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Increasing Consumer Surplus through a Novel Product Testing Mechanism

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Increasing Consumer Surplus through a Novel Product Testing Mechanism

Abstract

Our study proposes a novel mechanism to reduce information asymmetry about product quality between buyers and sellers. Product testing organizations like Consumer Reports (US) and Stiftung Warentest (Germany) seek to reduce this asymmetry by providing credible information. However, limited capacity leads to testing of only a select number of product models, often bestsellers, which can yield suboptimal information. After outlining our mechanism, we develop a game to derive testable predictions. We show theoretically that a unique Nash equilibrium exists in which our mechanism yields optimal information, equivalent to a world of complete information, while selecting bestsellers does not. Subsequently, we confirm experimentally that our mechanism increases consumer surplus.

JEL-Code: C72, C91, D82, L15

Keywords: Consumer surplus; information asymmetry; product quality; product test; information disclosure; mechanism design; experiment

December 2020

1 Ulrike Vollstaedt, University of Michigan, USA, and UDE; Patrick Imcke, UDE; Franziska Brendel, UDE; Christiane Ehses-Friedrich. *– We thank seminar participants at several institutions (University of Duisburg-Essen, ESA Mentoring Workshop Berlin, University of Jena, Max Planck Institute for Research on Collective Goods Bonn, ESA European Meeting Vienna, Thurgauer Wirtschaftsinstitut/University of Konstanz, and DICE/University of Düsseldorf), as well as Erwin Amann, Jeannette Brosig-Koch, Uwe Cantner, Yan Chen, Laura Gee, Malte Griebenow, Oliver Kirchkamp, Dorothea Kübler, David Miller, Xiaofei Pan, Katrin Schmelz, Jan Siebert, Franziska Then, and Silke Übelmesser for valuable comments. Philipp Allroggen, Luckson Chandrakumar, Denise Drabas, Annika Gauda, Beatus Ille, Franziska Michel, Martin Sklorz, and Maximilian Zinn provided excellent research assistance. Funding from the University of Duisburg-Essen is gratefully acknowledged.* *- All correspondence to: Ulrike Vollstaedt, University of Duisburg-Essen, Berliner Platz 6-8, 45127 Essen, Germany, e-mail: ulrike.vollstaedt@ibes.uni-due.de*

1 Introduction

From complex technical products to foodstuffs to consumer products such as toothpaste or strollers, sellers are often better informed about product quality than buyers. Unfortunately, this information asymmetry may lead to a fundamental economic problem: if sellers of high-quality products are not able to credibly signal the high quality of their products, not all buyers are able to choose the quality they would like to buy. Consequently, information asymmetry in the market can reduce both consumer and producer surplus (Akerlof, 1970).

One method of reducing this asymmetry is to make *credible* information available to buyers (Viscusi, 1978). This potential remedy has been institutionalized to some degree in many countries in the form of independent product testing organizations such as Stiftung Warentest (based in Germany, one of the major European product testing organizations), Consumer Reports (US) and Which? (UK).[1] The common goal of these product testing organizations is to provide objective information about product quality for consumers, often using their own test-buyers who purchase products anonymously. Product quality is then tested and rated.[2] Consumers can access the test results online or in print magazines. These sales of their own publications represent one of the main sources of financing for product testing organizations, as accepting advertisements would constitute a conflict of interest (International Consumer Research & Testing). These product testing organizations are well-known and well-regarded. For instance, 96 % (77 %) of all German consumers know of (strongly trust) Stiftung Warentest (KantarEmnid and Verbraucherzentrale Bundesverband, p. 9). In the US, Consumer Reports has more than 6 million paying members and their website receives an average of 14 million unique visits per month (Consumer Reports).[3]

[1] See http://www.international-testing.org/members.html for a detailed list of world-wide product testing organizations.

[2] Product quality is a multidimensional construct comprised of horizontal and vertical dimensions. To illustrate, vertical dimensions of a stroller's quality include its weight, how waterproof the raincover is, and the level (if any) of toxic substances contained in its materials. In contrast, horizontal dimensions include its aesthetic design. Usually, product testing organizations aim to provide a comprehensive rating of *vertical* product quality, i.e., they include ratings for a stroller's weight, how waterproof the raincover is, and the level of toxic substances. However, they do *not* include ratings for its design. In order to obtain a comprehensive quality rating, e.g. very good, good, satisfactory, fair and poor, product testing organizations weight and add the ratings of all included quality dimensions. Note that these ratings of vertical quality usually contain search, experience, and credence characteristics (Nelson, 1970; Darby and Karni, 1973). For a stroller, a search characteristic would be its weight since a stroller's weight can be determined before purchasing it. An experience characteristic would be how waterproof the raincover is since this is usually observable only after use. A credence characteristic would be how many toxic substances are contained in the fabric since consumers are usually not able to observe this amount even after having purchased the stroller.

