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JEL Classification: D21, D83, L41

Keywords: consumer search, Competition, loss aversion

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1 Introduction

The virtue of competitive markets is that they supply consumers with products that best satisfy their needs at prices equal to marginal production costs. In the absence of market frictions, the equilibrium in a competitive market is therefore efficient. An implicit assumption in the deduction of this statement is that consumers choose from the set of available offers a product that maximizes their payoff subject to their budget constraint. However, in many important markets such as health insurance, electricity, or mobile phones this does not seem to be the case. There is mounting evidence that a large fraction of consumers choose inferior products or do not switch to options that dominate their individual default. Firms may exploit this behavior by increasing mark-ups or selling inferior products, thereby reducing total welfare. Thus, consumer behavior is a major concern for market regulation and public policy.

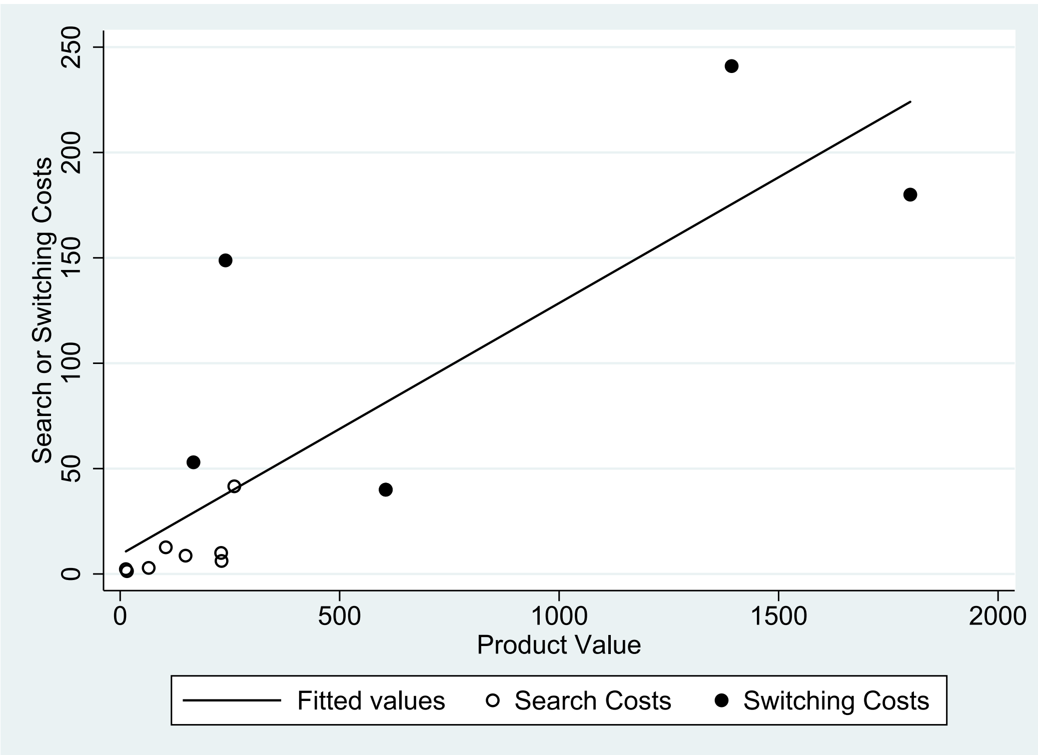

Figure 1: Overview of empirical estimates of search and switching costs (in USD)

To explain the consumers' failure to choose optimally, economists often invoke search or switching costs. 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. In Figure 1, we provide an overview of empirical estimates of search and switching costs in various markets.[1] On the x-axis, we display the average price of the transaction; on the y-axis, we show the estimated search costs (per item) or switching costs. Importantly, in all shown cases, search and switching can be done online, and in the case of complex products, such as health plans, there exists a well-known online comparison tool that suggests the best option based on the consumer's self-reported attributes. If such a tool is missing, then failure to choose optimally may just be the result of consumers' inability to understand complex product information.[2] Thus, in all cited settings, the time, hassle, and cognitive effort required to find the best (or a very reasonable) option should be rather small.

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

Our goal in this paper is to provide an explanation for inattentive behavior in markets where consumers can choose between different products. The proposed mechanism produces scale-dependent search and switching costs, and it is consistent with quantitatively reasonable consumer preferences and rational expectations. It is also compatible with inattentive behavior in other domains like financial decision making (e.g., Pagel 2018, Andries and Haddad 2020). We demonstrate that consumers' response to scale-dependent search or switching costs can lead to relaxed competition between firms, and we derive predictions that can be evaluated

[1] These estimates are based on various search/switching cost models and different types of data. In Table 3 in the appendix, we summarize the details of the cited studies.

[2] We therefore did not include estimates from Handel (2013) or Handel and Kolstad (2015) in Figure 1. In these studies, employees have to choose between different health plans, and many of them do not fully understand the contractual features of these plans.

empirically. Finally, we provide suggestive evidence for these predictions in new survey data.

We examine a simple model of Bertrand competition in which heterogeneous firms offer products of varying value. Consumers can inspect all products free of charge and then can choose the product that offers the largest surplus, i.e., product value minus price. Thus, we abstract away from time and hassle costs in our baseline model.[3] Instead, we follow Kőszegi and Rabin (2006, 2007) and assume that a fraction of consumers is expectation-based loss averse. Before inspecting all products, they make a plan which product (if any) they purchase when they encounter a certain set of product-price combinations. The attractiveness of this plan depends on the gain-loss sensations that 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 this plan and to stick to an individual default even if this default offers no surplus.

To illustrate, assume that, in order to realize a surplus of $\Delta > 0$, a consumer has to adopt a plan where she purchases with probability $\frac{1}{2}$ a high value product at a high price and surplus Δ, and with probability $\frac{1}{2}$ a low value product at a low price and surplus Δ. Only one of these products exists (each one with equal probability) and the consumer has to inspect products to find out which one it is. Let Γ be the difference between values and prices of the two products. A loss-neutral consumer would only care about the surplus Δ and realize this plan. In contrast, an expectation-based loss-averse consumer suffers from the uncertainty about the product value she is going to get and the uncertainty about the price she is going to pay. In both the product and price dimension a high and a low outcome are possible. The loss-averse consumer's expected payoff from the plan (which we explain in detail below) equals

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

where $\lambda > 1$ is the consumer's degree of loss aversion. The first term, Δ, is the consumer's surplus. The second term, $(\lambda - 1)\frac{1}{2}\Gamma$, is the consumer's disutility from gain-loss sensations in the product and price dimension. It reflects that high value (gain in value) comes with a high price (loss in money), and vice versa for the low value product. Overall, this leads to an expected net loss in both dimensions. Note that if the consumer's surplus Δ is too small relative to the extent of gain-loss sensations scaled by Γ, the expected payoff from the

[3]As we discuss in Section 6, we can also allow for such costs in our framework.

plan is negative. The consumer then prefers not to carry out the plan and to remain with an individual default that provides no surplus. Following the literature (Gneezy et al. 2006), we call such a reaction to the uncertainty involved in a plan "uncertainty effect." Whether the uncertainty effect materializes depends both on the firms' conduct and the consumers' degree of loss aversion.

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

We show that the presence of some loss-averse consumers can significantly change firms' conduct and welfare. In our framework, if consumers were loss neutral, then the firm with the best product (henceforth the "dominant firm") would price all other firms out of the market and serve all consumers, so that all gains from trade would be realized. However, when there are loss-averse consumers, each firm that sells an inferior product can retain some of them at the monopoly price since these consumers do not make a plan that involves searching for better deals. This reduces competitive pressure on the dominant firm, which then serves all loss-neutral consumers (who search the market) and some loss-averse consumers at a price that is close to the monopoly price. The firms' conduct then makes it optimal for loss-averse consumers not to inspect the available products even when they exhibit moderate degrees of loss aversion ($\lambda \approx 2$). This equilibrium is inefficient since inferior firms serve a positive share of consumers; moreover, consumer surplus is reduced, also for loss-neutral consumers, due to higher prices.

This result is essentially a robust version of the Diamond Paradox. Due to loss aversion, it may hold even if consumers experience individual, firm-specific and positive taste shocks of size Δ. These would make search beneficial for loss-neutral consumers and therefore rule out the original version of the paradox. We only need to assume that Δ is small relative to the size of potential gain-loss sensations. Importantly, this implies that the Diamond Paradox outcome may persist even if physical search and switching costs are reduced to zero, which is often suggested as a pro-competitive policy measure.

The framework can be extended in a number of ways. We replicate our results in a setting where products offer the same total value, but differ in multiple value dimensions such as customer support, delivery times, or firm reputation. If these aspects are sufficiently important, our model can also be applied to markets for homogeneous goods such as electricity. Furthermore, we discuss how biased consumer expectations about the attractiveness of available deals may exacerbate the uncertainty effect, how the model can be combined with explicit time and hassle costs, what consumer loss aversion implies for optimal marketing, and why our results do not obtain when consumers are risk- instead of loss-averse.

Our model generates two clear predictions that can be tested in empirical work: Loss-averse consumers are less likely to inspect available deals than loss-neutral consumers, and they are more likely to forgo advantageous deals (even after controlling for other factors that may generate such a correlation). We provide some suggestive evidence for the second prediction using a new survey with consumers from a large German retail bank. In these data, we find a strong positive correlation between consumers' degree of loss aversion and their tendency to agree with the statement "I pay too much for my contracts (e.g. internet, electricity)." Importantly, this correlation obtains even after controling for education, financial literacy, and household income, and it does not obtain with an alterantive risk preference measure that elicits individuals' risk tolerance.

To explain consumer inertia, economists used various concepts, such as status-quo bias (Samuelson and Zeckhauser 1988), random or rational inattention, or "captive" consumers (e.g., Armstrong and Vickers 2019). The behavior of loss-averse consumers in our model appears as if they were subject to these biases. We can quantify this behavior with one measurable parameter λ. Using loss aversion as an explanation is appealing since the different behavioral components needed for this explanation are firmly established in the empirical and experimental literature. We briefly outline the evidence on loss aversion, expectation-based reference points, mental accounting, and the uncertainty effect, and relate those concepts to consumer behavior in our model.

Loss aversion and expectation-based reference points. Loss aversion is one of the most robust behavioral patterns in lottery and riskless choice (Kahneman and Tversky 1979, Kahneman et al. 1990, Tversky and Kahneman 1992). The degree of loss aversion varies substantially in the population (von Gaudecker et al. 2011). Kőszegi and Rabin (2006, 2007) suggest that, in many circumstances, reference points are given by the agent's expectations over outcomes. Several empirical studies indeed find a significant connection between expectations and behavior, see Abeler et al. (2011), Card and Dahl (2011), Crawford and Meng (2011), Ericson and Fuster (2011), Pope and Schweitzer (2011), Gill and Prowse (2012), Karle et al. (2015).[4] In our model, consumers make a purchase plan for any possible realization of product values and prices; this plan induces expectations that serve as the consumers' reference point.

Mental accounting. A further phenomenon that is closely linked to loss aversion is mental accounting, i.e., individuals' tendency to assess gains and losses separately across different dimensions (Kahneman et al. 1990, Thaler 1985, 1999). For example, expenditures are assigned to different categories. An insurance customer therefore may treat regular premium payments and (unexpected) out-of-pocket expenses as different dimensions. In second-price auctions for real objects, Rosato and Tymula (2019) find evidence for mental accounting with respect to the dimensions product value and money. Assuming mental accounting and different hedonic dimensions is a crucial component of recent preferences models, such as expectation-based loss aversion (Kőszegi and Rabin 2006, 2007) and salience preferences (Bordalo et al. 2013). We assume that consumers engaged in product search care at least about one product dimension and one price dimension, and form expectations-based reference points in each dimension separately.

Uncertainty effect. The uncertainty effect captures that some individuals may value a lottery less than its worst outcome. It was first demonstrated experimentally by Gneezy et al. (2006). They applied a between-subject design and obtained the same result for different types of goods, elicitation methods, and implementation. Unsurprisingly, this provocative result triggered a sequence of papers that study its robustness. Sonsino (2008) finds in auctions for

[4]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.

single gifts and binary lotteries on these gifts that 27 percent of subjects sometimes submit higher bids for the single gift than for the lottery even though the lottery's worst outcome is the gift. In a post-experimental survey, many participants indicate "aversion to lotteries" as their explanation for such behavior. Simonsohn (2009) conducts several within-subject variations of the experiment by Gneezy et al. (2006) and finds that 62 percent of subjects exhibit the uncertainty effect. Yang et al. (2013) show that a pronounced uncertainty effect occurs if the certain outcome is framed as a "gift certificate" while the lottery is framed as "lottery ticket" (or coin flip, gamble, raffle). In this condition, 34 to 58 percent exhibit the uncertainty effect. Most recently, Mislavsky and Simonsohn (2018) find the uncertainty effect when subjects perceive the certain outcome as more natural transaction than the lottery. They interpret the lottery as a transaction that has an unexplained feature.[5] In our model, the uncertainty effect can be rationalized by expectation-based loss aversion. Loss-averse consumers may refrain from inspecting all products, and choose an individual default that is first-order stochastically dominated. With multiple product attributes mental accounting increases the scope for the uncertainty effect.

Our results complement recent research that analyzes for two other domains how loss aversion can make decision makers inattentive. Pagel (2018) uses expectation-based loss aversion to explain why investors often remain inattentive to their portfolios. Dreyfuss et al. (2019) and Meisner and von Wangenheim (2019) study the misrepresentation of preferences in deferred acceptance mechanisms when individuals are expectations-based loss averse. We discuss these papers in more depth at a later stage.

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

[5]In addition, Andreoni and Sprenger (2011) also find the uncertainty effect in their experimental data. Some studies demonstrate that the uncertainty effect does not show up under certain conditions; see Rydval et al. (2009) and Wang et al. (2013).

behavioral search. Section 8 concludes. All proofs and mathematical details are relegated to the appendix.

