

Karle, Heiko; Schumacher, Heiner; Vølund, Rune

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## Consumer Loss Aversion and Scale-Dependent Psycho- logical Switching Costs

*Heiko Karle, Heiner Schumacher, Rune Vølund*

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Telephone +49 (0)89 2180-2740, Telefax +49 (0)89 2180-17845, email [office@cesifo.de](mailto:office@cesifo.de)

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# Consumer Loss Aversion and Scale-Dependent Psychological Switching Costs

## Abstract

We consider the Salop (1979) model of product differentiation and assume that consumers are uncertain about the qualities and prices of firms' products. They can inspect all products at zero cost. A share of consumers is expectation-based loss averse. For these consumers, a purchase plan, which involves buying products of varying quality and price with positive probability, creates disutility from gain-loss sensations. Even at modest degrees of loss aversion they may refrain from inspecting all products and choose an individual default that is strictly dominated in terms of surplus. Firms' strategic behavior exacerbates the scope for this effect. The model generates "scale-dependent psychological switching costs" that increase in the value of the transaction. We find empirical evidence for the predicted association between switching behavior and loss aversion in new survey data.

JEL-Codes: D210, D830, L410.

Keywords: switching costs, competition, loss aversion.

*Heiko Karle*  
*Frankfurt School of Finance and Management*  
*Department of Economics*  
*Adickesallee 32-34*  
*Germany – 60322 Frankfurt am Main*  
*h.karle@fs.de*

*Heiner Schumacher\**  
*KU Leuven*  
*Naamsestraat 69*  
*Belgium – 3000 Leuven*  
*heiner.schumacher@kuleuven.be*

*Rune Vølund*  
*Aarhus University*  
*Department of Economics*  
*Fuglesangs Allé 4*  
*Denmark – 8210 Aarhus V*  
*vension@hotmail.com*

\*corresponding author

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# 1 Introduction

For many markets, there is mounting evidence that a large fraction of consumers chooses inferior products or does not switch to options that dominate the individual default. Prominent examples include markets for supplementary health insurance (e.g., Ho et al. 2017, Heiss et al. 2021), electricity (Hortaçsu et al. 2017), and communication services (e.g., Lambrecht and Skiera 2006, Genakos et al. 2019). In these examples, many consumers seem to be inattentive to their options and leave substantial amounts of surplus on the table. Firms may exploit this behavior by increasing markups or selling inferior products, thereby reducing total welfare. Consumer behavior is therefore a major concern for market regulation and public policy.

To explain the consumers' failure to choose optimally, economists often invoke informational constraints, search or switching costs. Informational constraints occur, for example, when the offered contracts are so complex that many consumers struggle to identify the one that best fits their needs. Search costs are the time and hassle costs of identifying a product or service to purchase; switching costs capture time and hassle costs of switching from a given default to another product.<sup>1</sup> However, none of these explanations can fully explain consumers' inattention. In Figure 1, we provide an overview of empirical estimates of search and switching costs in various markets.<sup>2</sup> On the  $x$ -axis, we display the average price of the transaction; on the  $y$ -axis, we show the estimated search costs (per item) or switching costs. Importantly, in all shown cases, search and switching can be done online, and in the case of complex products, such as health plans, there exists a well-known online comparison tool that suggests the best option based on self-reported attributes. Thus, in all cited settings, the time, hassle, and cognitive effort required to find the best (or a very reasonable) option should be rather small.

We observe two regularities from Figure 1. First, even in simple settings, search and switching costs can be quite high. For example, Hortaçsu et al. (2017) report that by investing 15 minutes into switching to a cheaper provider, consumers could reduce the average annual electricity bill by 100 USD. For comparison, the average hourly wage in the US in 2019 was around 23 USD. Second, search and switching costs seem to increase in the size of the transaction. For books of 20 USD, search costs are around 2 USD per item (e.g., Hong and Shum 2006). In contrast, for mobile phone contracts of 390 USD value Genakos et al. (2019) find switching costs of around 240 USD, even though, in their setting, customers self-subscribed to receive personalized information about more beneficial contracts, and switching can be done quickly. These "scale-dependent" costs are driven by a large fraction of consumers who do not

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<sup>1</sup>Throughout the paper, we treat search and switching costs as very similar objects and do not differentiate between them. For convenience, we will mostly refer to switching costs in the main part of the paper.

<sup>2</sup>These estimates are based on various search/switching cost models and different types of data. In Table A1 in the appendix, we provide an overview of the cited studies.

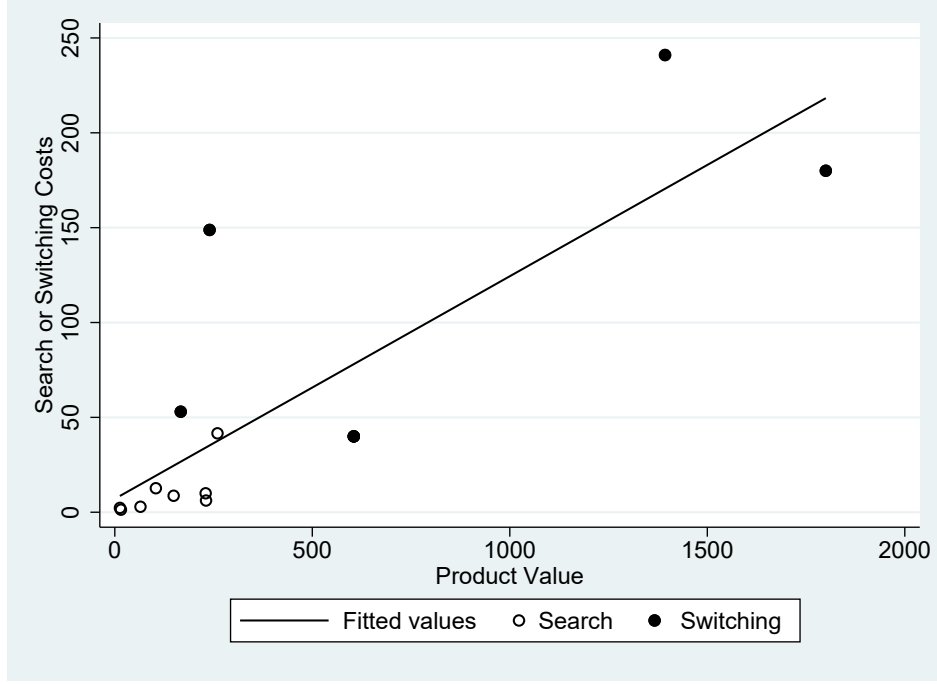


Figure 1: Overview of empirical estimates of search and switching costs (in USD)

search or switch at all; they seem to be inattentive to their choice set. Yet, this inattention is difficult to reconcile with time and hassle costs when search and switching requires only little effort from consumers.

Our goal in this paper is to provide an explanation for seemingly inattentive behavior in markets where consumers can benefit from active choice. The proposed mechanism produces “scale-dependent psychological switching costs.” It is consistent with quantitatively reasonable consumer preferences and rational expectations, and it is also compatible with inattentive behavior in other domains like financial decision making (e.g., Pagel 2018). We demonstrate that consumers’ response to scale-dependent switching costs can lead to relaxed competition between firms. Moreover, we derive new predictions that differ from those generated by inattention. Finally, we provide suggestive evidence for one of these predictions in survey data.

We examine the canonical model of product differentiation by Salop (1979) and assume that firms offer products of varying value. Consumers can inspect all products without incurring physical costs, e.g., by using a convenient online tool. They then can choose the product that offers the largest surplus, where surplus equals the payoff from the product minus the price. Thus, we abstract away from time and hassle costs in our baseline model. We follow Kőszegi and Rabin (2006, 2007) and assume that a fraction of consumers is expectation-based loss averse. Before inspecting all products, they plan which product (if any) they purchase when they encounter a certain set of product-price combinations. The appeal of this plan depends on the gain-loss sensations it implies. If these gain-loss sensations are too large relative

to the plan's expected surplus, it is optimal for the consumer to skip the plan and to stick to an individual default even if this default offers no surplus.

To illustrate, assume that, in order to realize a surplus of  $t > 0$ , a consumer has to adopt a plan where she purchases with probability  $\frac{1}{2}$  a high value product at a high price and surplus  $t$ , and with probability  $\frac{1}{2}$  a low value product at a low price and surplus  $t$ . Only one of these products is offered (each one with equal probability) and the consumer has to inspect products to find out which one it is. Let  $\Gamma$  be the difference between values and prices of the two products. A loss-neutral consumer would only care about the surplus  $t$  and realize this plan. In contrast, an expectation-based loss-averse consumer suffers from the uncertainty about the product value she is going to get and the uncertainty about the price she is going to pay. In both the product and price dimension, a high and a low outcome are possible. The loss-averse consumer's expected payoff from the plan (which we explain in detail below) equals

$$\underbrace{t}_{\text{Consumption Utility}} - \underbrace{(\lambda - 1) \times \frac{1}{2} \Gamma}_{\text{Gain-Loss Utility}}, \quad (1)$$

where  $\lambda > 1$  is the consumer's degree of loss aversion. The first term,  $t$ , is the consumer's surplus. The second term,  $(\lambda - 1)\frac{1}{2}\Gamma$ , is the consumer's disutility from gain-loss sensations in the product and price dimension. It reflects that high value (gain in value) comes with a high price (loss in money), and vice versa for the low value product. Overall, this leads to an expected net loss in both dimensions. Note that if the consumer's surplus  $t$  is too small relative to the extent of gain-loss sensations scaled by  $\Gamma$ , the expected payoff from the plan is negative. The consumer then prefers not to carry out the plan and to remain with an individual default that provides no surplus. This effect is driven by mental accounting (Kahneman et al. 1990, Thaler 1985, 1999): The consumer does not care about her surplus, but evaluates gains and losses in the product and price dimension separately. We therefore call the consumer's reaction "mental accounting effect." Whether it materializes depends both on the firms' conduct and the consumers' degree of loss aversion.

From equation (1) we can make an important observation. Suppose that  $\lambda$  is large enough so that the consumer does not execute the plan described above and strictly prefers a default with zero surplus. A researcher who correctly identifies the consumer's preferences over products, but ignores loss aversion, concludes that switching costs must at least equal  $t$ . However, the consumer's true switching costs are given by the negative gain-loss utility  $(\lambda - 1)\frac{1}{2}\Gamma$ . This term positively depends on the differences between product values and prices  $\Gamma$  the consumer encounters if she follows the original plan. Thus, the consumer's effective switching costs naturally scale according to the size of the transaction when relative value and price differences remain unchanged. We therefore obtain scale-dependent psychological switching costs.

We show that the presence of loss-averse consumers can significantly change firms' conduct. If all consumers were loss-neutral, firms would charge the equilibrium markup from the canonical model that approaches zero as the number of firms becomes large. Loss-averse consumers, however, may not make a plan that involves switching to better deals. If there is a share of such consumers, this reduces competitive pressure on firms and hence drives up equilibrium prices. When there are sufficiently many loss-averse consumers, firms charge the monopoly price, regardless of the number of firms. The firms' conduct in turn makes it optimal for loss-averse consumers not to inspect the available products even when they exhibit moderate degrees of loss aversion ( $\lambda \approx 2$ ). As a result, consumer surplus is reduced, also for loss-neutral consumers, due to higher prices.

This result is essentially a robust version of the Diamond Paradox. We show that, due to loss aversion, it may arise even if there is horizontal product differentiation, which would rule out the original version of the paradox. We only need to assume that the degree of horizontal product differentiation is small relative to the size of potential gain-loss sensations. In this case, consumers may exhibit inattentive behavior even if they have rational expectations, and there are no physical search and switching costs. From a policy perspective, this implies that information provision and facilitation of provider switching may not be enough to activate consumers.

The framework can be extended in a number of ways. We replicate our results in a setting where products offer homogeneous product values, but differ in multiple value dimensions such as customer support, delivery times, or firm reputation. If consumers treat these dimensions separately, our model can also be applied to markets for homogeneous goods such as electricity. Furthermore, we examine to what extent our results hold if we consider heterogeneous firms, alternative search models (such as sequential search), a combination of physical and psychological switching costs, pessimistic beliefs, and an alternative personal equilibrium definition for loss-averse consumers. We also show why our results would not obtain when consumers were risk- instead of loss-averse.

Our model generates a clear prediction about the relationship between loss aversion and switching behavior. Loss-averse consumers are less likely to switch away from their default contract than loss-neutral ones. We test this relationship in a short survey that we run on Amazon Mechanical Turk. In this survey, we measure subjects' degree of loss aversion in an incentive-compatible manner, and elicit whether they switched to another provider in three different domains (mobile, internet, and electricity) in the last three years. For all markets, we find a strong negative correlation between subjects' degree of loss aversion and their likelihood of switching. Importantly, this correlation obtains even after controlling for education and general risk tolerance (and other factors).



*Related Literature.* To explain consumer inertia, economists used various concepts, such as status-quo bias (Samuelson and Zeckhauser 1988), random or rational inattention, or “captive” consumers (e.g., Armstrong and Vickers 2019). On the surface, the behavior of loss-averse consumers in our model appears as if they were subject to these biases. In fact, they are attentive and fully rational, except that they value the absence of gain-loss sensations. The different behavioral components needed for our approach are firmly established in the empirical literature. In the following, we first outline the evidence on loss aversion, expectation-based reference points, and mental accounting. Then we relate our contribution to the literature.

Loss aversion is one of the most robust behavioral patterns in risky and riskless choice (Kahneman and Tversky 1979, Kahneman et al. 1990, Tversky and Kahneman 1992). The degree of loss aversion varies substantially in the population (von Gaudecker et al. 2011). Kőszegi and Rabin (2006, 2007) suggest that, in many circumstances, reference points are given by the agent’s expectations over outcomes. Several empirical studies indeed find a significant connection between expectations and behavior, see Abeler et al. (2011), Card and Dahl (2011), Crawford and Meng (2011), Ericson and Fuster (2011), Pope and Schweitzer (2011), Gill and Prowse (2012), Karle et al. (2015). Further evidence on expectation-based reference points includes Bell (1985), Loomes and Sugden (1987) and Gul (1991). Countervailing evidence is found in Heffetz and List (2014), Gneezy et al. (2017), and Smith (2018). However, Goette et al. (2019) find that accounting for heterogeneity over gain-loss types allows to both recover the central predictions of Kőszegi and Rabin (2006, 2007), and reconcile contradictory results across prior empirical tests.

Mental accounting is closely linked to loss aversion. It describes individuals’ tendency to assess gains and losses separately across different dimensions (Kahneman et al. 1990, Thaler 1985, 1999). For example, expenditures are assigned to different categories. An insurance customer therefore may treat regular premium payments and (unexpected) out-of-pocket expenses as different dimensions. In second-price auctions for real objects, Rosato and Tymula (2019) find evidence for mental accounting with respect to the dimensions product value and money. Assuming mental accounting and different hedonic dimensions is a crucial component of recent non-standard preferences models, such as expectation-based loss aversion (Kőszegi and Rabin 2006, 2007) and salience preferences (Bordalo et al. 2013).

Next, we relate our contribution to the behavioral industrial organization literature.<sup>3</sup> Several papers study competitive markets with expectation-based loss-averse consumers. The seminal paper by Heidhues and Kőszegi (2008) also considers a setting with horizontal product differentiation. Consumers initially are uncertain about both prices and match values. The consumers’ loss aversion then may eliminate price variations in the market even if firms exhibit

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<sup>3</sup>See Heidhues and Kőszegi (2018) for an extensive overview of this literature.

varying production costs. Relatedly, Courty and Nasiry (2018) show that it can be optimal for a monopolist to charge the same price for products of varying qualities. Karle and Peitz (2014) consider a similar setup as Heidhues and Köszegi (2008), but allow firms to post their prices upfront; consumers are either informed or uninformed about their match value. If firms differ in their production costs, the presence of uninformed loss-averse consumers leads to more competition and lower prices. Karle and Möller (2020) examine competition with loss-averse consumers in an advance purchase setting.

Monopolistic settings with expectation-based loss-averse consumers are examined in Heidhues and Köszegi (2014), Rosato (2016), and Karle and Schumacher (2017). They study a monopolist's optimal pricing and marketing strategies when expectations of ownership attach consumers to its product. A monopolist can create attachment through a sophisticated pricing strategy (as in Heidhues and Köszegi 2014 or Rosato 2016) or through the revelation of partial match value information (as in Karle and Schumacher 2017).