[3] We are aware that many consumers rely on online consumer ratings when deciding which product model to buy (De Langhe, Fernbach, and Lichtenstein, 2016). These ratings usually consist of two parts: a narrative review and a quantitative measure, e.g. the stars on amazon.com. While the narrative review may provide relevant information regarding horizontal differentiation, both the narrative review and the quantitative measure are problematic with regard to vertical differentiation for at least three reasons. First and most importantly, consumer ratings usually do not include quality dimensions which would require a controlled setting or are otherwise

While product testing organizations offer *credible* information about product quality, they are hampered by limited testing capacities, i.e., they select only a sample of product models[4] among all available product models in the market. Typically, they select which product models to test based on which ones are perceived to be of greatest interest for consumers. However, it is not clear whether their product model selection mechanisms do in fact provide *optimal* information for consumers, i.e., whether the selection of product models leads to optimal consumer surplus nor how the selection impacts producers' profits. Thus, the problem is not the limited testing capacity itself, but the consequences of this limited capacity for the provision of optimal information.

In their testing selection process, Stiftung Warentest uses current sales numbers to select a sample of 2 % to 33 % of all available product models for testing (for a sample of products tested in the 09/2016 magazine, see GfK SE; see appendix B for details and sources). While the logic behind this standardized selection procedure is that consumers are more likely to want information on the bestselling product models, the counterargument is that these are not necessarily the ones that buyers would have selected under complete information. In particular, there may be product models among the non-tested ones which dominate the tested product models, e.g. offer a higher quality at the same price, but have simply not been selected for a test (see section 2 for formal definitions of dominated and non-dominated product models). Indeed, among a sample from Stiftung Warentest, there are many dominated product models (see figures 7 and 8 in appendix A). Note that this observation is in line with several empirical studies which measure the correlation between product quality and price within the samples of tested product models in different countries.[5]

By contrast, Consumer Reports and Which? make their testing selections using a combination of sales numbers, price, and other criteria. Note that it is unclear if Consumer Reports uses a standardized procedure. Which? does *not* use a

costly to observe, e.g. safety characteristics of a car seat or the level of toxic substances in food. Second, opposed to ratings published by product testing organizations, consumer-generated ratings are usually less transparent regarding which quality dimensions they include and how these are weighted. Third, fake ratings constitute a real problem with these ratings, even among verified purchasers (see Mayzlin, Dover, and Chevalier, 2014, and Which?, 2018). Note also that online user ratings have been shown to correlate poorly with those provided by Consumer Reports and Stiftung Warentest (De Langhe et al., 2016, and Köcher and Köcher, 2018).

[4]In this paper, we use "product" ("product model") as the more general (specific) term. Usually, several product models belong to one certain type of product, e.g. several smartphone models belong to the product smartphone. Furthermore, we use "game" instead of "theoretical model" in this paper to avoid confusion.

[5]More specifically, researchers have repeatedly used ratings from different product testing organizations to measure the correlation between product quality and price. Surprisingly, most studies find only moderate, zero, or even negative correlations (for overviews, see Ratchford, Agrawal, Grimm, and Srinivasan, 1996, as well as Olbrich and Jansen, 2014). Low correlations have been found for the US, Germany, Japan, Canada, the Netherlands and Austria (Oxenfeldt, 1950; Diller, 1977, 1988; Yamada and Ackerman, 1984; Bodell, Kerton, and Schuster, 1986; Steenkamp, 1988; and Kirchler, Fischer, and Hölzl, 2010, respectively). Note that these results are sensitive to the weights of quality dimensions which are, to some degree, arbitrary. Yet, test results published by Consumer Reports show that more than half of all tested product models are dominated on *all* quality dimensions (Hjorth-Andersen, 1984).

standardized procedure.