2 The Model

We consider the competition of $n \geq 3$ firms $i = 1, ..., n$ for a unit mass of consumers. For convenience, we suppress notation for individual consumers. A consumer's payoff from firm i's product is $u_i = v_i + \xi_i$, where v_i is firm i's product value and ξ_i is a consumer-firm-specific taste shock. Ex-ante, each consumer is uncertain about both, product values and taste shocks: with probability $\frac{1}{2}$ firm i's product value is low, $v_i = v_{i.l}$, and with probability $\frac{1}{2}$ it is high, $v_i = v_{i.h}$; a taste shock ξ_i equals either 0 or $\Delta > 0$, each with probability $\frac{1}{2}$. Firms offer heterogeneous product values: Firm i's product value is larger than firm $i-1$'s product value. For convenience, we use the parametrization $v_{i.h} = v_{i.l} + \Gamma$ and $v_{i+1.l} = v_{i.h} + \Gamma$ for all i, where $\Gamma > 0$ and $v_{1.l} \geq \Gamma$, see Figure 2 for an illustration.[6] Firm n is the "dominant firm" that offers the highest product value, all other firms offer inferior products. Let p_i be the price that firm i charges for its product. If a consumer trades with firm i, her consumption utility is $u_i - p_i$ and firm i's profit is p_i, while the profit of the other firms is zero. If the consumer does not trade at all, firms' profits are zero.

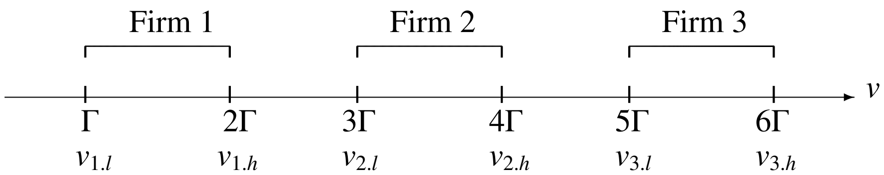

Figure 2: Example Parametrization for $n = 3$

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

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

[6] Our results do not depend on vertical product differentiation. In Section 4, we consider a setting in which all firms offer the same product value.

The function μ captures gain-loss utility. We assume that μ is piecewise linear with slope 1 for gains and slope $\lambda \geq 1$ for losses. Thus, λ is the degree of loss aversion. We allow for heterogeneity in loss-averse preferences. The share $\beta \in (0,1)$ of consumers is loss-neutral and exhibits $\lambda = 1$, while the share $1-\beta$ of consumers is loss averse with the degree of loss aversion $\lambda = \lambda^* > 1$.

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 50 percent, then an outcome of 6 units feels like a gain of 6 units weighted with 50 percent probability, and a loss of 4 units also weighted with 50 percent probability.

Pricing and Inspection. There are three stages. In Stage 1 – the "pricing stage" – firms observe the realization of product values $V = (v_1, ..., v_n)$, but not the realization of the taste shocks. Firms 1 to $n-1$ then choose their prices. Firm n observes these prices and chooses p_n. While this assumption is non-standard, it captures the fact that firm n is dominant so that it can repulse any attempt to price out its product. Crucially for us, this assumption allows for pure-strategy equilibria so that the model remains tractable.[7] In Stage 2 – the "planning stage" – each consumer is randomly assigned to a firm. Each firm's assignment is equally likely so that all firms get the same share of assigned consumers. If a consumer is assigned to firm i^*, she observes its product value v_{i^*}, utility shock ξ_{i^*}, and price p_{i^*}. She then makes a plan whether to inspect also the other products, and what product (if any) to buy once the inspection choice has been executed. Inspection is a binary decision $a \in \{0,1\}$. If the consumer inspects all products, $a = 1$, she observes all product values, utility shocks, and prices.[8] If she does not

[7]To the best of our knowledge, there exists no search model with expectation-based loss aversion preferences.

[8]We can also allow for sequential or restricted search (where the consumer can choose to inspect only one or a few products). However, this would make the model more complex without generating any new results.

inspect all products, $a = 0$, she only observes the product value, utility shock, and price of the assigned firm i^*. Given her plan, the consumer forms expectations G^u, G^p about the outcome in the utility and price dimension, respectively. Finally, in Stage 3 – the "market stage" – the consumer executes this plan and payoffs are realized. Figure 3 illustrates the timeline.

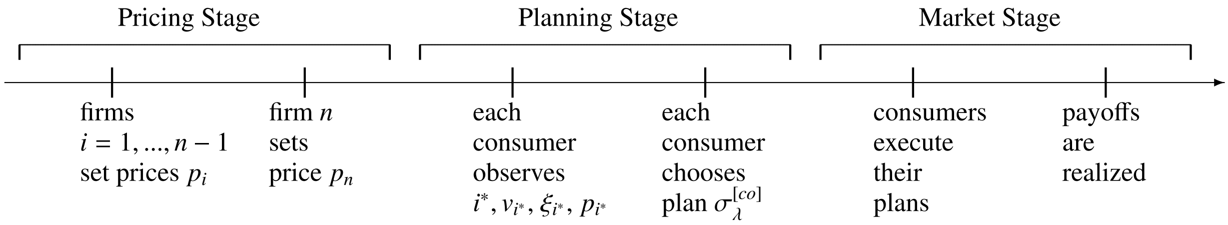

Figure 3: Timeline

Strategies and Equilibrium. We formally define the game. Let $\mathcal{V}$ be the set of all possible realizations V. For $i = 1, ..., n-1$, firm i's strategy σ_i maps the realization V into a price p_i, $\sigma_i : \mathcal{V} \to \mathbb{R}_+$. Firm n's strategy σ_n maps the realization V and the price vector $(p_1, ..., p_{n-1})$ into a price p_n, $\sigma_n : \mathcal{V} \times \mathbb{R}_+^{n-1} \to \mathbb{R}_+$. Let $\sigma_f = (\sigma_1, ..., \sigma_n)$ be the firms' strategy profile. For a given strategy profile σ_f, consumers derive beliefs $\mu(V \mid i^*, v_{i^*}, p_{i^*})$ 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 $\sigma_\lambda^{[1]}$, which maps the identity of the observed firm i^*, product value v_{i^*}, utility shock ξ_{i^*}, and price p_{i^*} into an inspection decision $a \in \{0, 1\}$,

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

and a purchase strategy $\sigma_\lambda^{[2]}$, which maps the identity of the assigned firm i^*, realization V, utility shocks $(\xi_1, ..., \xi_n)$, prices $(p_1, ..., p_n)$, and inspection decision a into a purchase decision $b \in \{1, ..., n\} \cup \{nb\}$,

$$\sigma_\lambda^{[2]} : \{1, ..., n\} \times \mathcal{V} \times \{0, \Delta\}^n \times \mathbb{R}_+^n \times \{0, 1\} \to \{1, ..., n\} \cup \{nb\}, \tag{5}$$

where $b = nb$ represents no purchase and $b = i$ represents trade with firm i. The consumers' strategies have to obey the following restriction: When a firm's product is not observed in the planning stage, the consumer can purchase it if and only if she chooses inspection ($a =$

1). 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 $G^u \equiv G^u(\tilde{u} \mid \sigma_f, \sigma_\lambda^{[co]}, \mu(V \mid i^*, v_{i^*}, p_{i^*}), \xi_{i^*})$ her expectations regarding utility in the product dimension, and by $G^p \equiv G^p(\tilde{p} \mid \sigma_f, \sigma_\lambda^{[co]}, \mu(V \mid i^*, v_{i^*}, p_{i^*}), \xi_{i^*})$ her expectations regarding utility in the price dimension when firms' and the consumer's strategies are given by $\sigma_f, \sigma_\lambda^{[co]}$, and the assigned firm is i^* with product value v_{i^*}, utility shock ξ_{i^*}, and price p_{i^*}. Define, for given firm strategy and beliefs, by $\mathbb{E}_{\sigma_\lambda^{[co]}}[U(u_i, p_i \mid G^v, G^p) \mid i^*, v_{i^*}, \xi_{i^*}, p_{i^*}]$ a consumer's expected payoff from strategy $\sigma_\lambda^{[co]}$ after observing the assigned firm i^*'s offer. We now can define the consumer's personal equilibrium as well as the equilibrium of the complete game.

Definition 1. *Let the firms' strategy σ_f and the consumers' beliefs μ be given. The consumer strategy $\sigma_\lambda^{[co]}$ is a personal equilibrium if at any possible observed firm i^*, realization V, utility shock $(\xi_1, ..., \xi_n)$, and prices $(p_1, ..., p_n)$, we have $\sigma_\lambda^{[2]} \in \arg\max_{i \in X} U(u_i, p_i \mid G^v, G^p)$, where X is the set of choices that are available after inspection decision $\sigma_\lambda^{[1]}$.*

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

$$\mathbb{E}_{\sigma_\lambda^{[co]}}[U(u_i, p_i \mid G^v, G^p) \mid i^*, v_{i^*}, \xi_{i^*}, p_{i^*}] \geq \mathbb{E}_{\hat{\sigma}_\lambda^{[co]}}[U(u_i, p_i \mid \hat{G}^v, \hat{G}^p) \mid i^*, v_{i^*}, \xi_{i^*}, p_{i^*}] \tag{6}$$

for any possible observed firm i^*, product value v_{i^*}, utility shock ξ_{i^*}, price p_{i^*}, and any alternative personal equilibrium $\hat{\sigma}_\lambda^{[co]}$.

Definition 3. *The quadruple $\sigma = (\sigma_f, \sigma_1^{[co]}, \sigma_{\lambda^*}^{[co]}, \mu)$ 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 and μ.*

To emphasize competition between firms, we make the following assumptions: If firms are indifferent between different prices, they charge the smallest non-negative price among them; consumers inspect all products if a PPE exists that involves trade with firms other than the assigned firm i^*; if consumers are indifferent between two or more firms, they choose the firm with the highest product value among them; finally, when consumers are indifferent between trading or not trading, they choose the former option.

3 The Market Equilibrium

In this section, we study the market equilibrium in our framework. We proceed in two steps. In Subsection 3.1, we consider the benchmark case when all consumers are loss-neutral. In Subsection 3.2, we then examine the framework with loss-neutral and loss-averse consumers, and derive a number of implications from the market equilibrium.

3.1 Benchmark Cases with Loss-Neutral Consumers

We study two useful benchmark cases when there are only loss-neutral consumers. They will help illustrate how expectation-based loss aversion affects the market outcome. For this, we introduce small inspection costs $c > 0$ 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 ($\beta = 1$) and inspection costs $c > 0$.*

(a) If Δ is small enough relative to c, then there is an equilibrium in which each firm i serves its assigned consumers at the monopoly price $p_i = v_i$ (Diamond Paradox).

(b) If Δ is small enough relative to Γ, and c is small enough relative to Δ, then in any equilibrium firm n serves all consumers at price $p_n = v_n - v_{n-1} - \Delta$.

The result in Proposition 1(a) states that when utility shocks are sufficiently small, we then obtain a Diamond Paradox outcome. 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^*. Suppose that each firm i charges its monopoly price $p_i = v_i$. If Δ is sufficiently small relative to c, 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 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, the result in Proposition 1(b) shows that the Diamond Paradox may break down when taste shocks are sufficiently large relative to inspection costs. Consider a consumer who experiences no positive taste shock at her assigned firm i^*, $\xi_{i^*} = 0$. There is a positive probability that she experiences a positive taste shock at another firm's product. Thus, if each firm i charges its monopoly price $p_i = v_i$, this consumer will inspect all products if the taste shock Δ is sufficiently large relative to the inspection costs c. Consequently, there is a share of consumers who inspect all products. Since firm n offers the highest product value, it has a competitive advantage and can price the other firms out of the market to serve these consumers. Indeed, this strategy is optimal if the consumers' taste shock Δ is sufficiently small relative to smallest possible product value difference Γ. In this case, firm n sets the price p_n so that it serves a consumer even if her taste shock at firm n is zero, the taste shock at firm $n-1$ is Δ, and firm $n-1$ charges a price of zero. This characterizes the unique equilibrium outcome in this market. Throughout, we will call it the "Bertrand equilibrium." Note that the Bertrand equilibrium is efficient since all gains from trade are realized in this equilibrium.

3.2 The Market Equilibrium with Loss-Averse Consumers

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

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

This is not the case for loss-averse consumers. Changes in the product and price dimension create experiences of losses and gains. 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[9] "trade with each firm with 50 percent probability." The expected payoff from this plan for loss-neutral consumers is zero, while for loss-averse

[9]This is of course not a fully specified strategy. For convenience, we use this reduced description of a strategy when it is not essential to specify further details of the complete strategy.

consumers it is $-(\lambda^* - 1)\frac{1}{2}\Gamma$. Thus, for loss-averse consumers, exploiting advantageous deals after inspection creates costs in terms of gain-loss sensations.

Consumers' loss aversion significantly changes the competitive position of firms with inferior products. In the Bertrand equilibrium of Proposition 1(b), a firm $i \neq n$ was unable to make a profit since firm n had a superior product and could price it out of the market. Now, when a loss-averse consumer is assigned to a firm $i^* \neq n$, this firm's advantage with this consumer is that 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 the product value v_i and utility shock ξ_i. Thus, any consumer plan $\sigma_\lambda^{[2]}$ 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.

We check under what circumstances an equilibrium exits in which each firm i charges its monopoly price $p_i = v_i$, as in Proposition 1(a). Suppose that all firms set monopoly prices. Then, first, for a consumer who experiences a positive utility shock at the assigned firm i^* there is nothing to gain from inspecting all products. Second, consider a consumer who experiences no positive utility shock at i^*. She may derive higher consumption utility if she trades with another firm i if at this firm she experiences a taste shock $\xi_i = \Delta$. However, realizing such a plan requires her to inspect all products and to face uncertainty about the product value and price of firm i's product. This uncertainty increases linearly in Γ. Hence, if Δ is small enough relative to Γ, the consumer optimally chooses not to inspect all products and to trade with the assigned firm i^*. Note that in this case the plan "always trade with the firm i^*" is not only a PE (since the consumer is not exposed to further information), but also a PPE. If all consumers adopt this PPE, this, in turn, may justify the firms' pricing behavior. We therefore get the following results.