Few papers analyze the implications of heterogeneity in expectation-based loss-averse preferences in market settings. Herweg and Mierendorff (2013) show that the optimal two-part tariff for loss-averse consumers frequently is a flat-rate tariff. Consumers prefer such a tariff to a measured tariff under which they would pay less in expectation. In an extension, they show that the monopolist can screen between consumers by offering a flat-rate and a measured tariff. The relatively more loss-averse consumers then choose the flat-rate tariff, while those with a lower degree of loss aversion choose the measured tariff.

The crucial difference between these papers and ours is that, in their settings, loss aversion affects consumers' behavior through attachment effects. Given that consumers inspect all products, expectations only matter for the purchase decision. In contrast, we explicitly allow consumers to avoid any information gathering. They therefore have commitment power to choose their individual default so that the plan "do not inspect all products and choose the default" is always a personal equilibrium.<sup>4</sup> Loss-averse consumers will choose this plan if the expected payoff from the optimal information-sensitive purchase plan is below the utility of their individual default. Thus, our results are not driven by attachment effects.

More generally, we are contributing to a literature that explains a variety of phenomena with expectation-based loss-averse decision-makers. Two recent papers exploit a mechanism that is similar to the mental accounting effect to explain the misrepresentation of preferences in deferred acceptance mechanisms used, e.g., in college-choice problems; see Dreyfuss et

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<sup>4</sup>In the previous literature, this modeling approach also has been used by Karle and Schumacher (2017). In their model, the consumer is not forced to inspect the product of the monopolist. Consequently, not purchasing the monopolist's product is always a personal equilibrium. However, other papers like Heidhues and Köszegi (2014) or Rosato (2016) assume that consumers are forced to inspect all products (as, for example, they cannot avoid going to the supermarket).

al. (2021) and Meisner and von Wangenheim (2019). Under standard preferences, indicating the true preference ranking is a dominant strategy for individuals in a deferred acceptance mechanism. However, loss-averse individuals may submit a preference ranking that does not reflect their true preferences if doing so saves them the disappointment of not getting their preferred option (in particular, when it is unlikely to get this option). The rationale behind this behavior is very similar to the mental accounting effect in our framework. Dreyfuss et al. (2021) re-evaluate experimental data taking loss aversion into account, Meisner and von Wangenheim (2019) analyze the set of rationalizable strategies and alternative mechanisms.

Pagel (2018) develops a life-cycle portfolio-choice model in which the loss-averse investor derives utility from news (Kőszegi and Rabin 2009), and can ignore developments in her portfolio. She shows that the investor prefers to ignore and not to re-balance her portfolio most of the time as she dislikes bad news more than she likes good news. Consequently, the loss-averse investor has a first-order willingness to pay a portfolio manager who re-balances actively on her behalf. Structural estimates of the preference parameters are in line with those in the literature, generate reasonable intervals of inattention, and simultaneously explain consumption and wealth accumulation over the life cycle. In our competition model, expectation-based loss-averse consumers are uncertain about the qualities and prices of firms' products. This generates consumer inattention to cross-sectional information (other products), rather than to dynamic information flows, and explains scale-dependent switching costs.

Finally, we are contributing to a growing literature on search markets with boundedly rational consumers. Gamp and Krähmer (2021) analyze a setting in which consumers have biased beliefs about the prices and qualities that are available in the market, e.g., they may neglect the correlation between price and quality. Such consumers may be overly optimistic about the deals that are available in the market, and search for too long so that the Diamond Paradox breaks down. Similarly, Antler and Bachi (2020) find for a matching market that agents who apply coarse reasoning may continue searching for a partner forever, and that the share of such agents converges to one as search costs vanish. In both cases, the behavioral bias leads to excessive search, while loss aversion results in too little search in our setting.

The rest of the paper is organized as follows. In Section 2, we introduce the model and the equilibrium concept. In Section 3, we first consider the benchmark case with loss-neutral consumers; then we analyze our framework with homogeneous and heterogeneous consumer populations, and examine the implications of our results. In Section 4, we consider a version of our model in which firms offer products with multiple value dimensions. In Section 5, we discuss a number of extensions and alternative explanations. In Section 6, we study the association between loss aversion and consumers' (self-stated) tendency to forgo advantageous deals in new survey data. Section 7 concludes. All proofs are relegated to the appendix.

## 2 The Model

We consider the competition of  $n \geq 2$  firms  $i = 1, \dots, n$  for a unit mass of consumers. Firms and consumers are distributed uniformly on a circle with perimeter equal to 1. We suppress notation for individual consumers. Each consumer wants to buy at most one unit of a good. A consumer's payoff from firm  $i$ 's product is  $u_i = v_i - d_i t$ , where  $v_i$  is firm  $i$ 's product value,  $d_i$  the minimal distance between firm  $i$  and the consumer on the circle, and  $t$  the degree of horizontal product differentiation. Consumers know their location and hence the distance  $d_i$  to each firm  $i$ . Firms offer heterogeneous product values: With probability  $\frac{1}{2}$  firm  $i$ 's product value is low,  $v_i = v_{i,l} > 0$ , and with probability  $\frac{1}{2}$  it is high,  $v_i = v_{i,h}$ . For convenience, we assume that product values are located on a grid so that  $v_{i,h} = v_{i,l} + \Gamma$  and  $v_{i+1,l} = v_{i,h} + \Gamma$  for all  $i$  and some  $\Gamma > 0$ , see Figure 2 for an illustration.<sup>5</sup> Each firm  $i$  has production costs of  $c_i = v_i - \Delta$  for some  $\Delta < v_{1,l}$ . Hence, the efficiency level of all firms is the same and equal to  $\Delta$ . Throughout, we assume that  $\Delta \geq t$  and  $\Gamma \geq t$ . Let  $p_i$  be the price that firm  $i$  charges for its product. If a consumer trades with firm  $i$ , her consumption utility is  $u_i - p_i$ . If a consumer does not trade at all, her payoff is zero. Firm  $i$ 's payoff is the mass of consumers it serves times  $p_i - c_i$ .

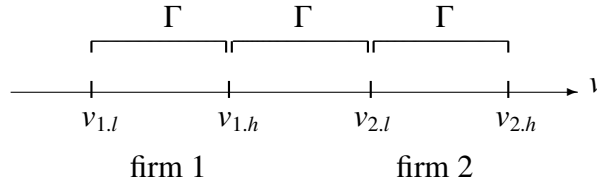


Figure 2: Example parametrization for  $n = 2$

*Consumer Loss Aversion.* We follow Kőszegi and Rabin (2006, 2007) to model a consumer's expectation-based loss aversion. Her total utility consists of consumption utility and gain-loss utility from comparisons of the actual outcome to a reference point given by her expectations. Below we make precise when and how these expectations are formed. Suppose that a consumer expects to get payoff  $\tilde{u}$  and to pay the price  $\tilde{p}$  with certainty. If she trades with firm  $i$ , her total utility equals

$$U(u_i, p_i \mid \tilde{u}, \tilde{p}) = u_i - p_i + \mu(u_i - \tilde{u}) + \mu(-p_i + \tilde{p}), \quad (2)$$

where the function  $\mu$  captures gain-loss utility. We assume that  $\mu$  is piecewise linear with slope 1 for positive values and slope  $\lambda \geq 1$  for negative ones. Thus,  $\lambda$  is the degree of loss aversion. We allow for heterogeneity in loss-averse preferences. The share  $\alpha \in [0, 1]$  of consumers is loss-neutral and exhibits  $\lambda = 1$ , while the share  $1 - \alpha$  of consumers is loss averse with the degree of loss aversion  $\lambda = \lambda^* > 1$ .

<sup>5</sup>The order of product values is inessential for our results (i.e., we could also reverse it). Our results also do not depend on vertical product differentiation. In Section 4, we consider a setting in which all firms offer the same product value.

A consumer may have stochastic expectations about the realization of payoff  $u$  and price  $p$ . The reference point reflects this uncertainty. Let the distribution function  $G^u$  be her expectation regarding the outcome in the product dimension and  $G^p$  her expectation regarding the outcome in the price dimension. The consumer's total utility from trading with firm  $i$  is then

$$U(u_i, p_i | G^u, G^p) = u_i - p_i + \int \mu(u_i - \tilde{u}) dG^u(\tilde{u}) + \int \mu(-p_i + \tilde{p}) dG^p(\tilde{p}). \quad (3)$$

Thus, gains and losses are weighted by the probability with which the consumer expects them to occur. This preference model captures the following intuition. If the consumer expects to win either 0 or 10 units in some dimension, each with probability 50 percent, then an outcome of 6 units feels like a gain of 6 units weighted with 50 percent probability, and a loss of 4 units also weighted with 50 percent probability.

*Pricing and Inspection.* There are three stages. In Stage 1 – the “pricing stage” – firms observe the realization of product values  $V = (v_1, \dots, v_n)$ . Firms then choose their prices simultaneously. In Stage 2 – the “planning stage” – each consumer is randomly assigned to a firm, so that each firm gets assigned the same share of consumers. If a consumer is assigned to firm  $i^*$ , she observes its product value  $v_{i^*}$  and price  $p_{i^*}$ . She then chooses whether to inspect the other products. Inspection is a binary decision  $a \in \{0, 1\}$ . If the consumer inspects all products,  $a = 1$ , she observes all product values and prices (for example, on a price comparison website). If she does not inspect all products,  $a = 0$ , she only observes the product value and price of the assigned firm  $i^*$ . In Stage 3 – the “market stage” – the consumer chooses the product she wants to buy (if any). She can only choose among products for which she knows value and price. Hence, by not inspecting all products, the consumer commits to trade with firm  $i^*$  or no trade at all. Figure 3 illustrates the timeline.

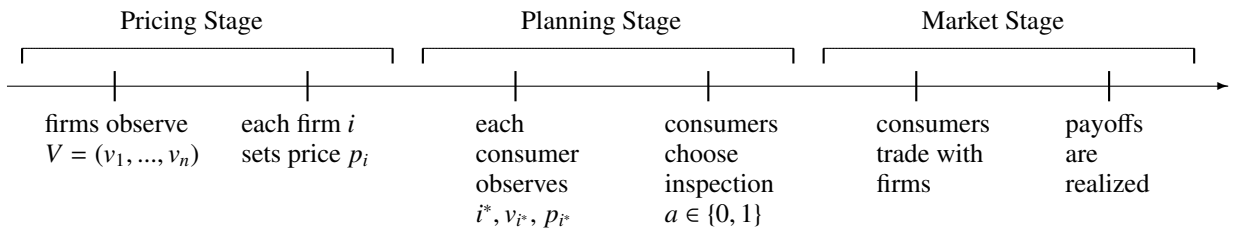


Figure 3: Timeline

*Strategies and Equilibrium.* We formally define the game. Let  $\mathcal{V}$  be the set of all possible realizations  $V$ . Firm  $i$ 's strategy  $\sigma_i$  maps the realization  $V$  into a price  $p_i$ ,  $\sigma_i : \mathcal{V} \rightarrow \mathbb{R}_+$ . Let  $\sigma_f = (\sigma_1, \dots, \sigma_n)$  be the firms' strategy profile. For a given strategy profile  $\sigma_f$ , consumers

derive beliefs  $\beta(V \mid i^*, v_{i^*}, p_{i^*})$  about the distribution of  $V$  from the identity of the assigned firm, its product value, and price.

All consumers with degree of loss aversion  $\lambda$  have the same strategy (or plan)  $\sigma_\lambda^{[co]}$ . It consists of two parts: An inspection strategy  $\sigma_\lambda^{[A]}$ , which maps the identity of the observed firm  $i^*$ , product value  $v_{i^*}$ , price  $p_{i^*}$ , and the consumer's location on the cycle  $x$  into an inspection decision  $a \in \{0, 1\}$ ,

$$\sigma_\lambda^{[A]} : \{1, \dots, n\} \times \mathbb{R}_+ \times \mathbb{R}_+ \times [0, 1] \rightarrow \{0, 1\}, \quad (4)$$

and a purchase strategy  $\sigma_\lambda^{[B]}$ , which maps the identity of the assigned firm  $i^*$ , realization  $V$ , prices  $(p_1, \dots, p_n)$ , inspection decision  $a$ , and the consumer's location on the cycle  $x$  into a purchase decision  $b \in \{1, \dots, n\} \cup \{nb\}$ ,

$$\sigma_\lambda^{[B]} : \{1, \dots, n\} \times \mathcal{V} \times \mathbb{R}_+^n \times \{0, 1\} \times [0, 1] \rightarrow \{1, \dots, n\} \cup \{nb\}, \quad (5)$$

where  $b = nb$  represents no purchase and  $b = i$  represents trade with firm  $i$ . The consumers' strategies have to obey the restriction that  $b$  is a constant, equal to  $i^*$  or  $nb$ , if no inspection took place ( $a = 0$ ). According to Kőzegi and Rabin (2006), carrying out the consumer strategy  $\sigma_\lambda^{[co]}$  must be credible. Given the expectations about final outcomes it generates, it must be rational for a consumer to follow it through. Denote her expectations regarding the outcome in the product dimension by  $G^u \equiv G^u(\tilde{u} \mid \sigma_f, \sigma_\lambda^{[co]}, x, \beta(V \mid i^*, v_{i^*}, p_{i^*}))$ , and by  $G^p \equiv G^p(\tilde{p} \mid \sigma_f, \sigma_\lambda^{[co]}, x, \beta(V \mid i^*, v_{i^*}, p_{i^*}))$  her expectations regarding the outcome in the price dimension when firms' and the consumer's strategies are given by  $\sigma_f, \sigma_\lambda^{[co]}$ , the consumer's location is  $x$ , and the assigned firm is  $i^*$  with product value  $v_{i^*}$  and price  $p_{i^*}$ . Define, for given firm strategy and beliefs, by  $\mathbb{E}_{\sigma_\lambda^{[co]}}[U(u_i, p_i \mid G^u, G^p) \mid i^*, v_{i^*}, p_{i^*}, x]$  a consumer's expected payoff from strategy  $\sigma_\lambda^{[co]}$  after observing the assigned firm  $i^*$ 's offer. We now can define the consumer's personal equilibrium as well as the equilibrium of the complete game.

**Definition 1.** *Let the firms' strategy  $\sigma_f$  and the consumers' beliefs  $\beta$  be given. The consumer strategy  $\sigma_\lambda^{[co]}$  is a personal equilibrium (PE) if at any possible assigned firm  $i^*$ , realization  $V$ , prices  $(p_1, \dots, p_n)$ , and location on the cycle  $x$  we have  $\sigma_\lambda^{[B]} \in \arg \max_{i \in X} U(u_i, p_i \mid G^u, G^p)$ , where  $X$  is the set of choices that are available after inspection decision  $\sigma_\lambda^{[A]}$ .*

**Definition 2.** *Let the firms' strategy  $\sigma_f$  and the consumers' beliefs  $\beta$  be given. The consumer strategy  $\sigma_\lambda^{[co]}$  is a preferred personal equilibrium (PPE) if*

$$\mathbb{E}_{\sigma_\lambda^{[co]}}[U(u_i, p_i \mid G^u, G^p) \mid i^*, v_{i^*}, p_{i^*}, x] \geq \mathbb{E}_{\sigma_\lambda^{[co]}}[U(u_i, p_i \mid \hat{G}^u, \hat{G}^p) \mid i^*, v_{i^*}, p_{i^*}, x]$$

*for any possible assigned firm  $i^*$ , product value  $v_{i^*}$ , price  $p_{i^*}$ , location on the cycle  $x$ , and any*

alternative personal equilibrium  $\hat{\sigma}_\lambda^{[co]}$ .

