Consumer Loss Aversion and Scale-Dependent Psychological Switching Costs*

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Version: July 22, 2022

Abstract

We consider a model of product differentiation where 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, buying products of varying quality and price 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. They imply that making switching easier or costless for consumers would not motivate more switching.

Keywords: Switching Costs, Competition, Loss Aversion

JEL Classification: D21, D83, L41

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*An earlier version of this paper circulated under the title "Consumer Search and the Uncertainty Effect." We are grateful to Vincent Crawford (the editor), an anonymous associate editor, three anonymous referees, David Byrne, Juan Carlos Carbajal, Zhijun Chen, Markus Dertwinkel-Kalt, Falko Fecht, Christina Gravert, Michael Grubb, Andreas Hackethal, Paul Heidhues, Fabian Herweg, Johannes Johnen, Alexander Koch, Jonathan Kolstad, Simon Loertscher, Nicola Maaser, Kathleen Mullen, Tymofiy Mylovanov, Michaela Pagel, Thomas Pauls, Antonio Rosato, Daniel Savelle, Stephan Seiler, Marco Schwarz, Christian Waibel, Chengsi Wang, Annika Weber, Philipp Weinschenk, as well as seminar audiences at Aarhus University, Heinrich-Heine University Düsseldorf, Monash University, University of Melbourne, UT Sydney, UNSW Sydney, Behavioral Contract Theory Workshop (Osaka), Econometric Society Africa Meeting in Rabat, EARIE Conference at Barcelona, World Congress of the Econometric Society in Milan (virtual), Young Researcher Workshop CRC 224 at Montabaur, the DICE-ZEW Winter School, the MaCCI Conference (Mannheim), and the Online Workshop on Loss Aversion (Durham) for their valuable comments and suggestions. We especially thank Florian Kerzenmacher for his support of the project.

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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.[1] However, none of these explanations can fully explain consumers' failure to choose optimally. In Figure 1, we provide an overview of empirical estimates of search costs (upper graph) and switching costs (lower graph) in various markets.[2] On the x-axis, we display the average price of the transaction; on the y-axis, we show the estimated search costs (per item) and switching costs, respectively. Higher search and switching costs directly imply that, by sticking to their individual default, consumers leave more surplus on the table. 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 (in both cases, the increase is significant at the 10-percent level). These "scale-

[1] Since search and switching are related consumer activities that matter for competition between firms, we mention both of them at this stage. However, for convenience, we will mostly refer to switching costs in the main part of the paper.

[2] These estimates are based on various search/switching cost models and different types of data. In Tables A1 and A2 in the appendix, we provide an overview of the cited studies. All studies except Honka (2014) estimate either search or switching costs; Honka (2014) estimates both types of costs in one setting.

