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# Add-on Pricing, Consumer Myopia and Regulatory Intervention

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## Abstract

Previous research shows that firms may offer excessively high (and shrouded) add-on prices in competitive markets when some consumers are myopic. We analyze the effects of regulatory intervention via educating myopic consumers on equilibrium strategies of firms, consumer protection and welfare. Our model allows firms to price discriminate between consumers. We show that intervention may actually decrease social welfare and weaken consumer protection if regulatory efforts are insufficient to alter the equilibrium strategy of firms. In consequence, regulation may do more harm than good and hence should only be considered if the regulator can be sure to have a good understanding of pricing strategies in an industry.

Keywords: bounded rationality, information suppression, regulation, social welfare, consumer protection

JEL Classification: D40, D80, L50

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# 1 Introduction

When consumers are boundedly rational and myopic in their decision making, firms will try to exploit it. Well-known examples are that consumers book a hotel room without considering the costs of the minibar, buy a computer without considering the costs for upgrades, or open a bank account without considering fees for additional banking services. As shown by Gabaix and Laibson (2006), the equilibrium pricing strategy of firms then may be to compete purely on the price of a base good (e.g., a hotel room, computer without upgrades, or bank account) and to suppress information about add-ons (e.g., the minibar, computer upgrades, or banking fees). The firm picks a price for the base good below marginal costs, and a price for the add-on above marginal costs. Consequences for consumers are twofold: First, sophisticated consumers substitute away from add-ons, which creates a social welfare loss if substitution is costly. Second, myopic consumers who buy the high-priced add-on subsidize sophisticated consumers, which raises consumer protection concerns. The question arises if and how the regulator should intervene to maximize social welfare and consumer protection.

In many situations, vigorous competition is the single best instrument for efficient market outcomes and for protecting consumer interests, and regulation is not needed (e.g., Armstrong, 2008). Regulation and consumer protection policies may even have possibly undesirable effects if it leads to a weakening of competitive pressures (e.g., Armstrong, Vickers, and Zhou, 2009). In some specific situations, however, regulatory intervention can help markets function better. For example, there can be a role for regulation to create transparency (Spiegler, 2006a,b). If regulatory intervention benefits vulnerable consumers without harming more sophisticated consumers, it is relatively uncontroversial. If interventionist consumer policies benefit one group of consumers at the expense of another, it is not so clear if regulatory intervention is warranted (Armstrong, 2008). Moreover, regulatory intervention is only relevant in fields where the regulator cares about the decisions of uninformed consumers. Uninformed consumers are not in general those citizens who need public subsidies. For example, the regulator probably does not care about add-on prices of luxury cars, but cares about high add-on prices in the context of tax-subsidized retirement funds (otherwise, why the tax subsidies in the first place?).

Efficient regulatory intervention is challenging.<sup>1</sup> An obvious regulatory intervention is to require firms to inform consumers about all relevant product characteristics and prices. Alternatively, the regulator could impose price caps on overpriced add-ons. Both strategies could work well when the firm offers one base good and one or few add-ons, e.g., a bank account and overdraft fees. In practice, however, the products and/or services offered are often much more complex. For example, a computer is offered with many potential upgrades, and a bank account comes with many complementary financial services. Thus, when certain products are regulated, firms may find ways to circumvent such regulation.

This paper analyzes regulatory intervention when firms exploit consumers who are myopic in their decision making. A regulator may educate myopic consumers about add-on prices before firms decide on their pricing strategy. Such regulatory intervention could be through general public information or requiring “warning labels” placed on marketing materials. The rationale for such an intervention is that *shrouding* information about add-ons only prevails for a sufficiently high portion of uninformed myopic consumers, and that *unshrouding*, which is socially desirable, prevails otherwise. Such efforts to correct individuals’ factual mistakes are largely uncontroversial in politics and the academic literature (see, e.g., Jolls and Sunstein, 2006, 230,232). What is not so clear is to which degree educating consumers can change the behavior of myopic consumers. Recent research finds that a surprisingly small fraction of consumers makes better decisions after being informed about important decision criteria.<sup>2</sup> Thus, it is unlikely that a regulator can make all consumers act like sophisticated consumers through education, and a more or less large fraction of uninformed consumers will remain. Furthermore, we consider that firms may own a technology that allows them to price discriminate between myopic and sophisticated consumers (more or less successfully). This may lead to new price equilibria, and mitigate the social welfare problem even without regulatory intervention. However, it may also have adverse effects, and it will not solve potential consumer protection concerns. Effects of regulatory intervention therefore also depend on the potential of firms to price discriminate. Finally, we analyze alternative ways of regulatory intervention

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<sup>1</sup>Gabaix and Laibson (2006, 530-31) discuss verbally alternative remedies that the regulator can consider, but do not derive formal results.

<sup>2</sup>For a literature review about the limited impact of financial education on consumer behavior, see De Meza, Irlenbusch, and Reyniers (2008). Choi, Laibson, and Madrian (2010) and Beshears, Choi, Laibson, and Madrian (2009) provide experimental evidence regarding investments in mutual funds.

through subsidizing firms that accept to follow a certain (loss-making) pricing strategy that is in the public interest.

Generally, price discrimination exists when the difference in prices among consumers is not proportional to the difference in marginal costs (see, e.g., Stole, 2007). We consider price discrimination that is based on observed consumer heterogeneity (e.g., past purchasing decisions, age, profession, education), called *third-degree* or *direct* price discrimination: The firm offers add-on products at different prices to consumers who the firm considers to be myopic or sophisticated.<sup>3</sup> Potential profits of firms from charging different prices to different consumers are competed away in our model. However, the potential to price discriminate impacts the firms' pricing strategies, and thereby consumers' buying decisions, social welfare and consumer protection.

To illustrate, consider the following example. A bank offers a cash account (the base good) and one or two investment funds (the add-ons). The first fund is a high-priced managed investment fund and the second fund is a low-priced exchange traded fund (ETF). Both funds track the same index and can be considered as perfect substitutes. Informed consumers consider both the price for the cash account and the price for the investment fund for their buying decision while uninformed consumers only consider the price of the cash account. The pricing strategy of the bank then involves two decisions. First, whether its range of products consists of the managed investment fund, the ETF, or both funds. Second, whether to compete purely on the price of the cash account, e.g., by offering high interest rates, or also to advertise the fees of the investment funds. If the bank owns a technology to price differentiate between myopic and sophisticated investors, the bank can shroud information about add-ons towards myopic consumers and offer them managed investment funds once they open a cash account. Furthermore, the bank can unshroud information about ETFs towards sophisticated consumers.<sup>4</sup>

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<sup>3</sup>Alternatively, *first-degree* price discrimination exists when the firm charges a different price per unit of product and per consumer. *Second-degree* price discrimination exists when the firm charges different prices based on unobservable consumer heterogeneity, because consumers self-select into the appropriate product. Special forms of price discrimination are, e.g., bundling, introductory offers, poaching and versioning. For a literature review on price discrimination, see Armstrong (2006), Esteves (2009), Fudenberg and Villas-Boas (2006), or Stole (2007).

<sup>4</sup>ETFs are traded on the German stock exchange since 2000. However, until recently most banks in Germany offered only managed funds and no ETFs. This seems to change. Deutsche Bank, for example, offers ETFs under the name *db x-trackers* since 2007. The German savings banks offer ETFs under the name DEKA since

Another example in the field of retail finance are credit cards. As discussed by Ausubel (1991), consumers often make credit card choices without considering the high probability that they will pay high interest rates on their outstanding balances.

As a reference point for our analysis, consider the following situations: first, all consumers are informed, and second, all consumers are uninformed. In the first situation, the profit maximizing pricing strategy of firms is to compete on both the price of the base good and the price of the add-on. The bundle of both products will be offered at cost-reflective prices to all consumers. In the second situation, the profit maximizing pricing strategy of firms is to compete purely on the price of the base good and to charge the reservation price of consumers for the add-on. Again, the bundle of both products will be offered at cost-reflective prices to all consumers because the firms' profits from high add-on prices get competed away on the base good. Such a price equilibrium represent the so-called *loss-leader pricing* (Lal and Matutes, 1994). Thus, the consumer harm is limited to the inefficiency caused by the departure of prices from costs on a product-by-product basis (the "deadweight loss"), e.g., consumers replace the base good too early. It is generally argued that this welfare loss is relatively small (see, e.g., Armstrong, 2008, footnote 64; Shapiro, 1994, 497-498). In sum, as well a situation where all consumers are informed as a situation where all consumers are uninformed does in general not require regulatory intervention. The social welfare and consumer protection issues discussed in this paper arise because of *heterogenous* consumers.

Our main results are as follows. First, if educating consumers changes a *high-priced add-on* equilibrium or a *price discrimination* equilibrium of firms, social welfare increases. Second, if educating consumers does not change a *high-priced add-on* equilibrium or a *price discrimination* equilibrium, social welfare decreases. Finally, if a *low-priced add-on* equilibrium exists without educating consumers, intervention is obviously irrelevant because there is no social welfare loss in the first place. Effects depend on the fraction of myopic consumers, the efficiency of educating myopic consumers, the effort costs of substituting away from add-ons, the upper level for the add-on price, and the efficiency of price discrimination. We develop alternative regulatory strategies based on subsidizing firms, and we show that these strategies

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2008. An exception is, e.g., Citibank Deutschland (now called Targobank and part of Credit Mutuel Group) who does not offer own ETFs. Until 2008 Citibank Deutschland even did not allow customers to buy ETFs from external providers into their securities account, officially because of "technical difficulties".

can create a social welfare gain. In summary, the regulator needs to carefully analyze the situation before intervening via educating myopic consumers and may find no intervention at all or other regulatory strategies more beneficial.

The paper proceeds as follows. Section 2 contains the details of the model (2.1), the price equilibria when the regulator decides not to educate myopic consumers (2.2), and the price equilibria when the regulator decides to educate myopic consumers (2.3). Section 3 discusses implications for social welfare and consumer protection. Section 4 discusses alternative ways of regulatory intervention through subsidizing firms. Finally, Section 5 contains concluding remarks. Proofs and detailed calculations appear in the appendix.

## 2 Model

The following pricing game is closely related to the model of Gabaix and Laibson (2006). The innovation of our model is twofold. First, the model allows firms to choose price discrimination besides uniform pricing. Second, a regulator may intervene and educate myopic consumers about the relevance of add-on prices.

### 2.1 Details

Firms produce base goods and add-ons. Add-ons are always avoidable for informed consumers, in contrast to unavoidable *surcharges*. For simplicity, marginal costs for the base good and for add-ons are zero. The mass of consumers is normalized to 1. Many firms exist and, depending on the parameters of the demand function of consumers, a zero profit equilibrium may exist.

**Consumer types.** Two types of consumers are considered: myopic consumers, a fraction  $\alpha$  of all consumers, where  $\alpha \in (0, 1]$ , and sophisticated consumers, a fraction  $1 - \alpha$ , of all consumers. Myopic consumers per se only take the price for the base good into consideration when deciding where to purchase a good. Sophisticated consumers always take both the price for the base good and the price for the add-on into consideration when deciding where to

purchase a good.

**Information strategy of firms.** *Shrouding* means that the firm suppresses information about the price of the add-on. *Unshrouding* means that the firm provides information about the price of the add-on. By providing this price, the firm at the same time educates a fraction  $\lambda_F$  of myopic consumers about the relevance of the add-on price, where  $\lambda_F \in [0, 1]$ . Thus, this fraction of myopic consumers becomes informed and is therefore called *informed myopic*. Unshrouding is free.

**Regulatory intervention through education.** The regulator can educate a fraction  $\lambda_R \in [0, 1]$  of myopic consumers about the relevance of add-on prices, which increases the fraction of informed consumers before firms decide on a pricing strategy from  $1 - \alpha$  to  $1 - (1 - \lambda_R)\alpha$ . Educating consumers is free. Furthermore, a fraction  $\lambda'_F \in [0, \lambda_F]$  of the remaining uninformed myopic consumers becomes informed when firms *unshroud*. At the one extreme when  $\lambda'_F = 0$ , it is assumed that following education through a regulator, *unshrouding* through firms has no complementary effect because all myopic consumers who potentially could become informed already got informed through the regulator. The remaining fraction of the population is just not receptive for any kind of information, or not capable to use any but the most simple decision rationale. At the other extreme when  $\lambda'_F = \lambda_F$ , it is assumed that unshrouding through firms always informs an additional fraction  $\lambda_F$  of the remaining uninformed consumers, regardless of any potential prior education through the regulator.<sup>5</sup>

**Pricing strategy of firms.** The firm chooses a price for the base good,  $p$ , and a price for the add-on,  $\hat{p}$ . In case of price discrimination, the prices of the low-priced add-on and the high-priced add-on are denoted as  $\hat{p}_L$  and  $\hat{p}_H$ . The prices for the add-ons have an upper bound,  $\bar{p} \in (0, 1]$ .<sup>6</sup> No consumer will buy an add-on above this price. All prices refer to firm  $i$  (for simplicity, the subscript  $i$  is omitted). We focus on symmetric price equilibria.

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<sup>5</sup>We consider alternative regulatory strategies, namely intervention through subsidized public firms, in an extension of the model in Section 4.

<sup>6</sup>The assumption that  $\bar{p} \in (0, 1]$  simplifies Corollary 3, otherwise it does not matter.

**Price discrimination.** Firms may own a technology that allows them to use interpersonal information about consumers (previous purchases, education, etc.) in order to classify them as uninformed or informed consumer. Then, the firm may offer the add-on to uninformed and to informed consumers at different prices. The reservation price for the add-on of informed consumers is relatively low because they are in a position to substitute away. Thus, the firm offers them a low-priced add-on. The reservation price for the add-on of uninformed consumers is relatively high. Thus, the firm offers them a high-priced add-on. For simplicity, we assume that all add-ons have the same quality and consumer utility.<sup>7</sup> If available, the technology for price discrimination is free. Realistically, price discrimination works more or less well, depending on the industry, product, and customer characteristics. We consider two potential limits:

- The error when firms classify an informed consumer as uninformed is called *attrition*. This error implies that the firm will unintentionally *shroud* (not advertise) the low-priced add-on towards a fraction  $1 - \beta$  of informed consumers. It follows that this fraction will substitute away.
- The error when firms classify an uninformed consumer as informed consumer is called *cannibalization*. This error implies that the firm will unintentionally *unshroud* (advertise) the low-priced add-on towards a fraction  $1 - \gamma$  of uninformed consumers. It follows that these customers buy the low-priced add-on instead of the high-priced add-on.

See Figure 1 for an overview on effects of price discrimination.

**Demand function.** The demand function of firm  $i$  is modeled as the probability density function that a consumer purchases at firm  $i$ ,  $D(x_i) \in [0, 1]$ , where  $x_i$  represents the *anticipated net surplus* from purchasing a product at firm  $i$  less the *anticipated net surplus* from purchasing a product at the best alternative firm. The demand function  $D(x_i)$  is strictly increasing and reflects the degree of competition in the industry that is given by  $\mu = \frac{D(0)}{D'(0)}$ .

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<sup>7</sup>A weaker assumption would be that prices of both add-ons are not proportional to the difference in marginal costs, the so-called *versioning* (see, e.g., Shapiro and Varian, 1998).

Perfect competition corresponds to  $\mu = 0$ .<sup>8</sup> The arguments of the decision rationale  $x_i$  depend on the consumer type that is either an *informed consumer* (sophisticated and informed myopic) or an *uninformed consumer*.

- For uninformed consumers,  $x_i$  is given by  $\bar{x}_i = -p + p^*$ , where  $p$  represents the price for the base good at firm  $i$ , and  $p^*$  represents the price for the base good at the best alternative firm. Uninformed consumers ignore prices of add-ons when they make their buying decision.
- For informed consumers,  $x_i$  is given by  $\hat{x}_i = -p - \min\{E\hat{p}, e\} + p^* + \min\{E\hat{p}^*, e\}$ , where  $p$  and  $p^*$  are defined as above,  $E\hat{p}$  represents the expected price for the add-on at firm  $i$ ,  $E\hat{p}^*$  represents the expected price for the add on at the best alternative firm, and  $e$  represents the costs for substituting away from the add-on. If firms unshroud, the expected prices  $E\hat{p}$  and  $E\hat{p}^*$  become the known prices  $\hat{p}$  and  $\hat{p}^*$ , respectively.

**Timing.** The model has four periods. In period 0 the regulator may intervene. In period 1 firms determine their pricing strategy. In period 2 consumers make a decision where to buy the base good. In period 3 consumers observe the price of the add-on and decide whether to buy it or not to buy it.