**Definition 3.** *The quadruple  $\sigma = (\sigma_f, \sigma_1^{[co]}, \sigma_{\lambda^*}^{[co]}, \beta)$  is a perfect Bayesian equilibrium if  $\sigma_f$  implies that each firm maximizes its expected payoff given  $\sigma_1^{[co]}$  and  $\sigma_{\lambda^*}^{[co]}$ , and for consumers with degree of loss aversion  $\lambda \in \{1, \lambda^*\}$  strategy  $\sigma_\lambda^{[co]}$  is a PPE for given  $\sigma_f, \beta$ , and  $\beta$  is derived from the firms' strategy  $\sigma_f$  and Bayes' rule whenever possible.*

### 3 The Market Equilibrium

In this section, we study the market equilibrium in our framework. In Subsection 3.1, we consider the benchmark case when all consumers are loss-neutral. In Subsection 3.2, we examine the framework with loss-neutral and loss-averse consumers and state our main results. Finally, in Subsection 3.3, we derive from these results a number of implications for switching costs, consumer and firm behavior.

#### 3.1 Benchmark Cases with Loss-Neutral Consumers

We study two useful benchmark cases when there are only loss-neutral consumers. They will help us illustrate how expectation-based loss aversion affects the market outcome. For this, we introduce small inspection costs  $e > 0$  that consumers have to pay if and only if they choose to inspect all products. We get the following results.

**Proposition 1.** *Consider the market with only loss-neutral consumers ( $\alpha = 1$ ) and inspection costs  $e > 0$ .*

- (a) *If  $t$  is small enough relative to  $e$ , then there is an equilibrium in which each firm  $i$  serves all of its assigned consumers at the monopoly price  $p_i = v_i - \frac{t}{2}$  (Diamond Paradox).*
- (b) *If  $e$  is small enough relative to  $t$ , then in any equilibrium each firm  $i$  charges the (competitive) price  $p_i = c_i + \frac{t}{n-1}$ .*

Proposition 1(a) states that when the level of horizontal product differentiation is sufficiently small, we obtain a Diamond Paradox outcome. The assumption  $\Delta \geq t$  ensures that it is optimal for a firm to serve all of its assigned consumers, regardless of their location on the circle. Hence,  $p_i = v_i - \frac{t}{2}$  is the monopoly price. Consumers are willing to bear the inspection costs only if they expect to get, with positive probability, a better deal than the deal offered by the assigned firm  $i^*$ . If  $t$  is sufficiently small relative to  $e$ , consumers cannot gain from inspecting all products and strictly prefer to trade with their assigned firm  $i^*$ . This behavior in turn

makes it optimal for each firm  $i$  to charge its monopoly price. Thus, as in Diamond (1971), small inspection costs can turn a competitive market into a market with monopoly pricing.

Next, Proposition 1(b) shows that the Diamond Paradox outcome is not sustainable when the level of horizontal product differentiation is large enough relative to inspection costs. Consider a consumer who is located far away from her assigned firm  $i^*$ . This consumer would find a firm that is closer to her if she inspects all products. If each firm  $i$  charges its monopoly price  $p_i = v_i - \frac{t}{2}$ , and inspection costs  $e$  are small enough relative to the level of horizontal product differentiation  $t$ , there is a share of consumers who inspect all products. Firms compete for these consumers, which in turn limits the equilibrium price of each firm  $i$  to its competitive level  $p_i = c_i + \frac{t}{n-1}$ . This characterizes the unique equilibrium outcome in this market.

Two further observations can be made here. First, the differences in product values are not essential for the equilibrium outcome. In both Proposition 1(a) and (b) they create price dispersion, as firm  $i$  charges a higher price than firm  $i - 1$ . However, markups are the same for all firms. This would also be the case if all firms would offer products with the same value  $v$ . Second, if inspection costs were exactly zero, the competitive price for firm  $i$  would be  $c_i + \frac{t}{n}$  as in the standard model of product differentiation with linear transportation costs. The somewhat higher competitive price here is due to the fact that consumers who trade with a firm  $j$  without inspecting all products would not notice a price cut by a neighboring firm  $i$ . This in turn reduces competitive pressure.

### 3.2 The Market Equilibrium with Loss-Averse Consumers

We next examine how the market equilibrium is affected when some consumers are loss-averse. First, we consider the case when all consumers are loss-averse ( $\alpha = 0$ ). Then, we allow for heterogeneous consumers,  $\alpha \in (0, 1)$ , and discuss the implications of preference heterogeneity for the market equilibrium.

*Homogeneous Consumers.* There is an important difference between loss-neutral and loss-averse consumers when it comes to finding and exploiting advantageous deals. For loss-neutral consumers only the difference between utility from the product and its price,  $u_i - p_i$ , matter for the purchase decision. It is irrelevant for them whether they get a high product value  $v_i$  at a high price  $p_i$  or a low product value  $v_j$  at a low price  $p_j$ , as long as  $u_i - p_i = u_j - p_j$ .

This is not the case for loss-averse consumers. Changes in the product and price dimension create experiences of losses and gains, respectively. When the outcome of a transaction is uncertain, then, by loss aversion, the expected payoff from these gain-loss sensations is negative. To illustrate, suppose that trading with the firms  $i$  and  $j$  does not create a surplus in consumption value,  $u_i - p_i = u_j - p_j = 0$ , but that firm  $j$ 's product offers higher utility, so that



we have  $u_j - u_i = \Gamma$  and  $p_j - p_i = \Gamma$ . Consider the plan<sup>6</sup> “trade with each firm  $i, j$  with 50 percent probability.” The expected payoff from this plan for loss-neutral consumers is zero, while for loss-averse consumers it is  $-(\lambda^* - 1)\frac{1}{2}\Gamma$ . Thus, for loss-averse consumers, exploiting advantageous deals after inspection may create costs in terms of gain-loss sensations.

Consumers’ loss aversion significantly changes the competition between firms. When a loss-averse consumer is assigned to a firm  $i^*$ , this firm has a competitive advantage with this consumer against other firms. It can offer her a certain and (weakly) positive payoff  $u_{i^*} - p_{i^*}$ . For any other firm  $i$ , the consumer does not know the exact realization of its product value  $v_i$  and (potentially) also not its price  $p_i$ . Thus, any consumer plan  $\sigma_\lambda^{[co]}$  that comprises the purchase of other products with positive probability implies uncertainty, which, as seen above, reduces the expected utility from this plan. Whether or not the consumer adopts such a plan or trades with firm  $i^*$  with certainty then depends on the firms’ equilibrium conduct.

Suppose that the firms’ strategy  $\sigma_f$  is such that each firm  $i$  offers the same positive  $v_i - p_i$  to consumers. We then check under what circumstances the plan “always trade with firm  $i^*$ ” is a loss-averse consumer’s PPE, regardless of her location. Observe first that it is always a PE. By not inspecting all products ( $a = 0$ ), the consumer can ensure that the only offer she can choose in the market stage is the one by the assigned firm  $i^*$ . If a consumer is assigned to a firm  $i^*$  that is also the closest firm to her location, she cannot benefit from trading with any other firm. Consider therefore a consumer who is assigned to a firm  $i^*$  that is not the closest firm to her location. This consumer could increase her consumption utility by inspecting all products and trading with the closest firm  $i$ . However, realizing this plan requires her to face the uncertainty about the product value and, by the assumption above, the price of firm  $i$ ’s product. This uncertainty increases linearly in the minimal product value difference  $\Gamma$ . If the degree of horizontal product differentiation  $t$  is small enough relative to  $\Gamma$ , then the consumer prefers trading with firm  $i^*$  to this plan.

To obtain a general statement, we characterize when the plan “always trade with firm  $i^*$ ” is strictly better than any other plan for a loss-averse consumer. This could be a tedious task since the mapping between plan and expected utility is complex. Fortunately, the problem has enough structure so that a few comparisons suffice to characterize a PPE.

**Lemma 1.** *Suppose that each firm  $i$  charges  $p_i = v_i - T$  for some  $T \in [\frac{1}{2}, \Delta]$ . Consider a loss-averse consumer assigned to any firm  $i^*$ . The plan “always trade with firm  $i^*$ ” is a PPE for this consumer if  $(\lambda^* - 1)\frac{7}{8}\Gamma > t$ .*

This result characterizes a loss-averse consumer’s PPE when all firms charge the same

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<sup>6</sup>This is of course not a fully specified strategy  $\sigma_\lambda^{[co]}$ . For convenience, we use this reduced description of a strategy when it is not essential to specify further details of the complete strategy.

markup  $\Delta - T$ . Note that  $T = \frac{t}{2}$  implies that each firm  $i$  charges the monopoly price, and  $T = \Delta$  means that firms set the price equal to marginal costs. The latter case is the limit in the Salop (1979) model of product differentiation when the number of firms approaches infinity.

The inequality  $(\lambda^* - 1)\frac{7}{8}\Gamma > t$  is a conservative condition on the degree of loss aversion  $\lambda^*$  and the product differentiation parameters  $\Gamma, t$ , which ensures that there is no plan that yields a loss-averse consumer a higher payoff than the plan “always trade with firm  $i^*$ .” Note that for any degree of loss aversion  $\lambda^*$  the consumer is willing to forgo payoff from a better match if the vertical product differences are large enough relative to the degree of horizontal product differentiation. Hence, a mental accounting effect can occur at modest levels of loss aversion: Loss-averse consumers prefer a certain option to an uncertain alternative even though this alternative is – in terms of consumption utility – strictly better than the certain option.

Lemma 1 allows us to characterize when an equilibrium exist in which each firm  $i$  charges its monopoly price  $p_i = v_i - \frac{t}{2}$ . Given that no consumer inspects all products, it is optimal for firms to serve all assigned consumers at the monopoly price. Given that all firms charge monopoly prices, it can be optimal for loss-averse consumers not to inspect all products. We therefore obtain the following result.

**Proposition 2.** *Suppose that all consumers are loss-averse ( $\alpha = 0$ ). If we have  $(\lambda^* - 1)\frac{7}{8}\Gamma > t$ , then there exists a symmetric equilibrium in which*

- (a) *each firm  $i$  serves its assigned consumers at price  $p_i = v_i - \frac{t}{2}$ , and*
- (b) *consumers do not inspect all products and trade with the assigned firm.*

Proposition 2 shows that a Diamond Paradox outcome can be obtained even though products are horizontally differentiated and there are no physical inspection costs. All switching costs are created in the consumers’ mind through the aversion against gain-loss sensations. These are particularly large relative to potential surplus gains since the consumer distinguishes between variations in the product and price dimension due to mental accounting. In equilibrium, the share  $\frac{n-1}{n}$  of consumers forgoes surplus from finding a better deal. The reason for this is that any plan, which involves inspecting all products and purchasing a product with uncertain value and price, generates negative expected utility through the mental accounting effect at the planning stage. The firms’ behavior exacerbates the consequences of loss aversion by reducing the consumers’ potential surplus from inspection.

*Heterogeneous Consumers.* We next consider the case when there is a share  $\alpha \in (0, 1)$  of loss-neutral and a share  $1 - \alpha$  of loss-averse consumers. Assume first that each firm  $i$  charges the monopoly price  $p_i = v_i - \frac{t}{2}$ . Loss-neutral consumers whose assigned firm  $i^*$  is not their closest

firm will then inspect all products to find a better match. Thus, there will be a positive share of consumers who inspect all products. Each firm then faces the trade-off between charging a high price to serve its assigned non-inspecting consumers and charging a lower price to serve inspecting consumers (assigned as well as non-assigned ones). The optimal price depends on the relative shares of the two consumer types. We therefore get the following result.

**Proposition 3.** *Suppose there are both loss-averse and loss-neutral consumers. If we have  $(\lambda^* - 1)\frac{7}{8}\Gamma > t$ , then there exists an equilibrium in which*

- (a) *each firm  $i$  serves its assigned loss-averse consumers and a share of loss-neutral consumers at price*

$$p_i = \min \left\{ c_i + \frac{1}{\alpha} \frac{t}{n}, v_i - \frac{t}{2} \right\},$$

- (b) *loss-averse consumers do not inspect all products and trade with the assigned firm, and*  
 (c) *loss-neutral consumers trade with the closest firm.*

The condition  $(\lambda^* - 1)\frac{7}{8}\Gamma > t$  again follows from Lemma 1 and ensures that loss-averse consumers only trade with the assigned firm, regardless of their location, provided that each firm  $i$  charges the same markup. If this is the case in equilibrium, then any loss-neutral consumer who is not assigned to the firm which maximizes her payoff (at given equilibrium prices) chooses to inspect all products. In equilibrium, each loss-neutral consumer therefore trades with the firm that is located closest to her location. Firms' equilibrium prices depend on the share  $\alpha$  of loss-neutral consumers. Observe that as the share of loss-neutral consumers converges towards unity,  $\alpha \rightarrow 1$ , the equilibrium price of each firm  $i$  converges towards the competitive level of the canonical model,  $p_i \rightarrow c_i + \frac{t}{n}$ . If the share of loss-neutral consumers is sufficiently small, each firm  $i$  charges the monopoly price  $p_i = v_i - \frac{t}{2}$ . In between, the equilibrium price strictly increases in the share of loss-averse consumers. Therefore, loss-neutral consumers are negatively affected by the presence of loss-averse consumers.

Before we discuss in detail the implications of Proposition 3, we briefly analyze the loss-averse consumers' incentives for not trading with the closest firm. First, we note that the plan "always trade with the closest firm  $i$ " constitutes a PE as long as all firms charge the same markup. In particular, this result holds regardless of the consumer's degree of loss aversion. The reason is that the consumer would suffer from relatively large gain-loss sensations if she unexpectedly trades with another firm or does not trade at all.

**Lemma 2.** *Suppose that each firm  $i$  charges  $p_i = v_i - T$  for some  $T \in [\frac{t}{2}, \Delta]$ . Consider a loss-averse consumer assigned to any firm  $i^*$ . Let firm  $i$  be the firm that is closest to the consumer's location. The plan "always trade with firm  $i$ " is then a PE for her.*

Next, suppose each firm  $j$  charges  $p_j = v_j - T$  for some  $T \in [\frac{t}{2}, \Delta]$ . The payoff from the plan “always trade with firm  $i^*$ ” equals  $T - d_{i^*}t$ , while the expected payoff from the plan “always trade with firm  $i$ ” is given by

$$T - d_i t - (\lambda^* - 1) \frac{1}{2} \Gamma. \quad (6)$$

The last term contains the expected gain-loss utility in the product dimension,  $(\lambda^* - 1) \frac{1}{2} \frac{1}{2} \Gamma$ , and the expected gain-loss utility in the price dimension, which equals the same value. The consumer strictly prefers the plan “always trade with firm  $i^*$ ” to the plan “always trade with firm  $i$ ” if

$$(d_{i^*} - d_i)t - (\lambda^* - 1) \frac{1}{2} \Gamma < 0. \quad (7)$$

Note that the maximal difference in the distances,  $d_{i^*} - d_i$ , is  $\frac{1}{2}$ . Thus, the inequality holds regardless of the consumer’s location if  $(\lambda^* - 1)\Gamma > t$ , which is of course implied by the inequality required in Lemma 1.

### 3.3 Implications

We obtain several implications from the results of the previous subsection. In the following, we first interpret the equilibrium outcome from Proposition 3 in the context of switching costs. Then we examine how loss-averse consumers could be motivated to inspect all products and to purchase the best deal for them. Finally, we discuss what the presence of loss-averse consumers implies for firms’ conduct and industry structure.

*Physical versus Psychological Scale-Dependent Switching Costs.* Loss-averse consumers forgo payoffs due to the mental accounting effect since a share of them trades with the assigned firm and not with the firm that best satisfies their needs. The list below provides an overview of the three relevant consumer groups. For each group, we indicate how much surplus on average this group does not realize through its choice. We call this value “average forgone surplus.”

	consumer share	loss aversion	av. forgone surplus
group 1	$\alpha$	1	0
group 2	$(1 - \alpha) \frac{1}{n}$	$\lambda^*$	0
group 3	$(1 - \alpha) \frac{n-1}{n}$	$\lambda^*$	$\frac{t}{4}$

The first group is the fraction of loss-neutral consumers. They trade with the closest firm

and leave no surplus on the table. The second group is the fraction of loss-averse consumers whose assigned firm is also their closest firm. Since they trade with this firm in equilibrium, they also realize the maximal possible surplus. The third group of consumers is the fraction of loss-averse consumers whose assigned firm is not their closest firm and who waste surplus. The size of this group increases in the share of loss-averse consumers  $1 - \alpha$  and the number of firms  $n$ . The average forgone surplus in this group can be calculated<sup>7</sup> as  $\frac{t}{4}$ . There is, however, substantial heterogeneity in forgone surplus. It can vary between zero and  $\frac{t}{2}$ . The former amount is incurred by loss-averse consumers located in between the assigned firm and the closest firm. The latter amount is incurred by loss-averse consumers located at the same spot as the closest firm  $i$  and whose assigned firm has distance  $\frac{1}{2}$  to firm  $i$  (provided this firm exists).

