] Again, we can consider that context-dependent preferences increase the actual consumption utility of behavioral consumers with $\tilde{\omega}^s = 2\pi^s + \tilde{CS}^s$. Proposition 4 is robust to such a definition.

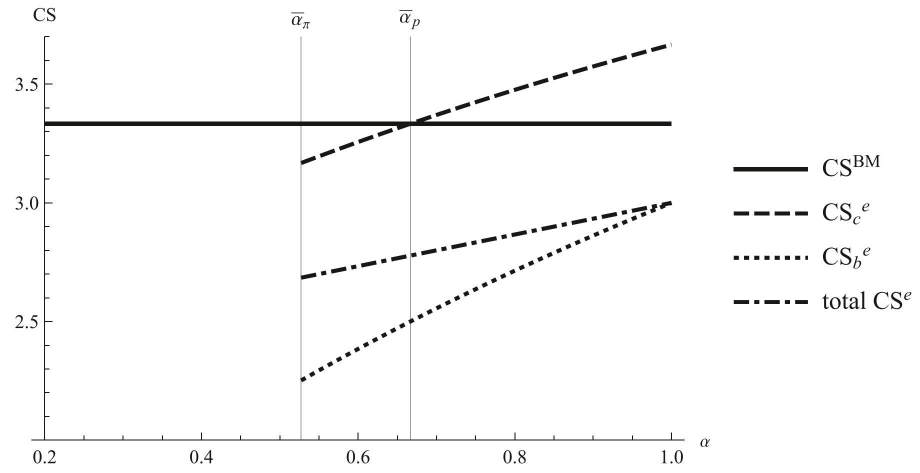

Fig. 2. Consumer surplus.
Note: The figure depicts Propositions 2 and 3, using $W(v_2, \tilde{\Delta}) = v_2 + \beta_i(p_1 - p_2)$ with $\beta_b = 1$ and $\beta_c = 0$. The parameter specifications are $t = \frac{2}{3}$, $v_1 = 7$, $v_2 = 2$, $c_1 = 4$, and $c_2 = 1$.

Proposition 4 (*Welfare*)**.**

(i) Exploitation of behavioral consumers increases producer surplus. This is increasing in the share of behavioral consumers.
(ii) Exploitation of behavioral consumers reduces welfare.
(iii) Welfare is non-monotonic in the share of behavioral consumers.

While firms make greater profits when the exploitation strategy is optimal, the loss in total consumer surplus is always greater. Therefore, welfare is lower when firms adopt the exploitative strategy, such that $\omega^e < \omega^{BM}$ for all $\alpha \in [0, 1)$. The distortion arises because classical consumers underpurchase the extra item, leading to lost gains from trade since $v_2 > c_2$.[16] Conditional on firms adopting the exploitation strategy, welfare is strictly increasing in the share of behavioral consumers since the share of classical consumers who fail to realize the gains from trade in the aftermarket shrinks. Therefore, welfare is U-shaped in α. The welfare loss from firms' exploitation is greatest when the population share of behavioral consumers is intermediate and just sufficient for firms to exploit in equilibrium. The findings of Proposition 4 are depicted in Fig. 3.

3.6. The effect of competition

Ensuring that markets are competitive is a goal of many regulatory authorities. In our setting, more intense competition, expressed by a reduction of t, clearly decreases base good prices, increases consumer surplus, and decreases firms' profits. The impact on the distribution of the surplus, however, is more nuanced, affecting the profit and price thresholds, $\bar{\alpha}_\pi$ and $\bar{\alpha}_p$, which determine whether we have exploitation in equilibrium and the base good is cheaper than in the benchmark, respectively.

Proposition 5 (*Competition*)**.**

(i) More competition (lower t) strictly increases $\bar{\alpha}_\pi$, making exploitation less likely in equilibrium.
(ii) More competition (lower t) benefits behavioral consumers more than classical consumers in the exploiting equilibrium. Total consumer surplus strictly increases.

An increase in competition reduces exploitation profits, π^e, while it increases the profits when deviating from the symmetric exploiting outcome. Hence, the profit threshold $\bar{\alpha}_\pi$ increases in competition intensity, reducing the interval where exploitation is optimal, $\alpha \in [\bar{\alpha}_\pi, 1]$. Because increased competition lowers the base good price, both consumer types benefit from a cheaper base good. Competition also reduces context effects and with it, the price of the extra item, which benefits behavioral consumers additionally. Overall, more competition makes exploitation in equilibrium less likely and increases total consumer surplus.