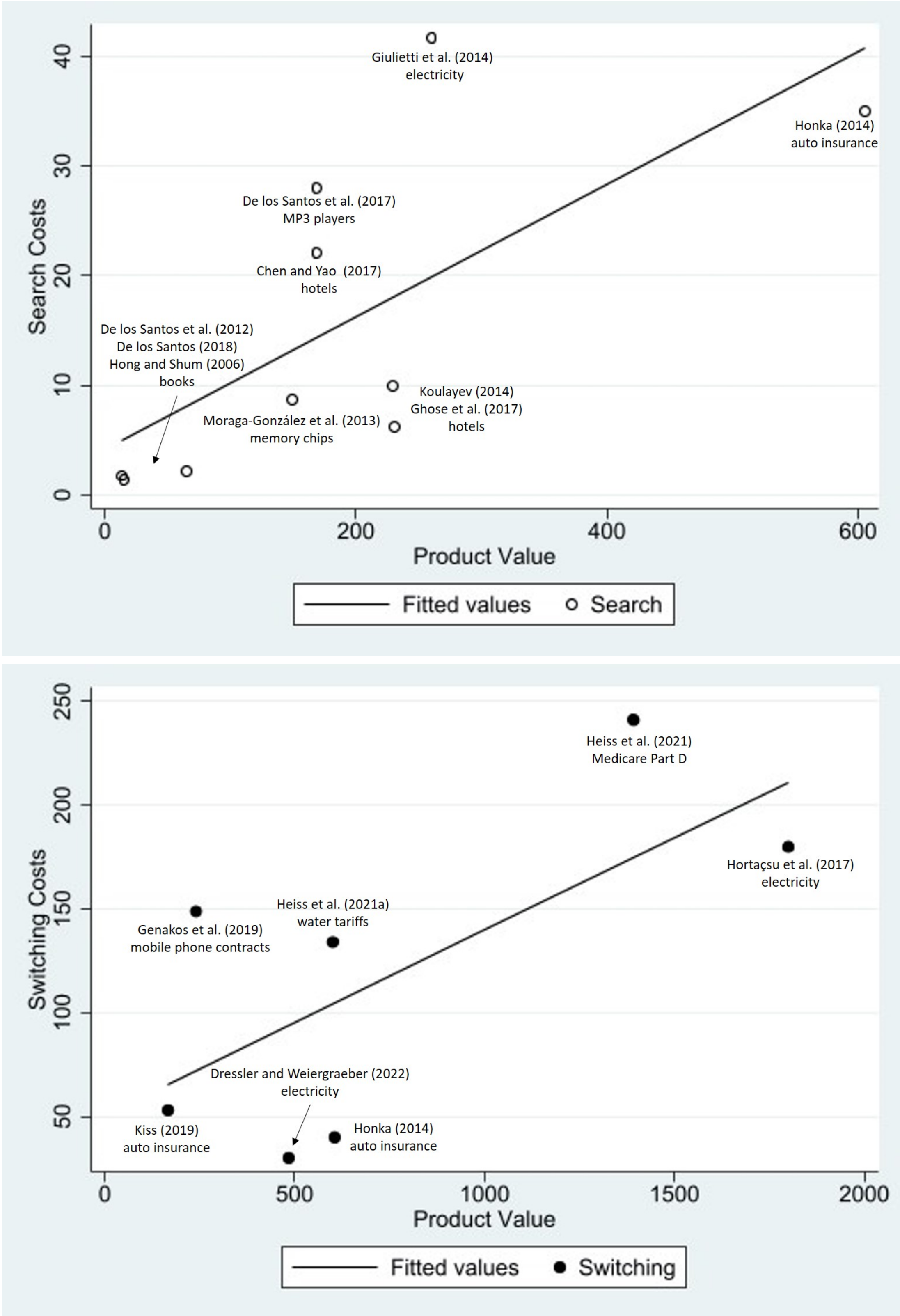

Figure 1: Overview of empirical estimates of search costs (upper graph) and switching costs (lower graph) in USD.

dependent" costs are driven by a large fraction of consumers who do not 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 consumers' failure to switch in markets where they can benefit from active choice. This explanation relies on expectation-based loss aversion and produces "scale-dependent psychological switching costs." It is consistent with utility maximization, quantitatively reasonable consumer preferences, and rational expectations. It is also compatible with inertia 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 other behavioral mechanisms like cognitive limitations, procrastination, or status-quo bias.

We examine a model with both horizontal and vertical product differentiation. 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. 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. At this stage, they face uncertainty about which product-price combinations are available in the market. The appeal of a purchase 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.

These results are driven by two behavioral properties of the expectations-based reference point model of Kőszegi and Rabin (2006, 2007). First, the consumer evaluates gains and losses in the product and price dimension separately. This separation is motivated by the endowment effect in experimental settings (Kahneman et al. 1990, 1991). It is typically explained as follows: If a subject with a product (e.g., a mug) sells it, she experiences a loss in product value and a gain in money. If a subject without a product buys it, she experiences a gain in product value and a loss in money. Due to loss aversion, the losses feel more intense than gains of equal size, so there is too little trade between subjects.

The second behavioral effect is that a consumer anticipates the gain-loss sensations she will be exposed to if she plans to purchase a product of (yet) unknown characteristics. In our model, this can be a high value product at a high price or a low value product at a low price. For example, suppose the former product has a value v_h and price p_h, the latter product has a value v_l and price p_l with $v_h > v_l$ and $p_h > p_l$, and the surplus is the same for both products,

$v_h - p_h = v_l - p_l = T$. Only one of these products is available, each one with equal probability. The loss-averse consumer's expected payoff from the plan "always purchase the product" then equals[3]

$$\underbrace{T}_{\text{consumption utility}} \quad \underbrace{-(\lambda - 1) \times \left(\frac{1}{2}\frac{1}{2}(v_h - v_l) + \frac{1}{2}\frac{1}{2}(p_h - p_l) \right)}_{\text{gain-loss utility}}, \tag{1}$$

where $\lambda > 1$ is the consumer's degree of loss aversion. The second term (titled "gain-loss utility") 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.

From equation (1) we can make several observations. First, if for given $\lambda > 1$ the differences in values $v_h - v_l$ and prices $p_h - p_l$ are large enough relative to the surplus T, the expected payoff from always purchasing the product is negative. The consumer then prefers to remain with an individual default that provides no surplus. This effect is driven by the uncertainty about outcomes in the product and price dimension. We therefore call the consumer's reaction "uncertainty effect."[4] Whether it materializes or not depends both on the firms' conduct (which determines the surplus) and the consumers' degree of loss aversion.

Next, suppose the parameters are such that the consumer strictly prefers a default with zero surplus. A (hypothetical) 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. This term positively depends on the differences between product values and prices the consumer encounters if she follows the plan "always purchase the product." Thus, the consumer's effective switching costs naturally scale according to the size of the transaction. Multiplying all values and prices, by, say, a factor of 100, would also increase the surplus by a factor of 100, but would not alter the consumer's switching behavior as the negative gain-loss utility also increases by this factor. We therefore obtain scale-dependent psychological switching costs. Note that a (hypothetical) researcher who assumes fixed physical switching costs would predict that the consumer will switch away from the default if the scaling factor, and hence surplus, is sufficiently large. The absence of switching at large scales would then mistakenly be rationalized by excessively high physical 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 firms becomes large. Loss-averse

[3]We provide a detailed derivation of this utility function in the model section.

[4]The term "uncertainty effect" has been coined by Gneezy et al. (2006). They show experimentally that some individuals may value a lottery less than its worst outcome.

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. As a result, consumer surplus is reduced, also for loss-neutral consumers, due to higher prices.

The model generates two implications that – as we explain in detail below – cannot be obtained jointly with existing explanations for consumers' failure to switch. First, we get scale-dependent switching costs. Failure to switch therefore occurs both in markets for cheap and very expensive products, as discussed above. For this, we only need to assume that the economic gains from switching are sufficiently small relative to the size of potential gain-loss sensations, or that non-switching consumers are sufficiently loss-averse.