In this paper, we explore the process by which product models are selected for testing. In particular, we propose a novel, capacity-neutral mechanism to select product models that yields greater buyer information. Since our mechanism is capacity-neutral, the testing capacity remains constant. Only the selection process differs to take advantage of the sellers' information. In our mechanism, testing organizations announce how they will measure quality, including relevant dimensions of quality and respective weights. Sellers may then apply for testing by supplying a product model number and a (true or false) quality of their product model. The product testing organization then collects the prices of all applicants' product models.[6] Subsequently, it uses a pre-specified algorithm to select product models (see section 2.2.3 for details about the algorithm). Eventually, all product models selected by the algorithm are tested, and the quality stated during the application may or may not be confirmed. The final test results are then published.

To test the performance of our proposed selection mechanism, we first develop a new game to derive theoretical, testable predictions. We then use a lab setting to test these theoretical predictions. Our product testing game is based on a model by Encaoua and Hollander (2007) and represents a market with sellers, buyers, and a product testing organization. However, while Encaoua and Hollander analyze a duopoly with two quality levels, our product testing game allows for a potentially large number of sellers and quality levels (see section 2 for details). Our mechanism contributes to the theoretical literature in industrial organization by including a product testing organization as a means to provide credible information for buyers and, most fundamentally, by allowing for prices which may *not* be positively correlated with quality. As depicted in figures 7 and 8 in appendix A, product models are represented by points in the quality-price space, and dominated product models may exist. In our mechanism, sellers of non-dominated product models can voluntarily and credibly disclose their product quality, illustrating the existence of unraveling (see Grossman, 1981, and Milgrom, 1981).[7] Specifically, we create a game which allows us to analyze information unraveling in a *two*-dimensional framework – quality and price – where price does not necessarily equal quality. To the best of our knowledge, we are the first to do so. Our study differs from Encaoua and Hollander (2007) in that we model a short-term situation where qualities and prices have already been set. This allows us to focus on the degree to which sellers apply to be tested, i.e., which information unravels, as a first step in analyzing the performance of our mechanism.[8]

Our proposed mechanism with unraveling and voluntary information disclosure is supported by previous theoretical, empirical, and experimental research

[6] Stiftung Warentests collects the prices of all product models to be tested (if prices vary for a certain product model, the mean price is calculated). It is likely that Consumer Reports and Which? also collect prices for several product models not eventually tested.

[7] Importantly, the final decision which product models to test remains with the product testing organization.

[8] In a follow-up study, we extend the setting of the present paper to a long-term context where sellers are able to set both quality and price.

(for overviews, see Dranove and Jin, 2010, and Brendel, 2020). On the theoretical side, several studies investigate the different conditions under which unraveling occurs (see, for instance, the seminal papers of Grossman, 1981, and Milgrom, 1981, as well as the overviews in Dranove and Jin, 2010 and Brendel, 2020) and find that complete unraveling requires several strong assumptions. By contrast, unraveling has been observed but to an incomplete degree in empirical studies (see, for instance, Mathios, 2000, and Jin and Leslie, 2003, amongst many others). The experimental papers also observe unraveling, sometimes to an incomplete degree (see, for example, Benndorf, Kübler, and Normann, 2015), but sometimes to a complete degree when allowing for detailed feedback and learning (see, for example, Forsythe, Isaac, and Palfrey, 1989). To the best of our knowledge, there is no study that investigates whether unraveling leads to improved information in contexts with limited capacities. Our aim is to fill this gap.

The rest of our paper proceeds as follows. Section 2 introduces our theoretical framework and product testing game, and derives our theoretical, testable predictions. Section 3 presents our experimental design and hypotheses. Section 4 reports the experimental results. Section 5 discusses our findings and concludes.

2 The product testing game

As mentioned, our product testing game represents a market with sellers, buyers, and a product testing organization. This one-shot game allows us to analyze how information about a limited sample of tested product models influences consumer surplus and seller profits in the short term, i.e., in situations where quality and price have already been set. We start by describing the general properties of the game. Subsequently, we present three different versions which vary by the degree of available information and the presence of a product testing organization. These three different versions allow us to prove that, under certain conditions, a unique Nash equilibrium exists for our new product model selection mechanism in which

- all sellers of product models that buyers would have bought under complete information apply to be tested while stating their *true* quality,
- all sellers of product models that no buyer would have bought under complete information do *not* apply to be tested, and
- all buyers choose the optimal product model they would have chosen under complete information.