Consider now the extreme case of perfect competition by setting $t = 0$. Consumers purchase the base good from the cheaper firm, and if prices are equal, demand is split evenly. This leads to

$$p_1^e(\alpha) = c_1 + \alpha(c_2 - W(v_2, \tilde{\Delta})), \quad p_1^{BM} = c_1 + c_2 - v_2$$

[16] By contrast, behavioral consumers' purchases of the extra item at equilibrium price $p_2 = W(v_2, \tilde{\Delta})$ are socially efficient since $v_2 > c_2$, and have only distributional consequences: a transfer of surplus from consumers to firms.

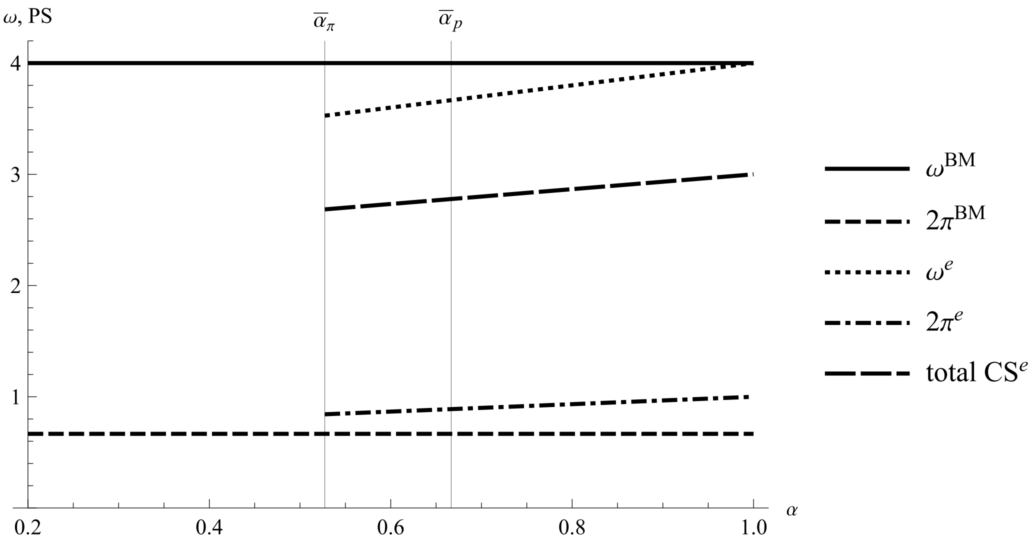

Fig. 3. Welfare.
Note: The figure depicts Proposition 4 and producer surplus, using $W(v_2, \tilde{\Delta}) = v_2 + \beta_i(p_1 - p_2)$ with $\beta_b = 1$ and $\beta_c = 0$. The parameter specifications are $t = \frac{2}{3}$, $v_1 = 7$, $v_2 = 2$, $c_1 = 4$, and $c_2 = 1$.

and zero profits. An important observation is that perfect competition eliminates the endogenous price floor. Firms must set the lowest feasible base price to obtain positive demand. This shows that at least some market power is required for context effects to directly distort base good prices (through the strategic choice to raise p_1 in order to manipulate context effects). Put differently, under perfect competition, context effects distort the base good price only indirectly through the cross-subsidization of add-on mark-ups. The symmetric exploiting equilibrium exists when $p_1^e(\alpha) < p_1^{BM} \Leftrightarrow \alpha > \frac{v_2 - c_2}{W(v_2, \tilde{\Delta}) - c_2}$. Otherwise, firms do not exploit in equilibrium and behave as if there are no behavioral consumers, leading to the same outcome as in the benchmark.

Proposition 6 (*Perfect Competition*). *Suppose $t = 0$.*

(i) The symmetric exploiting equilibrium exists for $\alpha > \frac{v_2 - c_2}{W(v_2, \tilde{\Delta}) - c_2}$ under perfect competition and the base good is always cheaper than in the benchmark.
(ii) Total consumer surplus and welfare are lower in the exploiting equilibrium. Welfare is still non-monotonic in the share of behavioral consumers.

While perfect competition does not prevent exploitation of behavioral consumers, it is less likely to occur, by Proposition 5 (i), and protects classical consumers from being harmed. If firms exploit in equilibrium, then it must be that the base good is strictly cheaper, $p_1^e(\alpha) < p_1^{BM}$, which benefits classical consumers. Yet, there is no safety in markets: perfect competition does not guarantee that the aggregate consumer obtains the benchmark economy surplus. Similarly to Gabaix and Laibson (2006), the reason is lost gains from trade in the aftermarket because classical consumers do not purchase the extra in any exploiting equilibrium, which is inefficient since $v_2 > c_2$.