Proposition 2. *Suppose that each firm i charges the monopoly price $p_i = v_i$. Consider a loss-averse consumer assigned to any firm i^*. If*

$$(\lambda^* - 1)\frac{3}{8}\Gamma \geq \Delta, \tag{7}$$

the plan "always trade with firm i^*" is the consumer's unique PPE.

Proposition 3. *Suppose that all consumers are loss-averse ($\beta = 0$). If Δ is small enough relative to Γ, then there is an equilibrium in which*

(a) consumers do not inspect all products, and

(b) each firm i serves its assigned consumers at price $p_i = v_i$.

The two results describe the consumers' behavior and the overall market equilibrium with monopoly prices. In Proposition 2, we provide a condition under which "always trade with firm i^*" is the unique PPE for loss-averse consumers. We show in the proof of Proposition 2 that the expected utility from any plan $\sigma^{[2]}_{\lambda^*}$ that involves trade with different firms with positive probability is less than

$$\Delta - (\lambda^* - 1)\frac{3}{8}\Gamma, \tag{8}$$

regardless of whether it is a PE or not. Inequality (7) then follows from this result. Note that we obtain an uncertainty effect: Loss-averse consumers prefer a certain option to an uncertain alternative even though the worst outcome of this alternative is – in terms of consumption utility – weakly better than the certain option. The important observation here is that for any degree of loss aversion $\lambda^* > 1$ we can find Δ small enough such that the inequality in (7) holds. Thus, in our framework, the uncertainty effect can occur for modest degrees of loss aversion.

In Proposition 3, we describe when the uncertainty effect occurs in a market equilibrium. Here Δ must be small enough relative to Γ for two reasons. First, the consumers' optimal plan needs to be "always trade with the assigned firm i^*" when all firms i charge their monopoly price. Second, it must be optimal for firms to serve all assigned consumers at $p_i = v_i$ (and not only those with positive taste shock at price $p_i = v_i + \Delta$).

Proposition 3 shows that a Diamond Paradox outcome can be obtained even though there are consumer-firm specific taste shocks and there are no explicit inspection costs. All "search" or "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, half of the consumers earn no surplus; they forgo the possibility to realize a positive surplus Δ by finding a product that better suits them than the assigned firm's product. The reason for this is that any plan, which involves inspecting all products and purchasing a product with uncertain value and price, generates negative expected utility through the uncertainty effect at the planning stage. The firms' behavior exacerbates the consequences of loss aversion by reducing the consumers' potential surplus from inspection.

Heterogeneous Consumers. We next consider the case when there is a share $\beta \in (0,1)$ of loss-neutral and a share $1-\beta$ of loss-averse consumers. Assume first that each firm i charges the monopoly price $p_i = v_i$. Loss-neutral consumers who do not experience a positive utility shock at their assigned firm will then inspect all products in the hope to find a product that yields them a positive payoff. Thus, there will be a positive share of consumers who inspect all products. Any firm potentially faces the trade-off between charging a high price to serve only its assigned non-inspecting consumers and charging a lower price to serve assigned non-inspecting as well as inspecting consumers. Since firm n has a competitive advantage, it is in the best position to exploit this new situation. Given that each firm $i \neq n$ charges the monopoly price $p_i = v_i$, firm n can serve all loss-neutral consumers who inspect all products by charging $p_n = v_n - \Delta$. Indeed, this can be the firms' pricing strategy in a market equilibrium.

Proposition 4. *Suppose that each firm $i \neq n$ charges the monopoly price $p_i = v_i$, while firm n charges $p_n = v_n - \Delta$. Consider a loss-averse consumer assigned to a firm $i^* \neq n$. If*

$$(\lambda^* - 1)\frac{3}{8}\Gamma \geq \Delta, \tag{9}$$

the plan "always trade with firm i^*" is the consumer's unique PPE. If the plan "always trade with firm i^*" is not a PPE, the plan "always trade with firm n" is the consumer's unique PPE.

Proposition 5. *Suppose there are both loss-averse and loss-neutral consumers. If Δ is small enough for given parameters λ^*, Γ and β, then there is an equilibrium in which*

(a) each firm $i \neq n$ serves its assigned loss-averse consumers at price $p_i = v_i$,

(b) firm n serves its assigned loss-averse consumers and all loss-neutral consumers at price $p_n = v_n - \Delta$, and

(c) loss-averse consumers do not inspect all products, while loss-neutral consumers do.

The two results separately describe the loss-averse consumers' behavior at the suggested pricing strategy, and the market equilibrium that exhibits this pricing strategy. We first explain why the result in Proposition 4 holds. Consider a consumer who is assigned to a firm $i^* \neq n$. She can realize a certain payoff of Δ in case of a positive utility shock at firm i^*, and one of zero in case of no positive utility shock. Since $p_n = v_n - \Delta$, the consumption utility from trading with firm n with certainty is 2Δ or Δ, each with equal probability. If she were loss-neutral, she would therefore always inspect all products and trade with firm n.

We examine which plan is the PPE for a loss-averse consumer in this situation. In general, this could be a tedious task since the mapping between plan and expected utility is complex (in the Appendix, we write down the expected utility for a generic plan). Fortunately, the problem has enough structure so that a few comparisons suffice to identify the PPE. Suppose that a loss-averse consumer assigned to a firm $i^* \neq n$ adopts the plan "always trade with firm n." Denote this plan by $\hat{\sigma}^{[2]}_{\lambda^*}$. At the planning stage, the expected utility from this plan is

$$\mathbb{E}[U(\hat{\sigma}^{[2]}_{\lambda^*})] = \frac{3}{2}\Delta - (\lambda^* - 1)\frac{1}{2}\Gamma - (\lambda^* - 1)\frac{1}{8}\Delta. \tag{10}$$

The first term $\frac{3}{2}\Delta$ is the consumption utility out of this plan; the second term $-(\lambda^* - 1)\frac{1}{2}\Gamma$ is the expected gain-loss utility that originates from the fact that firm n's product value v_n and therefore also its price p_n are uncertain and vary by Γ; the third term $-(\lambda^* - 1)\frac{1}{8}\Delta$ is the expected gain-loss utility from uncertainty about whether the consumer experiences a positive utility shock at firm n or not.

Does the loss-averse consumer execute this plan, instead of trading with the assigned firm i^*? Both "always trade with firm i^*" and "always trade with firm n" are personal equilibria. For the former plan this is true because the consumer can choose not to inspect all products ($a = 0$) and then avoids any potential temptation to buy another product. For the latter plan, we show this in the proof of Proposition 4. If the consumer experiences a positive utility shock at firm i^*, she prefers trading with i^* with certainty instead of trading with firm n if $\mathbb{E}[U(\hat{\sigma}^{[2]}_{\lambda^*})] < \Delta$; if the consumer experiences no positive utility shock at firm i^*, she prefers trading with firm i^* with certainty if $\mathbb{E}[U(\hat{\sigma}^{[2]}_{\lambda^*})] < 0$. It turns out that this last comparison actually suffices to state a condition under which "always trade with firm i^*" is the PPE for all loss-averse consumers. From this, we obtain inequality (9).

Next, consider Proposition 5. Here, Δ must be small enough relative to Γ for given parameters λ^*, β for three reasons. First, the loss-averse consumers' optimal plan, given the firms' pricing strategy, must be to always trade with the assigned firm i^*; the corresponding critical threshold for Δ is given by inequality (9). Second, Δ must be small enough so that firms cannot gain by only serving assigned loss-averse consumers with positive taste shock at price $p_i = v_i + \Delta$. And third, Δ must be small enough so that the dominant firm defends its customer share when a rival charges a lower price (and this price change would be profitable if the dominant firm does not react). Note that when there are consumers who inspect all products, each firm $i \neq n$ could be tempted to reduce its price in order to serve some of them, for example, those consumers who experience a positive utility shock at firm i, $\xi_i = \Delta$, and no positive utility shock at firm n, $\xi_n = 0$. However, if Δ is sufficiently small for given parameters Γ, β, firm n would always respond by cutting the price p_n so as to keep all inspecting consumers, rendering firm i's deviation non-profitable. Nevertheless, for loss-averse consumers who observe a price deviation at an assigned firm $i^* \neq n$ it would remain optimal to trade with firm i^*.

Implications. From Propositions 4 and 5 we obtain several important implications. Table 1 summarizes key characteristics and outcomes for different consumer groups in the equilibrium of Proposition 5. We distinguish between six different consumer groups: four groups of loss-averse consumers who are assigned to a firm $i^* \neq n$ (first four lines), a group of loss-averse consumers who are assigned to firm n (fifth line), and the group of loss-neutral consumers (sixth line). The share of each consumer group is in the first column, its degree of loss aversion is in the second column, and, in the third column, we have the utility shock consumers experience at the assigned firm i^* as well as the utility shock they would experience at firm n. In the following, we explain all implications using Table 1 (the remaining columns will be introduced below).

The first implication is that the majority of loss-averse consumers forgoes payoffs due to the uncertainty effect since they trade with the assigned firm, and not with firm n. In the fourth column of Table 1, we summarize how much consumption utility the different consumer groups lose. The first group of consumers leaves a payoff of 2Δ on the table. They do not experience a positive utility shock at the assigned firm i^*; but they would do so at firm n, and in addition they would pay Δ less than the monopoly price for firm n's product. The second and third consumer group forgoes a payoff of Δ; they experience the same utility shock at firm n and the assigned firm, but firm n is relatively cheaper. Note that a (hypothetical) empirical researcher who correctly identifies consumers' preferences, but neglects loss aversion, would conclude that there are two groups of consumers with positive conventional switching costs of

Table 1: Foregone Surplus and Switching Costs in Equilibrium

Consumer Share	Loss Aversion	Taste Shock	Forgone Surplus	Psychological Switching Costs	Required Payoff
$\frac{1}{4}(1-\beta)\frac{n-1}{n}$	λ^*	$\xi_{i^*}=0, \xi_n=\Delta$	2Δ	$\psi(\Gamma,\Delta)$	$\psi(\Gamma,\Delta)-\frac{3}{2}\Delta$
$\frac{1}{4}(1-\beta)\frac{n-1}{n}$	λ^*	$\xi_{i^*}=0, \xi_n=0$	Δ	$\psi(\Gamma,\Delta)$	$\psi(\Gamma,\Delta)-\frac{3}{2}\Delta$
$\frac{1}{4}(1-\beta)\frac{n-1}{n}$	λ^*	$\xi_{i^*}=\Delta, \xi_n=\Delta$	Δ	$\psi(\Gamma,\Delta)$	$\psi(\Gamma,\Delta)-\frac{1}{2}\Delta$
$\frac{1}{4}(1-\beta)\frac{n-1}{n}$	λ^*	$\xi_{i^*}=\Delta, \xi_n=0$	0	$\psi(\Gamma,\Delta)$	$\psi(\Gamma,\Delta)-\frac{1}{2}\Delta$
$(1-\beta)\frac{1}{n}$	λ^*	$\xi_{i^*}\in\{0,\Delta\}$	0	–	–
β	1	any	0	–	–

at least 2Δ and Δ, respectively.

Second, by Proposition 4, the switching costs of those consumers who forgo positive surplus are defined by the plan "always trade with firm n." They are equal to

$$\psi(\Gamma,\Delta) = (\lambda^*-1)\frac{1}{2}\Gamma + (\lambda^*-1)\frac{1}{8}\Delta, \tag{11}$$

which follows from equation (10). $\psi(\Gamma,\Delta)$ describes the negative payoff originating from expected gain-loss sensations that a loss-averse consumer incurs if she adopts this plan. We call $\psi(\Gamma,\Delta)$ "psychological switching costs." They depend on the value and price differences Γ between the different specifications of firm n's product, as well as on the variation Δ in potential utility shocks. 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. Thus, consumers forgo a surplus of any size Δ and 2Δ as long as Δ is small enough relative to the scale dependent psychological switching costs $\psi(\Gamma,\Delta)$.

Third, 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 conventional switching costs that are due to time and hassle costs. Conventional switching costs 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 consumption utility (after inspecting all products). This interpretation is not valid for psychological switching costs that accrue to a loss-averse consumer. Using equation (10) we can derive the payoff that we would have to give to a loss-averse consumer in the planning phase so that she adopts the plan "always trade with firm n" instead of "always trade with firm i^*." We call it "required payoff." For a consumer with taste shock ξ_{i^*} at her assigned firm it equals

$$\text{required payoff} = \psi(\Gamma, \Delta) - \left[\frac{3}{2}\Delta - \xi_{i^*}\right]. \tag{12}$$

In the last column of Table 1, we indicate this value for all consumer groups who trade with firms other than firm n. Observe that we obtain a negative correlation between forgone surplus and required payoff: Those with high forgone surplus 2Δ only require a small additional payoff in order to switch, while those with lower forgone surplus Δ require on average a higher additional payoff. This is intuitive: Those with high foregone surplus would gain the most consumption utility from adopting the plan "always trade with firm n." Thus, the payoff required to make these consumers switch could be quite small relative to their forgone surplus.

Fourth, we obtain a clear empirical prediction about the relationship between loss aversion and forgone surplus. Observe from Table 1 that the correlation between these variables must be positive. In Section 5, we provide suggestive empirical evidence for this finding and discuss how it could further be tested in empirical work.

Fifth, while in equilibrium loss-averse consumers do not inspect all products, this does not imply that they would switch products if, unexpectedly, they were informed about all details of all products. Consider a loss-averse consumer with the plan to always trade with the assigned firm $i^* \neq n$. Suppose that, unexpectedly, she gets informed about the specification and price of firm j's product. Her payoff from switching to firm j is then at most

$$2\Delta + (\lambda^* + 1)\Delta - (\lambda^* - 1) \mid v_j - v_{i^*} \mid, \tag{13}$$

where 2Δ is the increase in consumption utility, and the remaining terms capture the lowest possible loss from gain-loss comparisons. The value in (13) is negative if Δ is small enough relative to Γ. In this case, the consumer does not switch to firm j and trades with her assigned firm i^*. Note that the term in (13) decreases in the distance in values between firm j's and firm i^*'s product. Thus, consumers who are assigned to firm 1 (which offers the lowest product value and charges the lowest price) are least tempted to trade with the dominant firm n even if, unexpectedly, they learn the specifics of firm n's product. One implication of this is that we can have a share of loss-averse consumers who engage in "window-shopping", i.e., they may choose the plan to inspect all products and to trade with their assigned firm. If, for given parameters, the share of these consumers is small enough, the firms' pricing strategy profile and hence the equilibrium remains the same.