To derive switching costs in our framework, one has to take consumer loss aversion into account. Consider any consumer from the third group for whom the closest firm is located  $d_i < d_{i^*}$  away from her. A (hypothetical) empirical researcher who correctly identifies the consumer's preferences, but neglects her loss aversion, would conclude that her physical switching costs are at least equal to

$$\text{physical switching costs} = (d_{i^*} - d_i)t. \quad (8)$$

However, if the consumer adopts the plan “always trade with firm  $i^*$ ”, she suffers from gain-loss sensations. Recall from Lemma 2 that this plan is a PE. We call the negative payoff from the gain-loss sensations “psychological switching costs.” By the payoff in equation (6), these are given by

$$\text{psychological switching costs} = (\lambda^* - 1)\frac{1}{2}\Gamma. \quad (9)$$

In contrast to physical switching costs, psychological switching costs depend on the consumer's degree of loss aversion  $\lambda^*$  and on features of the transaction that are not related to the total surplus, namely the variations in product value and price as captured by  $\Gamma$ . Note that psychological switching costs are scale-dependent. That is, if we keep relative value differences between product specifications fixed, psychological switching costs increase linearly in the values of these product specifications. This rationalizes the finding from the introduction where estimated search and switching costs increase in the value of the transaction even though information gathering and choice require only little effort.

A policy implication that is mentioned frequently in the search and switching literature is

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<sup>7</sup>The calculation takes into account the segmentation of the unit circle. Consider a firm  $i^*$  located at 12 o'clock and the neighboring firm  $i$  that is reached if we move clockwise. For consumers located on the segment between the two firms the distance to firm  $i^*$  increases and the distance to firm  $i$  decreases when we move clockwise. After passing firm  $i$ , the distance to both firms increases at the same rate when we continue moving in the same direction. Taking this into account, and doing the calculation separately for even and odd  $n$  yields us the result.

that consumers' behavior and firm conduct can be changed by “reducing” search and switching costs, see Luco (2019) for a recent example. For instance, one can improve the design of a website or simplify the bureaucratic process through which switching takes place. However, this is not the case for the psychological switching costs in our setting. The mechanism outlined here would persist even if information gathering and switching is very simple. Indeed, Deller et al. (2021) find for a collective switching auction in the UK electricity market that more than 50 percent of consumers do not switch to a better contract even if savings are substantial and switching costs are tiny (like inserting name, address, date of birth, and bank account information on a website). An important question is therefore what could motivate loss-averse consumers to switch to better options.

*Monetary Incentives for Switching.* Psychological switching costs have an important implication for how to interpret forgone surplus. If loss aversion is ignored, one may treat forgone surplus as a lower bound on physical switching costs that are due to time and hassle costs. Physical switching costs as defined in equation (8) could be interpreted as the amount of money one has to give to the consumer so that she is indifferent between keeping her default and purchasing the product that maximizes her surplus. This interpretation is not valid for psychological switching costs that accrue to a loss-averse consumer. Using the inequality in (7) we can derive the payoff that we would have to give to the loss-averse consumer in the planning stage so that she adopts the plan “always trade with firm  $i$ ” instead of “always trade with firm  $i^*$ .” We call it “required payoff.” It equals

$$\text{required payoff} = (\lambda^* - 1) \frac{1}{2} \Gamma - (d_{i^*} - d_i)t. \quad (10)$$

Observe that we obtain a negative correlation between forgone surplus (physical switching costs) and required payoff: Those consumers with high forgone surplus  $(d_{i^*} - d_i)t$  only require a small additional payoff in order to switch, while those with lower forgone surplus require a higher additional payoff. This is intuitive: The consumers with high foregone surplus would gain the most consumption utility from adopting the plan “always trade with firm  $i$ .” Thus, the payoff required to make these consumers switch could be quite small relative to their forgone surplus.

This yields an implication for the case that monetary incentives are provided for inspecting all products and making an optimal or near-optimal choice. This policy seems heavy-handed, but it may be beneficial in markets like electricity or supplementary health insurance where

many consumers leave substantial amounts of surplus on the table.<sup>8</sup> The required payoff in equation (10) implies that, all else equal, for given incentives those loss-averse consumers would switch who exhibit the largest forgone surplus. As incentives are increased, more loss-averse consumers would choose to switch, but the average gains in terms of surplus would decrease.

*Standardization.* Loss-averse consumers refrain from switching to avoid the gain-loss sensations created by variations in product value and price of the firms' products. Hence, another way to make loss-averse consumers choose the best available deal for them is standardization. In terms of our model, standardization equalizes the value of all products to a certain number  $v$ . It would take out all uncertainty about the product value and, depending on the firms' conduct, also the uncertainty about the price. We briefly examine how standardization would affect the equilibrium outcome. Suppose that each firm offers a product with value  $v$  and has production costs of  $c$ , with  $v - c = \Delta$ . Note that this setting is quite similar to the one considered in Heidhues and Köszegi (2008). In this setting, an equilibrium exists in which all firms charge the same price  $p^*$ , and all consumers – loss-neutral and loss-averse ones – inspect all products and trade with their closest firm. We can show that for any price  $p^*$  in the range

$$c + \frac{t}{n} \leq p^* \leq c + \frac{1 + \lambda^*}{2 + \alpha(\lambda^* - 1)} \frac{t}{n} \quad (11)$$

such an equilibrium exists. In this equilibrium, loss-averse consumers are no longer exposed to gain-loss sensations. When they set out to inspect all products, they know exactly what they are going to find. Standardization therefore increases the surplus of all consumers relative to the equilibrium outcome of Proposition 3 if there are sufficiently many loss-averse consumers.

*Window Shopping.* A further difference between physical and psychological switching costs is that the latter is consistent with “window shopping.” Note that while in equilibrium loss-averse consumers do not inspect all products, this does not imply that they would switch products if, unexpectedly, they were informed about the characteristics of other products. Consider any loss-averse consumer with the plan to always trade with the assigned firm  $i^*$ . Suppose that, unexpectedly, she gets informed about the specification and price of firm  $i$ 's product. Her net gain from switching from firm  $i^*$  to firm  $i$  is then at most<sup>9</sup>

$$(1 + \lambda^*)(d_{i^*} - d_i)t - (\lambda^* - 1) |v_{i^*} - v_i|. \quad (12)$$

<sup>8</sup>Indeed, Allcott and Taubinsky (2015) find in a field experiment that demand for efficient lightbulbs increases through monetary subsidies. In contrast, there is no significant behavioral change when only information about the money savings from purchasing efficient lightbulbs instead of standard incandescents is provided.

<sup>9</sup>This term is derived under the assumption that  $v_{i^*} > v_i$ . If we have  $v_{i^*} < v_i$ , the corresponding expression is  $2(d_{i^*} - d_i)t - (\lambda^* - 1) |v_{i^*} - v_i|$ , which is strictly negative when  $(\lambda^* - 1)\Gamma > t$ .

Note that a switching consumer would either get higher quality and pay a higher price (than expected) or get lower quality and pay a lower price. These gain-loss sensations on average reduce her payoff, see the second term,  $-(\lambda^* - 1) |v_{i^*} - v_i|$ . The value in (12) is negative if  $t$  is small enough relative to  $\Gamma$ . In this case, the consumer does not switch to firm  $i$  and trades with her assigned firm  $i^*$ .

This observation implies that, in the equilibrium suggested in Proposition 3, we also could have a share of loss-averse consumers who engage in window shopping and forgo surplus: They inspect all products, but still trade with their assigned firm even though it is not the closest one for them. Note that a large share of such window-shoppers may create incentives for firms to cut prices. The firms' pricing strategy profile and the equilibrium outcome remain the same only if, for given parameters, the share of window-shoppers is small enough.

*Firm Conduct and Industry Structure.* When we look at the supply side of the market, we observe that the presence of loss-averse consumers affects firms' conduct. This effect is particularly pronounced when there many firms. If all consumers are loss-neutral, the firms' markup equals the value of the canonical model,  $\frac{t}{n}$ , and therefore converges to zero as the number of firms  $n$  grows large. If there are sufficiently many loss-averse consumers, the markup equals  $\Delta - \frac{t}{2}$ , regardless of the number of firms. In the former case, firms compete for customers who search for the best deal in the market. In the latter case, firms mostly extract rents from consumers who are afraid of switching to other suppliers.

Importantly, this implies that if there are sufficiently many loss-averse consumers, then an industry may charge substantial markups even when there are many firms and products are hardly differentiated. Some industries like the financial services industry exhibit this feature. Heidhues et al. (2017) consider a model where the equilibrium outcome may have the same property. However, their rationale for high profits in competitive markets is quite different. They create this outcome by assuming that some consumers do not anticipate the full price they are paying for a product and that competition for these customers cannot drive prices towards the competitive level. In our case, the result obtains with unrestricted prices and fully rational consumers as long as sufficiently many of them are expectation-based loss-averse.

## 4 Multi-Dimensional Product Values

In our baseline model, gain-loss sensations are caused by differences in product value and price. The mental accounting effect occurs for a given degree of loss aversion only if the value differences between products are large enough relative to potential gains from a better product match. This could be seen as a limitation of our model as in many markets the observed value differences between products are rather small.



However, in many applications, product value is not a one-dimensional attribute. Even if the good itself is homogeneous – like books or electricity – the transaction between consumers and firms can have many value-related features. Examples include speed and quality of customer support, service in case of product failures, delivery time, billing options and reliability, shopping experience, and firm reputation. These features matter, in particular, for online shopping on price comparison websites or shopping portals.

If consumers are expectation-based loss averse, the expected payoff from the transaction may depend on the expected gain-loss sensations in multiple product dimensions. In Kőszegi and Rabin’s (2006) framework, the outcome that defines gain-loss utility is a multi-dimensional object, and consumption utility is additively separable across dimensions. Similarly, Bordalo et al. (2013) define salience preferences over multiple product dimensions. In this section, we assume that product values are multi-dimensional and show that our results also obtain in a setting without vertical product differentiation.

Consider the following variation of our baseline model. Each firm  $i$  offers the same product value  $v$  to consumers.<sup>10</sup> Production costs are given by  $c$  with  $v - c = \Delta > 0$ . Products now differ along  $K \geq 2$  dimensions. Denote by  $v_i^\kappa$  the value of firm  $i$ ’s product in dimension  $\kappa$ . This number is a multiple of  $\Gamma$  and can take on the values  $0, \Gamma, 2\Gamma, \dots$ ; the total product value equals  $\sum_{\kappa=1}^K v_i^\kappa = v$ . Let  $v_i = (v_i^1, \dots, v_i^K)$  be the specification of firm  $i$ ’s product. For convenience, we assume that transport costs occur in an extra-dimension  $K + 1$ . A consumer treats all dimensions separately. Suppose she expects with certainty value  $\tilde{v}^\kappa$  in dimension  $\kappa \in \{1, \dots, K\}$ , distance  $\tilde{d}$ , and price  $\tilde{p}$ . Denote  $\tilde{v} = (\tilde{v}^1, \dots, \tilde{v}^K)$  the expected product specification. If the consumer trades with firm  $i$ , her total utility equals

$$U(v_i, d_i, p_i \mid \tilde{v}, \tilde{d}, \tilde{p}) = v - d_i t - p_i + \sum_{\kappa=1}^K \mu(v_i^\kappa - \tilde{v}^\kappa) + \mu(-d_i t + \tilde{d} t) + \mu(-p_i + \tilde{p}). \quad (13)$$

Suppose the product of each firm  $i$  can take on two specifications, either  $v_{i,l}$  or  $v_{i,h}$ . Here, the subscripts  $l$  and  $h$  no longer refer to “high” and “low” value realizations as in the baseline model, but to two distinct vectors of value realizations. Ex-ante, each consumer is uncertain about the specification of firm  $i$ ’s product: the specification is  $v_i = v_{i,l}$  with probability  $\frac{1}{2}$ , and it is  $v_i = v_{i,h}$  with probability  $\frac{1}{2}$ . All possible products and product specifications are differentiated from each other. The difference between any two products  $v_i$  and  $v_j$  is captured by the difference function

$$z(v_i, v_j) = \frac{1}{\Gamma} \sum_{\kappa=1}^K |v_i^\kappa - v_j^\kappa|. \quad (14)$$

<sup>10</sup>The assumption that all firms offer the same value can easily be dropped. It highlights that our main results also obtain in settings without the vertical product differentiation that we assume in the baseline model.

Let  $z^{min}$  be the minimal difference between any two product specifications of the same or different firms. The rest of the model remains the same.

We again first derive the market equilibrium when all consumers are loss-neutral. The model then collapses to the canonical model. Each consumer trades with the firm  $i$  that maximizes  $v - d_i t - p_i$ , and in equilibrium all firms charge the competitive price  $c + \frac{t}{n}$ . The differences in the product value dimensions are not relevant for the equilibrium outcome in this case. However, this changes when there is a share of loss-averse consumers who care about gain-loss sensations in multiple product dimensions. We obtain the following versions of Lemma 1 and Proposition 3.

**Lemma 3.** *Consider the model with multi-dimensional product values. Suppose that each firm  $i$  charges  $p_i = v - T$  for some  $T \in [\frac{t}{2}, \Delta]$ . Consider a loss-averse consumer assigned to any firm  $i^*$ . The plan “always trade with firm  $i^*$ ” is a PPE for the consumer if  $(\lambda^* - 1)2z^{min}\Gamma > t$ .*

**Proposition 4.** *Consider the model with multi-dimensional product values and suppose there are both loss-averse and loss-neutral consumers. If we have  $(\lambda^* - 1)2z^{min}\Gamma > t$ , then there exists an equilibrium in which*

- (a) *each firm  $i$  serves its assigned loss-averse consumers and a share of loss-neutral consumers at price*

$$p_i = \min \left\{ c + \frac{1}{\alpha} \frac{t}{n}, v - \frac{t}{2} \right\},$$

- (b) *loss-averse consumers do not inspect all products and trade with the assigned firm, and*
- (c) *loss-neutral consumers trade with the closest firm.*

The crucial difference between Proposition 3 and Proposition 4 is that in the equilibrium of the latter result, all firms offer the same product value  $v$  and charge the same price  $p$ . Nevertheless, the consumers' behavior is the same as in Proposition 3: Loss-neutral consumers trade with the closest firm, while loss-averse consumers trade with their assigned firm. A share of loss-averse consumers therefore forgoes the opportunity to obtain a product that better fits their needs. For them, any plan, which foresees to purchase different product specifications with positive probability, generates negative utility through gain-loss sensations in the  $K$  different product dimensions. If the inequality  $(\lambda^* - 1)2z^{min}\Gamma > t$  holds, only trade with the assigned firm is a PPE outcome. Again, this inequality holds for modest degrees of loss aversion if the level of differentiation between products as captured by  $z^{min}\Gamma$  is sufficiently large.

## 5 Extensions and Robustness

We discuss several extensions of our framework. In Subsection 5.1, we extend our baseline model by considering heterogeneous firms. In Subsection 5.2, we demonstrate that our results also obtain under alternative search models. In Subsection 5.3, we consider the role of physical search costs. In Subsection 5.4, we argue that pessimistic beliefs would enlarge the scope for the mental accounting effect in our framework. In Subsection 5.5, we briefly discuss to what extent our results also would obtain with risk aversion. Finally, in Subsection 5.6, we consider an alternative personal equilibrium definition for loss-averse consumers.

### 5.1 Heterogeneous Firms

In the equilibria of Proposition 3 and Proposition 4, all firms charge the same markup. In the former case, price dispersion is created mechanically through vertical product differentiation. In the latter case, there is no price dispersion at all. We consider a simple extension of our baseline framework that allows for dispersion of markups and prices through firm heterogeneity. Several additional implications will follow from this extension.