**Period 0:**

- The regulator decides whether to educate myopic consumers about the relevance of add-ons.

**Period 1:**

- Firms choose between uniform pricing and price discrimination.

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<sup>8</sup>The demand function  $D(x_i)$  is derived from a decision utility of a consumer  $a$  that is given by  $U_{ai} = v_i - q_i + \varepsilon_{ai}$ , where  $v_i$  represents the quality of a product at firm  $i$ ,  $q_i$  represents the price of a product at firm  $i$ , and  $\varepsilon_{ai}$  represents a random idiosyncratic preference of consumer  $a$  that is i.i.d. Depending on the consumer type, the variables  $v_i$  and  $q_i$  in the decision utility function refer just to the base good or to the base good plus the add-on. It is assumed that all firms produce products with the same quality  $v$ . See Gabaix and Laibson (2006), p. 532-533, for details on the microfoundation of the demand function  $D(x_i)$ .

- In case of uniform pricing: Firms pick a price for the base good,  $p$ , and a price for the standard add-on,  $\hat{p}$ .
- In case of price discrimination: Firms pick a price for the base good,  $p$ , a price for the high-priced add-on,  $\hat{p}_H$ , and a price for the low-priced add-on,  $\hat{p}_L$ .
- Firms decide to make the information about the add-ons *shrouded* or *unshrouded*.

**Period 2:**

- Informed consumers (sophisticated and informed myopic) always take the add-on and its price into consideration for their buying decision. If information about the add-on is *shrouded*, sophisticated consumers and informed myopic consumers form Bayesian posteriors about the unobserved add-on.
- Informed consumers can initiate behavior that allows them to substitute away at costs  $e$ .
- Uninformed myopic consumers do not consider the add-on for their buying decision.

**Period 3:**

- Consumers observe the add-on price (if firms have not *unshrouded* prices already).
- All consumers buy the base good.
- Uninformed consumers buy the standard add-on if the price they observe is at most their reservation price  $\bar{p}$ .
- Informed consumers buy the standard add-on if the price they observe is at most their substitution costs  $e$ , or otherwise substitute away.

We formally consider substitution costs only in the period prior to the purchase of the base good (period 2), equivalent to the Gabaix and Laibson (2006) model. In practice, however, substitution costs may occur both in period 2 and in period 3. For example, ... Substitution costs  $e$  may reflect costs only for period 2 or joint costs for period 2 and period 3. It has no consequences for the results of our analysis.

## 2.2 Price equilibria without educating consumers

This sub-section derives symmetric price equilibria of firms without regulatory intervention. It therefore serves as a benchmark for the evaluation of regulatory intervention. As it is shown in the following, the decisions of firms about *shrouding* or *unshrouding* and offering one add-on (uniform pricing) or two add-ons (price discrimination) result in three potential profit maximizing pricing strategies of the firm.

**High-priced add-on.** This pricing strategy may make sense if the firm can sell the high-priced add-on to a large fraction of uninformed consumers. The firm therefore *shrouds* information about the add-on because *unshrouding* would decrease the fraction of uninformed consumers. In order to maximize profits, the firm sets the price for the add on to  $\hat{p} = \bar{p}$ , where  $\bar{p}$  is the highest possible price for the add-on (i.e., the reservation price of uninformed consumers). Sophisticated consumers who observe that the firm *shrouds* anticipate this,  $E\hat{p} = \bar{p}$ . The expected profit of a firm is given by

$$\pi_h = (p + \alpha\bar{p})D(p^* - p). \quad (1)$$

Detailed calculations are in the appendix.

By solving the first-order condition for  $p^* = p$ , we get a profit maximizing price for the base good of  $p = -\alpha\bar{p} + \mu$ , where  $\mu = \frac{D(0)}{D'(0)}$ . It follows that the maximized profit of a firm under this pricing strategy is given by

$$\pi_h^* = \mu D(p^* + \alpha\bar{p} - \mu). \quad (2)$$

**Low-priced add-on.** This pricing strategy may make sense if the firm can sell the add-on also to sophisticated consumers who substitute away if they observe a price of the add on  $\hat{p} > e$ . The firm therefore *unshrouds* and sets the price  $\hat{p} = e$ . All consumers purchase both the base good and the add-on at the firm. The expected profit is given by

$$\pi_l = (p + e)D(p^* - p). \quad (3)$$

Detailed calculations are in the appendix.

By solving the first-order condition for  $p^* = p$ , we get a profit maximizing price for the base good of  $p = -e + \mu$ , where  $\mu = \frac{D(0)}{D'(0)}$ . It follows that the maximized profit of a firm under this pricing strategy is given by

$$\pi_l^* = \mu D(p^* + e - \mu). \quad (4)$$

**Price discrimination.** This pricing strategy may make sense if the firm has a technology to separate between myopic and sophisticated consumers, and to make them separate offers. The firm chooses a price for the low-priced add-on,  $\hat{p}_L$ , and a price for the high-priced add-on,  $\hat{p}_H$ . In order to maximize profits from uninformed consumers, the firm sets the price for the high-priced add on to  $\hat{p}_H = \bar{p}$ . In order to maximize profits from informed consumers, the firm also offers a low-priced add-on to informed consumers for a price  $\hat{p}_L = e$ . As discussed in sub-section 2.1, efficiency of price discrimination is limited by *attrition* ( $\beta$ ) and *cannibalization* ( $\gamma$ ). The expected profit of a firm is given by

$$\pi_d = (p + e((1 - \alpha)\beta + \alpha(1 - \gamma)) + \bar{p}\gamma\alpha)D(-p + p^*) \quad (5)$$

Detailed calculations are in the appendix.

By solving the first-order condition for  $p^* = p$ , we get a profit maximizing price for the base good of  $p = -e((1 - \alpha)\beta + \alpha(1 - \gamma)) - \bar{p}\gamma\alpha + \mu$ , where  $\mu = \frac{D(0)}{D'(0)}$ . It follows that the maximized profit of a firm under this pricing strategy is given by

$$\pi_d^* = \mu D(p^* + e((1 - \alpha)\beta + \alpha(1 - \gamma)) + \bar{p}\gamma\alpha - \mu) \quad (6)$$

**Symmetric price equilibria.** The firm chooses a pricing strategy to maximize its expected profit. The conditions for a *low-priced add-on* strategy are  $\pi_l^* > \max(\pi_h^*, \pi_d^*)$ . The conditions for a *high-priced add-on* strategy are  $\pi_h^* > \max(\pi_d^*, \pi_l^*)$ . The conditions for a *price discrimination* strategy are  $\pi_d^* > \max(\pi_h^*, \pi_l^*)$ . These conditions imply threshold levels for the fraction of myopic consumers of the population,  $\alpha$ , that determine the symmetric price equilibrium of all firms. The threshold level depend on substitution costs  $e$ , the upper level

for the add-on price  $\bar{p}$ , and the efficiency of product discrimination (the attrition effect  $\beta$ , and the cannibalization effect  $\gamma$ ).

**Proposition 1** (Price equilibria without regulatory intervention). *Let*

$$\alpha^\dagger = \min\left(\frac{e}{\bar{p}}, \frac{e(1-\beta)}{e(1-\beta) + (\bar{p}-e)\gamma}\right) \quad (7)$$

and

$$\alpha^\ddagger = \max\left(\frac{e}{\bar{p}}, \frac{e\beta}{e\beta + (\bar{p}-e)(1-\gamma)}\right). \quad (8)$$

The firm chooses a low-priced add-on strategy if  $\alpha < \alpha^\dagger$ , a price discrimination strategy if  $\alpha^\dagger < \alpha < \alpha^\ddagger$ , and a high-priced add-on strategy if  $\alpha^\ddagger < \alpha$ .

The proof is in the appendix.<sup>9</sup>

The threshold level that are defined in Proposition 1 are illustrated in Figure 2. The following corollaries represent special cases of Proposition 1.

**Corollary 1** (Equilibrium without price discrimination). *Price discrimination is not efficient if  $\beta \leq 1 - \gamma$ , which implies that  $\alpha^\dagger = \alpha^\ddagger = \frac{e}{\bar{p}}$ . Then, firms choose a low-priced add-on strategy if  $\alpha < \frac{e}{\bar{p}}$  and a high-priced add-on strategy otherwise.*

The proof is in the appendix.

Corollary 1 reflects that the positive effect from offering low-priced add-ons to sophisticated and informed myopic consumers,  $\beta$ , is weaker than the cannibalization effect,  $1 - \gamma$ . Note that the threshold level for  $\alpha$  of Corollary 1 is equivalent to the threshold level from Gabaix and Laibson (2006) who analyze price equilibria without price discrimination.

**Corollary 2** (Equilibrium with price discrimination and no attrition). *Suppose price discrimination involves no attrition of informed consumers ( $\beta = 1$ ). This implies that  $\alpha^\dagger = 0$  and  $\alpha^\ddagger = \frac{e}{e + (\bar{p}-e)(1-\gamma)}$ . Then, firms choose a price discrimination strategy if  $\alpha < \alpha^\ddagger$  and a high-priced add-on strategy otherwise. A low-priced add-on strategy cannot be the optimal strategy.*

The proof is in the appendix.

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<sup>9</sup>Comment on multiple equilibria. See also Gabaix and Laibson (2006), footnote 30.

**Corollary 3** (Equilibrium with price discrimination and no cannibalization). *Suppose price discrimination involves no cannibalization of uninformed consumers ( $\gamma = 1$ ). This implies that  $\alpha^\dagger = \frac{e(1-\beta)}{e(1-\beta)+(\bar{p}-e)}$  and  $\alpha^\ddagger = 1$ . Then, firms choose a low-priced add-on strategy if  $\alpha < \alpha^\dagger$  and a price discrimination strategy otherwise. A high-priced add-on strategy cannot be the optimal strategy.*

The proof is in the appendix.

### 2.3 Price equilibria with educating consumers

Suppose that the regulator decides to intervene via educating myopic consumers. A fraction  $\lambda_R$  of myopic consumers then becomes *informed consumers* and decides just like sophisticated consumers. Thus, the fraction of uninformed consumers decreases from  $\alpha$  to  $(1-\lambda_R)\alpha$ , and the impact of unshrouding changes from  $\lambda_F$  to  $\lambda'_F \in [0, \lambda_F]$ . As shown in the previous analysis,  $\lambda_F$  (and equivalently  $\lambda'_F$ ) does not impact the optimal pricing strategy of firms.<sup>10</sup>

For example, when the optimal strategy of a firm is a low priced add-on for  $\alpha < \alpha^\dagger$  without regulatory intervention, this strategy is only optimal for  $(1-\lambda_R)\alpha < \alpha^\dagger \Leftrightarrow \alpha < \frac{1}{1-\lambda_R}\alpha^\dagger$  with regulatory intervention. The impact on the threshold between a *price discrimination* and a *high priced add-on* pricing strategy is effected equivalently.

**Proposition 2** (Price equilibria with regulatory intervention). *Suppose the regulator educates a fraction  $\lambda_R$  of myopic consumers about the relevance of the add-on prices, and let*

$$\alpha^\S = \frac{1}{1-\lambda_R}\alpha^\dagger \tag{9}$$

and

$$\alpha^\# = \frac{1}{1-\lambda_R}\alpha^\ddagger. \tag{10}$$

*The firm chooses a low-priced add-on strategy if  $\alpha < \alpha^\S$ , a price discrimination strategy if  $\alpha^\S < \alpha < \alpha^\#$ , and a high-priced add-on strategy if  $\alpha^\# < \alpha$ .*

The proof is in the appendix.

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<sup>10</sup>Note that, however,  $\lambda_F$  or  $\lambda'_F$  impacts the range where two alternative pricing equilibria exist.

The threshold levels that are defined in Proposition 2 are illustrated in Figure 3. Similarly as before (see Corollary 1 to Corollary 3), when  $\beta \leq 1 - \gamma$ , it follows that price discrimination is not the optimal pricing strategy. Firms choose a *low-priced add-on* strategy if  $\alpha < \frac{e}{\bar{p}(1-\lambda)}$  and a *high-priced add-on* strategy otherwise. When  $\beta = 1$  which means that price discrimination involves no *attrition* of informed consumers, it follows that a *low-priced add-on* strategy is not the optimal strategy. Firms choose a *price discrimination* strategy if  $\alpha < \alpha^\#$  and a *high-priced add-on* strategy otherwise. When  $\gamma = 1$  which means that price discrimination involves no *cannibalization* of uninformed consumers, it follows that a *high-priced add-on* strategy is not the optimal strategy. Firms choose a *low-priced add-on* strategy if  $\alpha < \alpha^\S$  and a *price discrimination* strategy otherwise.

### 3 Welfare Effects

This section provides comparative statics for social welfare and consumer protection. First, we discuss generally social welfare and consumer protection issues that arise from different prices for uninformed and informed consumers. Second, we analyze effects of price discrimination. This is important for potential actions of the regulator. Third, we analyze effects of educating consumers and derive conditions when it is beneficial for social welfare and when it has adverse effects. Fourth, we discuss the case for subsidized public firms.

#### 3.1 Social welfare and consumer protection

As suggested by Camerer, Issacharoff, Loewenstein, O'Donoghue, and Rabin (2003) in an influential article on *asymmetric paternalism*, regulation should “create large benefits for those who make errors, while imposing little or no harm on those who are fully rational” (p. 1212). Furthermore, regulation should “increase economic efficiency as measured by the sum of consumer and producer surplus” (p. 1220). Our welfare analysis follows this line of thought.

The measure for *social welfare loss* is given by the number of consumers who substitute away from the add-on multiplied by their effort costs  $e$ .

Besides social welfare, the pricing strategy of firms also affects consumer protection. From an equality perspective, one may want to prevent that informed consumers benefit from the high add-on prices paid by uninformed consumers. However, it is not so clear if regulation and consumer policy is the right tool to create equality. It is often argued that not competition policy but other instruments such as taxation should be used for income redistribution between consumers (e.g., Motta, 2004; Armstrong, 2008). Furthermore, consumers should have the incentive to become informed, because competition between firms may otherwise be weakened, which leads to reduced consumer welfare (Armstrong, Vickers, and Zhou, 2009).

In any case, several alternative measure could be used to evaluate consumer protection. A simple measure for consumer protection is the fraction of exploited consumers. The fraction of exploited consumers obviously decreases through education whenever a *high-priced add-on* equilibrium or a *price discrimination* equilibrium exists.

*Expected total prices* of myopic consumers reflect that a myopic consumer may become informed but may also stay uninformed after education. The measure is calculated as total prices of an uninformed consumer times the probability that a myopic consumer stays uninformed ( $1 - \lambda_R$ ), plus total prices of an informed consumer times the probability that a myopic consumer becomes informed ( $\lambda_R$ ).

### 3.2 Welfare effects of price discrimination

**Proposition 3** (price discrimination and social welfare). *Price discrimination decreases social welfare under an otherwise low-priced add-on equilibrium ( $\alpha^\dagger < \alpha < \frac{e}{p}$ ). It increases social welfare under an otherwise high-priced add-on equilibrium ( $\frac{e}{p} < \alpha < \alpha^\ddagger$ ).*

Figure 4 illustrates effects of price discrimination on social welfare. Besides social welfare, the pricing strategy of firms also affects cross-subsidies from uninformed (myopic) to informed (sophisticated and informed myopic) consumers.

**Proposition 4** (price discrimination and prices). *Price discrimination always decreases prices of sophisticated consumers ( $\alpha^\dagger < \alpha < \alpha^\ddagger$ ). The effect of price discrimination on prices of myopic consumers depends on the add-on that myopic consumers are offered. For myopic*

consumers who are offered the low-priced add-ons, it always decreases prices ( $\alpha^\dagger < \alpha < \alpha^\ddagger$ ). For myopic consumers who are offered the high-priced add-ons, it decreases prices under an otherwise high-priced add-on equilibrium ( $\frac{\epsilon}{p} < \alpha < \alpha^\ddagger$ ) and increases prices under an otherwise low-priced add-on equilibrium ( $\alpha^\dagger < \alpha < \frac{\epsilon}{p}$ ). Similarly, it decreases expected prices of myopic consumers under an otherwise high-priced add-on equilibrium ( $\frac{\epsilon}{p} < \alpha < \alpha^\ddagger$ ) and increases expected prices under an otherwise low-priced add-on equilibrium ( $\alpha^\dagger < \alpha < \frac{\epsilon}{p}$ ).

Figure 5 illustrates effects of price discrimination on prices of uninformed and informed consumers.