4. Policy implications

4.1. Cap on the add-on price

Consider an add-on price cap that is binding for exploiting firms but does not affect the benchmark add-on price, $\bar{p}_2 \in (v_2, W(v_2, \tilde{\Delta}))$. In the exploiting equilibrium, firms must satisfy $p_2 \leq \bar{p}_2$ and the incentive compatibility of behavioral consumers, $p_2 \leq W(v_2, \bar{\Delta})$, where $\bar{\Delta}$ denotes the context effects induced under the price cap. The regulation's effects depend on how strongly it constrains the add-on price. We define the cap's strictness as the difference between the ex-ante add-on price and the price cap, $W(v_2, \tilde{\Delta}) - \bar{p}_2$. Proposition 7 summarizes the implications of a price cap on the add-on, and Appendix B.8 provides the formal analysis.

Proposition 7 (*Price Cap on the Add-on*).

(i) The symmetric exploiting equilibrium still exists under a price cap $\bar{p}_2 \in (v_2, W(v_2, \tilde{\Delta}))$.
(ii) When $p_2 = W(v_2, \bar{\Delta}) \leq \bar{p}_2$ is optimal, the price cap makes the base good cheaper.
(iii) When $p_2 = \bar{p}_2 < W(v_2, \bar{\Delta})$ is optimal, the price cap eliminates the endogenous price floor and makes the base good cheaper if $W(v_2, \tilde{\Delta}) - \bar{p}_2 < tW'(v_2, \tilde{\Delta})$. In any case, the total price is strictly lower because of the regulation.

(iv) *The price cap increases behavioral and total consumer surplus. Classical consumer surplus increases only if the base good is cheaper.*

While the price cap limits exploitation profits, $\bar{\pi}^e < \pi^e$, it also makes potential deviations less profitable, and the symmetric exploiting equilibrium still exists after the regulation.

When the price cap is not too strict, it remains optimal to set the add-on price equal to the behavioral consumers' perceived utility $p_2 = W(v_2, \bar{\Delta}) \leq \bar{p}_2$. In this case, the ex-post optimal base good price must also be lower, $\bar{p}_1^e < p_1^e(\alpha)$.[17] The price cap limits the firms' ability to exploit behavioral consumers by manipulating context effects. Hence, the regulation lowers the endogenous price floor, which intensifies competition in the primary market. This implies that the price cap lowers p_2 directly, but also indirectly reduces the base good price p_1. The usual waterbed logic that cutting prices for one component simply raises prices for the other component does not apply in this setting—the cap has even a multiplier effect by lowering *both* prices. Further, when context effects adjust relatively strongly to a cheaper base good, the ex-ante binding price cap may no longer be binding ex-post.

When the price cap is strict, it is not optimal anymore to induce $p_2 = W(v_2, \bar{\Delta})$ because it would require an overly low base good price. Instead, firms sell the add-on at the price cap by setting $p_2 = \bar{p}_2 < W(v_2, \bar{\Delta})$. Firms no longer benefit from manipulating context effects, so the price cap eliminates the endogenous price floor in the primary market. Firms use the aftermarket margins to cross-subsidize the base good price and obtain benchmark profits. In this case, the waterbed effect exists, but the pass-through is not one-for-one: A price reduction for the add-on of \$1 leads to a base good price increase of less than \$1, so the total price still falls.

Distributionally, classical consumers benefit from the regulation in the case when the base good becomes cheaper, $\bar{p}_1^e < p_1^e(\alpha)$. Behavioral consumers are always better off with a price cap, because the reduction in aftermarket exploitation dominates any potential increase in the base good price. Overall, the policy always increases consumer surplus—the increase in behavioral consumer surplus outweighs the potential loss of classical consumer surplus.

4.2. Base good price floor

Loss-leading is a controversial practice because it raises concerns for anti-competitive effects if predatory.[18]

Proposition 8 (*Base Good Price Floor*)**.**

(i) *A price floor on the base good makes exploitation more likely in equilibrium.*
(ii) *A binding price floor in an exploiting equilibrium, $p_1^e(\alpha) < \underline{p}_1$, also increases the upgrade price, increases firms' profits and lowers total consumer surplus.*

In our model, a price floor facilitates exploitation in equilibrium when it binds and constrains a potential deviation (but not necessarily the exploiting outcome), $\underline{p}_1 > p_1^{d,e}$. This is particularly problematic when the share of behavioral consumers is close to $\bar{\alpha}_\pi$ as the price floor regulation could lead to a change in the equilibrium behavior of firms.[19] Therefore, existing price floors based on classical models without context effects and behavioral consumers may unintentionally enable exploitation in equilibrium.

A binding price floor $p_1^e(\alpha) < \underline{p}_1$ in the exploiting equilibrium leads to strictly more expensive base good prices. This amplifies context effects, makes the add-on more expensive, and facilitates sustaining the exploitative equilibrium. Firms benefit from the policy because the exogenous price floor softens competition in the base good market.