Let there be now  $m > n \geq 2$  firms. Each firm  $i \in \{1, \dots, n\}$  is “superior” and generates surplus  $v_i - c_i = \Delta$ . Each firm  $k \in \{n+1, \dots, m\}$  is “inferior” and generates only surplus  $v_k - c_k = \Delta_{inf} < \Delta$ . All firms are distributed uniformly on the circle. To exploit symmetry, we assume that superior firms are distributed uniformly on the circle, as before, and that the same number of inferior firms is located between any two neighboring superior firms. Hence, the number of inferior firms  $m - n$  is assumed to be a multiple of the number of superior firms  $n$ . The rest of the model is the same as before. In particular, the vertical differentiation between products parametrized by  $\Gamma$  holds for all firms.

Assume first that all consumers are loss-neutral. The superior firms then compete for consumers who search for the product that best fits their needs, which drives prices towards the competitive level. If  $\Delta_{inf}$  is sufficiently small, superior firms would price inferior firms out of the market. In equilibrium, consumers then only trade with superior firms at the competitive price  $p_i = c_i + \frac{t}{n}$  for each firm  $i = 1, \dots, n$ . Again, this changes if there are sufficiently many loss-averse consumers in the market, as our next result shows.

**Proposition 5.** *Consider the model with heterogeneous firms and suppose that there are both loss-averse and loss-neutral consumers. There exist values  $\alpha^*$ ,  $\Delta_{inf}^*$ , such that, if  $\alpha < \alpha^*$ ,  $\Delta_{inf} < \Delta_{inf}^*$ , and  $(\lambda^* - 1)\frac{7}{8}\Gamma > t$ , then an equilibrium exists in which*

- (a) *each superior firm  $i$  serves its assigned loss-averse consumers and a share of loss-neutral consumers at price  $p_i = v_i - \frac{t}{2}$ ,*

- (b) *each inferior firm  $k$  serves a fraction of its assigned loss-averse consumers at a price  $p_k > v_k - \frac{t}{4}$ ,*
- (c) *loss-averse consumers do not inspect all products and trade with their assigned firm or do not trade with any firm, and*
- (d) *loss-neutral consumers trade with the closest superior firm.*

This result adds several insights to those generated by Proposition 3. In the proposed equilibrium, loss-averse consumers are more likely to trade with inferior firms than loss-neutral consumers. The latter group always realizes an optimal deal by trading with a superior firm, while the former group trades at most with the assigned firm, which is inferior with probability  $\frac{m-n}{m}$ . Next, observe that there are two types of active firms in the proposed equilibrium. Superior firms serve their assigned consumers, but also compete for inspecting consumers. In contrast, the inferior firms only serve a share of their assigned consumers. They do not dare to compete with the superior firms for inspecting consumers since this would only ruin their profits. Finally, note that the presence of loss-averse consumers allows inferior firms to remain in business. If all consumers were loss-neutral and  $\Delta_{inf}$  sufficiently small, inferior firms would not have any business since they would be unable to make an attractive offer to any consumer. The presence of loss-averse consumers allows them to retain some consumers and even to do so profitably as long as  $\Delta_{inf} > 0$ .

## 5.2 Alternative Search Models

The search model we use in our framework extends the “clearinghouse model” of Varian (1980): Consumers choose between becoming a shopper or remaining loyal to their default firm. The former group inspects all products and learns their values and prices, while the latter only knows the product of the assigned firm. This approach is appropriate for our main application – online search and switching – where a consumer can learn all product characteristics on a website upon entering a few data. One may consider alternative search models, such as sequential or non-sequential search. For loss-averse consumers, considering a restricted set of products in general can be valuable, for example, if she wishes to exclude certain temptations.

Our results also hold under alternative standard search models. In particular, our result in Lemma 1 that “always trade with firm  $i^*$ ” is a loss-averse consumer’s PPE if  $(\lambda^* - 1)\frac{7}{8}\Gamma > t$  holds under random sequential search. This search model proposes that, after learning the characteristics of a (randomly chosen) product, a consumer can select whether she wants to continue search or make a definitive choice. Recall that we defined a purchase strategy  $\sigma_\lambda^{[B]}$

in (5) as a deterministic function that maps the assigned firm  $i^*$ , the realization of product values and prices, the inspection decision, and the consumer's location into a purchase decision. This definition does not capture purchase decisions under random sequential search since for a given combination of product values and prices the consumer may choose several products with positive probability. However, the proof of Lemma 1 explicitly allows for random purchase decisions when we derive the sufficient condition  $(\lambda^* - 1)\frac{7}{8}\Gamma > t$ . Hence, this condition also holds for any purchase strategy that follows from random sequential search (or any other standard search model). Since loss-neutral consumers do not face any search costs, it follows that the consumers' behavior and firms' strategy suggested in Proposition 3 are also consistent with alternative search models.

### 5.3 Physical Inspection Costs

In our benchmark cases in Subsection 3.1, we considered physical inspection costs, while in our baseline model, we abstracted from them. Nevertheless, it makes sense to also take physical inspection costs into account, as switching typically requires (potentially small) investments of time and money, even when it can be done online. Using insights from the proofs of Propositions 1 and 3, we can show that a version of our main result in Proposition 3 remains valid with physical inspection costs, provided they are sufficiently small.

Assume that a consumer incurs small costs  $e > 0$  if she chooses to inspect all products. Let each firm  $i$  charge the price

$$p_i = \min \left\{ c_i + \frac{1}{\alpha} \frac{t}{n-1}, v_i - \frac{t}{2} \right\}. \quad (15)$$

By Lemma 1, it is then the unique PPE outcome for loss-averse consumers to trade with the assigned firm if  $(\lambda^* - 1)\frac{7}{8}\Gamma > t$ . The inspection costs just provide an additional reason to avoid inspection. All loss-averse consumers now have a strict preference not to inspect all products (recall from our discussion of the window shoppers in Subsection 3.3 that the plan “inspect all products and trade with the assigned firm  $i$ ” could have been a PPE). For loss-neutral consumers, it is optimal to inspect all products if they are not assigned to the closest firm and  $e$  is sufficiently small. Hence, if  $e$  is sufficiently small, consumer behavior is hardly affected and we get the same equilibrium as in Proposition 3, with the only difference that the equilibrium price for each firm  $i$  is now given by (15). Thus, as in Proposition 1, the equilibrium price can be a little bit higher,  $p_i = c_i + \frac{1}{\alpha} \frac{t}{n-1}$  instead of  $p_i = c_i + \frac{1}{\alpha} \frac{t}{n}$ , due to the fact that consumers who trade with their assigned firm  $j$  would not notice a price cut by a neighboring firm  $i$ .

## 5.4 Pessimistic Beliefs

So far, we assumed that consumers have rational expectations about the distribution of product values, firms' location, and their conduct. Loss-averse consumers then do not inspect all products when the expected increase in match value is small relative to the expected gain-loss sensations they have to incur to realize this surplus. Therefore, consumers' beliefs about the expected surplus crucially matter for the decision (not) to switch to better deals. Indeed, Waddams Price and Zhu (2016) find that consumers differ in their beliefs about the gains from search and switching, and that these differences matter for behavior.

Typically, consumers do not learn about the potential surplus as long as they do not trade with firms. They may apply a misspecified model to make sense of price dispersion. One plausible narrative to explain price differences is to equate them with payoff differences ("there is no free lunch"). This narrative seems natural in many contexts. If loss-averse consumers form beliefs according to it, they may refrain from inspecting all products even if substantial price savings can be realized in the market. Thus, pessimistic beliefs strengthen the case for the mental accounting effect. Note that this argument does not apply to loss-neutral consumers in our framework with free inspection. Regardless of whether beliefs are misspecified or not, as long as a better deal can be found with positive probability, they inspect all products and purchase the product that yields the highest surplus. Thus, pessimistic beliefs may amplify the effects of loss aversion.

## 5.5 Risk Aversion

A question that is often asked in the context of loss aversion applications in industrial organization is whether the proposed effects could also occur with risk-averse consumers. This question is justified since search models typically assume risk-neutral consumers. However, in our framework, it is easy to see that risk aversion is not enough to make consumers forgo payoffs from finding better deals. Consider a loss-neutral, but risk-averse consumer who derives utility  $u(v_i - d_{it} - p_i)$  from trading with firm  $i$ . In the market stage, when the consumer makes her final choice, the term  $v_i - d_{it} - p_i$  is certain for each firm  $i$ . The risk-averse consumer would therefore always trade with the firm  $i$  that maximizes  $v_i - d_{it} - p_i$ , just like the loss-neutral consumers. Therefore, risk aversion cannot generate the same results. The crucial element that we need for our main results is mental accounting in combination with loss-aversion.

## 5.6 Choice-Acclimating Personal Equilibrium

Kőszegi and Rabin (2007) define an alternative personal equilibrium concept for expectation-based loss-averse individuals, the choice-acclimating personal equilibrium (CPE). In a CPE,

the reference points  $G^u, G^p$  in an individual's utility function  $U(u_i, p_i \mid G^u, G^p)$  are defined by her actual choice and not by a plan that has been made at an earlier stage. The CPE is a static concept. In the following, we consider a simple dynamic extension of the CPE in our framework and briefly discuss to what extent a version of Lemma 1, and hence Proposition 3, can be consistent with the CPE.

Suppose that each firm  $i$  charges  $p_i = v_i - T$  for some  $T \in [\frac{t}{2}, \Delta]$ , as requested in Lemma 1. We examine a loss-averse consumer's behavior who at each stage acts according to the CPE. To this end, we apply backward-induction. Assume first that in Stage 3 the consumer can choose between all products. This situation is essentially choice under certainty. According to the CPE, the utility from each product equals its consumption utility. The consumer will therefore trade with the closest firm  $i$ . Next, consider Stage 2 where the consumer has to choose between inspecting or not inspecting all products. Again, let her decision be consistent with the CPE. Given her choice in Stage 3, she faces the decision between accepting the assigned firm's product for sure, which generates payoff of  $T - d_i t$ , or the product of the closest firm  $i$ . If  $i^* \neq i$ , the value and price of this product is uncertain, so that the total expected payoff from this choice equals

$$T - d_i t - (\lambda^* - 1) \frac{1}{2} \Gamma. \quad (16)$$

The two firms are at most  $\frac{1}{2}$  away from each other. Hence, if  $(\lambda^* - 1)\Gamma > t$ , the optimal decision of the loss-averse consumer in Stage 2 is not to inspect all products and to trade with the assigned firm  $i^*$ . The result from Lemma 1 therefore can also hold with the CPE as solution concept.

Note that our application of the CPE generates a time-inconsistency. In Stage 3, the consumer's payoff would be  $T - d_i t$  after inspection, regardless of the realization of the chosen firm's product. However, in Stage 2, her expected payoff from inspection is not equal to  $T - d_i t$ , but is reduced by expected gain-loss sensations  $(\lambda^* - 1) \frac{1}{2} \Gamma$ . This reflects the fact that, despite the consumer's ability to adjust reference points quickly, her payoff is reduced by expected gain-loss sensations when the uncertainty cannot be resolved immediately.

## 6 Empirical Evidence

One key prediction of our model is that there is a relationship between consumers' degree of loss aversion and their switching behavior. Loss-neutral consumers choose the product that best fits their needs, while loss-averse consumers tend to stick to their individual default. Several studies examine consumers' switching behavior in various markets, but measures of loss aversion are typically not included in surveys. To evaluate the empirical validity of the main prediction of our model, we conduct a short survey on Amazon Mechanical Turk (AMT)

in which we collect data on switching behavior as well as on loss aversion.

*Survey Design and Procedures.* At the beginning of the survey, we elicit age, gender, education, and general risk tolerance. Next, we ask subjects questions about their mobile phone, internet, and electricity contracts. In particular, we ask whether they switched their provider for these three products in the last three years. The precise question we ask is as follows:

*Apart from when moving, have you switched the provider of any of these products in the last three years? [Answer is yes/no, separately for mobile, internet, and electricity]*

After these questions, we elicit subjects' degree of loss aversion. To this end, subjects receive an additional endowment of 0.50 USD (on top of their participation fee). They then have to choose between a safe payment and a lottery in three situations. After the completion of the study, one of these situations is selected randomly to determine a subject's payment. The choice in each situation is described as follows:

*You have to choose between a lottery and a safe payment. If you choose the lottery, you win 0.50 USD with probability 50% and you lose  $L$  USD with probability 50%. The safe payment is 0.00 USD. Which option do you choose? [Answer is lottery or safe payment]*

The number  $L$  is the loss and equals 0.10, 0.30, and 0.50, respectively, in the three situations. We classify a subject as loss-neutral if she chooses the lottery in all three situations. Otherwise, we classify her as loss averse. Our results are mostly robust to using loss aversion measures with more than two categories. A similar method to elicit loss aversion has been used, for example, by Fehr and Goette (2007).

We conducted the survey in August 2021 with 1,000 subjects on AMT.<sup>11</sup> We only recruited subjects who have at least a 98 percent approval rating and who have performed at least 500 jobs on AMT. We paid them 1.00 USD participation fee plus their earnings from the lottery choice. Subjects earned on average 1.79 USD and it took them on average around 7 minutes to complete the survey. We obtained a diverse subject pool: The average age is 39.1 years ( $sd = 11.0$ ), 57.7 percent are male, the average risk tolerance is 5.34 ( $sd = 2.70$ ) on the 11-point scale between 0 and 10. Also the level of education was quite heterogeneous.<sup>12</sup> Out of all subjects, 937 made consistent lottery choices (a lottery is chosen only if also all lotteries with smaller losses are chosen). We use these subjects in our subsequent analysis.

<sup>11</sup>Beforehand, we registered the survey on aspredicted.org (registry number 73498).

<sup>12</sup>Overall, 13.5 percent indicated to have a Bachelor's degree, 57.3 percent a High school degree, 28 percent some high school, and 1.2 percent no degree.



Table 1: Loss Aversion and Switching Behavior

	Mobile		Internet		Electricity	
	(1)	(2)	(3)	(4)	(5)	(6)
loss aversion	-0.236*** (0.085)	-0.148* (0.088)	-0.375*** (0.087)	-0.243*** (0.091)	-0.433*** (0.107)	-0.272** (0.117)
age	-0.011*** (0.004)	-0.010** (0.004)	-0.008** (0.004)	-0.006 (0.004)	-0.014*** (0.005)	-0.010* (0.005)
male	-0.071 (0.087)	-0.126 (0.088)	0.061 (0.089)	-0.025 (0.091)	0.059 (0.109)	-0.063 (0.114)
education	0.218*** (0.065)	0.167** (0.067)	0.316*** (0.067)	0.235*** (0.069)	0.390*** (0.089)	0.276*** (0.100)
risk tolerance		0.064*** (0.017)		0.101*** (0.018)		0.164*** (0.025)
constant	-0.432* (0.247)	-0.683*** (0.259)	-0.911*** (0.256)	-1.325*** (0.272)	-1.546*** (0.338)	-2.348*** (0.378)
Observations	937	937	937	937	937	937
Pseudo R square	0.0228	0.0343	0.0408	0.0690	0.0627	0.1351

Notes: Probit regressions. The dependent variable is a dummy that indicates whether the consumer has switched the provider in the last three years (separately for the three markets). Loss aversion is a dummy that indicates whether a subject chose the save payment in at least one situation. Education is a variable that indicates the highest degree a subject has obtained. Risk tolerance is a subject's general willingness to take risks on the 11-point scale between 0 and 10. Standard errors are in parentheses. Significance at the 1%, 5%, and 10% level is denoted by \*\*\*, \*\*, and \*, respectively.

*Results.* Subjects' self-reported switching behavior is as follows: 34.4 switched their mobile phone provider at least once in the last three years, 31.0 percent their internet provider, and only 13.3 percent switched their electricity provider in that period. To analyze what drives switching behavior, we run a probit regression where the dependent variable is a dummy that indicates whether the consumer has switched the provider for mobile phone, internet, and electricity, respectively. We control for loss aversion, age, gender, and education. In our sample, 54.4 percent of subjects are classified as loss-averse, the rest as loss-neutral. Controlling for education is important since cognitive ability has been shown to correlate negatively with loss

aversion<sup>13</sup> (e.g., Benjamin et al. 2013), and education is typically correlated with contract switching (e.g., Hortaçsu et al. 2017). In additional regressions, we also control for general risk tolerance.