Second, psychological switching costs imply that failure to switch can occur even if switching is simple and does neither require a major cognitive effort nor a significant time commitment. This implication is important since a standard policy recommendation in the literature is to make switching easier (e.g., by providing more information or offering online comparison tools) and less time consuming. However, a substantial share of consumers fails to switch even in settings where such recommendations have been implemented (e.g., Deller et al. 2021, Heiss et al. 2021). We can explain this phenomenon since the gain-loss sensations that create psychological switching costs are independent from cognitive effort or physical search costs.

Alternative explanations for consumers' failure to switch. Several explanations exist in the literature to make sense of consumers' failure to switch. On the most basic level, consumers may not understand the available options and therefore stick to their default, which naturally leads to scale-dependent switching costs. Indeed, Handel (2013) finds large switching costs for health insurance plans as many employees do not understand the contractual features of these plans. However, the psychological switching costs in our setting remain in place even if individuals have rational expectations and choose the payoff maximizing option.

Another important mechanism that can explain failure to switch is procrastination. If switching requires some physical effort (filling out paperwork), consumers with naive time-inconsistent preferences may repeatedly delay the decision to switch so that they are stuck with an inefficient contract (O'Donoghue and Rabin 2001, DellaVigna and Malmendier 2004). In a related paper, Heidhues et al. (2021a) exploit this mechanism and show that competition is not enough to motivate consumer switching. We believe that procrastination is an important explanation for failure to switch in many settings. However, since it relies on the presence of physical switching costs, it does not explain our two main findings, i.e., scale-dependent switching costs and failure to switch in settings where switching is essentially costless.

Some further concepts have been introduced to motivate consumer inertia, such as status-quo bias (Samuelson and Zeckhauser 1988), endowment effects (Kahneman et al. 1990), or "captive" consumers (Armstrong and Vickers 2019). These assumptions on behavior, however, do not follow from utility maximization. In contrast, we use a utility maximization framework with endogenous reference points and only rely on conservative behavioral assumptions. Another psychological mechanism that discourages choice is "choice overload." Iyengar and Lepper (2000) expose shoppers to choice sets with varying numbers of options. They find that those consumers with relatively small choice sets are more likely to choose any product. Indeed, participation in retirement funds seems to decrease in the number of available funds (Iyengar et al. 2004). Hence, many consumers may not switch products since they are confronted with too many options. Importantly, our mechanism also works if consumers can filter options through an online search tool so that there is no scope for choice overload.[5]

Our behavioral assumptions are established in an extensive empirical literature. Loss aversion is one of the most robust behavioral patterns in risky choice (Kahneman and Tversky 1979, Tversky and Kahneman 1992). It matters both for low and high stakes environments such as trade in real estate markets (Genesove and Mayer 2001) and labor supply (Crawford and Meng 2011). 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.[6] Loss aversion is closely linked to mental accounting (and the endowment effect). It describes individuals' tendency to assess gains and losses separately across different dimensions (Kahneman et al. 1990, 1991, Thaler 1985, 1999), so that expenditures are assigned to different categories. For example, an insurance customer may treat regular premium payments and (unexpected) out-of-pocket expenses as different dimensions. Indeed, in second-price auctions for real objects, Rosato and Tymula (2019) find evidence for mental accounting with respect to product value and money.

The rest of the paper is organized as follows. Section 2 relates our contribution to the literature. In Section 3, we introduce the model and the equilibrium concept. In Section 4, 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

[5]Moreover, the robustness of the choice overload hypothesis is contested (see, e.g., Scheibehenne et al. 2010).

[6]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.

our results. In Section 5, we consider a version of our model in which firms offer products with multiple value dimensions. In Section 6, we discuss a number of extensions and alternative explanations. Section 7 concludes. All proofs are relegated to the appendix.

2 Related Literature

Our paper contributes to the behavioral industrial organization literature.[7] Several papers in this literature study competitive markets with expectation-based loss-averse consumers. The seminal paper of 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 makes it optimal for firms to charge a uniform price, even if they exhibit 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 Kőszegi (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.

Heidhues and Kőszegi (2014), Rosato (2016), and Karle and Schumacher (2017) examine monopolistic settings with expectation-based loss-averse consumers. These papers study a monopolist's optimal pricing and marketing strategy when expectations of ownership attach consumers to its product. A monopolist can create attachment through a sophisticated pricing strategy (as in Heidhues and Kőszegi 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 loss aversion preferences in market settings. Herweg and Mierendorff (2013) show that a monopolist can screen between consumer types 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. They therefore have the commitment power to choose their individual default so that the plan "do not inspect any product and choose the default" is

[7] See Heidhues and Kőszegi (2018) for an extensive overview of this literature.

always a personal equilibrium.[8] 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 rationalizes a variety of phenomena with expectation-based loss-averse decision-makers. Two recent papers exploit a mechanism that is similar to the uncertainty effect to explain the misrepresentation of preferences in deferred acceptance mechanisms used, e.g., in college-choice problems; see Dreyfuss et al. (2021) and Meisner and von Wangenheim (2021). 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 uncertainty effect in our framework. Dreyfuss et al. (2021) re-evaluate experimental data taking loss aversion into account, Meisner and von Wangenheim (2021) 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. 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 generates scale-dependent switching costs.

Finally, we are contributing to a growing literature on search markets with boundedly rational consumers. Gamp and Krähmer (2022) 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.

[8]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 Kőszegi (2014) or Rosato (2016) assume that consumers are forced to inspect all products (e.g., they cannot avoid going to the supermarket).