### 3.3 Welfare effects of educating consumers

**Proposition 5** (education and social welfare). *Educating consumers increases social welfare, if it changes a high-priced add-on equilibrium ( $\alpha^\ddagger < \alpha < \alpha^\#$ ) or a price discrimination equilibrium ( $\alpha^\dagger < \alpha < \alpha^\S$ ). It decreases social welfare, if a high-priced add-on equilibrium ( $\alpha^\# < \alpha$ ) or a price discrimination equilibrium ( $\alpha^\S < \alpha < \alpha^\ddagger$ ) remains.*

The proof is in the appendix.

Table 1 shows the welfare loss or welfare gain from educating consumers for each range of  $\alpha$ . Figure 6 illustrates effects of educating consumers on social welfare.

So far, the analysis has focussed on varying fractions of myopic consumers  $\alpha$ . The efficiency of educating myopic consumers that is reflected in  $\lambda$  is also important, especially, if the regulator can increase  $\lambda$  with high education efforts or with the right strategy. Ideally, the regulator makes enough myopic consumers informed such that firms choose the socially optimal *low-priced add-on* equilibrium. However, it is often not possible for the regulator to make a sufficiently large fraction of myopic consumers informed for at least two reasons: first, experimental studies show that a surprisingly low fraction of consumers changes its behavior based on new important information (e.g., Choi, Laibson, and Madrian, 2010), and second, firms may add complexity to their price structures in order to prevent that consumers become informed (Carlin, 2009).

A special case where price discrimination is not efficient ( $\beta \leq 1 - \gamma$ ) and only a *low-priced add-on* or a *high-priced add-on* equilibrium exists, is illustrated in Figure 7. A special case where price discrimination is efficient without attrition of informed consumers ( $\beta = 1$ ) and only a *price discrimination* or a *high-priced add-on* equilibrium exists, is illustrated in Figure 8. These figures show as well consequences for a varying fraction of myopic consumers  $\alpha$  as consequences for a varying effect of educating myopic consumers  $\lambda$ .

Figure 9 illustrates how education affects total prices (base good and add-on) of uninformed and informed consumers. It shows that total prices for uninformed consumers increase for a lower  $\alpha$ , until a *low-priced add-on* equilibrium is reached. Total prices for informed consumers also increase for a lower  $\alpha$  until a *low-priced add-on* equilibrium is reached. The *expected* total prices of myopic consumers with education are largely below total prices without education (for  $\alpha < 0.7$ ), even within a *high-priced add-on* or *price discrimination* equilibrium. Interestingly, for a high fraction of myopic consumers ( $\alpha > 0.7$ ), education even increases *expected* total prices of myopic consumers.

**Proposition 6** (education and expected prices). *Let*

$$\alpha^\diamond = \max\left(1 - \frac{e}{\bar{p}}, \alpha^\#\right). \quad (11)$$

*Educating consumers increases expected prices for myopic consumers for  $\alpha^\diamond < \alpha$ . It decreases expected prices for  $\alpha^\dagger < \alpha < \alpha^\diamond$ .*

The proof is in the appendix.

**Pitfalls for the regulator** As shown in the previous analysis, effects of educating myopic consumers depend on price equilibria, which in turn depend on the pricing flexibility of firms. The regulator can evaluate effects of educating myopic consumers if full information about the pricing dynamics is available. In many situations, however, this will not be the case.

Figure 10 illustrates a situation when effects of educating consumers depend on the pricing flexibility of firms. Suppose the regulator observes a high-priced add-on equilibrium. The regulator estimates that a fraction  $\alpha = 0.6$  of consumers is myopic, and that education could

make a fraction  $\lambda = 0.3$  of myopic consumers informed. Without knowing if firms own or could acquire a technology for price discrimination, it's not possible for the regulator to evaluate effects of educating consumers. If firms can only apply uniform pricing strategies, educating consumers decreases social welfare. If firms own a technology for price discrimination, educating consumers increases social welfare.

## 4 Alternative ways of regulatory intervention

This section discusses how the regulator can impact pricing strategies, consumer behavior and social welfare through subsidized public firms when an equilibrium pricing strategy exists where firms offer high-priced-add-ons to uninformed consumers.

A “public firm” represents a firm that accepts to follow a certain (loss-making) pricing strategy suggested by the regulator, and in turn receives a subsidy from the regulator. Subsidizing a public firm is different from a pure redistribution of income from taxpayers to uninformed consumers because it directly affects the purchase decision of consumers and the related social welfare loss. Thus, it may be a better way for creating equality than the redistribution of income through taxes or other isolated instruments. For the evaluation of such an intervention, costs for subsidizing a public firm are compared to a potential social welfare gain which reflects the benefit of all consumers from lower prices net taxes to finance subsidies.

The benefit of regulatory intervention is that social welfare increases for every informed consumer who does not substitute away, but would have substituted away without the public firm. The drawback of such a strategy is that it may require high subsidies for the public firm. Although the social welfare gain is net of subsidies, a strategy where huge subsidies are necessary in order to create a relatively small net social welfare gain does not seem to be justified. The measure we use to evaluate the efficiency of subsidies to a public firm is the costs of a subsidy divided by the social welfare gain, which is the lower the better.

## 4.1 Subsidizing add-ons

Consider a strategy where the regulator pays subsidies to consumers for buying certain products. E.g., consumers get tax breaks for investing in retirement funds. The rationale behind such a strategy may be the observation that a fraction of consumers does not buy a product that is socially desirable, a tax break makes the product more attractive, and consequently, more consumers buy it.

However, when the subsidized product is a *high-priced add-on* that myopic consumers already buy and sophisticated consumers avoid, it is easy to see that subsidies have purely adverse effects. Subsidies increase the reservation price  $\bar{p}$ , which makes a *high-priced add-on* strategy more profitable. Consequently, the thresholds for  $\alpha$  where a *low-priced add-on* equilibrium or a *price discrimination* equilibrium exist decrease (see also Proposition 1 and Proposition 2). Thus, when subsidies for add-ons lead to a *high-priced add-on* equilibrium instead of a *low-priced add-on* or *price discrimination* equilibrium, or to a *price discrimination add-on* equilibrium instead of a *low-priced add-on* equilibrium, direct consequences of subsidies are a higher social welfare loss.

When subsidies do not change a price equilibrium, there is no effect on social welfare. However, it has redistribution effects among consumers. Profits of firms are unchanged because the higher prices on the add-ons get competed away via the base good. The price of the add-on increases from  $\bar{p}$  to  $\bar{p} + \tau$ , where  $\tau$  represents the value of the tax break. The price of the base good decreases from  $-\alpha\bar{p} + \mu$  to  $-\alpha(\bar{p} + \tau) + \mu$  in a *high-priced add-on* equilibrium. In sum, uninformed consumers who buy the base good and the add-on pay  $(1 - \alpha)\tau$  less and informed consumers who only buy the base good pay  $\alpha\tau$  less. Thus, uninformed consumers profit relatively more for a low  $\alpha$ , and informed consumers profit relatively more for a high  $\alpha$ . Subsidies, of course, have to be financed by all consumers via higher taxes. Consequences are equivalent under a *price discrimination* equilibrium. In sum, when subsidies for add-ons do not change a prices equilibrium, which is the best possible case, it has no effect on social welfare but leads to an obscure redistribution of income among consumers.

## 4.2 Offering low-priced add-ons to all consumers

Suppose that the suggested strategy is to offer the base good for the equilibrium market price, i.e.,  $p = -\alpha\bar{p} + \mu$ , and the add-on for  $e$ . Recall that such a pricing strategy cannot exist for *for-profit* firms, as shown in the previous analysis. The following analysis assumes that the total volume of potential subsidies is such that all firms can participate in the subsidized pricing strategy.

A detailed description of this strategy is provided in Figure 12. Consider a *high-priced add-on* equilibrium without education, and suppose price discrimination is not attractive, i.e., the threshold between a low-priced add-on and a high-priced add-on equilibrium is  $\alpha^\dagger = \alpha^\ddagger = \frac{e}{\bar{p}}$  (see Corollary 1). Then, subsidies are given by  $\alpha\bar{p} - e$ . For  $\alpha \rightarrow \alpha^\ddagger = \frac{e}{\bar{p}}$  (from above), subsidies  $S_h \rightarrow 0$  and the social welfare gain  $G_h \rightarrow e(1 - \frac{e}{\bar{p}})$ . Thus, this strategy is very attractive for relatively low  $\alpha$ . For  $\alpha \rightarrow 1$ , subsidies are  $S_h \rightarrow \bar{p} - e$  and the social welfare gain  $G_h \rightarrow 0$ . This is obviously unattractive. The intuition is the following: The firm could sell the add-on for a price  $\bar{p}$  to all consumers under a *high-priced add-on* equilibrium. When the firm offers the add-on for  $e$  instead of  $\bar{p}$  to all consumers, the firm loses some of its profit with uninformed consumers. The lower the fraction of uninformed consumers  $\alpha$ , the lower these losses. Moreover, when firms offer the low-priced add-on to all consumers, they get an additional profit from informed consumers who otherwise substitute away, i.e.,  $e(1 - \alpha)$ . The higher the fraction of informed consumers, i.e., the lower  $\alpha$ , the higher this additional profit. Thus, required subsidies to compensate firms for a loss-making price strategy are increasing in  $\alpha$ .

**Proposition 7** (offering of low-priced add-on for all consumers). *Suppose the regulator subsidizes firms that offer uninformed consumers low-priced add-ons, and does not educate consumers. The efficiency of this intervention, defined as the cost of the required subsidy divided by the net social welfare gain, is*

$$E_h = \frac{\alpha\bar{p} - e}{e(1 - \alpha)} \quad (12)$$

*under a high-priced add-on equilibrium ( $\alpha^\ddagger < \alpha$ ).*

The proof is in the appendix.

Proposition 7 yields an important result: If a public firm makes losses, the firm is not necessarily inefficient. In fact, the firm may be very efficient in redistributing income to uninformed consumers.

Recall that  $E_h$  is defined such that the lower the better. This measure increases in  $\alpha$ . Therefore, educating consumers (lowering the fraction of uninformed consumers) increases the efficiency of this regulatory intervention.

### 4.3 Offering low-priced add-ons to informed consumers only

From the perspective of a “paternalistic” regulator who cares for myopic consumers, a strategy looks attractive where a public firm offers products to myopic consumers while private firms offer products to sophisticated consumers. Then, private firms would choose a *low-priced add-on* pricing strategy, and there would be no social welfare loss or consumer protection issue. However, when the public firm offers the base good at a price that is attractive to myopic consumers, this offer is also attractive to sophisticated consumers. Therefore, a public firm cannot increase its market share only with myopic consumers.

However, offers that only attract informed consumers are feasible. For such a strategy, the net anticipated surplus of informed consumers, i.e.,  $\hat{x}_i = -p - \min\{E\hat{p}, e\} + p^* + \min\{E\hat{p}^*, e\}$ , needs to be higher at the public firm than at the private firm, while the net anticipated surplus of uninformed consumers, i.e.,  $\bar{x}_i = -p + p^*$ , needs to be lower at the public firm. Therefore, suppose that the strategy is to offer the base good above the equilibrium market price, i.e.,  $p + \Delta$ , and the add-on for  $\hat{e} - \Delta$ , where  $\hat{e} < e$ .

The intuition for this strategy is as follows: When a private firm only attracts myopic consumers, this leads to the so-called *loss leader pricing*. The price of the base good is  $p = -\bar{p} + \mu$  and the price of the add-on is  $\hat{p} = \bar{p}$ . Myopic consumers do NOT subsidize sophisticated consumers and are NOT exploited. At first glance, private firms may be happy that they don’t have to serve informed consumers. However, this benefit gets competed away if all private firms enjoy this effect, which results in a *loss leader pricing*. The public firm attracts informed consumers who do not need to substitute away. In a high-priced add-on equilibrium, social

welfare gain is  $(1 - \alpha)e$ .

A detailed description of this strategy is provided in Figure 13. Similarly as in Section 4.2, consider a *high-priced add-on* equilibrium without education, and suppose price discrimination is not attractive, i.e.,  $\alpha^\dagger = \alpha^\ddagger = \frac{e}{\bar{p}}$ . Then, subsidies are given by  $(\bar{p} - \hat{e})(1 - \alpha)$ . For  $\alpha \rightarrow \alpha^\ddagger = \frac{e}{\bar{p}}$  (from above), subsidies  $S_h \rightarrow \bar{p} - 2e + \frac{e^2}{\bar{p}}$ . Subsidies are decreasing in  $\alpha$ . For  $\alpha = 1$ , subsidies are 0. The intuition is the following: the market price of the base good decrease by  $\bar{p}(1 - \alpha)$  through the intervention. Thus, the lower  $\alpha$ , the higher the loss of firms on the base good. Moreover, on the positive side, firms get additional profits of  $e(1 - \alpha)$  from informed consumers. The lower  $\alpha$ , the lower the additional profits. In sum, the lower  $\alpha$ , the higher the required subsidies for firms in order to compensate them for losses if they accept the suggested pricing strategy of the regulator.

**Proposition 8** (offering of low-priced add-ons for informed consumers). *Suppose the regulator subsidizes firms that offer informed consumers low-priced add-ons, and does not educate consumers. The efficiency of this intervention, defined as the cost of the required subsidy divided by the net social welfare gain, is*

$$E_h = \frac{\bar{p} - \hat{e}}{e} \quad (13)$$

*under a high-priced add-on equilibrium ( $\alpha^\ddagger < \alpha$ ).*

The proof is in the appendix.

The measure is constant in  $\alpha$ . Therefore, educating consumers does not matter for the efficiency of this regulatory strategy, and the goal should be to minimize the total volume of subsidies. For this strategy this is  $S_h = (\bar{p} - \hat{e})(1 - \alpha)$ . Subsidies decrease in  $\alpha$ . Therefore, educating consumers (lowering the fraction of uninformed consumers) increases subsidies, and, unless it changes the equilibrium price strategy of firms, should not be carried out.

#### 4.4 Educating consumers and optimal subsidization

Including regulatory intervention through educating consumers, we presented four alternative regulatory strategies: first, educating consumers, and second, directly subsidizing add-ons,

third, subsidizing firms that offer low-priced add-ons to all consumers, and fourth, subsidizing firms that offer low-priced add-ons to informed consumers. In this section, we discuss the optimal regulatory strategy. The rationale for the evaluation of alternative intervention strategies is that the regulator should use the strategy that first, yields the highest social welfare gain, and second, requires the least subsidies (taxes).

It is easy to see that whenever the regulator can achieve a *low-priced add-on* equilibrium through educating consumers, this is the optimal strategy and other interventions are not necessary. When the regulator can change a *high-priced add-on* equilibrium to a *price discrimination* equilibrium through educating consumers, this strategy should be combined with subsidizing public firms. When the regulator cannot change a *high-priced add-on* equilibrium or a *price discrimination* equilibrium through educating consumers, educating consumers may be beneficial or counterproductive, depending on the details how firms are subsidized.

When considering to subsidize firms, the regulator can choose between two reasonable strategies: subsidizing firms that offer low-priced add-ons *to all consumers*, as discussed in Section 4.2, or subsidizing firms that offer low-priced add-ons *only to informed consumers*, as discussed in Section 4.3. Subsidizing firms that offer low-priced add-ons only to uninformed consumers is not feasible, and directly subsidizing add-ons is never optimal.

With both relevant strategies, the regulator can avoid any social welfare loss that would exist under a *high-priced add-on* equilibrium. Thus, the strategies only differ in the amount of required subsidies, and the regulator should choose the strategy where the subsidies are minimized.

**Proposition 9** (subsidizing firms). *The regulator can increase social welfare through subsidizing firms that accept loss-making price strategies when a high-priced add-on equilibrium exists. Let*

$$\alpha^H = \frac{\bar{p} - \hat{e} + e}{\bar{p} - \hat{e} + \bar{p}}. \quad (14)$$

*The optimal strategy that requires the lowest subsidies for the same net effect on social welfare is subsidizing firms that offer low-priced add-ons to all consumers for  $\alpha < \alpha^H$  and, otherwise, subsidizing firms that offer low-priced add-ons only to informed consumers.*

See Figure 14 for an illustration.