Sixth, when we look at the supply side of the market, we observe that the presence of loss-averse consumers significantly changes the market outcome relative to the benchmark case considered in Proposition 1(b). In that case, the dominant firm served the whole market at a relatively low price, and all other firms made zero profits. The market outcome was efficient since all consumers purchased the good that offers the highest surplus. When there are some loss-averse consumers and the conditions of Proposition 5 are satisfied, then all n firms serve a share of the market and all firms make positive profits. Overall, prices are higher than in the benchmark case. The interesting observation here is that the market consists of two types of firms. The dominant firm serves its assigned consumers, but also competes for searching consumers by choosing a price that is below its monopoly price. In contrast, the other firms only serve their assigned consumers at the monopoly price. They do not dare to compete with the dominant firm for searching consumers since this would only ruin their prices without generating more revenues.

Seventh, the change in firms' conduct implies that loss-neutral consumers may be hurt by the presence of loss-averse consumers. In both the benchmark case of Proposition 1(b) and in the market equilibrium of Proposition 5, they trade with the dominant firm. However, since loss-averse consumers' behavior soften the competition between firms, loss-neutral consumers have to pay more for the same product in the latter case.

Eighth, the loss-averse consumers' behavior further implies that firms with inferior products have some market power. In contrast to the benchmark case in Proposition 1(b), the market outcome is inefficient since many loss-averse consumers purchase inferior products. In addition, consumer surplus is substantially reduced due to higher prices.

4 Multi-Dimensional Product Values

In our baseline model, gain-loss sensations are caused by differences in product value and price. The uncertainty effect then occurs for a given degree of loss aversion only if value differences between products are large enough relative to potential gains from utility shocks and price savings. This could be seen as a limitation of our model as in many markets the observed value differences may not be large enough.

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 these different dimensions. In Kőszegi and Rabin's (2006) framework, the outcome that defines gain-loss utility is a multi-dimensional object, and consumption utility is additively separable across dimensions. Similarly, Bordalo et al. (2013) define salience preferences over multiple product dimensions. In this section, we allow for multi-dimensional product values and show that our results also obtain in a setting where absolute value differences between products are small or non-existent.

Consider the following variation of our baseline model. Each firm offers a product of value $\bar{v}$ to consumers.[10] Products now differ along M dimensions. Denote by v_i^m the value of firm i's product in dimension m; suppose this number is a multiple of Γ and can take on the values $0, \Gamma, 2\Gamma, ...$; the total product value equals $\sum_{m=1}^{M} v_i^m = \bar{v}$. Let $v_i = (v_i^1, ..., v_i^M)$ be the specification of firm i's product. For convenience, we assume that the utility shock occurs in an extra-dimension $M + 1$. A consumer treats all dimensions separately. Suppose she expects with certainty value $\tilde{v}^m$ in dimension $m \in \{1, ..., M\}$, $\tilde{\xi}$ in the utility shock dimension, and price $\tilde{p}$. Denote $\tilde{v} = (\tilde{v}^1, ..., \tilde{v}^M)$ the expected product specification. If the consumer trades with firm

[10] The assumption that all firms offer the same value can easily be dropped. It highlights that our main results also obtain in settings where firms offer products with the same absolute product value.

i, her total utility then equals

$$U(v_i, \xi_i, p_i \mid \tilde{v}, \tilde{\xi}, \tilde{p}) = \bar{v} + \xi_i - p_i + \sum_{m=1}^{M} \mu(v_i^m - \tilde{v}^m) + \mu(\xi_i - \tilde{\xi}) + \mu(-p_i + \tilde{p}). \tag{14}$$

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 and the corresponding taste shock: with probability $\frac{1}{2}$ the specification is $v_i = v_{i.l}$, and with probability $\frac{1}{2}$ it is $v_i = v_{i.h}$; the taste shock is again 0 or $\Delta > 0$, each with equal probability.

All possible products and product specifications are differentiated from each other. The difference between any two products v_i and v_j is captured by the difference function

$$d(v_i, v_j) = \sum_{m=1}^{M} \mid v_i^m - v_j^m \mid . \tag{15}$$

The degree of differentiation in this market is captured by the minimum difference d_{min} between any two product specifications of the same or different firms. Finally, to maintain the notion that firm n is the dominant firm, we assume that each firm $i \neq n$ has per unit production costs of $c_h \in (0, \bar{v})$, while firm n has low production costs that we normalize to zero. The rest of the model remains the same.

We again first derive the market equilibrium when consumers are loss-neutral. Consumers then inspect all products and firm n can price the other firms out of the market. Indeed, if c_h is sufficiently close to $\bar{v}$ and Δ is small enough relative to $\bar{v}$, this is firm n's profit-maximizing strategy. In any equilibrium, firm n then charges $p_n = c_h - \Delta$ and serves all consumers, while each firm $i \neq n$ charges $p_i = c_h$ and has no business.

This Bertrand-equilibrium may no longer be the unique equilibrium outcome if there is a positive share of loss-averse consumers. We get the following results.

Proposition 6. *Suppose that each firm $i \neq n$ charges $p_i = \bar{v}$, while firm n charges $p_n = \bar{v} - \Delta$. Consider a loss-averse consumer assigned to a firm $i^* \neq n$. The plan "always trade with firm*

i^*" is the consumer's unique PPE if

$$\frac{1}{4}(\lambda^* - 1)d_{min} \geq \Delta. \tag{16}$$

Proposition 7. *Suppose there are both loss-averse and loss-neutral consumers. If inequality (16) holds, Δ is small enough relative to $\bar{v}$, and firms' costs c_h are close enough to $\bar{v}$, then there is an equilibrium in which*

(a) each firm $i \neq n$ serves its assigned loss-averse consumers at price $p_i = \bar{v}$,

(b) firm n serves its assigned loss-averse consumers and all loss-neutral consumers at price $p_n = \bar{v} - \Delta$, and

(c) loss-averse consumers do not inspect all products, while loss-neutral consumers do.

In Proposition 6, we consider a situation where all firms sell products of the same value $\bar{v}$ and charge the same price $p_i = \bar{v}$, except that firm n charges a lower price $p_n = \bar{v} - \Delta$. Loss-neutral consumers take advantage of this situation by trading with firm n. In contrast, a plan, which foresees to purchase different product specifications with positive probability, generates negative utility through gain-loss sensations for loss-averse consumers who separately weight the M different value dimension of a product. Even if at the assigned firm $i^* \neq n$ a loss-averse consumer does not benefit from a positive utility shock, she trades with this firm if inequality (16) is satisfied. She then forgoes the opportunity to purchase a product with positive utility shock and the opportunity to realize savings of Δ. Observe that inequality (16) holds for modest degrees of loss aversion if the degree of differentiation – as captured by d_{min} – is large enough.

Proposition 7 shows that the prices from Proposition 6 can in fact occur in an equilibrium. Given that loss-averse consumers always trade with their assigned firm, while loss-neutral consumers inspect all products, it is optimal for all firms $i \neq n$ to only serve loss-averse consumers at the monopoly price, while the dominant firm also serves all loss-neutral consumers. If, for given β, the taste shock Δ is small enough relative to $\bar{v}$, it pays off for all firms $i \neq n$ to charge $p_i = \bar{v}$ instead of $p_i = \bar{v} + \Delta$; and if c_H is close enough to $\bar{v}$, these firms cannot profitably compete with the dominant firm for the loss-neutral consumers, so that they optimally charge $p_i = \bar{v}$.

5 Empirical Evidence

The key prediction from our model is that there is a positive relationship between loss aversion and forgone surplus. This prediction can be evaluated empirically using surveys and, if available, choice data. In this section, we provide some suggestive evidence using new survey data on clients of a large German retail bank (see Weber 2020 for further details).[11] The survey focuses on financial decision making and financial literacy. It contains a number of questions on general consumption behavior. One item proxies to what extent individuals think that they leave surplus on the table in several contracts. It reads as follows (translated from German).

> *I pay too much for my contracts (e.g. internet, electricity).* [Answer on a scale between 1 (least relevant) and 6 (most relevant)]

In the following, we call this variable[12] "forgone surplus." Next, the survey contains an item that proxies the degree of loss aversion. It directly asks about the kink in the utility function around a reference point and reads as follows.

> *The possibility of even small losses for my savings (e.g. through financial risk) makes me nervous.* [Answer on a scale between 1 (do not agree at all) and 7 (fully agree)]

There are a number of further variables for which we can control in our analysis, i.e., age, gender, trust, patience, risk tolerance, education, household income, and the degree of financial literacy. Table 4 in the appendix provides a detailed overview. Controlling for education is important since cognitive ability has been shown to correlate negatively with loss aversion (e.g., Benjamin et al. 2013). Indeed, this is the case in the data. The correlation between

[11]The survey comprises 3983 observations in the first wave (second wave 2.247; third wave 1.936; fourth wave 1.977); see Weber (2020), Appendix D. Compared to the 2016 sample of the Panel of Household Finances, a survey panel run by the German Central Bank which aims to be representative for the German Population as a whole, participating clients are slightly more often male (mean = 0.66; diff = −0.12; p-value < 0.01), older (age < 50 dummy: mean = 0.28; diff = 0.16; p-value < 0.01), more educated (college degree dummy: mean = 0.43; diff = −0.11; p-value < 0.01), more financially literate (Big 3 financial literacy questions aggregate score: mean = 2.51; diff = −0.11; p-value < 0.01), and have higher income (household income < 4.500 Eur/month: mean = 0.73; diff = 0.14; p-value < 0.01).

[12]In principle, respondents could also interpret this as a question about whether companies charge fair prices. We think that is rather unlikely. The survey is mostly on financial literacy and need for advise. The two statements preceding the forgone surplus questions are "I have no overview of my contracts and insurance policies" and "I do not know the benefits of my insurance policy."

our loss aversion measure and education is -0.0946 and significantly different from zero (p-value < 0.0001). Similarly, loss aversion is also negatively correlated with financial literacy (correlation coefficient $= -0.1462$, p-value < 0.0001). Therefore, we need to control for education and financial literacy when analyzing the association between loss aversion and forgone payoffs.

Table 2: Loss Aversion and Forgone Surplus

Specification	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
loss aversion	0.031*** (0.006)	0.018*** (0.006)	0.020*** (0.007)		0.018*** (0.006)	0.020*** (0.007)	
risk tolerance			0.005 (0.008)	-0.004 (0.008)		0.006 (0.008)	-0.003 (0.008)
education					0.030 (0.023)	0.030 (0.023)	0.030 (0.023)
trust					-0.006 (0.007)	-0.007 (0.007)	-0.008 (0.007)
patience					-0.000 (0.010)	-0.000 (0.010)	-0.002 (0.011)
financial literacy		-0.039*** (0.009)	-0.040*** (0.009)	-0.043*** (0.009)	-0.040*** (0.009)	-0.041*** (0.009)	-0.044*** (0.009)
male		-0.043 (0.056)	-0.043 (0.056)	-0.037 (0.057)	-0.013 (0.025)	-0.015 (0.025)	-0.024 (0.025)
age (in categories)	no	yes	yes	yes	yes	yes	yes
household income (in categories)	no	yes	yes	yes	yes	yes	yes
constant	0.194*** (0.022)	0.277 (0.191)	0.257 (0.193)	0.355* (0.191)	0.306 (0.196)	0.287 (0.198)	0.392** (0.195)
Observations	1,764	1,737	1,737	1,737	1,737	1,737	1,737
R-squared	0.016	0.043	0.043	0.038	0.044	0.044	0.039

Notes: OLS regresssion. The dependent variable is forgone surplus as a dummy. All other variables are described in detail in Table 4 in the Appendix. Standard errors are in parentheses. Significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

In Table 2, we report the estimates of an OLS regression where the dependent variable is forgone surplus as a dummy (equaling one if the respondent indicated 4 to 6, and zero otherwise). We find a positive coefficient of loss aversion, significant at the 1 percent level, see column (1). Adding controls for financial literacy, gender, age (in categories), and household income (in categories) does not change this result, see column (2). Except for financial literacy, none of the controls has a statistically significant effect. In column (3), we add risk tolerance as an independent variable. Note that this alternative measure of risk preference has no statistically significant effect. This also holds true when we only consider risk tolerance without loss aversion, see column (4). In column (5) to (7), we replicate column (2) to (4), but add control variables for education, trust and patience. Our results are not altered. We interpret this as suggestive evidence for our prediction that loss averse consumers are less likely to realize advantageous deals that would offer them more consumer surplus. All results are robust to using the original variable for forgone surplus, and to using a probit estimator instead of an OLS estimator.[13]

The results presented in this section of course only constitute suggestive evidence. Future research that combines choice and survey data may further study whether loss-averse consumers are less likely to inspect available deals than loss-neutral consumers, or whether they are more likely to forgo advantageous deals. There exist several methods to elicit individuals' degree of loss aversion that can be incorporated into surveys. Abdellaoui et al. (2007) propose a non-parametric experimental elicitation method of loss aversion based on simple lottery choices where individuals compare two lotteries over a series of decision tasks that vary payoffs and probabilities of good and bad states. More easily applicable elicitation methods keep probabilities fixed and only vary the payoffs of lotteries (e.g., Fehr and Goette 2007, Karle et al. 2015, 2019).

6 Extensions and Discussion

In this section, we briefly discuss several extensions of our framework.