3 The Model

We consider the competition of $n \geq 2$ firms $i = 1, ..., n$ for a unit mass of consumers (we suppress notation for individual consumers). There is both horizontal and vertical product differentiation. To capture horizontal differentiation, we use the model of Salop (1979). Consumers are uniformly distributed on a circle with perimeter equal to 1. Firms take on predefined equidistant positions on this circle; see the graph on the left of Figure 2 for an example with two firms. There is no assumption on the order with which firms appear on the circle.

To capture vertical differentiation, we assume that firms offer heterogeneous product values. Denote by v_i the product value of firm i. With probability $\frac{1}{2}$ this value is low, $v_i = v_{i.l} > 0$, and with probability $\frac{1}{2}$ it is high, $v_i = v_{i.h}$. Firms' product values are drawn independently from each other. To simplify notation, we assume that all 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 the graph on the right of Figure 2 for the example with two firms.[9] 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 Δ. 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 $u_i - p_i = v_i - d_i t - p_i$, where d_i is the minimal distance between firm i and the consumer on the circle (see the left graph of Figure 2 for an example), and t the degree of horizontal product differentiation. If a consumer does not trade at all, her payoff is zero. Firm i's payoff is the mass of consumers it serves times $p_i - c_i$.

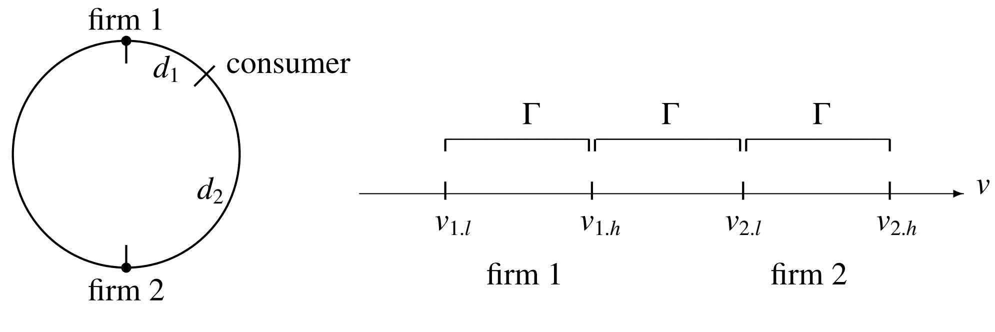

Figure 2: Example parametrization of horizontal and vertical product differentiation for $n = 2$

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

[9] The order of product values is not essential for our results (i.e., we could also reverse it). The parametrization and the assumption on the probability distribution over product values allow us to economize on notation, but again are not important for our main results. Moreover, our results also do not depend on vertical product differentiation. In Section 5, we consider a setting in which all firms offer the same product value.

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

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

where the function μ captures gain-loss utility. We assume that μ is piecewise linear with $\mu(0) = 0$, slope 1 for positive values, and slope $\lambda \geq 1$ for negative ones. Thus, λ 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 $\lambda = \lambda^* > 1$.[10]

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

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

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 $\frac{1}{2}$, then an outcome of 6 units feels like a gain of 6 units weighted with $\frac{1}{2}$ probability, and a loss of 4 units also weighted with $\frac{1}{2}$ probability.

Pricing and Inspection. There are three stages. In Stage 1 – the "pricing stage" – firms observe the realization of product values $V = (v_1, ..., v_n)$. 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^*}. At this stage, she does not yet know the product value and price of any other firm $i \neq i^*$; she only knows the probability distribution over product values and the location of each firm i (and hence distance d_i). The consumer then chooses whether to inspect the other products in the next stage. Inspection is a binary decision $a \in \{0, 1\}$. If the consumer chooses to inspect all products, $a = 1$, she will observe all product values and prices in the next stage (for example, on a price comparison website). If she chooses not to inspect any product, $a = 0$, she will only observe the product value and price of the assigned firm i^*. At the end of Stage 2, the consumer makes a plan and forms expectations about the outcomes it induces in the product and price dimension. This determines her reference point. In Stage 3 – the "market stage" – the consumer chooses the

[10]Here we implicitly assume that the weight of gain-loss sensations in the utility function – often denoted by the parameter η – equals one. We only do this in order to economize on notation.

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.

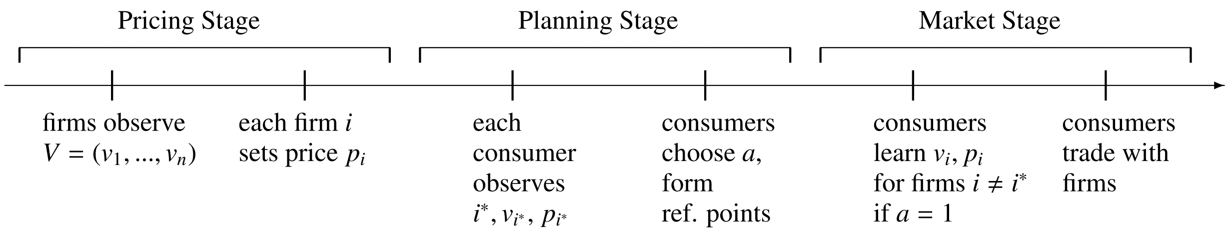

Figure 3: Timeline

Strategies and Equilibrium. We formally define the game. Let $\mathcal{V}$ be the set of all possible realizations V. Firm i's strategy σ_i maps the realization V into a price p_i, $\sigma_i : \mathcal{V} \rightarrow \mathbb{R}_+$. Let $\sigma_f = (\sigma_1, ..., \sigma_n)$ be the firms' strategy profile. For a given strategy profile σ_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 λ 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 assigned firm i^*, product value v_{i^*}, price p_{i^*}, and the consumer's location on the circle x into an inspection decision $a \in \{0, 1\}$,

$$\sigma_\lambda^{[A]} : \{1, ..., n\} \times \mathbb{R}_+ \times \mathbb{R}_+ \times [0, 1] \rightarrow \{0, 1\}, \tag{4}$$