## 5 Conclusion

The goal of educating consumers is that firms offer the base good and the add-on at “fair” prices that are attractive for all consumers. If educating consumers changes a *high-priced add-on* equilibrium or a *price discrimination* equilibrium of firms, social welfare increases. However, educating consumers is not always successful in reaching this goal because a fraction of consumers may not be receptive for new information or not be able to use any but the most simple decision rationale. Then, as we show in this paper, educating consumers may decrease social welfare. Effects depend on the fraction of myopic consumers, the efficiency of educating myopic consumers, the effort costs of substituting away from add-ons, the upper level for the add-on price, and the efficiency of price discrimination. When educating consumers does not lead to a new price equilibrium where firms offer low-priced add-ons, the regulator should intervene in the product market. We define a “public firm” as a firm that accepts to follow a certain (loss-making) pricing strategy suggested by the regulator, and in turn receives a subsidy from the regulator. We develop alternative regulatory strategies with different comparative advantages that each create a net social welfare gain. Depending on the specific situation, the optimal regulatory strategy may be 1) only educating consumer, 2) educating consumers and subsidizing firms, or 3) only subsidizing firms.

Our paper develops a framework to analyze effects of alternative regulatory interventions and to derive the optimal regulatory strategy. In summary, the regulator needs to carefully analyze the situation before intervening via educating myopic consumers and may find no intervention at all or other regulatory strategies more beneficial.

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## A Appendix: Calculations and proofs

### A.1 Calculations and proofs for Section 2.2

**Equation 1 (high-priced add-on w/o regulatory intervention).** The expected profit of a firm is composed of the expected profit from sales to informed consumers who only purchase the base good,  $p(1 - \alpha)D(\hat{x}_i)$ , and the expected profit from sales to uninformed consumers who buy both the base good and the add-on,  $(p + \hat{p})\alpha D(\bar{x}_i)$ . Thus, the expected profit is given by

$$\begin{aligned}
 \pi_h &= p(1 - \alpha)D(\hat{x}_i) + (p + \hat{p})\alpha D(\bar{x}_i) \\
 &= p(1 - \alpha)D(-p - \min\{E\hat{p}, e\} + p^* + \min\{E\hat{p}^*, e\}) \\
 &\quad + (p + \hat{p})\alpha D(-p + p^*) \\
 &= p(1 - \alpha)D(-p - e + p^* + e) + (p + \bar{p})\alpha D(-p + p^*) \\
 &= (p + \alpha\bar{p})D(p^* - p)
 \end{aligned}$$

**Equation 3 (low-priced add-on w/o regulatory intervention).** The expected profit of a firm is composed of the expected profit from sales to informed (sophisticated and informed myopic) consumers,  $(p + \hat{p})(1 - (1 - \lambda_F)\alpha)D(\hat{x}_i)$ , and the expected profit from sales to uninformed myopic consumers,  $(p + \hat{p})(1 - \lambda_F)\alpha D(\bar{x}_i)$ . All consumers purchase both the base good and the add-on at the firm. Thus, the expected profit is given by

$$\begin{aligned}
 \pi_l &= (p + \hat{p})(1 - (1 - \lambda_F)\alpha)D(-p - \min\{E\hat{p}, e\} + p^* + \min\{E\hat{p}^*, e\}) \\
 &\quad + (p + \hat{p})(1 - \lambda_F)\alpha D(-p + p^*) \\
 &= (p + e)(1 - (1 - \lambda_F)\alpha)D(-p - e + p^* + e) + (p + e)(1 - \lambda_F)\alpha D(-p + p^*) \\
 &= (p + e)D(p^* - p)
 \end{aligned}$$

**Equation 5 (price discrimination w/o regulatory intervention).** Recall that price discrimination may not be fully efficient. First, because of *attrition*, only a fraction  $\beta$  of informed consumers (pre advertising) buys it at the firm, and a fraction  $1 - \beta$  substitutes away.

Second, because of *product cannibalization*, a fraction  $1 - \gamma$  of myopic consumers becomes informed, and a fraction  $\gamma$  stays uninformed. The expected profit of a firm is composed of the expected profit from sales to informed consumers who substitute away,  $p(1 - \alpha)(1 - \beta)D(\hat{x})$ , sales to informed consumers who buy the low-priced add-on,  $(p + e)(1 - \alpha)\beta D(\hat{x})$ , sales to informed consumers (myopic consumers who got informed through *product cannibalization*) who buy the low-priced add-on,  $(p + e)(1 - \lambda_F)\alpha(1 - \gamma)D(\hat{x})$ , sales to uninformed consumers (myopic consumers who don't get informed but get the low-priced add-on offered) who buy the low-priced add-on,  $(p + e)\lambda_F\alpha(1 - \gamma)D(\bar{x})$ , and sales to uninformed myopic consumers who buy the high-priced add-on,  $(p + \bar{p})\alpha\gamma D(\bar{x})$ . Thus, the expected profit of a firm is given by

$$\begin{aligned}
\pi_d &= p(1 - \alpha)(1 - \beta)D(\hat{x}) + (p + e)(1 - \alpha)\beta D(\hat{x}) \\
&\quad + (p + e)(1 - \lambda_F)\alpha(1 - \gamma)D(\hat{x}) + (p + e)\lambda_F\alpha(1 - \gamma)D(\bar{x}) \\
&\quad + (p + \bar{p})\alpha\gamma D(\bar{x}) \\
&= p(1 - \alpha)(1 - \beta)D(-p + p^*) + (p + e)(1 - \alpha)\beta D(-p + p^*) \\
&\quad + (p + e)(1 - \lambda_F)\alpha(1 - \gamma)D(-p + p^*) + (p + e)\lambda_F\alpha(1 - \gamma)D(-p + p^*) \\
&\quad + (p + \bar{p})\alpha\gamma D(-p + p^*) \\
&= [p(1 - \alpha)(1 - \beta) + (p + e)(1 - \alpha)\beta + (p + e)\alpha(1 - \gamma) + (p + \bar{p})\alpha\gamma] D(-p + p^*) \\
&= [p + e((1 - \alpha)\beta + \alpha(1 - \gamma)) + \bar{p}\alpha\gamma] D(-p + p^*)
\end{aligned}$$

**Proposition 1 (price equilibria w/o regulatory intervention).** The firm chooses a pricing strategy to maximize its expected profit. The conditions for a *low-priced add-on* strategy are that  $\pi_l^* > \pi_h^*$  and  $\pi_l^* > \pi_d^*$ , which is equivalent to  $\pi_l^* > \max(\pi_h^*, \pi_d^*)$ . First, we get

$$\begin{aligned}
\pi_l^* &> \pi_h^* \\
\mu D(p^* + e - \mu) &> \mu D(p^* + \alpha\bar{p} - \mu) \\
e &> \alpha\bar{p} \\
\frac{e}{\bar{p}} &> \alpha.
\end{aligned}$$

Second, we get

$$\begin{aligned}
\pi_l^* &> \pi_d^* \\
\mu D(p^* + e - \mu) &> \mu D(p^* + e((1 - \alpha)\beta + \alpha(1 - \gamma)) + \bar{p}\gamma\alpha - \mu) \\
e &> e((1 - \alpha)\beta + \alpha(1 - \gamma)) + \bar{p}\gamma\alpha \\
e &> e\beta - e\alpha\beta + e\alpha(1 - \gamma) + \bar{p}\gamma\alpha \\
e - e\beta &> \alpha(-e\beta + e - e\gamma + \bar{p}\gamma) \\
e - e\beta &> \alpha(e(1 - \beta) + (\bar{p} - e)\gamma) \\
\frac{e(1 - \beta)}{e(1 - \beta) + (\bar{p} - e)\gamma} &> \alpha.
\end{aligned}$$

Thus, the conditions for a *low-priced add-on* strategy hold if  $\alpha < \frac{e}{\bar{p}}$  and  $\alpha < \frac{e(1 - \beta)}{e(1 - \beta) + (\bar{p} - e)\gamma}$ , which can be written as  $\alpha < \alpha^\dagger$ , where

$$\alpha^\dagger = \min\left(\frac{e}{\bar{p}}, \frac{e(1 - \beta)}{e(1 - \beta) + (\bar{p} - e)\gamma}\right).$$

The conditions for a *high-priced add-on* strategy are  $\pi_h^* > \pi_d^*$  and  $\pi_h^* > \pi_l^*$ , which is equivalent to  $\pi_h^* > \max(\pi_d^*, \pi_l^*)$ . First, we get

$$\begin{aligned}
\pi_h^* &> \pi_d^* \\
\mu D(p^* + \alpha\bar{p} - \mu) &> \mu D(p^* + e((1 - \alpha)\beta + \alpha(1 - \gamma)) + \bar{p}\gamma\alpha - \mu) \\
\alpha\bar{p} &> e((1 - \alpha)\beta + \alpha(1 - \gamma)) + \bar{p}\gamma\alpha \\
\alpha\bar{p} &> e\beta - e\alpha\beta + e\alpha(1 - \gamma) + \bar{p}\gamma\alpha \\
\alpha\bar{p} &> e\beta - \alpha(e\beta - e + e\gamma - \bar{p}\gamma) \\
\alpha\bar{p} + \alpha(e\beta - e + e\gamma - \bar{p}\gamma) &> e\beta \\
\alpha(\bar{p} + e\beta - e + e\gamma - \bar{p}\gamma) &> e\beta \\
\alpha(e\beta + \bar{p}(1 - \gamma) - e(1 - \gamma)) &> e\beta \\
\alpha(e\beta + (\bar{p} - e)(1 - \gamma)) &> e\beta \\
\alpha &> \frac{e\beta}{e\beta + (\bar{p} - e)(1 - \gamma)}.
\end{aligned}$$

Second, we get

$$\begin{aligned}
\pi_h^* &> \pi_l^* \\
\mu D(p^* + \alpha \bar{p} - \mu) &> \mu D(p^* + e - \mu) \\
\alpha \bar{p} &> e \\
\alpha &> \frac{e}{\bar{p}}.
\end{aligned}$$

Thus, the conditions for a *high-priced add-on* strategy hold if  $\alpha > \frac{e\beta}{e\beta + (\bar{p} - e)(1 - \gamma)}$  and  $\alpha > \frac{e}{\bar{p}}$ , which can be written as  $\alpha > \alpha^\ddagger$ , where

$$\alpha^\ddagger = \max\left(\frac{e}{\bar{p}}, \frac{e\beta}{e\beta + (\bar{p} - e)(1 - \gamma)}\right).$$

The conditions for a *price discrimination* strategy are  $\pi_d^* > \pi_h^*$  and  $\pi_d^* > \pi_l^*$ , which is equivalent to  $\pi_d^* > \max(\pi_h^*, \pi_l^*)$ . From the above calculations it is easy to see that these conditions hold if  $\alpha^\dagger < \alpha < \alpha^\ddagger$ . *Q.E.D.*

**Multiple equilibria.** If any firm unshrouds, which changes the fraction of myopic consumers from  $\alpha$  to  $(1 - \lambda_F)\alpha$ , the expected profit of a high-priced add-on strategy decreases to

$$\begin{aligned}
\pi_h' &= p(1 - (1 - \lambda_F)\alpha)D(-p - \min\{E\hat{p}, e\} + p^* + \min\{E\hat{p}^*, e\}) \\
&\quad + (p + \hat{p})(1 - \lambda_F)\alpha D(-p + p^*) \\
&= p(1 - (1 - \lambda_F)\alpha)D(-p - e + p^* + e) + (p + \bar{p})(1 - \lambda_F)\alpha D(-p + p^*) \\
&= (p + (1 - \lambda_F)\alpha \bar{p})D(p^* - p)
\end{aligned}$$

For the optimal pricing strategy of firms (see Proposition 1) it follows that more than one equilibrium price strategy may exist.

**Corollary 1 (equilibrium w/o price discrimination).** The threshold level  $\alpha^\dagger$  and  $\alpha^\ddagger$  are defined as

$$\alpha^\dagger = \min \left( \frac{e}{\bar{p}}, \frac{e(1-\beta)}{e(1-\beta) + (\bar{p}-e)\gamma} \right)$$

and

$$\alpha^\ddagger = \max \left( \frac{e}{\bar{p}}, \frac{e\beta}{e\beta + (\bar{p}-e)(1-\gamma)} \right).$$

These threshold level imply that  $\alpha^\dagger \leq \frac{e}{\bar{p}}$  and  $\alpha^\ddagger \geq \frac{e}{\bar{p}}$ . It follows that  $\alpha^\dagger = \alpha^\ddagger$  if, and only if,  $\alpha^\dagger = \frac{e}{\bar{p}}$  and  $\alpha^\ddagger = \frac{e}{\bar{p}}$ . First,  $\alpha^\dagger = \frac{e}{\bar{p}}$ , if  $\frac{e}{\bar{p}} \leq \frac{e(1-\beta)}{e(1-\beta) + (\bar{p}-e)\gamma}$ . This is the case if  $\beta \leq 1 - \gamma$ . Second,  $\alpha^\ddagger = \frac{e}{\bar{p}}$ , if  $\frac{e}{\bar{p}} \geq \frac{e\beta}{e\beta + (\bar{p}-e)(1-\gamma)}$ . This is the case if  $\beta \leq \frac{\bar{p}-e}{e\bar{p}-e}(1-\gamma)$ . Based on the assumptions that  $\bar{p} \in (0, 1]$  and  $e < \bar{p}$ , we know that  $1 - \gamma < \frac{\bar{p}-e}{e\bar{p}-e}(1-\gamma)$ . It follows that  $\alpha^\dagger = \alpha^\ddagger = \frac{e}{\bar{p}}$ , if  $\beta \leq (1 - \gamma)$ . *Q.E.D.*

**Corollary 2 (equilibrium with price discrimination and no attrition).** The corollary follows directly from using  $\beta = 1$  and from Proposition 1, where

$$\alpha^\dagger = \min \left( \frac{e}{\bar{p}}, \frac{e(1-\beta)}{e(1-\beta) + (\bar{p}-e)\gamma} \right) \quad (15)$$

and

$$\alpha^\ddagger = \max \left( \frac{e}{\bar{p}}, \frac{e\beta}{e\beta + (\bar{p}-e)(1-\gamma)} \right). \quad (16)$$

Then,  $\alpha^\dagger = 0$  and  $\alpha^\ddagger = \frac{e}{e + (\bar{p}-e)(1-\gamma)}$ . The statement of Proposition 1 becomes: The firm chooses a *low-priced add-on* strategy if  $\alpha < 0$ , a *price discrimination* strategy if  $0 < \alpha < \frac{e}{e + (\bar{p}-e)(1-\gamma)}$ , and a *high-priced add-on* strategy if  $\frac{e}{e + (\bar{p}-e)(1-\gamma)} < \alpha$ . Given that  $\alpha \in [0, 1]$ , this is equivalent with the stated results. *Q.E.D.*

**Corollary 3 (equilibrium with price discrimination and no cannibalization).** The corollary follows directly and from using  $\gamma = 1$  and from Proposition 1, where

$$\alpha^\dagger = \min \left( \frac{e}{\bar{p}}, \frac{e(1-\beta)}{e(1-\beta) + (\bar{p}-e)\gamma} \right) \quad (17)$$

and

$$\alpha^\ddagger = \max\left(\frac{e}{\bar{p}}, \frac{e\beta}{e\beta + (\bar{p} - e)(1 - \gamma)}\right). \quad (18)$$

Then,  $\alpha^\dagger = \frac{e(1-\beta)}{e(1-\beta)+(\bar{p}-e)}$  and  $\alpha^\ddagger = 1$ . The statement of Proposition 1 becomes: The firm chooses a *low-priced add-on* strategy if  $\alpha < \frac{e(1-\beta)}{e(1-\beta)+(\bar{p}-e)}$ , a *price discrimination* strategy if  $\frac{e(1-\beta)}{e(1-\beta)+(\bar{p}-e)} < \alpha < 1$ , and a *high-priced add-on* strategy if  $1 < \alpha$ . Given that  $\alpha \in [0, 1]$ , this is equivalent with the stated results. Q.E.D.

## A.2 Calculations and proofs for Section 2.3

**Proposition 2 (price equilibria with regulatory intervention).** Regulatory intervention through educating consumers changes the fraction of informed consumers that firms consider for their pricing strategies from  $\alpha$  to  $(1 - \lambda_R)\alpha$ . Using the results from Proposition 1, it follows that the firm chooses a *low-priced add-on* strategy if  $(1 - \lambda_R)\alpha < \alpha^\dagger$ , a *price discrimination* strategy if  $\alpha^\dagger < (1 - \lambda_R)\alpha < \alpha^\ddagger$ , and a *high-priced add-on* strategy if  $\alpha^\ddagger < (1 - \lambda_R)\alpha$ . Equivalently, as stated in Proposition 2, the firm chooses a *low-priced add-on* strategy if  $\alpha < \frac{1}{1-\lambda_R}\alpha^\dagger = \alpha^\S$ , a *price discrimination* strategy if  $\frac{1}{1-\lambda_R}\alpha^\dagger = \alpha^\S < \alpha < \frac{1}{1-\lambda_R}\alpha^\ddagger = \alpha^\#$ , and a *high-priced add-on* strategy if  $\frac{1}{1-\lambda_R}\alpha^\ddagger = \alpha^\# < \alpha$ . Q.E.D.