In Table 1, we report the estimates of the Probit regressions. We find a negative coefficient for loss aversion for all markets and in all specifications, see Columns (1) to (6). With controls for age, gender, and education, the negative coefficient of loss aversion is significant at the 1-percent level for all markets, see Columns (1), (3), and (5). Education and age have a statistically significant effect on switching behavior. As expected, subjects with more education are more likely to switch their supplier. Age tends to have a negative effect on the probability of switching. In Columns (2), (4), and (6), we add general risk tolerance as an additional control variable. Risk tolerance has a statistically significant, positive effect on switching behavior. However, the loss aversion effect remains significant at the 10-percent level for mobile phone providers, at the 5-percent level for electricity providers, and at the 1-percent level for internet providers. The marginal effects of loss aversion for a loss-neutral subject (using the sample mean for other variables) are -0.09 for mobile (Column 1), -0.13 for internet (Column 3), and -0.09 for electricity (Column 5). They account for a reduction of the predicted switching probability of 22.4 percent for mobile, 34.9 percent for internet, and 51.3 percent for electricity. We interpret this as evidence for our prediction that loss-averse consumers are less likely to realize advantageous deals that would offer them more surplus.

## 7 Conclusion

Our goal in this paper was to provide an explanation for seemingly inattentive consumer behavior in markets where consumers can choose between different products and both information gathering and switching requires not much effort. Loss-averse consumers may derive little utility from information-sensitive choice if the implied expected consumer surplus is small relative to the gain-loss sensations that such a plan generates. Thus, they may stick to an individual default even when this default offers less surplus than another available option. This mental accounting effect can occur for modest degrees of loss aversion.

We considered a standard model of product differentiation and showed that firms may charge monopoly prices, regardless of the number of firms, if the share of loss-averse consumers is sufficiently large. This equilibrium outcome motivated scale-dependent psychological switching costs, which we defined as the payoff loss-averse consumers are willing to give up in order to avoid gain-loss sensations. In contrast to classic switching costs, these costs in-

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<sup>13</sup>In our sample, the correlation between loss aversion and education is not significant. Similarly, loss aversion is not significantly correlated with age or gender.

crease in the value of the transaction. Psychological switching costs imply that a policy which lowers the hassle costs of switching may not be enough to reduce the extent of seemingly inattentive behavior. In new survey data, we found evidence for the predicted correlation between loss aversion and switching behavior.

Our analysis implies that simple information on potential surplus may not be sufficient to motivate more consumer switching. However, since mental accounting exacerbates the behavioral impact of loss aversion, one option to induce more switching is to change the environment in a way so that individuals do not have to worry about changes in multiple dimensions. For example, one can use advertisements or reminders tailored to individual consumers that only suggest products which are identical to the consumer's default, except that they provide an improvement in one dimension – e.g., a reduction in price – and no trade-off in other dimensions. Modestly loss-averse consumers may react to such advertisement as the uncertainty is concentrated in one dimension so that there is less scope for the mental accounting effect. Future empirical work may be able to evaluate whether the reduction in product dimensions that are uncertain positively affects search and switching behavior.

## References

- ABELER, JOHANNES, ARMIN FALK, LORENZ GOETTE, AND DAVID HUFFMAN (2011): "Reference points and effort provision," *American Economic Review*, 101(2), 470–492.
- ALLCOTT, HUNT, AND DMITRY TAUBINSKY (2015): "Evaluating behaviorally motivated policy: Experimental evidence from the lightbulb market," *American Economic Review*, 105(8), 2501–2538.
- ANTLER, YAIR, AND BENJAMIN BACHI (2020): "Searching forever after," *American Economic Journal: Microeconomics*, forthcoming.
- ARMSTRONG, MARK, AND JOHN VICKERS (2019): "Discriminating against captive customers," *AER: Insights*, 1(3), 257–272.
- BELL, DAVID E. (1985): "Disappointment in decision making under uncertainty," *Operations Research*, 33(1), 1–27.
- BENJAMIN, DANIEL, SEBASTIAN BROWN, AND JESSE SHAPIRO (2013): "Who is 'behavioral'? Cognitive ability and anomalous preferences," *Journal of the European Economic Association*, 11(6), 1231–1255.

- BORDALO, PEDRO, NICOLA GENNAIOLI, AND ANDREI SHLEIFER (2013): "Salience and consumer choice," *Journal of Political Economy*, 121(5), 803–843.
- CARD, DAVID, AND GORDON DAHL (2011): "Family violence and football: The effect of unexpected emotional cues on violent behavior," *Quarterly Journal of Economics*, 126(1), 103–143.
- COURTY, PASCAL, AND JAVAD NASIRY (2018): "Loss aversion and the uniform pricing puzzle for media and entertainment products," *Economic Theory*, 66(1), 105–140.
- CRAWFORD, VINCENT, AND JUANJUAN MENG (2011): "New York City cab drivers' labor supply revisited: Reference-dependent preferences with rational-expectations targets for hours and income," *American Economic Review*, 101(5), 1912–1932.
- DE LOS SANTOS, BABUR, ALI HORTAÇSU, AND MATTHIJS WILDENBEEST (2012): "Testing models of consumer search using data on web browsing and purchasing behavior," *American Economic Review*, 102(6), 2955–2980.
- DE LOS SANTOS, BABUR (2018): "Consumer search on the Internet," *International Journal of Industrial Organization*, 58, 66–105.
- DELLER, DAVID, MONICA GIULIETTI, GRAHAM LOOMES, CATHERINE WADDAMS PRICE, ANNA MONICHE, AND JOO YOUNG JEON (2021): "Switching energy suppliers: It's not all about the money," *Energy Journal*, 42(3), 1–26.
- DIAMOND, PETER (1971): "A model of price adjustment," *Journal of Economic Theory*, 3(2), 156–168.
- DONG, XIAOJING, ILYA MOROZOV, STEPHAN SEILER, AND LIWEN HOU (2021): "Estimation of preference heterogeneity in markets with costly search," *Marketing Science*, forthcoming.
- DREYFUSS, BNAYA, ORI HEFFETZ, AND MATTHEW RABIN (2021): "Expectations-based loss aversion may help explain seemingly dominated choices in strategy-proof mechanisms," *American Economic Journal: Microeconomics*, forthcoming.
- ERICSON, KEITH M. MARZILLI, AND ANDREAS FUSTER (2011): "Expectations as endowments: Evidence creating attachment through advertising on reference-dependent preferences from exchange and valuation experiments," *Quarterly Journal of Economics*, 126(4), 1879–1907.
- FEHR, ERNST, AND LORENZ GOETTE (2007): "Do workers work more if wages are high? Evidence from a randomized field experiment," *American Economic Review*, 97(1), 298–317.

- GAMP, TOBIAS, AND DANIEL KRÄHMER (2021): “Biased beliefs in search markets,” Working Paper.
- GENAKOS, CHRISTOS, COSTAS ROUMANIAS, AND TOMMASO VALLETTI (2019): “Is having an expert ‘friend’ enough? An analysis of consumer switching behaviour in mobile telephony,” Working Paper, Cambridge Judge Business School.
- GHOSE, ANINDYA, PANAGIOTIS IPEIROTIS, AND BEIBEI LI (2017): “Modeling consumer footprints on search engines: An interplay with social media,” *Management Science*, 65(3), 1363–1385.
- GILL, DAVID, AND VICTORIA PROWSE (2012): “A structural analysis of disappointment aversion in a real effort competition,” *American Economic Review*, 102(1), 469–503.
- GIULIETTI, MONICA, MICHAEL WATERSON, AND MATTHIJS WILDENBEEST (2014): “Estimation of search frictions in the British electricity market,” *Journal of Industrial Economics*, 62(4), 555–590.
- GNEEZY, URI, LORENZ GOETTE, CHARLES SPRENGER, AND FLORIAN ZIMMERMANN (2017): “The limits of expectations-based reference dependence,” *Journal of the European Economic Association*, 15(4), 861–876.
- GOETTE, LORENZ, THOMAS GRAEBER, ALEXANDRE KELLOGG, AND CHARLES SPRENGER (2019): “Heterogeneity of gain-loss attitudes and expectations-based reference points,” Working Paper.
- GUL, FARUK (1991): “A theory of disappointment aversion,” *Econometrica*, 95(3), 667–686.
- HEFFETZ, ORI, AND JOHN LIST (2014) “Is the endowment effect an expectations effect?,” *Journal of the European Economic Association*, 12(5), 1396–1422.
- HEIDHUES, PAUL, AND BOTOND KŐSZEGI (2008): “Competition and price variation when consumers are loss averse,” *American Economic Review*, 98(4), 1245–1268.
- HEIDHUES, PAUL, AND BOTOND KŐSZEGI (2014): “Regular prices and sales,” *Theoretical Economics*, 9(1), 217–251.
- HEIDHUES, PAUL, BOTOND KŐSZEGI, AND TAKESHI MUROOKA (2017): “Inferior products and profitable deception,” *Review of Economic Studies*, 84(1), 323–356.
- HEIDHUES, PAUL, AND BOTOND KŐSZEGI (2018): “Behavioral industrial organization,” *Handbook of Behavioral Economics: Applications and Foundations*, Volume 1, 517–612.
- HEISS, FLORIAN, DANIEL MCFADDEN, JOACHIM WINTER, AMELIE WUPPERMANN, AND BO ZHOU (2021): “Inattention and switching costs as sources of inertia in Medicare Part D,” *American Economic Review*, forthcoming.

- HERWEG, FABIAN, AND KONRAD MIERENDORFF (2013): "Uncertain demand, consumer loss aversion, and flat-rate tariffs," *Journal of the European Economic Association*, 11(2), 399–432.
- HO, KATE, JOSEPH HOGAN, AND FIONA SCOTT MORTON (2017): "The impact of consumer inattention on insurer pricing in the Medicare Part D program," *RAND Journal of Economics*, 48(4), 877–905.
- HONG, HAN, AND MATTHEW SHUM (2006): "Using price distributions to estimate search costs," *RAND Journal of Economics*, 37(2), 257–275.
- HONKA, ELISABETH (2014): "Quantifying search and switching costs in the US auto insurance industry," *RAND Journal of Economics*, 45(4), 847–884.
- HORTAÇSU, ALI, SEYED ALI MADANIZADEH, AND STEVEN PULLER (2017): "Power to choose? An analysis of consumer inertia in the residential electricity market," *American Economic Journal: Economic Policy*, 9(4), 192–226.
- KAHNEMAN, DANIEL, AND AMOS TVERSKY (1979): "Prospect Theory: An analysis of decision under risk," *Econometrica*, 47(2), 263–292.
- KAHNEMAN, DANIEL, JACK KNETSCH, AND RICHARD THALER (1990): "Experimental tests of the endowment effect and the Coase Theorem," *Journal of Political Economy*, 98(6), 1325–1348.
- KARLE, HEIKO, AND MARTIN PEITZ (2014): "Competition under consumer loss aversion," *RAND Journal of Economics*, 45(1), 1–31.
- KARLE, HEIKO, GEORG KIRCHSTEIGER, AND MARTIN PEITZ (2015): "Loss aversion and consumption choice: Theory and experimental evidence," *American Economic Journal: Microeconomics*, 7(2), 101–120.
- KARLE, HEIKO, AND HEINER SCHUMACHER (2017): "Advertising and attachment: Exploiting loss aversion through pre-purchase information," *RAND Journal of Economics*, 48(4), 927–948.
- KARLE, HEIKO, AND MARC MÖLLER (2020): "Selling in advance to loss averse consumers," *International Economic Review*, 61(1), 441–468.
- KISS, ANDRÁS (2019): "Salience and switching," Working Paper.
- KŐSZEGI, BOTOND, AND MATTHEW RABIN (2006): "A model of reference-dependent preferences," *Quarterly Journal of Economics*, 121(4), 1133–1165.

- KŐSZEGI, BOTOND, AND MATTHEW RABIN (2007): "Reference-dependent risk attitudes," *American Economic Review*, 97(4), 1047–1073.
- KŐSZEGI, BOTOND, AND MATTHEW RABIN (2009): "Reference-dependent consumption plans," *American Economic Review*, 99(3), 909–936.
- KOULAYEV, SERGEI (2014): "Search for differentiated products: Identification and estimation," *RAND Journal of Economics*, 45(3), 553–575.
- LAMBRECHT, ANJA, AND BERND SKIERA (2006): "Paying too much and being happy about it: Existence, causes, and consequences of tariff-choice biases," *Journal of Marketing Research*, 43(2), 212–223.
- LOOMES, GRAHAM, AND ROBERT SUDGEN (1987): "Testing for regret and disappointment in choice under uncertainty," *Economic Journal*, 97, 118–129.
- LUCO, FERNANDO (2019): "Switching costs and competition in retirement investment," *American Economic Journal: Microeconomics*, 11(2), 26–54.
- LUSARDI, ANNAMARIA, AND OLIVIA S. MITCHELL (2011): "Financial literacy around the world: An overview," *Journal of Pension Economics and Finance*, 10(4), 497–508.
- MEISNER, VINCENT, AND JONAS VON WANGENHEIM (2019): "School choice and loss aversion," Working Paper.
- MORAGA-GONZÁLEZ, JOSÉ LUIS, ZSOLT SÁNDOR, AND MATTHIJS WILDENBREEST (2013): "Semi-nonparametric estimation of consumer search costs," *Journal of Applied Econometrics*, 28(7), 1205–1223.
- PAGEL, MICHAELA (2018): "News utility, portfolio choice, inattention, delegation," *Econometrica*, 86(2), 491–522.
- POPE, DEVIN AND MAURICE SCHWEITZER (2011): "Is Tiger Woods loss averse? Persistent bias in the face of experience, competition, and high stakes," *American Economic Review*, 101(1), 129–157.
- ROSATO, ANTONIO (2016): "Selling substitute goods to loss-averse consumers: Limited availability, bargains and rip-offs," *RAND Journal of Economics*, 47(3), 709–733.
- ROSATO, ANTONIO, AND AGNIESZKA TYMULA (2019): "Loss aversion and competition in Vickrey auctions: Money ain't no good," *Games and Economic Behavior*, 115, 188–208.

- SALOP, STEVEN (1979): "Monopolistic competition with outside goods," *Bell Journal of Economics*, 10(1), 141–156.
- SAMUELSON, WILLIAM, AND RICHARD ZECKHAUSER (1988): "Status quo bias in decision making," *Journal of Risk and Uncertainty*, 1(1), 7–59.
- SMITH, ALEC (2019): "Lagged beliefs and reference-dependent preferences," *Journal of Economic Behavior and Organization*, 167, 331–340.
- THALER, RICHARD (1985): "Mental accounting and consumer choice," *Marketing Science*, 4(3), 199–214.
- THALER, RICHARD (1999): "Mental accounting matters," *Journal of Behavioral Decision Making*, 12(3), 183–206.
- TVERSKY, AMOS, AND DANIEL KAHNEMAN (1992): "Advances in Prospect Theory: Cumulative representation of uncertainty," *Journal of Risk and Uncertainty*, 5(4), 297–323.
- VARIAN, HAL (1980): "A model of sales," *American Economic Review*, 70(4), 651–659.
- VON GAUDECKER, HANS-MARTIN, ARTHUR VAN SOEST, AND ERIK WENGSTRÖM (2011): "Heterogeneity in risky choice behavior in a broad population," *American Economic Review*, 101(2), 664–694.
- WADDAMS PRICE, CATHERINE, AND MINYAN ZHU (2016): "Empirical evidence of consumer response in regulated markets," *Journal of Competition Law and Economics*, 12(1), 113–149.