Explicit Inspection Costs. In our benchmark cases in Subsection 3.1, we considered explicit costs, while in our main model, we abstracted from them. It makes sense to also take explicit

[13]These estimates can be obtained from the authors upon request.

inspection costs into account, as search typically requires (potentially small) investments of time and money. Assume therefore that consumers have to pay $c > 0$ if they inspect all products. We can show that this does not affect the results in Propositions 2 to 7 if c is sufficiently small. Assume first that the firms' pricing strategy profile is unchanged. Loss-averse consumers do not change their behavior as there is now an additional reason to avoid inspection. All of them now have a strict preference not to inspect all products (recall that for some of them "window-shopping" also could have been optimal). For loss-neutral consumers, the expected gains from inspection are strictly positive and linearly depend on Δ. Thus, if c is sufficiently small relative to Δ, they continue to inspect all products. Now, given that the consumers' behavior is unaffected, the proposed pricing strategies remain optimal for firms. Hence, our main results remain valid if we allow for small inspection costs.

Pessimistic Beliefs. So far, we assumed that consumers have rational expectations about the distribution of product values, utility shocks, and firms' conduct. Loss-averse consumers then do not inspect all products when the expected 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 search for better deals.

Typically, consumers do not learn about the potential surplus as long as they do not trade with firms. They may apply a potentially misspecified model to make sense of price dispersion. One plausible narrative to explain price differences is to equate them with quality differences ("there is no free lunch"). This narrative seems natural in many contexts. If consumers form beliefs according to this narrative, the expected surplus is given by individual taste shocks. These may be small, in particular, when goods are homogeneous. A loss-averse consumer therefore may refrain from inspecting all products even if the market allows for substantial consumer surplus. 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 the expected surplus is positive, they inspect all products and purchase the product that yields the highest surplus. Thus, pessimistic beliefs may amplify the effects of loss aversion in search markets with price dispersion.

Paying for Prominence. We assumed that every firm i gets a share $\frac{1}{n}$ of consumers who then make a plan whether to inspect other products. Alternatively, we can allow firms to invest into "prominence" so that higher investments result in a higher share of consumers who know their product before making a plan. We briefly discuss such an extension of our framework.

Denote by s_i the share of consumers that firm i receives. Firm i can affect this share by investing b_i. Denote by $b = (b_1, ..., b_n)$ the investments of all firms. The share s_i is then given by a function $f_i(b)$, which we assume to be continuously differentiable, concave in all entries, and $f_i(b) \geq \bar{f} > 0$ for all i and b; moreover, we assume that it is always optimal to invest a small amount, i.e., $\frac{\partial f_i(b)}{\partial b_i} > 1$ at small values b_i. Investments have to be carried out before V realizes (so that consumers cannot make inferences about V from their assignment).

Suppose that the continuation equilibrium in the pricing stage is the one outlined in Proposition 5. We then can specify optimal investments. The profit functions are $\mathbb{E}(v_i)(1-\beta)f_i(b)-b_i$ for all firms $i \neq n$ and $(\mathbb{E}(v_n)-\Delta)[(1-\beta)f_n(b)+\beta]-b_n$ for firm n. Standard arguments show that an equilibrium level of investments b^* exists. At such an equilibrium, the following first-order conditions must be satisfied:

$$\mathbb{E}(v_i)(1-\beta)\frac{\partial f_i(b^*)}{\partial b_i} - 1 = 0 \qquad \text{for all firms } i \neq n, \tag{17}$$

$$(\mathbb{E}(v_n) - \Delta)(1-\beta)\frac{\partial f_i(b^*)}{\partial b_n} - 1 = 0 \qquad \text{for firm } n. \tag{18}$$

Since all shares s_i are strictly positive, Proposition 5 continues to hold. So b^* captures investment levels that can occur in an equilibrium of the complete game. We can derive two implications from the first-order conditions. First, firms with higher product values also invest more into prominence. Thus, more loss-averse consumers end up purchasing high-value products. Second, the share of loss-averse consumers $1-\beta$ influences investments into prominence. The higher is this share, the higher are investments.

Risk Aversion. Search models typically assume risk-neutral consumers. One may therefore ask whether our results are just driven by a non-linearity in the utility function, so that they would also obtain in a setting with risk-averse consumers. We show that this is not the case. Under expected utility preferences, a consumer's utility is defined over final wealth positions. Let a consumer's utility from wealth w be given by the strictly increasing and concave utility function $u(w)$. We normalize initial wealth to zero. So if a consumer purchases a product of value v_i at price p_i and experiences utility shock ξ_i, her utility is $u(v_i + \xi_i - p_i)$. Suppose the utility costs of inspecting all products are again given by c. The rest of the model remains the same.

Let firms charge the same prices as in the equilibrium of Proposition 5: Each firm $i \neq n$ charges $p_i = v_i$ and firm n charges $p_n = v_n - \Delta$. A consumer assigned to a firm $i^* \neq n$ who experiences no positive utility shock at this firm will not inspect all products if

$$u(0) \geq \frac{1}{2}u(\Delta) + \frac{1}{2}u(2\Delta) - c. \tag{19}$$

From this, we can draw a number of conclusions. First, if inspection costs c are small enough, this inequality is violated so that the consumer will always inspect all products. More generally, we will always obtain a Bertrand equilibrium as in Proposition 1(b) if c is sufficiently small. Second, risk aversion may cause the consumer not to inspect all products, regardless of the difference Δ, but only under restrictive assumptions. Suppose that the utility function is bounded from above, i.e, $\lim_{w\to\infty} u(w) = \bar{u}$ for some positive value $\bar{u}$. Then we can find large enough search costs c so that (19) is satisfied for all $\Delta \geq 0$. However, if u is not bounded from above, this statement does not hold. Bounded utility functions are quite uncommon in economics and would cause conceptual problems. We therefore argue that risk aversion alone cannot generate our results under reasonable assumptions.

7 Related Literature

In this section, we relate our contribution to the related literature. In particular, we discuss its link to the behavioral industrial organization literature that analyzes the implications of expectation-based loss aversion for trade between consumers and firms.[14]

Several papers study competitive markets with expectation-based loss-averse consumers. Heidhues and Kőszegi (2008) consider a setting with differentiated products in which consumers initially are uncertain about both prices and match values. They show that consumers' loss aversion then may eliminate price variations in the market even if firms 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 dif-

[14] See Heidhues and Kőszegi (2018) for a recent overview of the behavioral industrial organization literature.

fer in their production costs, the presence of uninformed loss-averse consumers leads to more competition and lower prices. Karle and Möller (2020) examine competition with loss-averse consumers in an advance purchase setting.

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

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

The crucial difference between these papers and ours is that, in their settings, loss aversion affects consumers' behavior through attachment effects. When consumers inspect all products, expectations only matter for the purchase decision. In contrast, we explicitly allow consumers to avoid any information gathering and inspection in a first place. Loss-averse consumers will choose this option if the expected payoff from the optimal information-sensitive purchase plan is below the utility of their individual default. Thus, our results are driven by the uncertainty effect rather than by the attachment effect.

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

Pagel (2018) develops a life-cycle portfolio-choice model in which the loss-averse investor derives utility from news (Kőszegi and Rabin 2009), and can ignore developments in her portfolio. She shows that the investor prefers to ignore and not to re-balance her portfolio most of the time as she dislikes bad news more than she likes good news. Consequently, the loss-averse investor has a first-order willingness to pay a portfolio manager who re-balances actively on her behalf. Structural estimates of the preference parameters are in line with those in the literature, generate reasonable intervals of inattention, and simultaneously explain consumption and wealth accumulation over the life cycle. In related work, Andries and Haddad (2020) generate investor inattention with disappointment-averse preferences (Gul 1991, Dillenberger 2010) in a continuous-time portfolio-consumption model. They explain key empirical patterns on how households pay attention to savings. In our model of Bertrand competition, expectation-based loss-averse consumers are uncertain about the qualities and prices of firms' products. This generates consumer inattention to cross-sectional information (other products), rather than to dynamic information flows, and explains scale-dependent search or switching costs.

There are few papers that consider boundedly rational consumers in search markets. Gamp and Krähmer (2019) 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.[15]

[15]In a model of job search with reference-dependent preferences and loss aversion relative to recent income, DellaVigna et al. (2017) show that the search efforts of newly unemployed individuals first decrease over time, then increase in anticipation of a benefit cut, and again decline after the cut. This pattern is often observed in data, but cannot be explained by standard job search models without assuming heterogeneity in workers' productivity.

8 Conclusion

Our goal in this paper was to provide an explanation for inattentive consumer behavior in markets where consumers can choose between different products. Loss-averse consumers may derive little utility from search and information-sensitive choice if the implied expected consumer surplus is small relative to the gain-loss sensations that such a plan generates. Thus, they may stick to an individual default even when this default offers no surplus and even though there are options available that offer a strictly positive surplus. Due to mental accounting, this uncertainty effect can occur for modest degrees of loss aversion. We considered a model of Bertrand competition in which firms with inferior products may serve a share of loss-averse consumers at monopoly prices in equilibrium, while all loss-neutral consumers trade with a dominant firm that offers the best deal in the market. The important consequence of this result is the market outcome may be inefficient even though there is competition between firms, there are no explicit search or switching costs, there is no asymmetric information, and consumers have rational expectations. In new survey data from a large German retail bank, we found suggestive evidence for the predicted correlation between loss aversion and the surplus that consumers forgo.

The model suggests that loss aversion should be taken into account when studying interventions that intend to change behavior through the provision of information. Partial information may not be enough to lure individuals away from their default option. For example, the seller of a superior product may advertise how much money consumers save if they purchase the most recent technology. For loss-neutral consumers this information may be enough to change behavior. However, loss-averse individuals who engage in mental accounting may be discouraged by the expected changes in the different accounts that switching to a new technology implies. Indeed, Allcott and Taubinsky (2015) do not find any significant behavioral change in a field experiment in which the treatment group receives information about the money savings from purchasing compact fluorescent lightbulbs instead of standard incandescents. In their setting, demand for the efficient lightbulbs only increases through monetary subsidies. Our suggestion for future research would be to obtain measures of loss aversion to shed light on the different channels that drive behavior.

How could loss-averse individuals be motivated to search and switch to better alternatives? Our analysis implies that information on potential surplus is not sufficient. However, since mental accounting exacerbates the behavioral impact of loss aversion, one option is to change the search environment in a way so that individuals do not have to worry about changes in multiple dimensions. For example, one can use advertisements or reminders tailored to individual consumers that only suggest products which are identical to the consumer's default, except that they provide an improvement in one dimension, e.g., a reduction in price, and no trade-off in other dimensions. Modestly loss-averse consumers would react to such advertisement since uncertainty is concentrated in one dimension so that there is less scope for the uncertainty effect. Relatedly, policy makers may be able to increase consumers search and switching (and hence competition between firms) by regulating standard-form contracts where most terms and obligations are fixed. In this way, the number of product dimensions that consumers have to consider and that drive the uncertainty effect could also be reduced.[16] Future empirical work may be able to evaluate whether the reduction in product dimensions that are uncertain positively affects search and switching behavior.

[16]This rationale for regulating standard-form contracts is different from that offered in Heidhues et al. (2020) where consumers exhibit limited attention from the outset and can only study a small number of complex products in all dimensions.

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Appendix

Proof of Proposition 1. The statement in (a) is straightforward to prove. We prove the statement in (b). The proof proceeds by steps. **Step 1.** We show that if c is small enough relative to Δ, then the following holds: In any equilibrium, for $n-1$ firms, it must be the case that those consumers who at the planning stage experience no positive utility shock at their assigned firm i ($\xi_i = 0$) choose to inspect all other products. Assume by contradiction that there are two firms i, j so that consumers assigned to firm i do not inspect all products when $v_i = v_{i.k_i^*}$ and $\xi_i = 0$, and consumers assigned to firm j do not inspect all products when $v_j = v_{j.k_j^*}$ and $\xi_j = 0$. Without loss of generality we assume $v_i \geq p_i$ for each firm i. Denote by $p_{i.k_i^*}$ ($p_{j.k_j^*}$) the price firm i (j) charges if $v_i = v_{i.k_i^*}$ ($v_j = v_{j.k_j^*}$). Consider the following alternative plan for consumers assigned for firm i when $v_i = v_{i.k_i^*}$ and $\xi_i = 0$: Inspect all products, trade with firm j if $v_j = v_{j.k_j^*}$ and $\xi_j = \Delta$; otherwise, trade with firm i. This plan is weakly worse than the original plan only if

$$v_{i.k_i^*} - p_{i.k_i^*} \geq \frac{3}{4}[v_{i.k_i^*} - p_{i.k_i^*}] + \frac{1}{4}[v_{j.k_j^*} - p_{j.k_j^*} + \Delta] - c. \tag{20}$$

Accordingly, we must have

$$v_{j.k_j^*} - p_{j.k_j^*} \geq \frac{3}{4}[v_{j.k_j^*} - p_{j.k_j^*}] + \frac{1}{4}[v_{i.k_i^*} - p_{i.k_i^*} + \Delta] - c. \tag{21}$$

These two inequalities taken together imply $c \geq \frac{1}{4}\Delta$, a contradiction if c is small enough relative to Δ. **Step 2.** Since $n \geq 3$, the result from Step 1 implies that the share x of consumers who inspect all products in equilibrium is at least $\frac{1}{3}$ when c is small enough relative to Δ. We study which price firm n charges in equilibrium. If c is small enough relative to Δ, we get the following result: If $p_n > v_n - max_{i\in\{1,\dots,n-1\}}(v_i - p_i) + \Delta$, the share of consumers firm n serves is zero; if $p_n = v_n - max_{i\in\{1,\dots,n-1\}}(v_i - p_i) + \varepsilon$, $\varepsilon \in (0, \Delta]$, the share of consumers firm n serves is at most $\frac{3}{4}\frac{1}{n} + \frac{1}{4}x$; if $p_n = v_n - max_{i\in\{1,\dots,n-1\}}(v_i - p_i) - \varepsilon$, $\varepsilon \in [0, \Delta)$, the share of consumers firm n serves is at most $\frac{1}{n} + \frac{3}{4}x$; and if $p_n = v_n - max_{i\in\{1,\dots,n-1\}}(v_i - p_i) - \Delta$, the share of consumers firm n serves is $\frac{1}{n} + x$. We use this to determine the optimal price p_n. Note that $v_n - max_{i\in\{1,\dots,n-1\}}(v_i - p_i) \geq \Gamma$. If $\frac{1}{8}\Gamma > \Delta$, the unique optimal price for firm n is $p_n = v_n - max_{i\in\{1,\dots,n-1\}}(v_i - p_i) - \Delta$, so that it prices all firms out of the market. By the assumption on firm 1 to $n-1$'s pricing strategy, we get $p_n = v_n - v_{n-1} - \Delta$, which completes the proof. □