## A.3 Calculations and proofs for Section 3.2

**Proposition 3 (price discrimination and social welfare).** The proposition considers the question how a technology that allows firms to price discriminate impacts social welfare. For the calculations, we use that the social welfare loss is equivalent to the number of consumers who substitute away multiplied by the substitution costs  $e$ . Note that we can focus the analysis on  $\alpha^\dagger < \alpha < \alpha^\ddagger$ . Otherwise, even when a technology to price discriminate is available, a price discrimination strategy is not the optimal price strategy (see Proposition 1). For an overview of results, see Table 1.

First, consider the social welfare loss for  $\alpha^\dagger < \alpha < \frac{e}{\bar{p}}$ . Without price discrimination (in a *low-priced add-on* equilibrium), the social welfare loss is 0. With price discrimination, the

social welfare loss is  $(1 - \beta)(1 - \alpha)e$ . Thus, the net effect of price discrimination on the social welfare loss is positive ( $(1 - \beta)(1 - \alpha)e > 0$ ). In other words, as stated in the proposition, price discrimination decreases social welfare.

Second, consider the social welfare loss for  $\frac{e}{p} < \alpha < \alpha^\dagger$ . Without price discrimination (in a *high-priced add-on* equilibrium), the social welfare loss is  $(1 - \alpha)e$ . With price discrimination, the social welfare loss is  $(1 - \beta)(1 - \alpha)e$ . Thus, the net effect of price discrimination on the social welfare loss is negative ( $-\beta(1 - \alpha)e < 0$ ). In other words, as stated in the proposition, price discrimination increases social welfare. *Q.E.D.*

**Proposition 4 (price discrimination and prices).** The proposition considers the question how a technology that allows firms to price discriminate impacts prices of consumers. Note that we can focus the analysis on  $\alpha^\dagger < \alpha < \alpha^\ddagger$ . Otherwise, even when a technology to price discriminate is available, a price discrimination strategy is not the optimal price strategy (see Proposition 1). In the following, we sequentially analyze all relevant cases. For an overview of results, see Tables 2 - 5.

1) Consider prices of sophisticated consumers for  $\alpha^\dagger < \alpha < \frac{e}{p}$ . Without price discrimination (under a *low-priced add-on* equilibrium), consumers pay a total for the base good and the add-on of

$$-e + \mu + e = \mu. \tag{19}$$

With price discrimination consumers pay

$$-e((1 - \alpha)\beta + \alpha(1 - \gamma)) - \bar{p}\gamma\alpha + \mu + e. \tag{20}$$

Thus, the net effect of price discrimination on prices of consumers is

$$-e((1 - \alpha)\beta + \alpha(1 - \gamma)) - \bar{p}\gamma\alpha + e. \tag{21}$$

According to the proposition, we need to show that the net effect is negative, i.e.,

$$-e((1 - \alpha)\beta + \alpha(1 - \gamma)) - \bar{p}\gamma\alpha + e < 0 \quad (22)$$

$$-e\beta + e\alpha\beta - e\alpha(1 - \gamma) - \bar{p}\gamma\alpha + e < 0 \quad (23)$$

$$-\alpha(-e\beta + e(1 - \gamma) + \bar{p}\gamma) + e(1 - \beta) < 0 \quad (24)$$

$$e(1 - \beta) < \alpha(-e\beta + e(1 - \gamma) + \bar{p}\gamma) \quad (25)$$

$$\frac{e(1 - \beta)}{-e\beta + e(1 - \gamma) + \bar{p}\gamma} < \alpha \quad (26)$$

$$\frac{e(1 - \beta)}{e(1 - \beta) + (\bar{p} - e)\gamma} < \alpha. \quad (27)$$

Using  $\alpha^\dagger < \alpha$ , where  $\alpha^\dagger = \min\left(\frac{e}{\bar{p}}, \frac{e(1 - \beta)}{e(1 - \beta) + (\bar{p} - e)\gamma}\right)$ , we know that the inequality holds.<sup>11</sup>

2) Consider prices of sophisticated consumers for  $\frac{e}{\bar{p}} < \alpha < \alpha^\dagger$ . Without price discrimination (under a *high-priced add-on* equilibrium), consumers pay a total for the base good and the add-on (more precisely, for the base good and for substituting the add-on) of

$$-\alpha\bar{p} + \mu + e = \mu. \quad (28)$$

With price discrimination consumers pay

$$-e((1 - \alpha)\beta + \alpha(1 - \gamma)) - \bar{p}\gamma\alpha + \mu + e. \quad (29)$$

Thus, the net effect of price discrimination on prices of consumers is

$$-e((1 - \alpha)\beta + \alpha(1 - \gamma)) - \bar{p}\gamma\alpha + \alpha\bar{p}. \quad (30)$$

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<sup>11</sup>Note that from  $\beta \leq (1 - \gamma)$  (see Corollary 1) we know that  $(-e\beta + e(1 - \gamma) + \bar{p}\gamma) > 0$ , such that dividing with this term does not reverse the direction of the inequality.

According to the proposition, we need to show that the net effect is negative, i.e.,

$$-e((1 - \alpha)\beta + \alpha(1 - \gamma)) - \bar{p}\gamma\alpha + \alpha\bar{p} < 0 \quad (31)$$

$$-e\beta + e\alpha\beta - e\alpha(1 - \gamma) - \bar{p}\gamma\alpha + \alpha\bar{p} < 0 \quad (32)$$

$$\alpha(e\beta - e(1 - \gamma) - \bar{p}\gamma + \bar{p}) < e\beta \quad (33)$$

$$\alpha(e\beta - e(1 - \gamma) + \bar{p}(1 - \gamma)) < e\beta \quad (34)$$

$$\alpha(e\beta + (\bar{p} - e)(1 - \gamma)) < e\beta \quad (35)$$

$$\alpha < \frac{e\beta}{e\beta + (\bar{p} - e)(1 - \gamma)} \quad (36)$$

Using  $\alpha < \alpha^\dagger$ , where  $\alpha^\dagger = \max\left(\frac{e}{\bar{p}}, \frac{e\beta}{e\beta + (\bar{p} - e)(1 - \gamma)}\right)$ , we know that the inequality holds.

3) Consider prices of myopic consumers who are offered the low-priced add-ons for  $\alpha^\dagger < \alpha < \frac{e}{\bar{p}}$ . The analysis is equivalent to the analysis under 1). Thus, we know that the net effect of price discrimination is negative.

4) Consider prices of myopic consumers who are offered the low-priced add-ons for  $\frac{e}{\bar{p}} < \alpha < \alpha^\dagger$ . Without price discrimination (under a *high-priced add-on* equilibrium), consumers pay a total for the base good and the add-on of

$$-\alpha\bar{p} + \mu + \bar{p}. \quad (37)$$

With price discrimination consumers pay

$$-e((1 - \alpha)\beta + \alpha(1 - \gamma)) - \bar{p}\gamma\alpha + \mu + e. \quad (38)$$

Thus, the net effect of price discrimination on prices of consumers is

$$-e((1 - \alpha)\beta + \alpha(1 - \gamma)) - \bar{p}\gamma\alpha + e - (1 - \alpha)\bar{p}. \quad (39)$$

According to the proposition, we need to show that the net effect is negative, i.e.,

$$-e((1 - \alpha)\beta + \alpha(1 - \gamma)) - \bar{p}\gamma\alpha + e - (1 - \alpha)\bar{p} < 0. \quad (40)$$

We know from the analysis under 1) that  $-e((1 - \alpha)\beta + \alpha(1 - \gamma)) - \bar{p}\gamma\alpha + e < 0$ . Thus, we know that the inequality above that differs only by  $-(1 - \alpha)\bar{p}$  also holds.

5) Consider prices of myopic consumers who are offered the high-priced add-ons for  $\alpha^\dagger < \alpha < \frac{e}{\bar{p}}$ . Without price discrimination (under a *low-priced add-on* equilibrium), consumers pay a total for the base good and the add-on of

$$-e + \mu + e = \mu. \quad (41)$$

With price discrimination consumers pay

$$-e((1 - \alpha)\beta + \alpha(1 - \gamma)) - \bar{p}\gamma\alpha + \mu + \bar{p}. \quad (42)$$

Thus, the net effect of price discrimination on prices of consumers is

$$-e((1 - \alpha)\beta + \alpha(1 - \gamma)) - \bar{p}\gamma\alpha + \bar{p}. \quad (43)$$

According to the proposition, we need to show that the net effect is positive, i.e.,

$$-e((1 - \alpha)\beta + \alpha(1 - \gamma)) - \bar{p}\gamma\alpha + \bar{p} > 0 \quad (44)$$

$$-e\beta + e\alpha\beta - e\alpha(1 - \gamma) - \bar{p}\gamma\alpha + \bar{p} > 0 \quad (45)$$

$$-\alpha(-e\beta + e(1 - \gamma) + \bar{p}\gamma) - e\beta + \bar{p} > 0 \quad (46)$$

$$-e\beta + \bar{p} > \alpha(-e\beta + e(1 - \gamma) + \bar{p}\gamma) \quad (47)$$

$$\frac{\bar{p} - e\beta}{e(1 - \gamma) + \bar{p}\gamma - e\beta} > \alpha \quad (48)$$

From  $\bar{p} > e(1 - \gamma) + \bar{p}\gamma$  it follows that  $\frac{\bar{p} - e\beta}{e(1 - \gamma) + \bar{p}\gamma - e\beta} > 1$ . Thus, because  $\alpha \in (0, 1]$ , the inequality above holds.<sup>12</sup>

6) Consider prices of myopic consumers who are offered the high-priced add-ons for  $\frac{e}{\bar{p}} < \alpha < \alpha^\dagger$ . Without price discrimination (under a *high-priced add-on* equilibrium), consumers pay a

<sup>12</sup>Note that from  $\beta \leq (1 - \gamma)$  (see Corollary 1) we know that  $(-e\beta + e(1 - \gamma) + \bar{p}\gamma) > 0$ , such that dividing with this term does not reverse the direction of the inequality.

total for the base good and the add-on of

$$-\alpha\bar{p} + \mu + \bar{p}. \quad (49)$$

With price discrimination consumers pay

$$-e((1 - \alpha)\beta + \alpha(1 - \gamma)) - \bar{p}\gamma\alpha + \mu + \bar{p}. \quad (50)$$

Thus, the net effect of price discrimination on prices of consumers is

$$-e((1 - \alpha)\beta + \alpha(1 - \gamma)) - \bar{p}\gamma\alpha + \alpha\bar{p}. \quad (51)$$

According to the proposition, we need to show that the net effect is negative, i.e.,

$$-e((1 - \alpha)\beta + \alpha(1 - \gamma)) - \bar{p}\gamma\alpha + \alpha\bar{p} < 0. \quad (52)$$

We know from the analysis under 2) that inequality above holds.

Next, we consider *expected* prices of myopic consumers. Recall that the *cannibalization* effect of price discrimination implies that firms offer the high-priced add-on to a fraction  $\gamma$  of myopic consumers, and the low-priced add-on (unintentionally) to a fraction  $1 - \gamma$  of myopic consumers. From the perspective of a myopic consumer, we interpret these fractions as the probabilities to get offered the high-priced add-on or the low-priced add-on, respectively.

7) Consider *expected* prices of myopic consumers for  $\alpha^\dagger < \alpha < \frac{e}{\bar{p}}$ . Without price discrimination (under a *low-priced add-on* equilibrium), consumers pay a total for the base good and the add-on of

$$-e + \mu + e = \mu. \quad (53)$$

With price discrimination consumers pay *expected* prices of

$$-e((1 - \alpha)\beta + \alpha(1 - \gamma)) - \bar{p}\gamma\alpha + \mu + \gamma\bar{p} + (1 - \gamma)e. \quad (54)$$

Thus, the net effect of price discrimination on prices of consumers is

$$-e((1 - \alpha)\beta + \alpha(1 - \gamma)) - \bar{p}\gamma\alpha + \gamma\bar{p} + (1 - \gamma)e. \quad (55)$$

According to the proposition, we need to show that the net effect is positive, i.e.,

$$-e((1 - \alpha)\beta + \alpha(1 - \gamma)) - \bar{p}\gamma\alpha + \gamma\bar{p} + (1 - \gamma)e > 0 \quad (56)$$

$$-e\beta + e\alpha\beta - e\alpha(1 - \gamma) - \bar{p}\gamma\alpha + \gamma\bar{p} + (1 - \gamma)e > 0 \quad (57)$$

$$-\alpha(-e\beta + e(1 - \gamma) + \bar{p}\gamma) > e\beta - \gamma\bar{p} - (1 - \gamma)e \quad (58)$$

$$-\alpha > \frac{e\beta - \gamma\bar{p} - (1 - \gamma)e}{-(e\beta - \gamma\bar{p} - (1 - \gamma)e)} \quad (59)$$

$$1 > \alpha \quad (60)$$

Thus, the inequality holds.<sup>13</sup>

8) Consider *expected* prices of myopic consumers for  $\frac{e}{\bar{p}} < \alpha < \alpha^\dagger$ . Without price discrimination (under a *high-priced add-on* equilibrium), consumers pay a total for the base good and the add-on of

$$-\alpha\bar{p} + \mu + \bar{p}. \quad (61)$$

With price discrimination consumers pay *expected* prices of

$$-e((1 - \alpha)\beta + \alpha(1 - \gamma)) - \bar{p}\gamma\alpha + \mu + \gamma\bar{p} + (1 - \gamma)e. \quad (62)$$

Thus, the net effect of price discrimination on prices of consumers is

$$-e((1 - \alpha)\beta + \alpha(1 - \gamma)) - \bar{p}\gamma\alpha + \gamma\bar{p} + (1 - \gamma)e - (1 - \alpha)\bar{p}. \quad (63)$$

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<sup>13</sup>Note that from  $\beta \leq (1 - \gamma)$  (see Corollary 1) we know that  $(-e\beta + e(1 - \gamma) + \bar{p}\gamma) > 0$ , such that dividing with this term does not reverse the direction of the inequality.

According to the proposition, we need to show that the net effect is negative, i.e.,

$$\begin{aligned}
-e((1-\alpha)\beta + \alpha(1-\gamma)) - \bar{p}\gamma\alpha + \gamma\bar{p} + (1-\gamma)e - (1-\alpha)\bar{p} &< 0 \\
-e\beta + e\alpha\beta - e\alpha(1-\gamma) - \bar{p}\gamma\alpha + \gamma\bar{p} + (1-\gamma)e - \bar{p} + \alpha\bar{p} &< 0 \\
\alpha(e\beta - e(1-\gamma) - \bar{p}\gamma + \bar{p}) &< e\beta - \gamma\bar{p} - (1-\gamma)e + \bar{p} \\
\alpha(e\beta - e(1-\gamma) + \bar{p}(1-\gamma)) &< e\beta + (1-\gamma)\bar{p} - (1-\gamma)e \\
\alpha(e\beta + (\bar{p} - e)(1-\gamma)) &< e\beta + (\bar{p} - e)(1-\gamma) \\
\alpha &< 1
\end{aligned}$$

Thus, the inequality holds.