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

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

where $b = nb$ represents no purchase and $b = i$ represents trade with firm i. The consumers' strategies have to obey the restriction that, if no inspection took place ($a = 0$), then b is a constant, equal to i^* or nb, at given values i^*, v_{i^*}, p_{i^*}, x. 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 by $G^u \equiv G^u(\tilde{u} \mid \sigma_f, \sigma_\lambda^{[co]}, x, \beta(V \mid i^*, v_{i^*}, p_{i^*}))$ her expectations regarding the outcome in the product dimension, 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 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, for given firm strategy and beliefs. We now can define the consumer's personal equilibrium as well as the equilibrium of the complete game.

Definition 1. *Let the firms' strategy σ_f and the consumers' beliefs β be given. The consumer strategy $\sigma_\lambda^{[co]}$ is a personal equilibrium (PE) if at any possible assigned firm i^*, realization V, prices $(p_1, ..., p_n)$, and location on the circle 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 σ_f and the consumers' beliefs β be given. The consumer strategy $\sigma_\lambda^{[co]}$ is a preferred personal equilibrium (PPE) if it is a personal equilibrium and*

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

for any possible assigned firm i^*, product value v_{i^*}, price p_{i^*}, location on the circle 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 σ_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 σ_f, β, and β is derived from the firms' strategy σ_f and Bayes' rule whenever possible.*

4 The Market Equilibrium

In this section, we study the market equilibrium in our framework. In Subsection 4.1, we consider the benchmark case when all consumers are loss-neutral. In Subsection 4.2, we examine the framework with loss-neutral and loss-averse consumers and state our main results. Finally, in Subsection 4.3, we derive from these results a number of implications for switching costs, consumer and firm behavior.

4.1 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 1(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.

Proposition 1 is consistent with the results of Anderson and Renault (1999) who consider a market model with search costs and product differentiation. They also find that if the degree of product differentiation is small enough relative to search costs, then the Diamond Paradox outcome obtains. However, if search costs are sufficiently small for a given degree of product differentiation, then the equilibrium price decreases in the number of firms.

4.2 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 payoff u_i at a high price p_i or a low payoff u_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[11] "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 σ_f is such that each firm i offers the same positive payoff net of transportation costs $v_i - p_i$ 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.

[11] 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.

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 Γ. If the degree of horizontal product differentiation t is small enough relative to Γ, then the consumer prefers trading with the assigned firm i^* to trading with the closest firm i.

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 $T \in [\frac{t}{2}, \Delta]$. Consider a loss-averse consumer assigned to any firm i^*. The plan "always trade with firm i^*" is a PPE for this consumer if $(\lambda^* - 1)\Gamma > t$.*

This result characterizes a loss-averse consumer's PPE when all firms charge the same 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 $(\lambda^* - 1)\Gamma > t$ is a conservative condition on the degree of loss aversion λ^* and the product differentiation parameters Γ, 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 $\lambda^* > 1$ 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, an uncertainty 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 any product. We therefore obtain the following result.

Proposition 2. *Suppose that all consumers are loss-averse ($\alpha = 0$). If we have $(\lambda^* - 1)\Gamma > t$, 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 any product 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 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 $(\lambda^* - 1)\Gamma > t$, 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 any product and trade with the assigned firm, and

(c) loss-neutral consumers trade with the closest firm.

The condition $(\lambda^* - 1)\Gamma > t$ 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 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. Firms' equilibrium prices depend on the share α of loss-neutral consumers. Observe that, as the share of loss-neutral consumers converges towards unity, $\alpha \to 1$, the equilibrium price of each firm i converges towards the competitive level of the canonical model, $p_i \to c_i + \frac{t}{n}$. 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 the consumer.*

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

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

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

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

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.

4.3 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 uncertainty 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	α	1	0
group 2	$(1-\alpha)\frac{1}{n}$	λ^*	0
group 3	$(1-\alpha)\frac{n-1}{n}$	λ^*	$\frac{t}{4}$

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, 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[12] 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).

The forgone surplus can be interpreted both in monetary terms or in terms of product quantity. For example, if the product is an insurance contract, the product dimension may be the

[12]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.

degree of insurance protection (i.e., the payout in case of damage), while the price dimension is the insurance premium. Consumers in the wrong contract then purchase to much or too little insurance given their risk preferences. Another example are mobile phone contracts. The product dimension then captures services that are free of charge, while the price dimension are fixed monthly payments. Consumers who choose the wrong contract then purchase too much or too little of these services given their user type.

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

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

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. The negative payoffs from gain-loss sensations are "psychological switching costs." By equation (6), these are given by

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

In contrast to physical switching costs, psychological switching costs depend on the consumer's degree of loss aversion λ^* 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 Γ. 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 that consumers' behavior and firm conduct can be changed by "reducing" search and switching costs, see Luco (2019) for an 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

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

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 need a small additional payoff 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 small relative to their forgone surplus.