Expected utility from a generic plan. Suppose the consumer adopts plan $\sigma_\lambda^{[2]}$. Define by $\pi(v+\xi)$ the corresponding probability that the consumer realizes utility $v+\xi$. Note that the probability that the consumer pays the price $p = v$ (or, in case of firm n, price $p = v - \Delta$) is then given by $\pi(v) + \pi(v+\Delta)$. The consumers expected utility in the planning phase from this plan is then given by

$$\begin{aligned}\mathbb{E}[\bar{U}(\sigma_\lambda^{[2]})] \;=\;& \sum_{i=1}^{n-1}[\pi(v_{i.l}+\Delta)+\pi(v_{i.h}+\Delta)]\Delta + [\pi(v_{n.l})+\pi(v_{n.h})]\Delta \\ &+[\pi(v_{n.l}+\Delta)+\pi(v_{n.h}+\Delta)]2\Delta - (\lambda-1)\bar{A}(\sigma_\lambda^{[2]}) - (\lambda-1)\bar{B}(\sigma_\lambda^{[2]}), \qquad (22)\end{aligned}$$

where $\bar{A}(\sigma_\lambda^{[2]})$ captures gain-loss sensations in the product dimension,

$$\begin{aligned}\bar{A}(\sigma_\lambda^{[2]}) \;=\;& \sum_{i=1}^{n-1}\pi(v_{i.l})\Bigg[\sum_{j=i+1}^{n}\pi(v_{j.l})(v_{j.l}-v_{i.l}) + \sum_{j=i}^{n}\pi(v_{j.l}+\Delta)(v_{j.l}+\Delta-v_{i.l}) \\ &\qquad + \sum_{j=i}^{n}\pi(v_{j.h})(v_{j.h}-v_{i.l}) + \sum_{j=i}^{n}\pi(v_{j.h}+\Delta)(v_{j.h}+\Delta-v_{i.l})\Bigg] \\ &+ \sum_{i=1}^{n-1}\pi(v_{i.l}+\Delta)\Bigg[\sum_{j=i+1}^{n}\pi(v_{j.l})(v_{j.l}-v_{i.l}-\Delta) + \sum_{j=i+1}^{n}\pi(v_{j.l}+\Delta)(v_{j.l}-v_{i.l}) \\ &\qquad + \sum_{j=i}^{n}\pi(v_{j.h})(v_{j.h}-v_{i.l}-\Delta) + \sum_{j=i}^{n}\pi(v_{j.h}+\Delta)(v_{j.h}-v_{i.l})\Bigg] \\ &+ \sum_{i=1}^{n-1}\pi(v_{i.h})\Bigg[\sum_{j=i+1}^{n}\pi(v_{j.l})(v_{j.l}-v_{i.l}) + \sum_{j=i+1}^{n}\pi(v_{j.l}+\Delta)(v_{j.l}+\Delta-v_{i.l}) \\ &\qquad + \sum_{j=i+1}^{n}\pi(v_{j.h})(v_{j.h}-v_{i.l}) + \sum_{j=i}^{n}\pi(v_{j.h}+\Delta)(v_{j.h}+\Delta-v_{i.l})\Bigg] \\ &+ \sum_{i=1}^{n-1}\pi(v_{i.h}+\Delta)\Bigg[\sum_{j=i+1}^{n}\pi(v_{j.l})(v_{j.l}-v_{i.l}-\Delta) + \sum_{j=i+1}^{n}\pi(v_{j.l}+\Delta)(v_{j.l}-v_{i.l}) \\ &\qquad + \sum_{j=i+1}^{n}\pi(v_{j.h})(v_{j.h}-v_{i.l}-\Delta) + \sum_{j=i+1}^{n}\pi(v_{j.h}+\Delta)(v_{j.h}-v_{i.l})\Bigg] \\ &+ \pi(v_{n.l})\,[\pi(v_{n.l}+\Delta)\Delta + \pi(v_{n.h})\Gamma + \pi(v_{n.h}+\Delta)(\Gamma+\Delta)] \\ &+ \pi(v_{n.l}+\Delta)\,[\pi(v_{n.h})(\Gamma-\Delta) + \pi(v_{n.h}+\Delta)\Gamma] - \pi(v_{n.h})\,\pi(v_{n.h}+\Delta)\Delta, \qquad (23)\end{aligned}$$

while $\bar{B}(\sigma_{\lambda}^{[2]})$ captures gain-loss sensations in the price dimension,

$$\begin{aligned}
\bar{B}(\sigma_{\lambda}^{[2]}) \;=\; & \sum_{i=1}^{n-1}[\pi(v_{i.l})+\pi(v_{i.l}+\Delta)] \\
& \quad \times\Bigg[\sum_{j=i+1}^{n-1}[\pi(v_{j.l})+\pi(v_{j.l}+\Delta)](v_{j.l}-v_{i.l})+[\pi(v_{n.l})+\pi(v_{n.l}+\Delta)](v_{n.l}-v_{i.l}-\Delta) \\
& \qquad +\sum_{j=i}^{n-1}[\pi(v_{j.h})+\pi(v_{j.h}+\Delta)](v_{j.h}-v_{i.l})+[\pi(v_{n.h})+\pi(v_{n.h}+\Delta)](v_{n.h}-v_{i.l}-\Delta)\Bigg] \\
& +\sum_{i=1}^{n-1}[\pi(v_{i.h})+\pi(v_{i.h}+\Delta)] \\
& \quad \times\Bigg[\sum_{j=i+1}^{n-1}[\pi(v_{j.l})+\pi(v_{j.l}+\Delta)](v_{j.l}-v_{i.h})+[\pi(v_{n.l})+\pi(v_{n.l}+\Delta)](v_{n.l}-v_{i.h}-\Delta) \\
& \qquad +\sum_{j=i+1}^{n-1}[\pi(v_{j.h})+\pi(v_{j.h}+\Delta)](v_{j.h}-v_{i.h})+[\pi(v_{n.h})+\pi(v_{n.h}+\Delta)](v_{n.h}-v_{i.h}-\Delta)\Bigg] \\
& +[\pi(v_{n.l})+\pi(v_{n.l}+\Delta)][\pi(v_{n.h})+\pi(v_{n.h}+\Delta)]\Gamma. \qquad (24)
\end{aligned}$$

We use this expression implicitly in the subsequent proofs. □

Proof of Proposition 2. If at the assigned firm i^* the consumer experiences a positive utility shock, she cannot increase her payoff by trading with another firm. Assume therefore that the consumer experiences no positive utility shock at the assigned firm, $\xi_{i^*} = 0$. Suppose the consumer inspects all products and adopts plan $\tilde{\sigma}_{\lambda^*}^{[2]}$. We find an upper bound on the expected utility from this plan.[17] To this end, we define an alternative plan $\sigma_{\lambda^*}^{[2]}$ that will weakly dominate $\tilde{\sigma}_{\lambda^*}^{[2]}$. This alternative plan involves trade with two firms, i^* and i; if $i^* = n$, we choose $i = n-1$; otherwise, we choose $i = i^* + 1$ (in terms of the proof, the two cases are equivalent). Define scenario $j \in \{1, 2\}$, where $j = 1$ indicates $v_i = v_{i.l}$ and $j = 2$ indicates $v_i = v_{i.h}$. Define by π_i^j the probability induced by plan $\sigma_{\lambda^*}^{[2]}$ that the scenario is j and the consumer trades with firm i; define $\pi_{i^*}^j$ accordingly; for the original plan, define $\tilde{\pi}_i^j$ and $\tilde{\pi}_{i^*}^j$ in the same manner. The alternative plan $\sigma_{\lambda^*}^{[2]}$ is derived from the original plan $\tilde{\sigma}_{\lambda^*}^{[2]}$ so that for each scenario j we have

[17]We will use the same arguments in the proof of Proposition 4. Hence, this proof is probably a bit more detailed than it needs to be.

$\pi^j_{i^*} = \tilde{\pi}^j_{i^*}$, and $\pi^j_i = \frac{1}{2} - \tilde{\pi}^j_{i^*}$. We define

$$\pi_0 = \pi^1_{i^*} + \pi^2_{i^*}, \tag{25}$$

$$\pi_1 = \pi^1_i, \tag{26}$$

$$\pi_2 = \pi^2_i, \tag{27}$$

We now define an upper bound on the expected utility from the alternative plan, which, by construction, also holds for the original plan. For $\pi = (\pi_0, \pi_1, \pi_2)$, this upper bound is given by

$$\mathbb{E}[U(\pi)] = [\pi_1 + \pi_2]\Delta - (\lambda^* - 1)\pi_0[\pi_1 + \pi_2](2\Gamma - \Delta) - (\lambda^* - 1)\pi_1\pi_2(2\Gamma - \Delta). \tag{28}$$

To see where this equation comes from, note that the price difference between different products is at least Γ, and the difference in utility between different products is at least $\Gamma - \Delta$. We now find the alternative plan that maximizes (28). Consider the following variations of an alternative plan: $\pi_0 = \pi'_0 + \varepsilon$ and $\pi_y = \pi'_y - \varepsilon$ with $y \in \{1, 2\}$. For any such variation we get

$$\frac{\partial \mathbb{E}[U(\pi)]}{\partial \varepsilon} = A - (\lambda^* - 1)(\pi_y - \pi_0)(2\Gamma - \Delta), \tag{29}$$

where A is some constant. Thus, any admissible π that maximizes $\mathbb{E}[U(\pi)]$ is a corner-solution. At a plan that maximizes (28), we therefore must have either $\pi_0 = 1$, or $\pi_0 = \frac{1}{2}$ and either $\pi_1 = \frac{1}{2}$ or $\pi_2 = \frac{1}{2}$, or $\pi_1 = \pi_2 = \frac{1}{2}$. Thus, we obtain four vectors π that represent candidate plans for a maximum of (28), and that we can compare to each other in terms of $\mathbb{E}[U(\pi)]$. Using $\Gamma \geq 2\Delta$, we can derive the following result from this comparison: If inequality (7) holds, then the plan "always trade with firm i^*" is the unique PPE. □

Proof of Proposition 3. Consider any firm i and take the consumer's strategy as given. We specify that the consumer's beliefs about products $j \neq i^*$ are independent of p_{i^*}. Firm i's profit from charging $p_i = v_i$ equals $\frac{1}{n}v_i$; its profit from charging a price $p_i > v_i$ is at most $\frac{1}{n}\frac{1}{2}(v_i + \Delta)$. Since $v_i \geq \Gamma$ and $\frac{1}{2}\Gamma \geq \Delta$, this deviation is not profitable. Clearly, it also does not pay off to charge a price $p_i < v_i$. This completes the proof. □

Proof of Proposition 4. The proof proceeds in two steps. In Step 1, we show the statement when in the planning stage the consumer does not experience a positive utility shock at the assigned firm i^*. In Step 2, we show the statement when there is a positive utility shock at firm i^*. **Step 1.** Consider first the case when the consumer experiences no positive utility shock at the assigned firm, $\xi_{i^*} = 0$. Suppose the consumer inspects all products and adopts plan $\tilde{\sigma}^{[2]}_{\lambda^*}$. We find an upper bound on the expected utility from this plan. To this end, we define an alternative plan $\sigma^{[2]}_{\lambda^*}$ that will weakly dominate $\tilde{\sigma}^{[2]}_{\lambda^*}$. This alternative plan involves trade with three firms, n, i^*, and i; if $i^* = n-1$, we choose $i = n-2$ (Case A); otherwise, we choose $i = n-1$ (Case B). Define scenario j,k for $j \in \{1,2\}$ and $k \in \{3,4,5,6\}$, where $j = 1$ indicates $v_i = v_{i.l}$, $j = 2$ indicates $v_i = v_{i.h}$, $k = 3$ indicates $u_n = v_{n.l}$, $k = 4$ indicates $u_n = v_{n.l} + \Delta$, $k = 5$ indicates $u_n = v_{n.h}$, and $k = 6$ indicates $u_n = v_{n.h} + \Delta$. Define by $\pi_n^{j,k}$ the probability induced by plan $\sigma^{[2]}_{\lambda^*}$ that the scenario is j,k and the consumer trades with firm n; define $\pi_{i^*}^{j,k}$ and $\pi_i^{j,k}$ accordingly; for the original plan, define $\tilde{\pi}_n^{j,k}$ and $\tilde{\pi}_{i^*}^{j,k}$ in the same manner. The alternative plan $\sigma^{[2]}_{\lambda^*}$ is derived from the original plan $\tilde{\sigma}^{[2]}_{\lambda^*}$ so that for each scenario j,k we have $\pi_n^{j,k} = \tilde{\pi}_n^{j,k}$, $\pi_{i^*}^{j,k} = \tilde{\pi}_{i^*}^{j,k}$, and $\pi_i^{j,k} = \frac{1}{8} - \tilde{\pi}_n^{j,k} - \tilde{\pi}_{i^*}^{j,k}$. Define

$$\begin{aligned}
\pi_0 &= \sum_{j\in\{1,2\}} \sum_{k\in\{3,...,6\}} \pi_{i^*}^{j,k}, && (30)\\
\pi_j &= \sum_{k\in\{3,...,6\}} \pi_i^{j,k} \text{ for all } j \in \{1,2\}, && (31)\\
\pi_k &= \sum_{j\in\{1,2\}} \pi_n^{j,k} \text{ for all } k \in \{3,...,6\}. && (32)
\end{aligned}$$