*Q.E.D.*

#### A.4 Calculations and proofs for Section 3.3

**Proposition 5 (education and social welfare).** This proposition follows directly from the calculations of social welfare in Table 6. *Q.E.D.*

**Proposition 6 (education and expected prices).** Consider a situation when educating consumers through the regulator cannot change a high-priced add-on pricing equilibrium, i.e.,  $\alpha^\# < \alpha$ . Without education, the total price for the base good and the add-on that each uninformed consumer pays is

$$\begin{aligned}
p + \hat{p} &= -\alpha\bar{p} + \mu + \bar{p} \\
&= (1-\alpha)\bar{p} + \mu
\end{aligned}$$

Recall that a fraction  $\lambda_R$  of uninformed consumers becomes informed through education. This fraction is interpreted as ex-ante probability of an uninformed consumer to become informed. Thus, the total *expected* price that each uninformed consumer pays if the regulator decides

to educate consumers is

$$\begin{aligned}
E(p + \hat{p}) &= (1 - \lambda_R)(-(1 - \lambda_R)\alpha\bar{p} + \mu + \bar{p}) + \lambda_R(-(1 - \lambda_R)\alpha\bar{p} + \mu + e) \\
&= (1 - \lambda_R)\bar{p} + \lambda_R e - (1 - \lambda_R)\alpha\bar{p} + \mu \\
&= (1 - \lambda_R)(1 - \alpha)\bar{p} + \lambda_R e + \mu
\end{aligned}$$

It follows that educating consumers increases expected prices, if

$$\begin{aligned}
E(p + \hat{p}) &> p + \hat{p} \\
(1 - \lambda_R)(1 - \alpha)\bar{p} + \lambda_R e + \mu &> (1 - \alpha)\bar{p} + \mu \\
(-\lambda_R)(1 - \alpha)\bar{p} + \lambda_R e &> 0 \\
(-\lambda_R)(1 - \alpha)\bar{p} &> -\lambda_R e \\
(1 - \alpha)\bar{p} &< e \\
\bar{p} - \alpha\bar{p} &< e \\
\bar{p} - e &< \alpha\bar{p} \\
1 - \frac{e}{\bar{p}} &< \alpha
\end{aligned}$$

Considering the condition  $\alpha^\# < \alpha$  for a *high-priced add-on* pricing strategy, it follows that educating consumers increases expected prices if  $\alpha^\diamond = \max(1 - \frac{e}{\bar{p}}, \alpha^\#) < \alpha$ . *Q.E.D.*

## A.5 Calculations and proofs for Section 4.2

**Proposition 7 (offering of low-priced add-on for all consumers).** First, let us consider a *high-priced add-on* equilibrium. Market prices are  $p = -\alpha\bar{p} + \mu$  for the base good and  $\hat{p} = \bar{p}$  for the add-on. The public firm then offers the base good at the market price and the add-on at  $e$ . Consider that the regulator offers subsidies to all firms in order to maximize social welfare. Calculations therefore reflect a demand at the public firm of  $D(\cdot) = 1$ . The expected profit of the public firm per consumer is given by

$$\pi_h = (-\alpha\bar{p} + \mu + e)D(\cdot). \tag{64}$$

Relative to the firms' profits under a high-priced add-on strategy, i.e.,  $\mu$ , the profit is

$$\tilde{\pi}_h = (-\alpha\bar{p} + e)D(\cdot), \quad (65)$$

Recall that a *high-priced add-on* equilibrium exists only for  $\alpha > \max\left(\frac{e}{\bar{p}}, \frac{e\beta}{e\beta + (\bar{p} - e)(1 - \gamma)}\right)$ . Thus, as expected,  $\tilde{\pi}_h$  is below zero and represents a relative loss. We define the required subsidy to compensate firms who follow the suggested strategy as

$$S_h = -\tilde{\pi} = (\alpha\bar{p} - e)D(\cdot). \quad (66)$$

The benefit of uninformed consumers is that they each save an amount  $\bar{p} - e$ . Thus, total redistribution to uninformed consumers is  $(\bar{p} - e)\alpha D(\cdot)$ . Informed consumers have no benefit because they would pay  $p + e$ , i.e., the market price for the base good plus substitution costs  $e$ , anyway. Thus, the social welfare gain is the redistribution to uninformed consumers net substitution costs that need to be financed via taxes, i.e.,

$$G_h = (\bar{p} - e)\alpha D(\cdot) - (\alpha\bar{p} - e)D(\cdot) \quad (67)$$

$$= e(1 - \alpha)D(\cdot), \quad (68)$$

which, by construction, equals the prevented substitution costs of informed consumers. Finally, the efficiency of a subsidy is given by

$$E_h = \frac{S_h}{G_h} = \frac{\alpha\bar{p} - e}{e(1 - \alpha)}. \quad (69)$$

Note that  $E_h$  is increasing in  $\alpha$ , which is interpreted as the higher the worse. *Q.E.D.*

## A.6 Calculations and proofs for Section 4.3

**Proposition 8 (offering of low-priced add-ons for informed consumers).** First, let us consider a *high-priced add-on* equilibrium. Market prices are  $p = -\alpha\bar{p} + \mu$  for the base good and  $\hat{p} = \bar{p}$  for the add-on. The public firm then offers the base good above the equilibrium market price, i.e.,  $p + \Delta$ , and the add-on for  $\hat{e} - \Delta$ , where  $\hat{e} < e$ . Consider that the regulator

offers subsidies to all firms in order to maximize social welfare. Because the public firm will only have informed customers, the total demand at the public firms is  $D(\cdot) = 1 - \alpha$ , and the total demand at the private firms is  $1 - D(\cdot) = \alpha$ .

Because private firms only have uninformed consumers, the market price of the base good decreases from  $p = -\alpha\bar{p} + \mu$  to  $p = -\bar{p} + \mu$ . The expected profit of the public firm is given by

$$\pi_h = (-\bar{p} + \mu + \Delta + \hat{e} - \Delta)D(\cdot). \quad (70)$$

Relative to the firms' profits under a high-priced add-on strategy, i.e.,  $\mu$ , the profit is

$$\tilde{\pi}_h = (-\bar{p} + \hat{e})D(\cdot), \quad (71)$$

Recall that a *high-priced add-on* equilibrium exists only for  $\alpha > \max\left(\frac{e}{\bar{p}}, \frac{e\beta}{e\beta + (\bar{p} - e)(1 - \gamma)}\right)$ . Thus, as expected,  $\tilde{\pi}_h$  is below zero and represents a relative loss. We define the required subsidy to compensate firms who follow the suggested strategy as

$$\begin{aligned} S_h &= -\tilde{\pi}_h = (\bar{p} - \hat{e})D(\cdot) \\ &= (\bar{p} - \hat{e})(1 - \alpha). \end{aligned} \quad (72)$$

Note that the expected profit of private firms is unchanged. They yield

$$\begin{aligned} \pi &= (-\bar{p} + \mu + \bar{p})D(\cdot) \\ &= \mu D(\cdot). \end{aligned} \quad (73)$$

The benefit of uninformed consumers is that they each save an amount  $(1 - \alpha)\bar{p}$  because of the lower price of the base good. The benefit of informed consumers is twofold: first,  $(1 - \alpha)\bar{p}(1 - \alpha)$  because they get the base good at a lower price, and second,  $(e - \hat{e})(1 - \alpha)$  because they get the add-on below their substitution costs. The resulting social welfare gain is the redistribution to uninformed and informed consumers net substitution costs that need

to be financed via taxes, i.e.,

$$\begin{aligned}
G_h &= (1 - \alpha)\bar{p}(1 - D(\cdot)) + ((1 - \alpha)\bar{p} + (e - \hat{e}))D(\cdot) - (\bar{p} - \hat{e})D(\cdot) \\
&= (1 - \alpha)\bar{p}\alpha + ((1 - \alpha)\bar{p} + (e - \hat{e}))(1 - \alpha) - (\bar{p} - \hat{e})(1 - \alpha) \\
&= e(1 - \alpha),
\end{aligned} \tag{74}$$

which, by construction, equals the prevented substitution costs of informed consumers. Finally, the efficiency of a subsidy is given by

$$E_h = \frac{S_h}{G_h} = \frac{\bar{p} - e}{e}. \tag{75}$$

Note that  $E_h$  is constant in  $\alpha$ .

*Q.E.D.*

## A.7 Calculations and proofs for Section 4.5

**Proposition 9 (subsidizing firms).** Under a *high-priced add-on* equilibrium, subsidizing firms that offer low-priced add-ons *to all consumers* requires subsidies of  $\alpha\bar{p} - e$  to reach a net social welfare gain of  $e(1 - \alpha)$ , as shown in Proposition 7. Subsidizing firms that offer low-priced add-ons *only to informed consumers* requires subsidies of  $(\bar{p} - \hat{e})(1 - \alpha)$  for the same net social welfare gain, as shown in Proposition 8. Thus, the former strategy requires lower subsidies, if

$$\alpha\bar{p} - e < (\bar{p} - \hat{e})(1 - \alpha) \tag{76}$$

$$\alpha\bar{p} - e < \bar{p} - \bar{p}\alpha - \hat{e} + \hat{e}\alpha \tag{77}$$

$$\alpha\bar{p} - \hat{e}\alpha + \bar{p}\alpha < \bar{p} - \hat{e} + e \tag{78}$$

$$\alpha < \frac{\bar{p} - \hat{e} + e}{\bar{p} - \hat{e} + \bar{p}}. \tag{79}$$

*Q.E.D.*

## B Appendix: Figures

Figure 1: Price discrimination

This figure shows effects of price discrimination on consumers without regulatory intervention. The fractions of informed and uninformed consumers (pre cannibalization) are  $1 - \alpha$  (sophisticated consumers) and  $\alpha$  (myopic consumers), respectively. The *attrition effect* reflects that the firm will unintentionally *shroud* (not advertise) the low-priced add-on towards a fraction  $1 - \beta$  of informed consumers who consequently substitute away. The *cannibalization effect* reflects that the firm will unintentionally *unshroud* (advertise) the low-priced add-on towards a fraction  $1 - \gamma$  of myopic consumers, who consequently buy the low-priced add-on instead of the high-priced add-on. Note that a fraction  $\lambda$  of these consumers then becomes informed and a fraction  $1 - \lambda$  stays uninformed. This is, however, not relevant because these consumers all buy the low-priced add-on they get offered anyway.

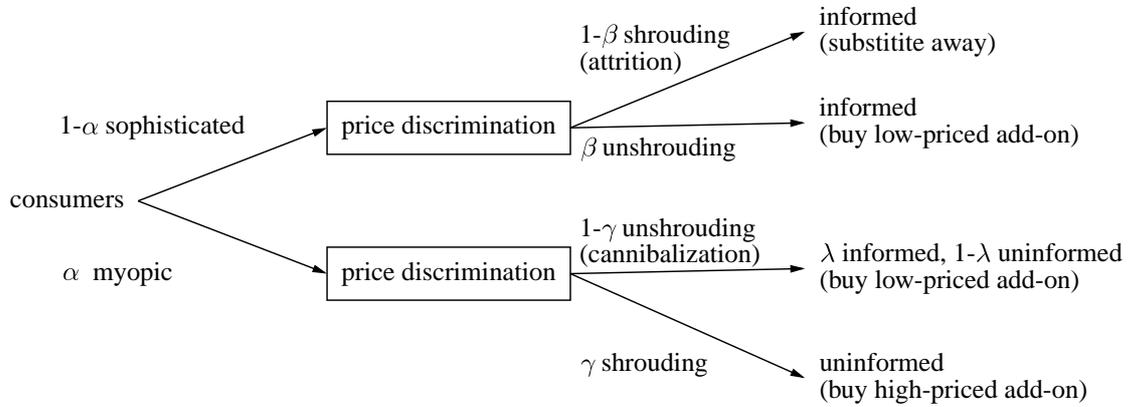


Figure 2: Threshold level for  $\alpha$  without regulatory intervention

The firm chooses a *low-priced add-on* strategy if  $\alpha < \alpha^\dagger$ , a *price discrimination* strategy if  $\alpha^\dagger < \alpha < \alpha^\ddagger$ , and a *high-priced add-on* strategy if  $\alpha^\ddagger < \alpha$ . The figure illustrates a case where price discrimination is efficient ( $\beta > 1 - \gamma$ ).

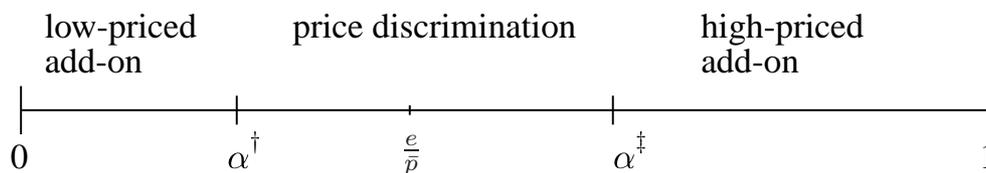


Figure 3: Threshold level for  $\alpha$  with regulatory intervention

Regulatory intervention change the threshold level by  $\frac{1}{1-\lambda}$  compared with the base case without regulatory intervention. The threshold level that determine the optimal pricing strategy of a firm are defined as  $\alpha^\S = \frac{1}{1-\lambda}\alpha^\dagger$  and  $\alpha^\# = \frac{1}{1-\lambda}\alpha^\ddagger$ . The firm chooses a *low-priced add-on* strategy if  $\alpha < \alpha^\S$ , a *price discrimination* strategy if  $\alpha^\S < \alpha < \alpha^\#$ , and a *high-priced add-on* strategy if  $\alpha^\# < \alpha$ . The figure illustrates a case where price discrimination is efficient ( $\beta > 1 - \gamma$ ).

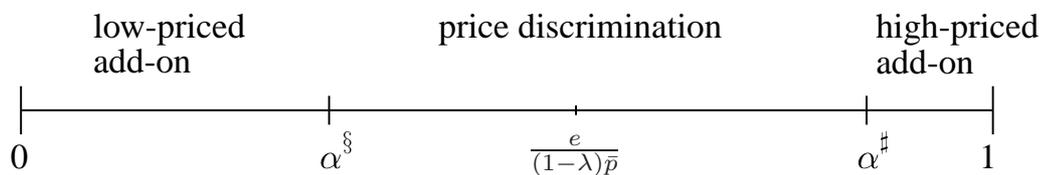


Figure 4: price discrimination and social welfare

The figure illustrates *social welfare loss* for varying  $\alpha$  with price discrimination and with uniform pricing. Suppose price discrimination is not fully efficient ( $\beta = 0.7$  and  $\gamma = 0.7$ ),  $\bar{p} = 1$  and  $e = 0.3$ .

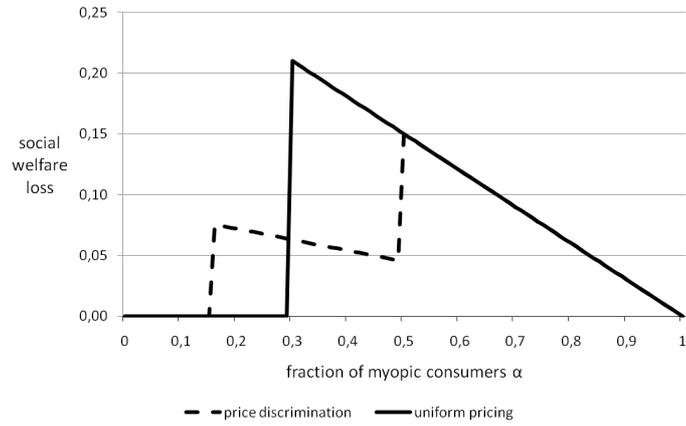


Figure 5: price discrimination and prices

Suppose price discrimination is not fully efficient ( $\beta = 0.7$  and  $\gamma = 0.7$ ),  $\bar{p} = 1$  and  $e = 0.3$ .

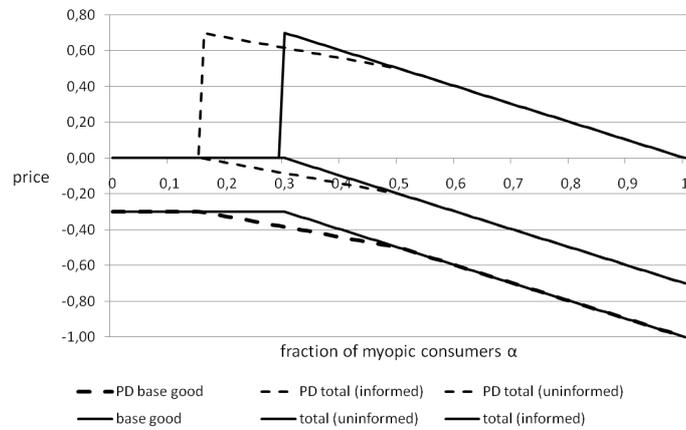


Figure 6: education and social welfare loss (with price discrimination)

The figure illustrates the *social welfare loss* for varying  $\alpha$ , with and without education. Suppose educating consumers makes 30% of myopic consumers informed.