## Appendix

*Proof of Proposition 1.* The proof proceeds by steps. In Step 1, we prove statement (a), and in Step 2, we prove statement (b). **Step 1.** We prove statement (a). We show that if each firm  $i$  charges  $p_i = v_i - \frac{t}{2}$  and  $t$  is small enough relative to  $e$ , then consumers do not inspect all products and trade with their assigned firm. A consumer's payoff from trading with the assigned firm  $i^*$  is at least  $v_{i^*} - p_{i^*} - \frac{t}{2} = v_{i^*} - (v_{i^*} - \frac{t}{2}) - \frac{t}{2} = 0$ . Her payoff from trading with any other firm is at most  $v_j - (v_j - \frac{t}{2}) - e$ , which is strictly negative if  $t$  is small enough relative to  $e$ . Hence, all consumers trade with their assigned firm in this case. Next, we show that  $\Delta \geq t$  ensures that it is optimal for each firm  $i$  to serve all assigned consumers at price  $p_i = v_i - \frac{t}{2}$ . If firm  $i$  charges a price  $p_i > v_i - \frac{t}{2}$ , its profit equals

$$\pi_i = \frac{1}{n}(p_i - c_i) \left( \frac{v_i - p_i}{v_i - (v_i - \frac{t}{2})} \right) = \frac{1}{n} \frac{2}{t} (p_i - c_i)(v_i - p_i). \quad (17)$$

Firm  $i$  would then benefit from charging a lower price if

$$\frac{\partial \pi_i}{\partial p_i} = \frac{1}{n} \frac{2}{t} (v_i - 2p_i + c_i) < 0. \quad (18)$$

This inequality is implied by

$$v_i - 2 \left( v_i - \frac{t}{2} \right) + c_i \leq 0, \quad (19)$$

which is equivalent to  $\Delta \geq t$ . This completes the proof. **Step 2.** We prove statement (b). Let  $\tilde{v}_i, \tilde{c}_i, \tilde{p}_i$  be the realized product value, production costs, and price of firm  $i$ 's product. Loss-neutral consumers only care about the surplus  $\tilde{v}_i - \tilde{p}_i$ . To simplify the exposition of the proof, we set all product values to  $v = v_{n,h}$ , and normalize for each firm  $i$  the price  $p_i = \tilde{p}_i + (v - \tilde{v}_i)$  as well as costs  $c_i = \tilde{c}_i + (v - \tilde{v}_i)$ . This leaves the payoffs and incentives of all parties unchanged. We show that each firm  $i$  charges  $p_i = c_i + \frac{t}{n-1}$  in any equilibrium if  $e$  is small enough relative to  $t$  (for convenience, we do not always state this qualification explicitly in the rest of the proof). To this end, we first show that there exists no equilibrium in which a firm  $i$  charges  $p_i > c_i + \frac{t}{n-1}$ . Then we show that there exists no equilibrium in which a firm  $i$  charges  $p_i < c_i + \frac{t}{n-1}$ . Assume by contradiction that an equilibrium exists in which at least one firm  $i$  charges  $p_i > c_i + \frac{t}{n-1}$ . Let  $p_1, \dots, p_n$  be the equilibrium prices of all firms. Assume w.l.o.g. that  $p_i \geq p_j$  for all  $j = 1, \dots, n$ . We show that firm  $i$  can deviate profitably by cutting its price by some  $\varepsilon > 0$ . To calculate the the profit of firm  $i$  after the price cut, we derive the marginal consumers located on the segment between firm  $i$  and a neighboring firm  $j$  among those who (i) are assigned to firm  $i$ , (ii) are assigned to firm  $j$ , and (iii) are assigned to any other firm (these group of course does not exist if  $n = 2$ ; the proof then adjusts in straightforward manner). Consumers in group (i) observe

the price cut so that the marginal consumer in this group is defined by

$$v - p_i + \varepsilon - d_i t = v - p_j - e - \left( \frac{1}{n} - d_i \right) t. \quad (20)$$

Hence, the marginal consumer in this group is located at  $d = \frac{p_j - p_i + \varepsilon + e}{2t} + \frac{1}{2n}$ . Consumers in group (ii) do not observe the price cut when they trade with firm  $j$ . Hence, the marginal consumer in this group is defined by

$$v - p_i - e - d_i t = v - p_j - \left( \frac{1}{n} - d_i \right) t. \quad (21)$$

Hence, the marginal consumer in this group is located at  $d = \frac{p_j - p_i - e}{2t} + \frac{1}{2n}$ . Finally, consumers in group (iii) do not observe the price cut, but inspect all products in any case. Hence, the marginal consumer in this group is defined by

$$v - p_i + \varepsilon - d_i t = v - p_j - \left( \frac{1}{n} - d_i \right) t. \quad (22)$$

Hence, the marginal consumer in this group is located at  $d = \frac{p_j - p_i + \varepsilon}{2t} + \frac{1}{2n}$ . The share of the first two groups is  $\frac{1}{n}$  each and the share of the last group is  $\frac{n-2}{n}$ . Thus, firm  $i$ 's profit from the segment between firm  $i$  and firm  $j$  equals

$$\tilde{\pi}_i = \left( \frac{p_j - p_i}{2t} + \frac{n-1}{n} \frac{\varepsilon}{2t} + \frac{1}{2n} \right) (p_i - \varepsilon - c_i). \quad (23)$$

There exists a profitable deviation for firm  $i$  if  $\frac{\partial \tilde{\pi}_i}{\partial \varepsilon} > 0$  at  $\varepsilon = 0$ . This is the case if

$$\frac{2n-1}{n} p_i - p_j - \frac{n-1}{n} c_i > \frac{t}{n}. \quad (24)$$

Since  $p_i \geq p_j$  for all  $j = 1, \dots, n$ , this inequality is implied by

$$p_i > c_i + \frac{t}{n-1}, \quad (25)$$

which we assumed at the beginning of the argument. The same applies to the profit from the segment between firm  $i$  and the other neighboring firm. Therefore, there exists no equilibrium in which any firm  $i$  charges  $p_i > c_i + \frac{t}{n-1}$ . To show that there exists no equilibrium in which any firm  $i$  charges  $p_i < c_i + \frac{t}{n-1}$ , we assume by contradiction that an equilibrium exist in which at least one firm  $i$  charges  $p_i < c_i + \frac{t}{n-1}$ . Assume w.l.o.g. that  $p_i \leq p_j$  for all  $j = 1, \dots, n$ . We show that firm  $i$  can deviate profitably by increasing its price by some  $\varepsilon > 0$ . The proof applies the same steps as above, using the fact that consumers in group (ii) who inspect all products and encounter an unexpected high  $p_i$  still trade with firm  $i$  if  $\varepsilon \leq e$ . The rest of the proof is

very similar to the one above, and therefore omitted. Finally, by using similar arguments, we can show that there exists an equilibrium in which each firm  $i$  charges  $p_i = c_i + \frac{t}{n-1}$  if  $e$  is sufficiently small relative to  $t$ .  $\square$

*Proof of Lemma 1.* Consider a loss-averse consumer assigned to any firm  $i^*$ . The plan “always trade with firm  $i^*$ ” is a PE when the consumer chooses not to inspect all products. It is also the unique PPE if  $i^*$  is the closest firm to her location. Assume therefore that firm  $i^*$  is not the closest firm to her location. The expected payoff from the plan “always trade with firm  $i^*$ ” at the planning stage is  $T - d_{i^*}t$ . The rest of the proof proceeds by steps. In Step 1, we prove the result for the case  $n \geq 4$ . In Steps 2 and 3, we prove the result for the cases  $n = 3$  and  $n = 2$ , respectively. **Step 1.** Assume that  $n \geq 4$ . Consider any alternative plan  $\tilde{\sigma}_{\lambda^*}^{[B]}$  the consumer may adopt after inspecting all products. We find an upper bound on the expected utility from this plan, and then examine under what circumstances this upper bound is smaller than the expected payoff from “always trade with firm  $i^*$ ” (in which case this latter plan is a PPE). To this end, we define an alternative plan  $\sigma_{\lambda^*}^{[B]}$  that will weakly dominate  $\tilde{\sigma}_{\lambda^*}^{[B]}$  in terms of expected payoff. This alternative plan involves trade with three different firms: the assigned firm  $i^*$ , a firm  $j$  that is located at least  $\frac{1}{4}$  away from the consumer, and a firm  $i$  that is the closest one to the consumer. Define scenario  $\gamma, \xi$  for  $\gamma \in \{1, 2\}$  and  $\xi \in \{3, 4\}$ , where  $\gamma = 1$  indicates  $v_j = v_{j,l}$ ,  $\gamma = 2$  indicates  $v_j = v_{j,h}$ ,  $\xi = 3$  indicates  $v_i = v_{i,l}$ , and  $\xi = 4$  indicates  $v_i = v_{i,h}$ . Define by  $\pi_{i^*}^{\gamma,\xi}$  the probability induced by plan  $\sigma_{\lambda^*}^{[B]}$  that the scenario is  $\gamma, \xi$  and the consumer trades with firm  $i^*$ ; define  $\pi_j^{\gamma,\xi}$  and  $\pi_i^{\gamma,\xi}$  accordingly. For the original plan, define  $\tilde{\pi}_k^{\gamma,\xi}$  for any firm  $k$  in the same manner. The alternative plan  $\sigma_{\lambda^*}^{[B]}$  is derived from the original plan  $\tilde{\sigma}_{\lambda^*}^{[B]}$  so that for each scenario  $\gamma, \xi$  we have the following:  $\pi_{i^*}^{\gamma,\xi} = \tilde{\pi}_{i^*}^{\gamma,\xi}$ ;  $\pi_j^{\gamma,\xi}$  is the sum of all  $\tilde{\pi}_k^{\gamma,\xi}$  for all firms  $k \neq i^*$  that are located at least  $\frac{1}{4}$  away from the consumer;  $\pi_i^{\gamma,\xi}$  is the sum of all  $\tilde{\pi}_k^{\gamma,\xi}$  for all firms  $k \neq i^*$  that are located less than  $\frac{1}{4}$  away from the consumer. Define

$$\pi_0 = \sum_{\gamma \in \{1,2\}} \sum_{\xi \in \{3,4\}} \pi_{i^*}^{\gamma,\xi}, \quad (26)$$

$$\pi_\gamma = \sum_{\xi \in \{3,4\}} \pi_j^{\gamma,\xi} \text{ for } \gamma \in \{1, 2\}, \quad (27)$$

$$\pi_\xi = \sum_{\gamma \in \{1,2\}} \pi_i^{\gamma,\xi} \text{ for } \xi \in \{3, 4\}. \quad (28)$$

We now define an upper bound on the expected utility from the alternative plan, which, by

construction, also holds for the original plan. For  $\pi = (\pi_0, \dots, \pi_4)$ , this upper bound is given by

$$\begin{aligned}\mathbb{E}[U(\pi)] &= T - \pi_0 d_{i^*} t - (\pi_1 + \pi_2) \frac{t}{4} \\ &\quad - (\lambda^* - 1) \pi_0 (\pi_1 + \pi_2 + \pi_3 + \pi_4) \left(2\Gamma - \frac{t}{2}\right) \\ &\quad - (\lambda^* - 1) (\pi_1 + \pi_2) (\pi_3 + \pi_4) \left(2\Gamma - \frac{t}{2}\right) \\ &\quad - (\lambda^* - 1) (\pi_1 \pi_2 + \pi_3 \pi_4) \left(2\Gamma - \frac{t}{4}\right).\end{aligned}\quad (29)$$

To see this, note that the minimal difference in the payoff from two different firms' products is  $\Gamma - \frac{t}{2}$ , and the minimal difference in the price of two different firms' products is  $\Gamma$ . The upper bound in (29) is strictly smaller than the payoff from the plan “always trade with firm  $i^*$ ” if

$$\begin{aligned}\mathbb{E}[\bar{U}(\pi)] &= (\pi_1 + \pi_2) \frac{t}{4} + (\pi_3 + \pi_4) \frac{t}{2} \\ &\quad - (\lambda^* - 1) \pi_0 (\pi_1 + \pi_2 + \pi_3 + \pi_4) \left(2\Gamma - \frac{t}{2}\right) \\ &\quad - (\lambda^* - 1) (\pi_1 + \pi_2) (\pi_3 + \pi_4) \left(2\Gamma - \frac{t}{2}\right) \\ &\quad - (\lambda^* - 1) (\pi_1 \pi_2 + \pi_3 \pi_4) \left(2\Gamma - \frac{t}{4}\right) < 0.\end{aligned}\quad (30)$$

We now find an alternative plan that maximizes  $\mathbb{E}[\bar{U}(\pi)]$ . Consider the following variations of an alternative plan:  $\pi_y = \pi'_y - \varepsilon$  and  $\pi_z = \pi'_z + \varepsilon$  with  $y \in \{0, 1, 2\}$  and  $z \in \{3, 4\}$  or  $y = 0$  and  $z \in \{1, 2\}$ . For any such variation we get

$$\frac{\partial \mathbb{E}[U(\pi)]}{\partial \varepsilon} = C_1 - (\lambda^* - 1) (\pi_y - \pi_z) C_2, \quad (31)$$

where  $C_1$  is some constant,  $C_2$  is strictly a positive constant, and  $C_1, C_2$  are independent of  $\pi_y$  and  $\pi_z$ . Thus, there exists a corner-solution among those admissible  $\pi$  that maximize  $\mathbb{E}[\bar{U}(\pi)]$ . This corner-solution must have  $\pi_j^{\gamma, \xi}, \pi_i^{\gamma, \xi} \in \{0, \frac{1}{4}\}$  for all scenarios  $\gamma, \xi$ . Moreover, we must have  $\pi_0 = 0$  or  $\pi_1 = 0$  or  $\pi_2 = 0$  or  $\pi_1 = \pi_2 = 0$ . Thus, we obtain a finite set of vectors  $\pi$  that represent candidate alternative plans for a maximum of  $\mathbb{E}[\bar{U}(\pi)]$ , and that we can compare to each other in terms of  $\mathbb{E}[\bar{U}(\pi)]$ . From this comparison, we get the following result. For each vector  $\pi$ , we can write the value of  $\mathbb{E}[\bar{U}(\pi)]$  as  $D_1 - (\lambda^* - 1) D_2$ ;  $G_1$  is consumption utility and  $D_2$  are expected gain-loss sensations. Given that  $\Gamma \geq t$ , the vector  $\pi$  with the highest ratio  $\frac{D_1}{D_2}$  is  $\pi^{[1]} = (0, 0, 0, \frac{1}{2}, \frac{1}{2})$  and represents the plan the plan “always trade with firm  $i$ .” That is, if  $\mathbb{E}[\bar{U}(\pi^{[1]})] < 0$ , then  $\mathbb{E}[\bar{U}(\pi)] < 0$  for any admissible  $\pi$ . Using  $\Gamma \geq t$  again, we get that this is the case if  $t < (\lambda^* - 1) \frac{7}{8} \Gamma$ . This completes the proof of the result for  $n \geq 4$ . **Step 2.** Assume that  $n = 3$ . We consider any alternative plan  $\bar{\sigma}_{\lambda^*}^{[B]}$  the consumer may adopt after

inspecting all products and find an upper bound on the expected utility from this plan. To this end, we proceed in a similar manner as in Step 1. Denote by firm  $i$  the firm that is closest to the consumer, and by firm  $j$  the firm that is neither firm  $i$  nor the assigned firm  $i^*$ . Define scenario  $\gamma, \xi$  for  $\gamma \in \{1, 2\}$  and  $\xi \in \{3, 4\}$ , where  $\gamma = 1$  indicates  $v_j = v_{j,l}$ ,  $\gamma = 2$  indicates  $v_j = v_{j,h}$ ,  $\xi = 3$  indicates  $v_i = v_{i,l}$ , and  $\xi = 4$  indicates  $v_i = v_{i,h}$ . Let  $\pi_{i^*}^{\gamma, \xi}$  be the probability induced by plan  $\tilde{\sigma}_{\lambda^*}^{[B]}$  that the scenario is  $\gamma, \xi$  and the consumer trades with firm  $i^*$ ; define  $\pi_j^{\gamma, \xi}$  and  $\pi_i^{\gamma, \xi}$  accordingly. Define  $\pi = (\pi_0, \dots, \pi_4)$  as in the equations (26) to (28). An upper bound on the expected utility from plan  $\tilde{\sigma}_{\lambda^*}^{[B]}$  is given by

$$\begin{aligned} \mathbb{E}[U(\pi)] &= T - \pi_0 d_{i^*} t - (\pi_1 + \pi_2) \frac{t}{6} \\ &\quad - (\lambda^* - 1) \pi_0 (\pi_1 + \pi_2 + \pi_3 + \pi_4) \left( 2\Gamma - \frac{t}{3} \right) \\ &\quad - (\lambda^* - 1) (\pi_1 + \pi_2) (\pi_3 + \pi_4) \left( 2\Gamma - \frac{t}{3} \right) \\ &\quad - (\lambda^* - 1) (\pi_1 \pi_2 + \pi_3 \pi_4) 2\Gamma. \end{aligned} \quad (32)$$

Hence, the plan “always trade with firm  $i^*$ ” is the unique PPE if the expression

$$\begin{aligned} \mathbb{E}[\bar{U}(\pi)] &= (\pi_1 + \pi_2) \frac{t}{6} + (\pi_3 + \pi_4) \frac{t}{2} \\ &\quad - (\lambda^* - 1) \pi_0 (\pi_1 + \pi_2 + \pi_3 + \pi_4) \left( 2\Gamma - \frac{t}{3} \right) \\ &\quad - (\lambda^* - 1) (\pi_1 + \pi_2) (\pi_3 + \pi_4) \left( 2\Gamma - \frac{t}{3} \right) \\ &\quad - (\lambda^* - 1) (\pi_1 \pi_2 + \pi_3 \pi_4) 2\Gamma \end{aligned} \quad (33)$$

is strictly negative. By applying the same arguments as Step 1, we can show that this is the case for any admissible  $\pi$  if  $t < (\lambda^* - 1)\Gamma$ . This completes the proof of the result for  $n = 3$ .