5. Concluding remarks

This paper explores how the practice of add-on selling affects consumer behavior and market outcomes. We suggest that some consumers' preference for the extra item depends on the context of the base product's price. This makes the additional product appear less costly than it actually is. Our main result is that the presence of such context-sensitive consumers can soften competition in the primary market as it creates an endogenous price floor. Context effects, if exploited by firms, reduce total consumer surplus and welfare.

Our analysis is most applicable to markets where our assumptions likely hold reasonably well: differentiated products; a base good priced above the add-on; a sequential offer; the ability to decline the add-on at no cost; and aftermarket monopoly. Many markets may fit these conditions, including (i) food and beverages (extra toppings, size upgrades), (ii) electronics (extended warranties), (iii) new homes (builder upgrades), (iv) car rentals (additional driver, child seat), (v) airlines (seat selection, extra legroom), and (vi) new car purchases (service contracts, infotainment, upgraded battery capacity).

At the same time, our model does not apply to all types of add-ons. A substantial time lag between the purchase of the base good and the extra item, as in the case of printers and cartridges, may less distort consumers' demand for the add-on—time could attenuate context effects. Second, our model likely does not apply when the additional price is a significant part of the total price.

[17] Given our assumptions on how context effects behave, the base good price must decrease when $p_2 = W(v_2, \bar{\Delta}) \leq \bar{p}_2 < W(v_2, \tilde{\Delta})$.

[18] For that reason, it is banned in many US States and some European countries, see for example https://www.aeaweb.org/research/loss-leading-bans-retail-competition. The literature finds mixed results on the effectiveness of this policy (e.g., Chen and Rey, 2012; Johnson, 2017). A base good price floor can also emerge because of consumer suspicion that low base good prices are associated with high aftermarket prices (Heidhues et al., 2016; Shulman and Geng, 2019; Fehr and Wu, 2023).

[19] Note that we have $p_1^e(\alpha) > p_1^{d,e}$ when α is close to $\bar{\alpha}_\pi$, making $p_1^e(\alpha) > \underline{p}_1 > p_1^{d,e}$ possible.

Third, our model does not generalize to mandatory surcharges such as hotel resort fees, taxes, or other surcharges, being inconsistent with our assumption that additional items can be rejected at zero costs.

Our model abstracts away from the use of add-ons as screening devices for consumers with high add-on valuation. This could interact if context-dependent preferences correlate with valuation. We leave a full treatment for future work. However, our results are robust to heterogeneous valuations that are orthogonal to context-dependent preferences.

Another limitation of our model is the assumption that the perceived utility of context-dependent consumers for the extra item is monotonically increasing in the price of the base good. A disproportionately high-priced extra item, however, may be perceived as unfair (Rabin, 1993; Robbert and Roth, 2014; Herz and Taubinsky, 2017; Chiles, 2021). Hence, fairness effects may impose an upper limit for the additional price that behavioral consumers are willing to accept. Such an effect can be accommodated by our model—it would essentially create an endogenous price cap on the add-on. We analyzed the effects of an exogenously imposed add-on price cap: such a cap — whether exogenously imposed by a regulator or endogenously emerging from fairness concerns — always increases consumer surplus if it is binding.

A natural extension of our framework would be to analyze an economy in which consumers exhibit endogenous inattention to additional prices, rather than context-sensitive preferences: mounting evidence suggests that inattention to additional prices increases when those become a smaller part of the expenditure share (e.g. Hossain and Morgan, 2006; Brown et al., 2010; Taubinsky and Rees-Jones, 2018; Gabaix, 2019). We suspect the effect to be very similar: Because consumers devote more attention to relatively more important expenditures, firms can manipulate consumers' degree of inattention in the aftermarket.

Future research could also investigate whether our findings extend to sequential purchase settings in which the "extra item" has no direct connection to the base good, but is simply the good purchased next. If so, it would imply that the mere ordering of the sequential offers of two goods can affect consumer surplus and welfare in the economy.

Funding

This work was supported by the Deutsche Forschungsgemeinschaft, Germany (DFG, German Research Foundation, project No. 462020252) (P. Brunner).

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Philipp Brunner reports financial support was provided by DFG. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

We are grateful for valuable comments to three anonymous reviewers, Jean-Michel Benkert, Berno Büchel, Francisco Gomez Martinez, Andreas Grunewald, Paul Heidhues, Holger Herz, Heiko Karle, Marta Kozakiewicz, Mats Köster, Igor Letina, Marc Möller, Oleg Muratov, Alexander Rasch, Markus Reisinger, and Frederik Schwerter.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jebo.2026.107627.

Data availability

No data was used for the research described in the article.

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