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.[13] 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 Kőszegi (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

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

such an equilibrium exists. In this equilibrium, loss-averse consumers are no longer exposed

[13] Heidhues et al. (2021b) find a similar result in a framework with only rational consumers.

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." While in equilibrium loss-averse consumers do not inspect any product, 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[14]

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

Note that a switching consumer would either get a higher product value and pay a higher price (than expected) or get a lower product value and pay a lower price. These gain-loss sensations on average reduce her payoff, see the second term, $-(\lambda^* - 1) \mid v_{i^*} - v_i \mid$. The value in (12) is negative if t is small enough relative to Γ. 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. 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 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 are 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

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

hardly differentiated. Some industries like the financial services industry exhibit this feature. Heidhues et al. (2017) consider a model where the equilibrium outcome can have the same property. However, their rational 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.

5 Multi-Dimensional Product Values

In our baseline model, gain-loss sensations are caused by differences in product value and price. The uncertainty 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.[15] Similarly, Bordalo et al. (2013) define preferences with salience distortions 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.[16] Production costs are given by c with $v - c = \Delta > 0$. Products now differ along $K \geq 2$ dimensions. Denote by v_i^κ the value of firm i's product in dimension κ. This number is a multiple of Γ and can take on the values $0, \Gamma, 2\Gamma, ...$; the total product value equals $\sum_{\kappa=1}^{K} v_i^\kappa = v$. Let $v_i = (v_i^1, ..., v_i^K)$ be the specification of firm i's product. For convenience,

[15] Kőszegi and Rabin (2006) interpret different dimensions as different products (one of them being money). In this section, we interpret them as different dimensions of a single product.

[16] 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.

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 $\kappa \in \{1, ..., K\}$, distance $\tilde{d}$, and price $\tilde{p}$. Denote $\tilde{v} = (\tilde{v}^1, ..., \tilde{v}^K)$ the expected product specification. If the consumer trades with firm i, her total utility equals

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

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: It is $v_i = v_{i.l}$ with probability $\frac{1}{2}$ and $v_i = v_{i.h}$ 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 distance function

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

Let z^{min} be the minimal distance 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 any product 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 difference between any two products as captured by $z^{min}\Gamma$ is sufficiently large.

6 Extensions and Robustness

We discuss several extensions of our framework. In Subsection 6.1, we extend our baseline model by considering heterogeneous firms. In Subsection 6.2, we demonstrate that our results also obtain under alternative search models. In Subsection 6.3, we consider the role of physical search costs. In Subsection 6.4, we argue that pessimistic beliefs would enlarge the scope for the uncertainty effect in our framework. In Subsection 6.5, we briefly discuss to what extent our results also would obtain with risk aversion. Finally, in Subsection 6.6, we consider an alternative personal equilibrium definition for loss-averse consumers.

6.1 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 $i \in \{1, ..., n\}$ is "superior" and generates surplus $v_i - c_i = \Delta$. Each firm $k \in \{n+1, ..., m\}$ is "inferior" and generates only surplus $v_k - c_k = \Delta_{inf} < \Delta$. All firms are distributed on equidistant positions 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 Γ 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 Δ_{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 $i = 1, ..., n$. 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 α^*, Δ^*_{inf}, such that, if $\alpha < \alpha^*$, $\Delta_{inf} < \Delta^*_{inf}$, and $(\lambda^* - 1)\Gamma > t$, 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 any product 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 $\frac{m-n}{m}$. Note that loss-averse consumers who trade with an inferior firm pay a relatively high price compared to consumers who trade with superior firms.

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, the presence of loss-averse consumers allows inferior firms to remain in business. If all consumers were loss-neutral and Δ_{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 $\Delta_{inf} > 0$.

6.2 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 would also hold under alternative standard search models. In particular, the result in Lemma 1 that "always trade with firm i^*" is a loss-averse consumer's PPE if $(\lambda^* - 1)\Gamma > t$ 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 $(\lambda^* - 1)\Gamma > t$. 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.

6.3 Physical Inspection Costs

In our benchmark cases in Subsection 4.1, 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

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

By Lemma 1, it is then the unique PPE outcome for loss-averse consumers to trade with the assigned firm if $(\lambda^* - 1)\Gamma > t$. The inspection costs just provide an additional reason to avoid inspection. All loss-averse consumers now have a strict preference not to inspect any product (recall from our discussion of the window shoppers in Subsection 4.3 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 would not notice a price cut by a neighboring firm.

6.4 Pessimistic Beliefs

So far, we assumed that consumers have rational expectations about the distribution of product values and firms' conduct. Loss-averse consumers then do not inspect any product when the expected increase in surplus 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 are related to 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 uncertainty 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.

6.5 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 $u(v_i - d_i t - p_i)$ from trading with firm i. In the market stage, when the consumer makes her final choice, the term $v_i - d_i t - p_i$ is certain for each firm i. The risk-averse consumer would therefore always trade with the firm i that maximizes $v_i - d_i t - p_i$, 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.

6.6 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 the plan she 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 product of the assigned firm i^*, which generates a 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

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

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 any product 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 the 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.

The distinction between CPE and PPE has a further interesting implication. Recall that, under the PPE, a loss-averse consumer who wastes surplus may be indifferent between inspecting and not inspecting all products. She may well engage into window shopping. In contrast, under the CPE, such a consumer has a strict preference to avoid any information about other products. Therefore, she may have a higher valuation for privacy in online settings so that she does not, unexpectedly, encounter advertisements on tempting alternatives.