**Step 3.** We show the result for  $n = 2$ . Consider any alternative plan  $\tilde{\sigma}_{\lambda^*}^{[B]}$  the consumer may adopt after inspecting all products. Denote by firm  $i$  the firm that is closest to the consumer. Define scenario  $\gamma \in \{1, 2\}$ , where  $\gamma = 1$  indicates  $v_i = v_{i,l}$ ,  $\gamma = 2$  indicates  $v_i = v_{i,h}$ . Let  $\pi_{i^*}^\gamma$  be the probability induced by plan  $\tilde{\sigma}_{\lambda^*}^{[B]}$  that the scenario is  $\gamma$  and the consumer trades with firm  $i^*$ ; define  $\pi_i^\gamma$  accordingly. We now set  $\pi_0 = \pi_{i^*}^1 + \pi_{i^*}^2$ ,  $\pi_1 = \pi_i^1$ , and  $\pi_2 = \pi_i^2$ . An upper bound on the expected utility from plan  $\tilde{\sigma}_{\lambda^*}^{[B]}$  is then given by

$$\mathbb{E}[U(\pi)] = T - \pi_0 d_{i^*} t - (\lambda^* - 1) \pi_0 (\pi_1 + \pi_2) \left( 2\Gamma - \frac{t}{2} \right) - (\lambda^* - 1) \pi_1 \pi_2 2\Gamma. \quad (34)$$

The plan “always trade with firm  $i^*$ ” is the unique PPE if

$$\mathbb{E}[\bar{U}(\pi)] = (\pi_1 + \pi_2) \frac{t}{2} - (\lambda^* - 1) \pi_0 (\pi_1 + \pi_2) \left( 2\Gamma - \frac{t}{2} \right) - (\lambda^* - 1) \pi_1 \pi_2 2\Gamma < 0. \quad (35)$$

By applying the same arguments as Step 1, we can show that this is the case for any admissible  $\pi$  if  $t < (\lambda^* - 1)\Gamma$ . This completes the proof of the result for  $n = 2$ .  $\square$

*Proof of Proposition 2.* To establish this equilibrium, we assume that the consumers' beliefs  $\beta(\cdot)$  are such that consumers are not making any inference about the product value  $v_i$  of a firm  $i \neq i^*$  from the product value and price of the assigned firm  $i^*$ . A consumer does not inspect all products and trades with firm  $i^*$  if and only if  $v_{i^*} - d_{i^*}t - p_{i^*} \geq 0$ . By Lemma 1, this strategy is a PPE given the firms' prices. As in Step 1 of the proof of Proposition 1, we can show that it is optimal for each firm  $i$  to charge  $p_i = v_i - \frac{t}{2}$ , given the consumers' behavior. Hence, it serves all of its assigned consumers. This completes the proof.  $\square$

*Proof of Proposition 3.* To establish this equilibrium, we again assume that the consumers' beliefs  $\beta(\cdot)$  are such that consumers are not making any inference about the product value  $v_i$  of a firm  $i \neq i^*$  from the product value and price of the assigned firm  $i^*$ . We first show that no firm has an incentive to deviate from the proposed strategy, given the consumers' behavior. Suppose that loss-neutral consumers always inspect all products and trade with the closest firm, and that loss-averse consumers do not inspect all products and trade with the assigned firm  $i^*$  if and only if  $p_{i^*} \leq v_i - \frac{t}{2}$ . We show that it is then optimal for each firm  $i$  to charge  $p_i = \min \left\{ c_i + \frac{1}{\alpha} \frac{t}{n}, v_i - \frac{t}{2} \right\}$  provided that all other firms also charge this price. For convenience, we apply the same normalization as in Step 2 of the proof of Proposition 1. Consider firm  $i$  and assume that any other firm  $j$  charges a price  $p_j \leq v - \frac{t}{2}$ . If firm  $i$  also charges  $p_i \leq v - \frac{t}{2}$ , the marginal loss-neutral consumer on the segment between firm  $i$  and firm  $j$  is defined by

$$v - p_i - d_i t = v - p_j - \left( \frac{1}{n} - d_i \right) t. \quad (36)$$

Hence, the marginal loss-neutral consumer is located at  $d = \frac{p_j - p_i}{2t} + \frac{1}{2n}$ . Firm  $i$ 's profit from charging  $p_i \leq v - \frac{t}{2}$  therefore equals

$$\pi_i = \alpha(p_i - c) \left( \frac{p_j - p_i}{t} + \frac{1}{n} \right) + (1 - \alpha)(p_i - c) \frac{1}{n}. \quad (37)$$

The optimal price is hence given by

$$p_i = \frac{p_j + c}{2} + \frac{1}{\alpha} \frac{t}{2n}. \quad (38)$$

In a symmetric equilibrium, we have  $p_i = p_j$  so that

$$p_i = c + \frac{1}{\alpha} \frac{t}{n}. \quad (39)$$

In case this value exceeds  $v - \frac{t}{2}$ , each firm  $j$  charges  $p_j = v - \frac{t}{2}$ . We show that it does not pay off for firm  $i$  to charge a higher price. If firm  $i$  charges a price  $p_i$  with  $v - \frac{t}{2} < p_i \leq v - \frac{t}{2n}$ , its profit equals

$$\tilde{\pi}_i = \alpha(p_i - c) \left( \frac{p - p_i}{t} + \frac{1}{n} \right) + (1 - \alpha)(p_i - c) \frac{1}{n} \frac{2}{t} (v - p_i), \quad (40)$$

with  $p = v - \frac{t}{2n}$ . We differentiate this with respect to  $p_i$  and obtain

$$\frac{\partial \tilde{\pi}_i}{\partial p_i} = \alpha \left( \frac{p - 2p_i + c}{t} + \frac{1}{n} \right) + (1 - \alpha) \frac{2}{n} \frac{v - 2p_i + c}{t}. \quad (41)$$

The term in the large brackets is strictly negative since  $p_i > p$  and  $p_i > v - \frac{t}{2}$ . The term  $v - 2p_i + c$  is strictly negative since  $p_i > v - \frac{t}{2}$  and  $\Delta \geq t$ . Hence, it is optimal for firm  $i$  to charge  $v - \frac{t}{2}$  instead of  $p_i$ . Similarly, we can show the same for any price  $p_i > v - \frac{t}{2n}$ . Hence, it does not pay off for firm  $i$  to charge a price above  $v - \frac{t}{2}$ , which completes the proof of the first statement. Next, we show that no consumer has an incentive to deviate, given the firms' equilibrium prices. By Lemma 1 and the assumption that  $(\lambda^* - 1)\frac{7}{8}\Gamma > t$ , the proposed strategy is a PPE for loss-averse consumers. Finally, for a loss-neutral consumer it is always optimal to inspect all products and to trade with the firm  $i$  that maximizes  $u_i - p_i$ .  $\square$

*Proof of Lemma 2.* If the assigned firm  $i^*$  is also the closest firm to the consumer, the statement holds since the consumer can commit to trading with firm  $i^*$  by not inspecting all products. Assume that the assigned firm  $i^*$  is not the closest firm  $i$  to the consumer. Consider the plan “always trade with firm  $i$ .” In the market stage, the consumer's payoff from trading with firm  $i$  then equals

$$U_i = T - d_i t - (\lambda^* - 1) \frac{1}{2} \Gamma, \quad (42)$$

regardless of the realized product value  $v_i$ . Suppose the consumer deviates from this plan and trades with any other firm  $j$  that is located at distance  $d_j \geq d_i$  to the consumer. Assume first that  $v_j > v_i$ . The consumer's payoff from trading with firm  $j$  equals

$$U_j^{[h]} = T - d_j t - (\lambda^* - 1) \left( \frac{1}{2} z + \frac{1}{2} (z + 1) \right) \Gamma - (d_j - d_i) t \quad (43)$$

for some  $z \in \mathbb{N}_+$ . Next, assume that  $v_j < v_i$ . The consumer's payoff from trading with firm  $j$  then equals

$$U_j^{[l]} = T - d_j t - (\lambda^* - 1) \left( \frac{1}{2} z + \frac{1}{2} (z + 1) \right) \Gamma - \lambda^* (d_j - d_i) t \quad (44)$$

for some  $z \in \mathbb{N}_+$ . Since  $U_i > U_j^{[h]}$  and  $U_i > U_j^{[l]}$ , the original plan is a PE.  $\square$

*Proof of Lemma 3.* The proof uses the same arguments as the proof of Lemma 1. For the case

$n \geq 4$ , the upper bound on the expected payoff of alternative plan  $\tilde{\sigma}_{\lambda^*}^{[B]}$  is given by

$$\begin{aligned}\mathbb{E}[U(\pi)] &= T - \pi_0 d_{i^*} t - (\pi_1 + \pi_2) \frac{t}{4} \\ &\quad - (\lambda^* - 1) \pi_0 (\pi_1 + \pi_2 + \pi_3 + \pi_4) z^{\min} \Gamma \\ &\quad - (\lambda^* - 1) (\pi_1 + \pi_2) (\pi_3 + \pi_4) z^{\min} \Gamma \\ &\quad - (\lambda^* - 1) (\pi_1 \pi_2 + \pi_3 \pi_4) z^{\min} \Gamma,\end{aligned}\tag{45}$$

where  $\pi = (\pi_0, \dots, \pi_4)$  is defined as in the proof of Lemma 1. Note that there is no difference in firms' prices and the minimal total difference between any two products is  $z^{\min} \Gamma$ . The upper bound in (45) is strictly smaller than the payoff from the plan “always trade with firm  $i^*$ ” if

$$\begin{aligned}\mathbb{E}[\bar{U}(\pi)] &= (\pi_1 + \pi_2) \frac{t}{4} + (\pi_3 + \pi_4) \frac{t}{2} \\ &\quad - (\lambda^* - 1) \pi_0 (\pi_1 + \pi_2 + \pi_3 + \pi_4) z^{\min} \Gamma \\ &\quad - (\lambda^* - 1) (\pi_1 + \pi_2) (\pi_3 + \pi_4) z^{\min} \Gamma \\ &\quad - (\lambda^* - 1) (\pi_1 \pi_2 + \pi_3 \pi_4) z^{\min} \Gamma < 0.\end{aligned}\tag{46}$$

By applying the same arguments as in the proof of Lemma 1, we find that this inequality is satisfied if  $(\lambda^* - 1) 2z^{\min} \Gamma > t$ , which completes the proof for the case  $n \geq 4$ . The proofs for the cases  $n = 3$  and  $n = 2$  are very similar and therefore omitted.  $\square$

*Proof of Proposition 4.* The proof proceeds in the same manner as the proof of Proposition 3. It uses Lemma 3 instead of Lemma 1, but the rest is the same. We therefore omit it.  $\square$

*Proof of Proposition 5.* To establish this equilibrium, we again assume that the consumers' beliefs  $\beta(\cdot)$  are such that consumers are not making any inference about the product value  $v_i$  of a firm  $i \neq i^*$  from the product value and price of the assigned firm  $i^*$ . The proof proceeds in three steps. These steps taken together imply the statements in (a) to (d). **Step 1.** Consider a loss-averse consumer. It is a PPE for this consumer not to inspect all products and to trade with firm  $i^*$  if  $v_{i^*} - d_{i^*} t - p_{i^*} \geq 0$ , and not to trade with this firm if  $v_{i^*} - d_{i^*} t - p_{i^*} < 0$ . We can show this by using the same arguments as the proof of Lemma 1 for the case  $n \geq 4$ . To see this, note that the consumption utility from trading with a superior firm is at most  $\frac{t}{2}$  and the consumption utility from trading with an inferior firm is at most  $\frac{t}{4}$ . **Step 2.** Consider any inferior firm  $k$ . Note that if  $\Delta_{inf} \leq \frac{t}{4}$ , this firm cannot compete for loss-neutral consumers. These consumers can trade with a dominant firm  $i$  at price  $p_i = v_i - \frac{t}{2}$  and the maximal distance to a dominant firm is at most  $\frac{1}{4}$ . Hence, if  $\Delta_{inf}$  is sufficiently small, the optimal price of firm  $k$  is  $p_k > v_i - \frac{t}{4}$  so that only loss-averse consumers assigned to firm  $k$  trade with this firm. **Step 3.** Consider any superior firm  $k$ . We show that it is optimal for this firm to charge  $p_i = v_i - \frac{t}{2}$  if  $\alpha$  is sufficiently



small, given the consumers' behavior. For convenience, we apply the same normalization as in Step 2 of the proof of Proposition 1. Assume that any other firm  $j$  charges a price  $p_j = v - \frac{t}{2}$ . Firm  $i$ 's profit from charging  $p_i \leq v - \frac{t}{2}$  then equals

$$\pi_i = \alpha(p_i - c) \left( \frac{p_j - p_i}{t} + \frac{1}{n} \right) + (1 - \alpha)(p_i - c) \frac{1}{m}. \quad (47)$$

The optimal price is hence given by

$$p_i = \frac{p_j + c}{2} + \frac{t}{2} \left( \frac{1}{n} + \frac{1 - \alpha}{\alpha} \frac{1}{m} \right). \quad (48)$$

In a symmetric equilibrium, we have  $p_i = p_j$  so that

$$p_i = c + t \left( \frac{1}{n} + \frac{1 - \alpha}{\alpha} \frac{1}{m} \right). \quad (49)$$

If  $\alpha$  is sufficiently small, this value exceeds  $v - \frac{t}{2}$ . As in the proof of Proposition 3, we can show that firm  $i$  optimally charges  $p_i = v - \frac{t}{2}$  in this case. This completes the proof.  $\square$

Table A1: Overview of Empirical Studies on Inertia from Figure 1

Study	Product	Mean Price	Search Costs	Switching Costs	Share Inactive
Hong and Shum (2006)	books	35 - 95 USD	1.31 - 2.90 USD per unit	–	–
De los Santos et al. (2012)	books	8 - 23 USD	1.35 USD per unit	–	75 percent only one store
Moraga-González et al. (2013)	computer chips	116 - 182 USD	8.70 USD per unit	–	–
Giulietti et al. (2014)	electricity	260 USD	50 percent: > 41.6 USD per unit	–	93 percent do not use website
Honka (2014)	auto insurance	550 - 660 USD	30 - 40 USD per unit	40 USD	74 percent retention
Koulayev (2014)	hotels	230 USD	10 USD per page	–	35 percent only one page
Ghose et al. (2017)	hotels	231 USD	6.18 USD per unit	–	25 percent only one page
De los Santos (2018)	books	8 - 18 USD	1.24 - 2.30 USD per unit	–	75 percent only one store
Dong et al. (2021)	cosmetics	34 - 104 USD	12.66 USD per unit	–	–
Hortaçsu et al. (2017)	electricity	1800 USD	–	180 USD per year	81 percent do not search
Kiss (2019)	auto insurance	136 - 198 USD	–	53 USD	70 percent do not switch
Genakos et al. (2019)	mobile phone contracts	240 USD	–	148.8 USD [raw data]	62 percent despite pos. savings
Heiss et al. (2021)	Medicare Part D	1393 USD	–	241 - 2947 USD	88 percent do not switch