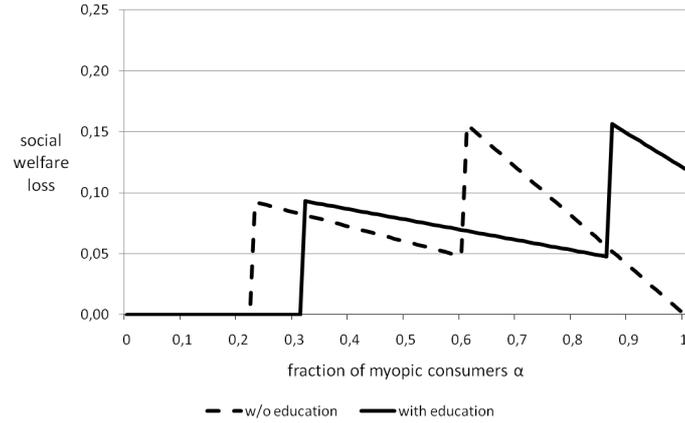
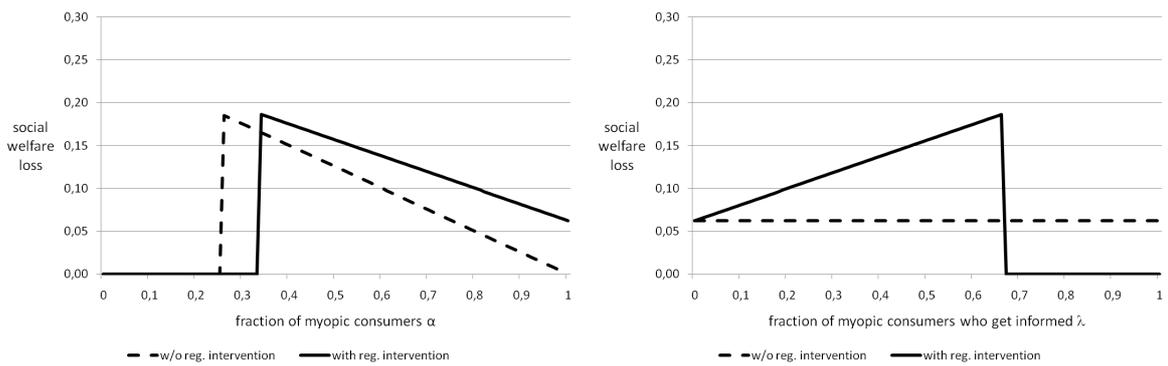


Figure 7: education and social welfare loss (price discrimination not efficient)

Let  $e = 0.25$ , and  $\bar{p} = 1$ . The social welfare loss without regulatory intervention is shown as dotted line, and the social welfare loss with regulatory intervention is shown as solid line.

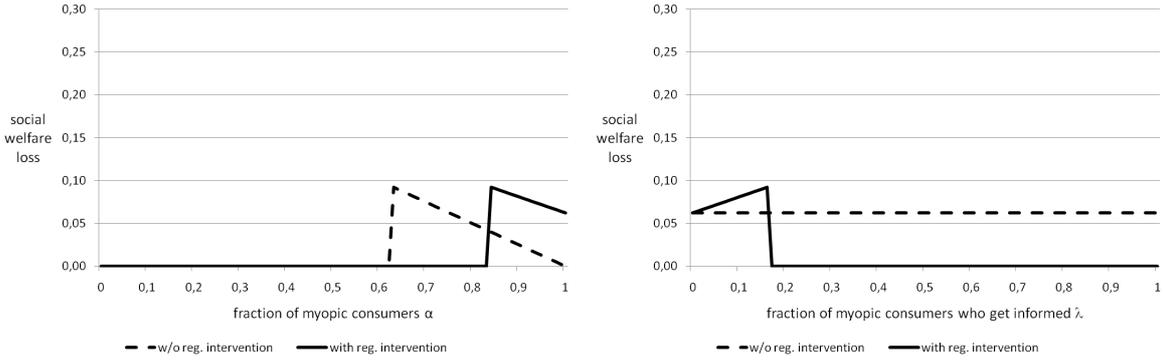


(a) varying  $\alpha$  and  $\lambda = 0.25$ : Without regulatory intervention, a social welfare loss comes from a shrouded price equilibrium for  $\alpha > 0.25$ . With regulatory intervention, a social welfare loss comes from a shrouded price equilibrium for  $\alpha > 0.33$ .

(b) varying  $\lambda$  and  $\alpha = 0.75$ :

Figure 8: education and social welfare loss (price discrimination w/o attrition)

Let  $\beta = 1$ ,  $\gamma = 0.2$ ,  $e = 0.25$ , and  $\bar{p} = 1$ . The social welfare loss without regulatory intervention is shown as dotted line. The social welfare loss is shown as solid line.



(a) varying  $\alpha$  and  $\lambda = 0.25$ : Without regulatory intervention, a social welfare loss comes from a shrouded price equilibrium with uniform pricing for  $\alpha > 0.625$ . With regulatory intervention, a social welfare loss comes from a shrouded price equilibrium with uniform pricing for  $\alpha > 0.833$ .

(b) varying  $\lambda$  and  $\alpha = 0.75$ :

Figure 9: education and prices

Suppose educating consumers makes 30% of myopic consumers informed.

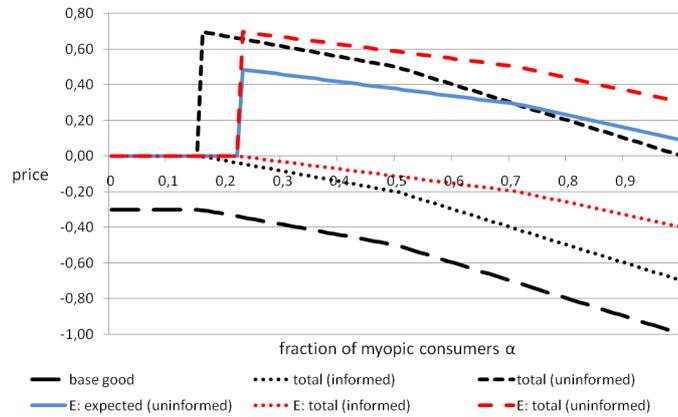


Figure 10: pitfalls of the regulator

Suppose the regulator observes *high-priced add-ons*, and estimates a fraction of myopic consumers  $\alpha = 0.6$ . Furthermore, the regulator estimates that educating consumers makes a fraction  $\lambda = 0.3$  informed. However, the regulator can only observe the status quo and does not know whether a technology for price discrimination is available to firms. Thus, a situation as shown in Figure a) may be relevant where educating consumers decreases social welfare, or a situation as shown in Figure b) where educating consumers increases social welfare.

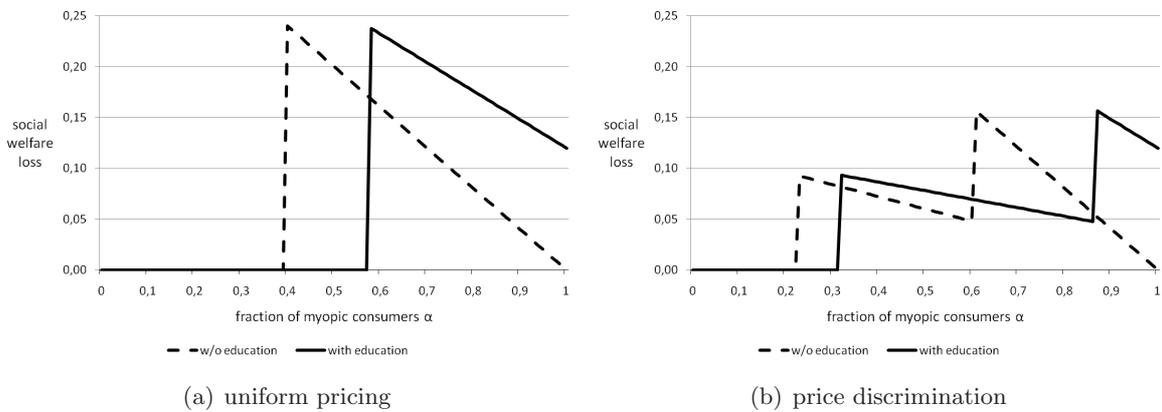
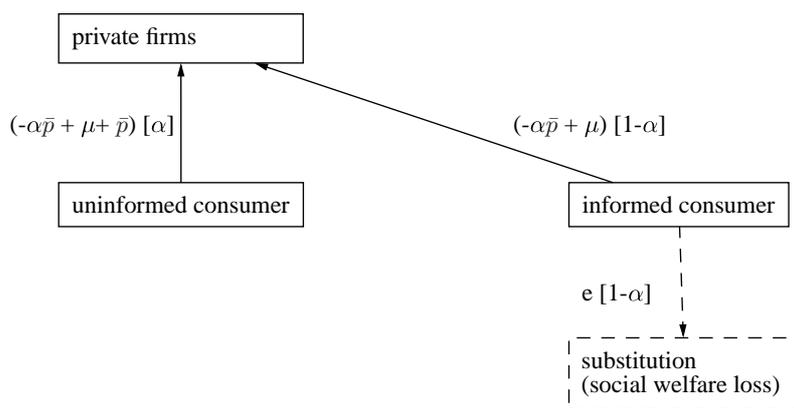


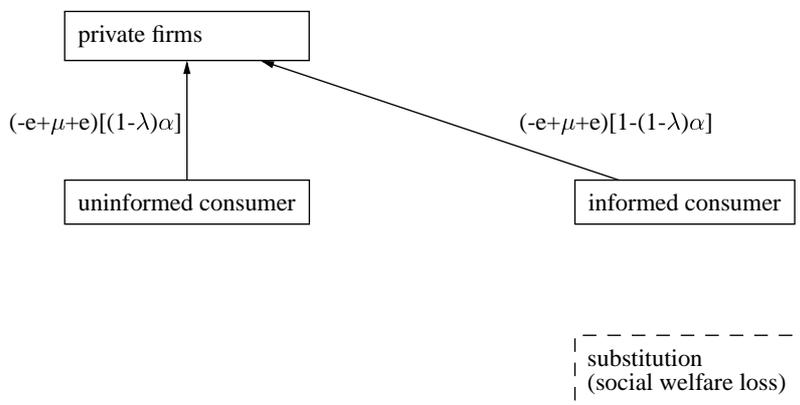
Figure 11: Cash flows under alternative price equilibria

The figure illustrates the cash flows under alternative price equilibria that depend on the fraction of myopic consumers  $\alpha$ . Note that under all alternatives, the total profit of private firms is  $\mu$ . Consumers always consume the base good and the add-on (or alternatively the substitution good). If some consumers substitute away at costs  $e$ , this leads to higher prices of the base good which harms all consumers. For example, substitution costs (high-priced add-on) = total prices of all consumers (high-priced add-on) - total prices of all consumers (low-priced add-on) = social welfare loss.

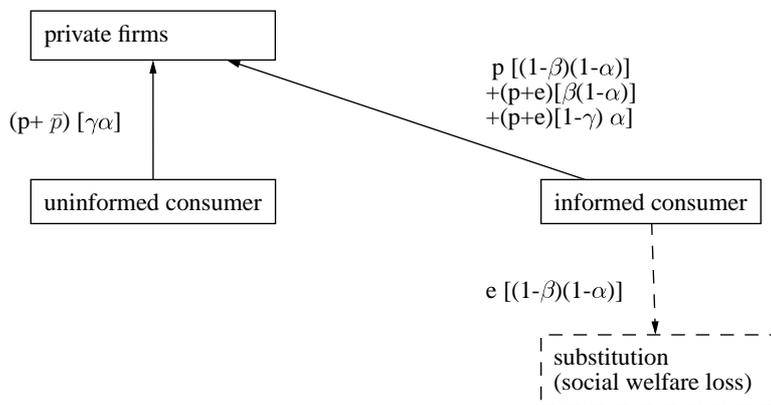
Note that, for clarity, each term in the figure begins with the economic effect on an affected consumer, and ends with the fraction of affected consumers in square brackets.



(a) high-priced add-on ( $\alpha^\ddagger < \alpha$ ) where  $p = -\alpha\bar{p} + \mu$



(b) low-priced add-on ( $\alpha < \alpha^\ddagger$ ) where  $p = -e + \mu$



(c) PD ( $\alpha^\dagger < \alpha < \alpha^\ddagger$ ) where  $p = \frac{\mu}{\beta}((1-\alpha)\beta + \alpha(1-\gamma)) - \bar{p}\gamma\alpha + \mu$

Figure 12: Offering of low-priced add-ons to all consumers under a *high-priced add-on* equilibrium

The figure shows cash flows relative to a *high-priced add-on* equilibrium without a public firm. A “public firm” represents a firm that accepts to follow a certain (loss-making) pricing strategy suggested by the regulator, and in turn receives a subsidy from the regulator. Suppose that the suggested strategy is to offer the base good for the equilibrium market price, i.e.,  $p = -\alpha\bar{p} + \mu$ , and the add-on for  $e$ . The total volume of potential subsidies is such that all firms can participate. The suggested pricing strategy has two consequences for firms: First, they make an additional profit of  $e[1 - \alpha]$  with all informed consumers who otherwise substitute away in a *high-priced add-on* equilibrium. Second, the firms’ profits with uninformed consumers decline by  $(\bar{p} - e)[\alpha]$ . In sum, this pricing strategy is loss-making for firms. Thus, a subsidy needs to balance out the net effect on firms of  $\alpha\bar{p} - e$ , otherwise firms would not accept the suggested pricing strategy. This subsidy, of course, needs to be financed by consumer through taxes. It follows that the net effect on all consumers is  $(\bar{p} - e)\alpha - \alpha\bar{p} - e = e(1 - \alpha)$  which, by construction, equates to the prevented substitution costs of informed consumers.

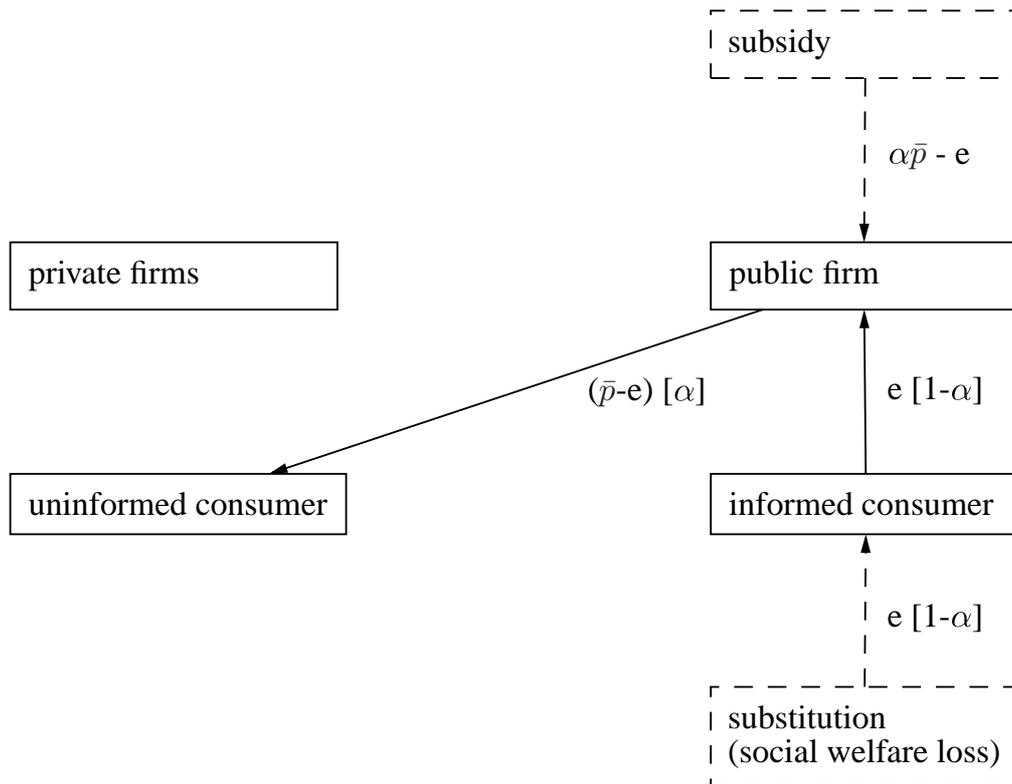


Figure 13: Offering of low-priced add-ons only to informed consumers under a *high-priced add-on* equilibrium

The figure shows cash flows relative to a *high-priced add-on* equilibrium without a public firm. A “public firm” represents a firm that accepts to follow a certain (loss-making) pricing strategy suggested by the regulator, and in turn receives a subsidy from the regulator. Suppose that the suggested strategy is to offer the base good above the equilibrium market price, i.e.,  $p + \Delta$ , and the add-on for  $\hat{e} - \Delta$ , where  $\hat{e} < e$ . The total volume of potential subsidies is such that firms who represent  $1 - \alpha$  of the market can participate.

Then, all informed consumers who otherwise would buy at private firms migrate to the public firm, and all uninformed consumers who otherwise buy at the public firm migrate to the private firms. Equilibrium market prices for the base good decrease from  $-\alpha\bar{p} + \mu$  to  $-\bar{p} + \mu$ . Therefore, existing uninformed consumers at private firms, i.e., a fraction  $\alpha\alpha$  of all consumers, and existing informed consumers at public firms, i.e., a fraction  $(1 - \alpha)(1 - \alpha)$  of all consumers, gain  $(1 - \alpha)\bar{p}$ .