7 Conclusion

Our goal in this paper was to provide an explanation for consumers' failure to switch in markets where they can choose between different products and both information gathering and switching requires only little effort. Loss-averse consumers may derive disutility 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 a certain individual default even when this default offers less surplus than another available uncertain option. This uncertainty effect can occur for modest degrees of loss aversion.

We considered a model with horizontal and vertical 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 increase in the value of the transaction. Psychological switching costs imply that a policy, which lowers the hassle costs of changing contracts, may not be enough to motivate more consumer switching.

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 price reduction – 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 uncertainty effect. Future empirical work may be able to evaluate whether the reduction in product dimensions that are uncertain positively affects search and switching behavior.

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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 any product 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 $v_j - (v_j - \frac{t}{2}) - e = \frac{t}{2} - e$, 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

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

Firm i would then benefit from charging a lower price if

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

This inequality is implied by

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

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 $v \equiv v_{n.h}$, 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 $p_1, ..., p_n$ be the equilibrium prices of all firms. Assume w.l.o.g. that $p_i \geq p_j$ for all $j = 1, ..., n$. 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

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

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. The marginal consumer in this group is defined by

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

Thus, 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. The marginal consumer in this group is defined by

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

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

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

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

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

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

$$p_i > c_i + \frac{t}{n-1}, \tag{25}$$

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 $j = 1, ..., n$. 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. □

Proof of Lemma 1. 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^*. The plan "always trade with firm i^*" is a PE (since the consumer can choose not to inspect any product). It is also a 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 plan $\tilde{\sigma}_{\lambda^*}^{[B]}$ the consumer may adopt after inspecting all products. We find an upper bound on the expected payoff 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 γ, ξ 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 γ, ξ 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 γ, ξ 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. In words, under the alternative plan, the consumer trades with the three firms i^*, j, i according to the probabilities with which she trades (in the original plan) with firms that are d_{i^*}, at least $\frac{1}{4}$, and less than $\frac{1}{4}$, respectively, away from her. Define

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

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

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

We now define an upper bound on the expected utility from the alternative plan, which, by construction, also holds for the original plan. Define $\pi = (\pi_0, ..., \pi_4)$. The upper bound is then given by

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

The first line on the left-hand side of equation (29) is an upper bound on the consumption utility of the alternative plan. For this, note that the distance of the firm with which the consumer trades is d_{i^*} with probability π_0, it is at least $\frac{t}{4}$ with probability $\pi_1 + \pi_2$, and it can be zero with probability $\pi_3 + \pi_4$. The remaining lines are an upper bound on the gain-loss utility of the alternative plan. Observe that the minimal difference in the payoff from two different firms' products is $\Gamma - \frac{t}{2}$, the minimal difference in the payoff from products of the same firm is Γ, and the minimal difference in the price of any two products is also Γ. Hence, the minimal sum of differences in the product and price dimension between any two products is $2\Gamma - \frac{t}{2}$ and the minimal sum of differences in the product and price dimension between two products of the same firm is 2Γ. The upper bound in (29) is strictly smaller than $T - d_{i^*}t$ (the payoff from the plan "always trade with firm i^*") if

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

To obtain this upper bound, we set d_{i^*} to its maximal value $\frac{1}{2}$. We now find an alternative plan that maximizes $\mathbb{E}[\bar{U}(\pi)]$. Consider the following variation of an alternative plan (characterized by positive values $\pi'_0, ..., \pi'_4$): $\pi_y = \pi'_y - \varepsilon$ and $\pi_z = \pi'_z + \varepsilon$ with $y \in \{0, 1, 2\}$ and $z \in \{3, 4\}$ or $y = 0$ and $z \in \{1, 2\}$. In words, a variation shifts probability of trade between the three firms i^*, j, i. For any such variation we get

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

where C_1 is some constant, C_2 is a strictly positive constant, and C_1, C_2 are independent of π_y and π_z. From this it follows that there exists a corner-solution among those admissible vectors

π 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 γ, ξ, and (since π has five entries and firm j is further away from the consumer than firm i) 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 π that represent candidate alternative plans for a maximum of $\mathbb{E}[\bar{U}(\pi)]$. Observe from equation (30) that, for each of these vectors π, we can write the value of $\mathbb{E}[\bar{U}(\pi)]$ as $D_1 - (\lambda^* - 1)D_2$; D_1 is consumption utility and D_2 are expected gain-loss sensations. Given that $\Gamma \geq t$, the vector π 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 "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 π. Using $\Gamma \geq t$ again, we get that this is the case if $t < (\lambda^* - 1)\Gamma$. This completes the proof of the result for $n \geq 4$. **Step 2.** Assume that $n = 3$. We consider any alternative plan $\tilde{\sigma}_{\lambda^*}^{[B]}$ 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 γ, ξ 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 γ, ξ and the consumer trades with firm i^*; define $\pi_j^{\gamma,\xi}$ and $\pi_i^{\gamma,\xi}$ accordingly. Define $\pi = (\pi_0, ..., \pi_4)$ as in the equations (26) to (28). An upper bound on the expected utility from plan $\tilde{\sigma}_{\lambda^*}^{[B]}$ is given by