We now define an upper bound on the expected utility from the alternative plan, which, by construction, also holds for the original plan. Suppose we have Case A. For $\pi = (\pi_0, ..., \pi_6)$, this upper bound is then given by

$$\begin{aligned}
\mathbb{E}[U(\pi)] = \;& [\pi_1 + \pi_2 + \pi_3 + \pi_5]\Delta + [\pi_4 + \pi_6]2\Delta \\
& -(\lambda^* - 1)[\pi_0\pi_1 + \pi_0\pi_2 + \pi_1\pi_2](2\Gamma - \Delta) \\
& -(\lambda^* - 1)\pi_0[\pi_3 2\Gamma + \pi_4(2\Gamma + \Delta) + \pi_5 4\Gamma + \pi_6(4\Gamma + \Delta)] \\
& -(\lambda^* - 1)\pi_1[\pi_3(8\Gamma - \Delta) + \pi_4 8\Gamma + \pi_5(10\Gamma - \Delta) + \pi_6 10\Gamma] \\
& -(\lambda^* - 1)\pi_2[\pi_3(6\Gamma - \Delta) + \pi_4 6\Gamma + \pi_5(8\Gamma - \Delta) + \pi_6 8\Gamma] \\
& -(\lambda^* - 1)\pi_3[\pi_4\Delta + \pi_5 2\Gamma + \pi_6(2\Gamma + \Delta)] \\
& -(\lambda^* - 1)\pi_4[\pi_5(2\Gamma - \Delta) + \pi_6 2\Gamma] - (\lambda - 1)\pi_5\pi_6\Delta. && (33)
\end{aligned}$$

For Case B, this upper bound is given by

$$\begin{aligned}
\mathbb{E}[U(\pi)] \;=\; & [\pi_1+\pi_2+\pi_3+\pi_5]\Delta + [\pi_4+\pi_6]2\Delta \\
& -(\lambda^*-1)[\pi_0\pi_1+\pi_0\pi_2+\pi_1\pi_2](2\Gamma-\Delta) \\
& -(\lambda^*-1)\pi_0[\pi_3 6\Gamma+\pi_4(6\Gamma+\Delta)+\pi_5 8\Gamma+\pi_6(8\Gamma+\Delta)] \\
& -(\lambda^*-1)\pi_1[\pi_3(4\Gamma-\Delta)+\pi_4 4\Gamma+\pi_5(6\Gamma-\Delta)+\pi_6 6\Gamma] \\
& -(\lambda^*-1)\pi_2[\pi_3(2\Gamma-\Delta)+\pi_4 2\Gamma+\pi_5(4\Gamma-\Delta)+\pi_6 4\Gamma] \\
& -(\lambda^*-1)\pi_3[\pi_4\Delta+\pi_5 2\Gamma+\pi_6(2\Gamma+\Delta)] \\
& -(\lambda^*-1)\pi_4[\pi_5(2\Gamma-\Delta)+\pi_6 2\Gamma]-(\lambda-1)\pi_5\pi_6\Delta. \qquad (34)
\end{aligned}$$

In the following, we assume that we have Case A; for Case B, the proof is essentially the same. We now find the alternative plan that maximizes (33). Consider the following variations of an alternative plan: $\pi_x = \pi'_x + \varepsilon$ and $\pi_y = \pi'_y - \varepsilon$ with $x \in \{0,1,2\}$ and $y \in \{3,...,6\}$ or $x = 0$ and $y \in \{1,2\}$. For any such variation we get

$$\frac{\partial \mathbb{E}[U(\pi)]}{\partial \varepsilon} = A - (\lambda^*-1)(\pi_y - \pi_x)B, \qquad (35)$$

where A is some constant and B is strictly positive. Thus, any admissible π that maximizes $\mathbb{E}[U(\pi)]$ is a corner-solution. At a plan that maximizes (33), we must have $\pi_n^{j,k} \in \{0, \frac{1}{8}\}$ for all scenarios j,k. Moreover, we must have $\pi_0 = 0$ or $\pi_1 = 0$ or $\pi_2 = 0$ or $\pi_1 = \pi_2 = 0$. Thus, we obtain a finite set of vectors π that represent candidate plans for a maximum of (33), and that we can compare to each other in terms of $\mathbb{E}[U(\pi)]$. From this comparison, we get the following result. Consider the expected payoff from plan "always trade with firm n", with $\pi^{[1]} = (0,0,0,\frac{1}{4},\frac{1}{4},\frac{1}{4},\frac{1}{4})$, which is equal to

$$\mathbb{E}[U(\pi^{[1]})] = \frac{3}{2}\Delta - (\lambda^*-1)\frac{1}{2}\Gamma - (\lambda^*-1)\frac{1}{8}\Delta. \qquad (36)$$

This plan strictly dominates almost all plans for all values of $\lambda^* > 1$. Consider the plan "always trade with firm i", with $\pi^{[2]} = (0,\frac{1}{2},\frac{1}{2},0,0,0,0)$. The upper bound on expected utility from this plan equals

$$\mathbb{E}[U(\pi^{[2]})] = \Delta - (\lambda^*-1)\frac{1}{2}\Gamma + (\lambda^*-1)\frac{1}{4}\Delta. \qquad (37)$$

Since $\Gamma > 2\Delta$, we get $\mathbb{E}[U(\pi^{[2]})] > 0$ only if $\lambda^* < \frac{7}{3}$, and $\mathbb{E}[U(\pi^{[1]})] > \mathbb{E}[U(\pi^{[2]})]$ if $\lambda^* < \frac{7}{3}$. Hence, if the plan "always trade with firm i" generates positive expected utility, it is strictly dominated by plan "always trade with firm n." The same holds for all plans that are not strictly dominated by "always trade with firm n" for all values λ^*:[18] Whenever they offer positive expected utility, they are strictly dominated by "always trade with firm n." It remains to show that the plan "always trade with firm n" is a personal equilibrium. Suppose that the consumer deviates and chooses any other option. Compared to any possible utility-price pair u_n, p_n the consumer then loses at least $z\Gamma - \Delta$, $z \in \mathbb{N}_+$, in the product dimension, and gains $z\Gamma - \Delta$ in the price dimension. Since $\lambda^* > 1$ and there are no gains from deviation in terms of consumption utility, the plan "always trade with firm n" is a personal equilibrium. By the argument above it is also a PPE if $\mathbb{E}[U(\pi^{[1]})] \geq 0$, while "always trade with firm i^*" is the unique PPE if $\mathbb{E}[U(\pi^{[1]})] < 0$. **Step 2.** Consider next the case when the consumer experiences a positive utility shock at the assigned firm, $\xi_{i^*} = \Delta$. The proof is a simplified version from that in Step 1. Suppose the consumer inspects all products and adopts plan $\tilde{\sigma}^{[2]}_{\lambda^*}$. We again define an alternative plan $\sigma^{[2]}_{\lambda^*}$ that will weakly dominate $\tilde{\sigma}^{[2]}_{\lambda^*}$ and for which we can find an upper bound on the expected utility from $\sigma^{[2]}_{\lambda^*}$. This alternative plan involves trade with two firms, n and i^*. Define by π_0 the probability induced by plan $\sigma^{[2]}_{\lambda^*}$ that the consumer trades with firm i^*, and by π_1 (resp. π_2, π_3, π_4) the probability induced by plan $\sigma^{[2]}_{\lambda^*}$ that $u_n = v_{n.l}$ (resp. $u_n = v_{n.l} + \Delta$, $u_n = v_{n.h}$, $u_n = v_{h.l} + \Delta$) and the consumer trades with firm n. For the original plan, define $\tilde{\pi}_1, ..., \tilde{\pi}_4$ in the same manner. The alternative plan $\sigma^{[2]}_{\lambda^*}$ is derived from the original plan $\tilde{\sigma}^{[2]}_{\lambda^*}$ so that $\pi_j = \tilde{\pi}_j$ for $j = 1, ..., 4$, and $\pi_0 = 1 - \tilde{\pi}_1 - \tilde{\pi}_2 - \tilde{\pi}_3 - \tilde{\pi}_4$. We now define an upper bound on the expected utility from the alternative plan, which, by construction, also holds for the original plan. For $\pi = (\pi_0, ..., \pi_4)$ this upper bound is given by

$$\begin{aligned}\mathbb{E}[U(\pi)] = {} & [\pi_0 + \pi_1 + \pi_3]\Delta + [\pi_2 + \pi_4]2\Delta \\ & -(\lambda^* - 1)\pi_0[\pi_1(2\Gamma - \Delta) + \pi_2 2\Gamma + \pi_3(4\Gamma - \Delta) + \pi_4 4\Gamma] \\ & -(\lambda^* - 1)\pi_1[\pi_2\Delta + \pi_3 2\Gamma + \pi_4(2\Gamma + \Delta)] \\ & -(\lambda^* - 1)\pi_2[\pi_3(2\Gamma - \Delta) + \pi_4 2\Gamma] - (\lambda - 1)\pi_3\pi_4\Delta. \qquad (38)\end{aligned}$$

[18] Specifically, these are the following plans (or payoff-equivalent plans): "trade with firm n if the scenario is $j = 2, k \in \{3, 4\}$, and with firm i^* otherwise", with $\pi^{[3]} = (\frac{3}{4}, 0, 0, \frac{1}{8}, \frac{1}{8}, 0, 0)$ and $\mathbb{E}[U(\pi^{[3]})] = 0.375\Delta - (\lambda^* - 1)0.38\Gamma - (\lambda^* - 1)0.11\Delta$; "trade with firm n if the scenario is $j = 2, k = 4$, and with firm i^* otherwise", with $\pi^{[4]} = (\frac{7}{8}, 0, 0, 0, \frac{1}{8}, 0, 0)$ and $\mathbb{E}[U(\pi^{[4]})] = 0.25\Delta - (\lambda^* - 1)0.22\Gamma - (\lambda^* - 1)0.11\Delta$; "trade with firm n if the scenario is $j = 2, k = 3$, and with firm i^* otherwise", with $\pi^{[5]} = (\frac{7}{7}, 0, 0, \frac{1}{8}, 0, 0, 0)$ and $\mathbb{E}[U(\pi^{[5]})] = 0.125\Delta - (\lambda^* - 1)0.22\Gamma$.

We find an alternative plan that maximizes (38). With a similar argument as used in Step 1, we can show that at a global maximum we must have, for all $j = 1, ..., 4$, that $\pi_j = \frac{1}{4}$ or $\pi_j = 0$. Thus, we obtain a finite set of vectors π that represent candidate plans for a maximum of (38), and that we can compare to each other in terms of $\mathbb{E}[U(\pi)]$. From this comparison, we get the following result. The expected payoff from the plan "always trade with firm n" with $\pi^{[1]} = (0, \frac{1}{4}, \frac{1}{4}, \frac{1}{4}, \frac{1}{4})$ equals

$$\mathbb{E}[U(\pi^{[1]})] = \frac{3}{2}\Delta - (\lambda^* - 1)\frac{1}{2}\Gamma - (\lambda^* - 1)\frac{1}{8}\Delta. \tag{39}$$

Since $\Gamma > 2\Delta$, this plan strictly dominates almost all plans for all values of $\lambda^* > 1$. The only exception is the plan "trade with firm n if $u_n = v_{n.l} + \Delta$ and with firm i^* otherwise" with $\pi^{[2]} = (\frac{3}{4}, 0, \frac{1}{4}, 0, 0)$. The upper bound on expected utility from this plan equals

$$\mathbb{E}[U(\pi^{[2]})] = \frac{5}{4}\Delta - (\lambda^* - 1)\frac{3}{8}\Gamma. \tag{40}$$

Note that if $\mathbb{E}[U(\pi^{[1]})] \geq \Delta$, then $\mathbb{E}[U(\pi^{[1]})] \geq \mathbb{E}[U(\pi^{[2]})]$, and $\mathbb{E}[U(\pi^{[2]})] < \Delta$ when $\mathbb{E}[U(\pi^{[1]})] < \Delta$. As in Step 1, we can show that the plan "always trade with firm n" is a personal equilibrium. By the argument above it is a PPE if $\mathbb{E}[U(\pi^{[1]})] \geq \Delta$, while "always trade with firm i^*" is the unique PPE if $\mathbb{E}[U(\pi^{[1]})] < \Delta$. This completes the poof. □

Proof of Proposition 5. We first specify the firms' strategies of the proposed equilibrium: Each firm $i \neq n$ charges $p_i = v_i$, and firm n charges the profit maximizing price, assuming that only loss-neutral consumers may switch firms when at least one firm $i \neq n$ charges $p_i \neq v_i$. The proof proceeds in steps. **Step 1.** We first examine whether consumers can deviate profitably, given the firms' behavior . Proposition 4 implies that for loss-averse consumers it is optimal to trade with their assigned firm i^* if $p_{i^*} = v_{i^*}$ and Δ is sufficiently small relative to Γ; loss-neutral consumers always inspect all products and trade with a firm i if firm i's product maximizes consumption utility (in case of a tie, they trade with the firm that offers the highest product value). Consider a loss-averse consumer who observes that her assigned firm i^* deviates from the equilibrium strategy and charges $p_{i^*} = v_{i^*} - \varepsilon$ for some $\varepsilon > 0$. Assume w.l.o.g. that ε is small enough such that firm n reacts by charging $v_n - \Delta - \varepsilon$. Observe that the trade-off between the plans "always trade with firm i^*" and "always trade with firm n" is then unaffected. Thus, if Δ is sufficiently small relative to Γ, loss-averse consumers assigned to firm i^* follow the former plan. **Step 2.** Next, we show that no firm has an incentive to deviate from the prescribed pricing strategy, given the consumers' behavior. Suppose that firm $i \neq n$ unilaterally deviates and charges $p_i = v_i - \varepsilon$. We show that, for given $\beta \in (0, 1)$, if Δ is small enough relative to Γ, it is then optimal for firm n to charge $p_n = v_n - \varepsilon - \Delta$ (so that firm i does not benefit from its deviation), or it is not optimal for firm i to charge $p_i = v_i - \varepsilon$. We have to consider three deviations of firm n: (i) firm n charges $p_n = v_n$, (ii) firm n charges $p_n = v_n - \varepsilon + \Delta$, and (iii) firm n charges $p_n = v_n - \varepsilon$; other prices cannot be optimal for firm n. Consider deviation (i) when $\varepsilon > \Delta$. The share of consumers firm n then serves is $(1-\beta)\frac{1}{n}$, and we must have

$$(v_n - \varepsilon - \Delta)\left((1-\beta)\frac{1}{n} + \beta\right) \leq v_n(1-\beta)\frac{1}{n}. \tag{41}$$