Furthermore, existing informed consumers at public firms buy the add-on at the public firm for  $\hat{e}$  and do not substitute away. Uninformed consumer who migrate to private firms decrease profits at public firms by  $(-\alpha\bar{p} + \mu + \bar{p})[\alpha(1 - \alpha)]$  and increase profits at private firms by  $(-\bar{p} + \mu + \bar{p})[\alpha(1 - \alpha)]$ . Informed consumer who migrate to public firms decrease profits at private firms by  $(-\alpha\bar{p} + \mu)[(1 - \alpha)\alpha]$  and increase profits at public firms by  $(-\bar{p} + \mu + \hat{e})[(1 - \alpha)\alpha]$ . The new informed consumers at the public firm do not substitute away. In total, substitution costs for existing and new informed consumers decrease by  $e[1 - \alpha]$ .

In sum, there are no effects on profits of private firms, but negative effects on profits of public firms. Thus, a subsidy of  $(\bar{p} - \hat{e})[1 - \alpha]$  needs to balance out the net effects on public firms, otherwise firms would not accept the suggested pricing strategy. This subsidy, of course, needs to be financed by consumer through taxes. The net effect on uninformed consumers (excluding taxes) is a gain of  $(1 - \alpha)\bar{p}[\alpha]$ . The net effect on informed consumers (excluding taxes) is a gain of  $((1 - \alpha)\bar{p} + (e - \hat{e}))[1 - \alpha]$ . It follows that the net effect on all consumers including taxes is  $(1 - \alpha)\bar{p}[\alpha] + ((1 - \alpha)\bar{p} + (e - \hat{e}))[1 - \alpha] - (\bar{p} - \hat{e})[1 - \alpha] = e[1 - \alpha]$  which, by construction, equates to the prevented substitution costs of informed consumers.

Note that, for clarity, each term in the figure begins with the economic effect on an affected consumer, and ends with the fraction of affected consumers in square brackets.

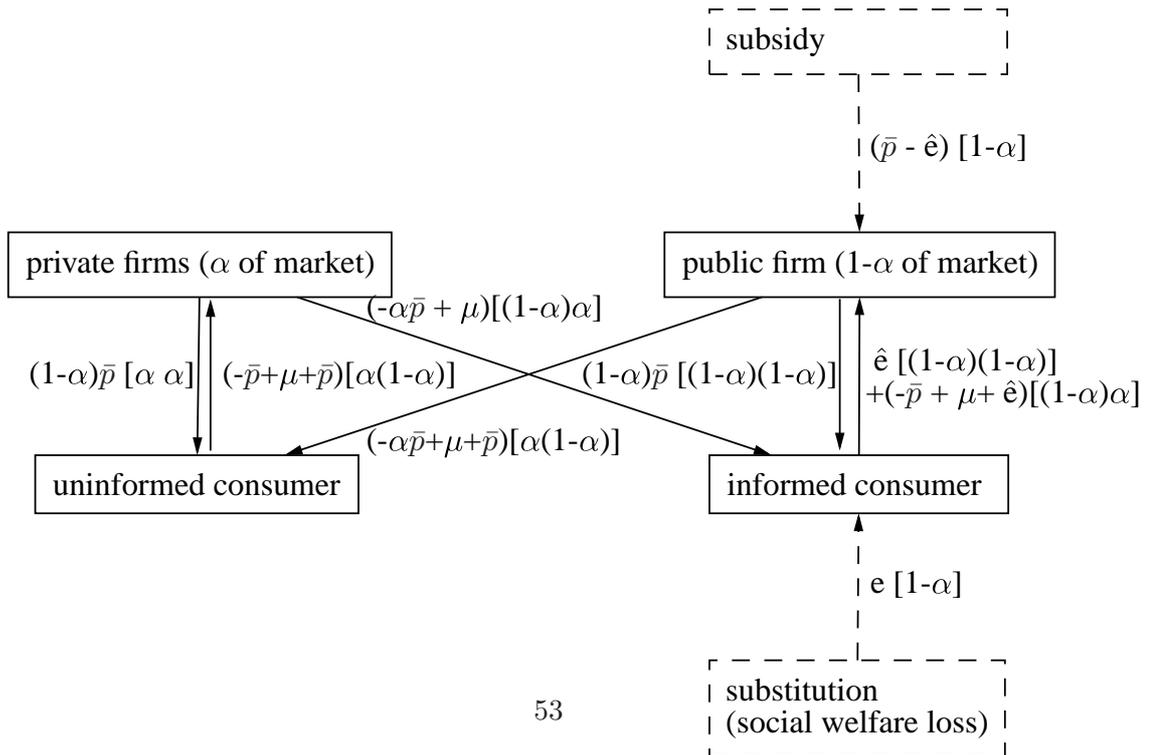
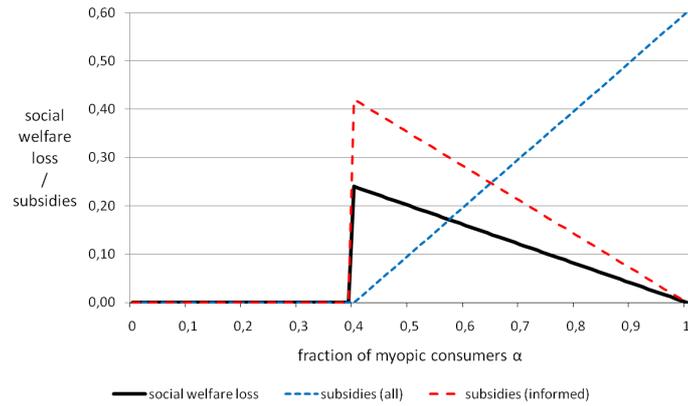


Figure 14: Required subsidies under alternative regulatory strategies

The Figure illustrates a situation without education where price discrimination is not attractive ( $\bar{p} = 1, e = 0.3, \hat{e} = 0.3, \beta = 0$ ). Both alternative regulatory strategies, offering low-priced add-ons to *all* consumers or offering low-priced add-ons only to *informed* consumers, yield a net social welfare gain of  $e[1 - \alpha]$ . Thus, the regulator will choose the strategy that requires the least subsidies (taxes). For this numerical example, the optimal strategy is offering low-priced add-ons to *all* consumers for  $0.4 < \alpha < 0.65$  and offering low-priced add-ons only to *informed* consumers for  $0.65 < \alpha$ .



## C Appendix: Tables

Cells without any shading represent a *low-priced add-on* equilibrium. Cells with a light grey shading represent a *price discrimination* equilibrium. Cells with a dark grey shading represent a *high-priced add-on* equilibrium. The thresholds ( $\alpha^\dagger$ ,  $\alpha^\ddagger$ ,  $\alpha^\S$  and  $\alpha^\#$ ) are defined in Proposition 1 and Proposition 2.

Table 1: Social welfare loss and price discrimination (w/o education)

Social welfare loss comes from informed consumers who substitute away at costs  $e$  if the firm does not offer them the add-on for a price of at most  $e$ . The first row shows the social welfare loss without price discrimination, the second row shows the social welfare loss with price discrimination, the third row shows the resulting net effect of price discrimination (second row minus first row), and the fourth row shows the sign of the net effect.

$\alpha < \alpha^\dagger$	$\alpha^\dagger < \alpha < \frac{e}{\bar{p}}$	$\frac{e}{\bar{p}} < \alpha < \alpha^\ddagger$	$\alpha^\ddagger < \alpha$
0	0	$(1 - \alpha)e$	$(1 - \alpha)e$
0	$(1 - \beta)(1 - \alpha)e$	$(1 - \beta)(1 - \alpha)e$	$(1 - \alpha)e$
0	$(1 - \beta)(1 - \alpha)e$	$-\beta(1 - \alpha)e$	0
	(+)	(-)	

Table 2: Prices for sophisticated consumers and price discrimination

The table shows prices for the base good plus the add-on under alternative price equilibria for sophisticated consumers. The first row shows prices without price discrimination, the second row shows prices with price discrimination, the third row shows the resulting net effect of price discrimination (second row minus first row), and the fourth row shows the sign of the net effect.

$\alpha < \alpha^\dagger$	$\alpha^\dagger < \alpha < \frac{e}{\bar{p}}$	$\frac{e}{\bar{p}} < \alpha < \alpha^\ddagger$	$\alpha^\ddagger < \alpha$
$-e + \mu + e = \mu$	$-e + \mu + e = \mu$	$-\alpha\bar{p} + \mu + e$	$-\alpha\bar{p} + \mu + e$
$-e + \mu + e = \mu$	$-e((1 - \alpha)\beta + \alpha(1 - \gamma))$ $-\bar{p}\gamma\alpha + \mu + e$	$-e((1 - \alpha)\beta + \alpha(1 - \gamma))$ $-\bar{p}\gamma\alpha + \mu + e$	$-\alpha\bar{p} + \mu + e$
0	$-e((1 - \alpha)\beta + \alpha(1 - \gamma))$ $-\bar{p}\gamma\alpha + e$	$-e((1 - \alpha)\beta + \alpha(1 - \gamma))$ $-\bar{p}\gamma\alpha + \alpha\bar{p}$	0
	(-)	(-)	

Table 3: Prices for myopic consumers and price discrimination with low-priced add-ons  
The table shows total prices for the base good plus the add-on under alternative price equilibria for myopic consumers. Here, the myopic consumers (unintentionally) get offered the low-priced add-ons in the *price discrimination* equilibrium, reflecting what we call *cannibalization*. The first row shows prices without price discrimination, the second row shows prices with price discrimination, the third row shows the resulting net effect of price discrimination (second row minus first row), and the fourth row shows the sign of the net effect.

$\alpha < \alpha^\dagger$	$\alpha^\dagger < \alpha < \frac{e}{\bar{p}}$	$\frac{e}{\bar{p}} < \alpha < \alpha^\dagger$	$\alpha^\dagger < \alpha$
$-e + \mu + e = \mu$	$-e + \mu + e = \mu$	$-\alpha\bar{p} + \mu + \bar{p}$	$-\alpha\bar{p} + \mu + \bar{p}$
$-e + \mu + e = \mu$	$-e((1 - \alpha)\beta + \alpha(1 - \gamma))$ $-\bar{p}\gamma\alpha + \mu + e$	$-e((1 - \alpha)\beta + \alpha(1 - \gamma))$ $-\bar{p}\gamma\alpha + \mu + e$	$-\alpha\bar{p} + \mu + \bar{p}$
0	$-e((1 - \alpha)\beta + \alpha(1 - \gamma))$ $-\bar{p}\gamma\alpha + e$	$-e((1 - \alpha)\beta + \alpha(1 - \gamma))$ $-\bar{p}\gamma\alpha + e - (1 - \alpha)\bar{p}$	0
	(-)	(-)	

Table 4: Prices for myopic consumers and price discrimination with high-priced add-ons  
The table shows prices for the base good plus the add-on under alternative price equilibria for myopic consumers. Here, the myopic consumers get offered the high-priced add-ons in the *price discrimination* equilibrium. The first row shows prices without price discrimination, the second row shows prices with price discrimination, the third row shows the resulting net effect of price discrimination (second row minus first row), and the fourth row shows the sign of the net effect.

$\alpha < \alpha^\dagger$	$\alpha^\dagger < \alpha < \frac{e}{\bar{p}}$	$\frac{e}{\bar{p}} < \alpha < \alpha^\dagger$	$\alpha^\dagger < \alpha$
$-e + \mu + e = \mu$	$-e + \mu + e = \mu$	$-\alpha\bar{p} + \mu + \bar{p}$	$-\alpha\bar{p} + \mu + \bar{p}$
$-e + \mu + e = \mu$	$-e((1 - \alpha)\beta + \alpha(1 - \gamma))$ $-\bar{p}\gamma\alpha + \mu + \bar{p}$	$-e((1 - \alpha)\beta + \alpha(1 - \gamma))$ $-\bar{p}\gamma\alpha + \mu + \bar{p}$	$-\alpha\bar{p} + \mu + \bar{p}$
0	$-e((1 - \alpha)\beta + \alpha(1 - \gamma))$ $-\bar{p}\gamma\alpha + \bar{p}$	$-e((1 - \alpha)\beta + \alpha(1 - \gamma))$ $-\bar{p}\gamma\alpha + \alpha\bar{p}$	0
	(+)	(-)	

Table 5: Expected prices for myopic consumers and price discrimination  
The table shows *expected* prices for the base good plus the add-on under alternative price equilibria for myopic consumers. Recall that the *cannibalization* effect of price discrimination implies that firms offer the high-priced add-on to a fraction  $\gamma$  of myopic consumers, and the low-priced add-on (unintentionally) to a fraction  $1 - \gamma$  of myopic consumers. From the perspective of a myopic consumer, we interpret these fraction as the probabilities to get offered the high-priced add-on or the low-priced add-on, respectively. The first row shows prices without price discrimination, the second row shows expected prices with price discrimination, the third row shows the resulting net effect of price discrimination (second row minus first row), and the fourth row shows the sign of the net effect.

$\alpha < \alpha^\dagger$	$\alpha^\dagger < \alpha < \frac{e}{\bar{p}}$	$\frac{e}{\bar{p}} < \alpha < \alpha^\dagger$	$\alpha^\dagger < \alpha$
$-e + \mu + e = \mu$	$-e + \mu + e = \mu$	$-\alpha\bar{p} + \mu + \bar{p}$	$-\alpha\bar{p} + \mu + \bar{p}$
$-e + \mu + e = \mu$	$-e((1 - \alpha)\beta + \alpha(1 - \gamma))$ $-\bar{p}\gamma\alpha + \mu + \gamma\bar{p} + (1 - \gamma)e$	$-e((1 - \alpha)\beta + \alpha(1 - \gamma))$ $-\bar{p}\gamma\alpha + \mu + \gamma\bar{p} + (1 - \gamma)e$	$-\alpha\bar{p} + \mu + \bar{p}$
0	$-e((1 - \alpha)\beta + \alpha(1 - \gamma))$ $-\bar{p}\gamma\alpha + \gamma\bar{p} + (1 - \gamma)e$	$-e((1 - \alpha)\beta + \alpha(1 - \gamma))$ $-\bar{p}\gamma\alpha + \gamma\bar{p} + (1 - \gamma)e - (1 - \alpha)\bar{p}$	0
	(+)	(-)	

Table 6: Social welfare loss and education

Social welfare loss comes from informed consumers who substitute away at costs  $e$  if the firm does not offer them the add-on for a price of at most  $e$ . The first row shows the social welfare loss without education, the second row shows the social welfare loss with education, the third row shows the resulting net effect of education (second row minus first row), and the fourth row shows the sign of the net effect.

$\alpha < \alpha^\dagger$	$\alpha^\dagger < \alpha < \alpha^\S$	$\alpha^\S < \alpha < \alpha^\ddagger$	$\alpha^\ddagger < \alpha < \alpha^\#$	$\alpha^\# < \alpha$
0	$(1 - \beta)(1 - \alpha)e$	$(1 - \beta)(1 - \alpha)e$	$(1 - \alpha)e$	$(1 - \alpha)e$
0	0	$(1 - \beta)(1 - (1 - \lambda_R)\alpha)e$	$(1 - \beta)(1 - (1 - \lambda_R)\alpha)e$	$(1 - (1 - \lambda_R)\alpha)e$
0	$-(1 - \beta)(1 - \alpha)e$	$(1 - \beta)\lambda_R\alpha e$	$-(\beta(1 - \alpha) - (1 - \beta)\lambda_R\alpha)e$	$\lambda_R\alpha e$
	(-)	(+)	(-)	(+)

Table 7: Fraction of exploited consumers

The first row shows the social welfare loss without education, the second row shows the social welfare loss with education, the third row shows the resulting net effect of education, and the fourth row shows the sign of the net effect.

$\alpha < \alpha^\dagger$	$\alpha^\dagger < \alpha < \alpha^\S$	$\alpha^\S < \alpha < \alpha^\ddagger$	$\alpha^\ddagger < \alpha < \alpha^\#$	$\alpha^\# < \alpha$
0	$(1 - \gamma)\alpha$	$(1 - \gamma)\alpha$	$\alpha$	$\alpha$
0	0	$(1 - \gamma)(1 - \lambda)\alpha$	$(1 - \gamma)(1 - \lambda)\alpha$	$(1 - \lambda)\alpha$
0	$-(1 - \gamma)\alpha$	$-(1 - \gamma)\lambda\alpha$	$-(\lambda + \gamma - \lambda\gamma)$	$-\lambda\alpha$
	(-)	(-)	(-)	(-)