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

Note that the distance of the firm with which the consumer trades is d_{i^*} with probability π_0, it is at least $\frac{t}{6}$ with probability $\pi_1 + \pi_2$, and it can be zero with probability $\pi_3 + \pi_4$. The minimal difference in the payoff from two different firms' products is $\Gamma - \frac{t}{3}$, the minimal difference in the payoff from products of the same firm is Γ, and the minimal difference in the price of any two products is also Γ. The plan "always trade with firm i^*" is a PPE if

$$\begin{aligned}
\mathbb{E}[\bar{U}(\pi)] \quad \equiv \quad & (\pi_1 + \pi_2)\frac{t}{6} + (\pi_3 + \pi_4)\frac{t}{2} \\
& -(\lambda^* - 1)\pi_0(\pi_1 + \pi_2 + \pi_3 + \pi_4)\left(2\Gamma - \frac{t}{3}\right) \\
& -(\lambda^* - 1)(\pi_1 + \pi_2)(\pi_3 + \pi_4)\left(2\Gamma - \frac{t}{3}\right) \\
& -(\lambda^* - 1)(\pi_1\pi_2 + \pi_3\pi_4)2\Gamma < 0. \qquad (33)
\end{aligned}$$

By applying the same arguments as Step 1, we can show that this is the case for any admissible vector π 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 $\tilde{\sigma}^{[B]}_{\lambda^*}$ the consumer may adopt after inspecting all products. We again proceed in a similar manner as in Step 1. Denote by firm i the firm that is closest to the consumer. Define scenario $\gamma \in \{1, 2\}$, where $\gamma = 1$ indicates $v_i = v_{i.l}$ and $\gamma = 2$ indicates $v_i = v_{i.h}$. Let $\pi^{\gamma}_{i^*}$ be the probability induced by plan $\tilde{\sigma}^{[B]}_{\lambda^*}$ that the scenario is γ and the consumer trades with firm i^*; define π^{γ}_{i} accordingly. We now set $\pi_0 = \pi^1_{i^*} + \pi^2_{i^*}$, $\pi_1 = \pi^1_i$, and $\pi_2 = \pi^2_i$. Define $\pi = (\pi_0, \pi_1, \pi_2)$. An upper bound on the expected utility from plan $\tilde{\sigma}^{[B]}_{\lambda^*}$ is then given by

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

The plan "always trade with firm i^*" is a PPE if

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

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

Proof of Proposition 2. To establish this equilibrium, we assume that 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^*. By Lemma 1, it is a PPE to not inspect any product and to trade with the assigned firm i^* if and only if $v_{i^*} - p_{i^*} - d_{i^*} t \geq 0$, 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. □

Proof of Proposition 3. To establish this equilibrium, we again assume that 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 any product and trade with the assigned firm i^* if and only if $v_{i^*} - p_{i^*} - d_{i^*} t \geq 0$. 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

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

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

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

The optimal price is hence given by

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

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

$$p_i = c + \frac{1}{\alpha}\frac{t}{n}. \tag{39}$$

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

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

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

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

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 this for any price $p_i > v - \frac{t}{2n}$. Hence, it does not pay off for firm i to charge a price $p_i > v - \frac{t}{2}$, 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 $(\lambda^* - 1)\Gamma > t$, 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 $u_i - p_i$. □

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

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

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 then equals

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

for some $z \in \mathbb{N}_+$. The term in the large bracket comes from the fact that the consumer's reference point in the product and price dimension is stochastic. Next, assume that $v_j < v_i$. The consumer's payoff from trading with firm j then equals

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

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

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 an alternative plan $\tilde{\sigma}_{\lambda^*}^{[B]}$ is given by

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

where $\pi = (\pi_0, ..., \pi_4)$ 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

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

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. □

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. □

Proof of Proposition 5. To establish this equilibrium, we again assume that 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 any product and to trade with firm i^* if $v_{i^*} - p_{i^*} - d_{i^*}t \geq 0$, and not to trade with this firm if $v_{i^*} - p_{i^*} - d_{i^*}t < 0$. 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 profitably for loss-neutral consumers. These consumers can trade with a superior firm i at price $p_i = v_i - \frac{t}{2}$ and the maximal distance to a superior firm is at most $\frac{1}{4}$. Hence, if Δ_{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 α 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 superior firm j charges a price $p_j \leq v - \frac{t}{2}$. Firm i's profit from charging $p_i \leq v - \frac{t}{2}$ then equals

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

The optimal price is hence given by

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

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

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

If α 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. □

Table A1: Overview of Empirical Studies on Search Costs from Figure 1

Study	**Product**	**Mean Price**	**Search 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)	memory 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	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 et al. (2017)	MP3 players	169 USD	28 USD per unit	–
Chen and Yao (2017)	hotels	169 USD	22 USD per unit	–
De los Santos (2018)	books	8 - 18 USD	1.24 - 2.30 USD per unit	75 percent only one store

Table A2: Overview of Empirical Studies on Switching Costs from Figure 1

Study	**Product**	**Mean Price**	**Switching Costs**	**Share Inactive**
Honka (2014)	auto insurance	550 - 660 USD	40 USD	74 percent retention
Hortaçsu et al. (2017)	electricity	1800 USD	180 USD	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	62 percent despite pos. savings
Heiss et al. (2021)	Medicare Part D	1393 USD	241 USD	88 percent do not switch
Heiss et al. (2021a)	water tariffs	600 USD	134 USD	72 percent do not switch
Dressler and Weiergraeber (2022)	electricity	484 USD	30 USD	–