If the deviation is profitable for firm i, we must have

$$(v_i - \varepsilon)\left((1-\beta)\frac{1}{n} + \beta\right) > v_i(1-\beta)\frac{1}{n}. \tag{42}$$

The first inequality is equivalent to $v_n\beta \leq (\varepsilon + \Delta)((1-\beta)\frac{1}{n} + \beta)$; the second inequality is equivalent to $v_i\beta > \varepsilon((1-\beta)\frac{1}{n} + \beta)$. Note that $v_n \geq v_i + \Gamma$. Thus, if Δ is small enough relative to Γ, we obtain a contradiction. Consider deviation (i) when $\varepsilon \leq \Delta$. The share of consumers firm n then serves is $(1-\beta)\frac{1}{n} + \frac{1}{4}\beta$, and we must have

$$(v_n - \varepsilon - \Delta)\left((1-\beta)\frac{1}{n} + \beta\right) \leq v_n\left((1-\beta)\frac{1}{n} + \frac{1}{4}\beta\right). \tag{43}$$

We can rewrite this inequality as

$$v_n\frac{3}{4}\beta \leq (\Delta + \varepsilon)(1-\beta)\frac{1}{n} + (\Delta + \varepsilon)\beta. \tag{44}$$

Hence, if Δ is small enough relative to Γ, this inequality is violated, in which case we obtain a contradiction. We obtain the same result for deviation (ii) and deviation (iii) in a similar manner. This completes the proof. □

Proof of Proposition 6. Suppose that each firm $i \neq n$ charges $p_i = \bar{v}$, while firm n charges $p_n = \bar{v} - \Delta$. Consider a loss-averse consumer assigned to a firm $i^* \neq n$. We show that if d_{min} is large enough so that inequality (16) holds, then "always trade with firm i^*" is the consumer's unique PPE. The proof uses the same arguments as the proof of Proposition 4. Suppose the consumer experiences no positive utility shock at the assigned firm, $\xi_{i^*} = 0$ (we consider the case $\xi_{i^*} = \Delta$ below). Assume the consumer inspects all products and adopts plan $\tilde{\sigma}^{[2]}_{\lambda^*}$. We find an upper bound on the expected utility from this plan. For this, we define an alternative plan $\sigma^{[2]}_{\lambda^*}$ that will weakly dominate $\tilde{\sigma}^{[2]}_{\lambda^*}$. This alternative plan involves trade with three firms, n, i^*, and i. If $i^* = n-1$, we choose $i = n-2$; otherwise, we choose $i = n-1$. Define scenario j,k for $j \in \{1,2\}$ and $k \in \{3,4,5,6\}$, where $j = 1$ indicates $v_i = v_{i.l}$, $j = 2$ indicates $v_i = v_{i.h}$, $k = 3$ indicates $v_n = v_{n.l}, \xi_n = 0$, $k = 4$ indicates $v_n = v_{n.l}, \xi_n = \Delta$, $k = 5$ indicates $v_n = v_{n.h}, \xi_n = 0$, and $k = 6$ indicates $v_n = v_{n.h}, \xi_n = \Delta$. Define by $\pi^{j,k}_n$ the probability induced by plan $\sigma^{[2]}_{\lambda^*}$ that the scenario is j,k and the consumer trades with firm n; define $\pi^{j,k}_{i^*}$ and $\pi^{j,k}_i$ accordingly; for the original plan, define $\tilde{\pi}^{j,k}_n$ and $\tilde{\pi}^{j,k}_{i^*}$ in the same manner. The alternative plan $\sigma^{[2]}_{\lambda^*}$ is derived from the original plan $\tilde{\sigma}^{[2]}_{\lambda^*}$ so that for each scenario j,k we have $\pi^{j,k}_n = \tilde{\pi}^{j,k}_n$, $\pi^{j,k}_{i^*} = \tilde{\pi}^{j,k}_{i^*}$, and $\pi^{j,k}_i = \frac{1}{8} - \tilde{\pi}^{j,k}_n - \tilde{\pi}^{j,k}_{i^*}$. Define π_0, π_j and π_k as in the proof of Proposition 4, equations (30), (31), and (32), respectively. We now can define an upper bound on the expected utility from the alternative plan, which, by construction, also holds for the original plan. For $\pi = (\pi_0, ..., \pi_6)$, this upper bound is given by

$$\begin{aligned}
\mathbb{E}[U(\pi)] \;=\; & [\pi_1+\pi_2+\pi_3+\pi_5]\Delta + [\pi_4+\pi_6]2\Delta \\
& -(\lambda^*-1)\pi_0[\pi_1+\pi_2+\pi_3+\pi_4+\pi_5+\pi_6]d_{min} \\
& -(\lambda^*-1)\pi_1[\pi_2+\pi_3+\pi_4+\pi_5+\pi_6]d_{min} \\
& -(\lambda^*-1)\pi_2[\pi_3+\pi_4+\pi_5+\pi_6]d_{min} \\
& -(\lambda^*-1)\pi_3[\pi_4+\pi_5+\pi_6]d_{min} \\
& -(\lambda^*-1)\pi_4[\pi_5+\pi_6]d_{min} - (\lambda^*-1)\pi_5\pi_6 d_{min}. \qquad (45)
\end{aligned}$$

As in the proof of Proposition 4, we can show with (33) that any admissible π that maximizes $\mathbb{E}[U(\pi)]$ is a corner-solution. Thus, at a plan that maximizes (45), we must have $\pi^{j,k}_n \in \{0, \frac{1}{8}\}$ for all scenarios j,k; moreover, we must have $\pi_0 = 0$ or $\pi_1 = 0$ or $\pi_2 = 0$ or $\pi_1 = \pi_2 = 0$. Thus, we obtain a finite set of vectors π that represent candidate plans for a maximum of (45). For each of these π we can write $\mathbb{E}[U(\pi)] = \alpha\Delta - \beta(\lambda^*-1)d_{min}$. Hence, we can find the largest possible ratio $\frac{\alpha}{\beta}$ from the finite set, and choose d_{min} large enough so that

$$\frac{\alpha}{\beta} < \frac{(\lambda^* - 1)d_{min}}{\Delta} \tag{46}$$

for all admissible π. If the degree of differentiation is this large, then "always trade with firm i^*" is the consumer's unique PPE. It turns out that the largest possible ratio equals 4, which yields inequality (16). If we go through the same steps for the case when the consumer experiences a positive utility shock at the assigned firm, $\xi_{i^*} = \Delta$, we find that "always trade with firm i^*" is the consumer's unique PPE if

$$\frac{7}{5} < \frac{(\lambda^* - 1)d_{min}}{\Delta}, \tag{47}$$

which completes the proof. □

Proof of Proposition 7. We first specify the firms' strategies of the proposed equilibrium: Each firm $i \neq n$ charges $p_i = \bar{v}$, and firm n charges the profit maximizing price, assuming that only loss-neutral consumers may switch firms when at least one firm $i \neq n$ charges $p_i \neq \bar{v}$. Loss-averse consumers then optimally trade with their assigned firm i^* as long as their payoff from doing so is non-negative; otherwise, they do not trade at all; loss-neutral consumers inspect all products and trade with a firm i if firm i's product maximizes consumption utility (in case of a tie, they trade with the firm with the highest number). Suppose that firm $i \neq n$ unilaterally deviates and charges $p_i = \bar{v} - \varepsilon$. We show the following statement: Assume that c_h is close enough to $\bar{v}$ so that

$$\frac{\bar{v} - c_h}{\bar{v}} < \frac{(1-\beta)\frac{1}{n} + \frac{1}{4}\beta}{(1-\beta)\frac{1}{n} + \beta}. \tag{48}$$

Then, if Δ is sufficiently small, it is optimal for firm n to charge $p_n = \bar{v} - \varepsilon - \Delta$ (so that firm i does not benefit from its deviation), or, if it is not optimal for firm n to defend its market share, it is also not optimal for firm i to charge $p_i = \bar{v} - \varepsilon$. If firm $i \neq n$ charges $p_i = \bar{v} - \varepsilon$, the optimal reaction for firm n is to charge either $p_n = \bar{v} - \varepsilon$ or $p_n = \bar{v} - \Delta$ or $p_n = \bar{v}$ or $p_n = \bar{v} - \Delta - \varepsilon$; other prices cannot be optimal for firm n if Δ is small enough relative to $\bar{v}$. We have to distinguish between different cases.

If firm n charges $\bar{v} - \Delta - \varepsilon$ (the equilibrium response), the share of consumers it serves equals $(1-\beta)\frac{1}{n} + \beta$; if it charges $\bar{v} - \varepsilon$, firm n's share equals $(1-\beta)\frac{1}{n} + \frac{3}{4}\beta$ and firm i's share equals $(1-\beta)\frac{1}{n} + \frac{1}{4}\beta$ (Case 1); if it charges $\bar{v} - \Delta$, firm n's share equals $(1-\beta)\frac{1}{n} + \frac{3}{4}\beta$ and firm i's share equals $(1-\beta)\frac{1}{n}+\frac{1}{4}\beta$ (Case 2a), or firm n's share equals $(1-\beta)\frac{1}{n}+\frac{1}{4}\beta$ and firm i's share equals $(1-\beta)\frac{1}{n}+\frac{3}{4}\beta$ (Case 2b); if it charges $\bar{v}$, firm n's share equals $(1-\beta)\frac{1}{n}+\frac{1}{4}\beta$ and firm i's share equals $(1-\beta)\frac{1}{n}+\frac{3}{4}\beta$ (Case 3a), or firm n's share equals $(1-\beta)\frac{1}{n}$ and firm i's share equals $(1-\beta)\frac{1}{n}+\beta$ (Case 3b). Consider Case 1. If it is optimal for firm n to charge $p_n=\bar{v}-\varepsilon$ instead of $\bar{v}-\Delta-\varepsilon$, we must have

$$(\bar{v}-\varepsilon)\left((1-\beta)\frac{1}{n}+\frac{3}{4}\beta\right)>(\bar{v}-\Delta-\varepsilon)\left((1-\beta)\frac{1}{n}+\beta\right). \tag{49}$$

The deviation is profitable for firm i only if

$$(\bar{v}-c_h-\varepsilon)\left((1-\beta)\frac{1}{n}+\frac{1}{4}\beta\right)>(\bar{v}-c_h)(1-\beta)\frac{1}{n}. \tag{50}$$

These two inequalities are satisfied simultaneously only if

$$\left(\bar{v}-\frac{\frac{1}{4}(\bar{v}-c_h)\beta}{(1-\beta)\frac{1}{n}+\frac{1}{4}\beta}\right)\frac{1}{4}\beta<\Delta\left((1-\beta)\frac{1}{n}+\beta\right). \tag{51}$$

Note that the fraction in the large brackets on the left-hand side of this inequality is strictly smaller than $\bar{v}$. Hence, the inequality is violated if Δ is small enough relative to $\bar{v}$, in which case we obtain a contradiction. Next, consider Case 2a. If it is optimal for firm n to charge $p_n=\bar{v}-\Delta$ instead of $\bar{v}-\Delta-\varepsilon$, we must have

$$(\bar{v}-\Delta)\left((1-\beta)\frac{1}{n}+\frac{3}{4}\beta\right)>(\bar{v}-\Delta-\varepsilon)\left((1-\beta)\frac{1}{n}+\beta\right). \tag{52}$$

Again, the deviation is profitable for firm i only if

$$(\bar{v}-c_h-\varepsilon)\left((1-\beta)\frac{1}{n}+\frac{1}{4}\beta\right)>(\bar{v}-c_h)(1-\beta)\frac{1}{n}. \tag{53}$$

The two inequalities are satisfied simultaneously only if

$$(\bar{v}-c_h)\frac{(1-\beta)\frac{1}{n}+\beta}{(1-\beta)\frac{1}{n}+\frac{1}{4}\beta}>\bar{v}-\Delta. \tag{54}$$

Note that when condition (48) is satisfied, this inequality is violated if Δ is small enough relative to $\bar{v}$, in which case we get a contradiction. Applying the same argument to Case 2b, Case 3a and Case 3b then completes the proof. □

Table 3: Overview of Empirical Studies on Inertia from Figure 1

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

Table 4: Overview of Independent Variables in Table 2

Variable	**Description**	**Scale**	**Note**
loss aversion	The possibility of even small losses for my savings (e.g. through financial risk) makes me nervous.	1-7	7 = highly averse
risk tolerance	If you personally make savings or investment decisions: How would you describe your risk attitude?	1-7	7 = highly tolerant
financial literacy	"Big Three" financial literacy questions by Lusardi and Mitchell (2011) and two similar questions E.g.: Assume that savings of 100 Euro earn interest of 2% per year. What do you think: How much credit does the savings account show after 5 years? More than 102 Euro; Exactly 102 Euro; Less than 102 Euro; N/A.	0-5	sum of correct answers; 5 = high literacy
education	high education	dummy	1 = college degree
trust	Do you think that you can trust most people or that you cannot be careful enough when dealing with other people?	1-7	7 = high trust
patience	I am generally a patient person.	1-7	7 = very patient
male	gender	dummy	1= male
age	age (in categories)	1-7	1 age lower than 25 2 age 26-35 3 age 36-45 4 age 46-55 5 age 56-65 6 age 66-75 7 age higher than 75
household income	household income (in categories) Which of the following categories best describes the monthly net income of your household? Please take into account all your household income (e.g. also income from renting/leasing and child benefit).	1-9, 999	1 no positive income 2 below 500 EUR 3 500 - 1500 EUR 4 1500 - 2500 EUR 5 2500 - 4500 EUR 6 4500 - 7500 EUR 7 7500 - 10.000 EUR 8 10.000 - 20.000 EUR 9 above 20.000 EUR 999 no response