Doing so, we show that our mechanism can create the maximum possible consumer surplus, equivalent to a world of complete information. Therefore, it outperforms current mechanisms or, in the worst case, leads to the same consumer surplus.

2.1 General properties of the game

In this section, we begin by identifying the properties of our sellers and buyers.

Sellers We first consider a market with a non-empty set of sellers, $\emptyset \neq F = \{F_1, \ldots, F_n\}$, with $n \in \mathbb{N}$.[9] These sellers offer heterogeneous product models. For simplicity, we assume that each seller offers exactly one product model but can sell as many units of that product model as demanded. For seller $F_r \in F$, with $r \in \{1, \ldots, n\}$, we call $0 \leqslant q_{F_r} \in \mathbb{R}$ the quality of the corresponding product model, and $0 \leqslant p_{F_r} \in \mathbb{R}$ its price. Since we are interested in analyzing short-term behavior, including product model quality disclosure, when quality and price are set, we assume quality and price to be exogeneously given. We further assume product quality is comprised of experience and credence characteristics, excluding search characteristics, according to Nelson (1970) and Darby and Karni (1973). This implies that buyers do *not* know the quality of a product model prior to purchase unless that information is revealed by a product testing organization. For simplicity, we exclude identical product models by assuming that there are no sellers offering the same quality at the same price, i.e., $\forall F_r, F_t \in F$ with $q_{F_r} = q_{F_t}$ and $r \neq t$, we require that $p_{F_r} \neq p_{F_t}$. For seller F_r, we assume the function $c(q_{F_r})$ denotes the unit costs of production. Thus, the unit costs of production $c(q_{F_r})$ depend on only the quality level and are independent of the total number of produced units. Furthermore, the cost function is assumed to be continuously differentiable, strictly increasing and strictly convex in quality, i.e., $c'(q_{F_r}) > 0$ and $c''(q_{F_r}) > 0$. Since we are not interested in analyzing market entry or exit decisions and since positive fixed costs would thus not influence equilibrium predictions, we assume all sellers' fixed costs equal zero. Finally, we assume sellers have complete information. We write seller F_r's profit function as

$$\mathbb{E}\Big(\pi_r(q_{F_r}, p_{F_r})\Big) = \Big(p_{F_r} - c(q_{F_r})\Big)\mathbb{E}\Big(d(p_{F_r}, q_{F_r})\Big), \tag{1}$$

where $d(p_{F_r}, q_{F_r})$ represents the number of buyers buying seller F_r's product model.

Buyers We next identify a non-empty set of buyers in our market, $\emptyset \neq B = \{b_1, \ldots, b_s\}$, with $s \in \mathbb{N}$. These buyers decide whether, and if so which, product model to buy (at most one). They are not able to resell. For buyer b_h, with $h \in \{1, \ldots, s\}$, we call $0 < \theta_h \in \mathbb{R}$ her valuation of quality. We assume

$$\mathbb{E}\Big(u_h(\theta_h, q_{F_r}, p_{F_r})\Big) = \mathbb{1}_{\{F_r \in K'\}}\big(\theta_h q_{F_r} - p_{F_r}\big) + \mathbb{1}_{\{F_r \in \{F \setminus K'\}\}}\Big(\theta_h \mathbb{E}(q_{F_r}) - p_{F_r}\Big) \tag{2}$$

is the expected utility function of buyer $b_h \in B$ buying seller F_r's product model, with K' being the set of sellers whose product models have been tested.[10] $\theta_h q_{F_r}$ is a buyer's willingness to pay for q_{F_r}. Note that, if a buyer

[9]Using the notation from "Basic definitions", we will sort $F_1, \ldots, F_n$ in a certain way using a permutation $\sigma : F \longrightarrow F$, and denote the resulting sellers with $f_1, \ldots, f_n$.

[10]Note that we use an indicator function to describe a buyer's utility with a single function. If the condition in braces is true, the indicator variable equals one. If the condition is not fulfilled, the indicator variable equals zero.

chooses a tested product model, her utility is deterministic since all buyers know the quality of a tested product model prior to purchase. Thus, if a buyer chooses to buy a tested product model, her utility simplifies to the first summand of equation 2, i.e., to $u_h(\theta_h, q_{F_r}, p_{F_r}) = \theta_h q_{F_r} - p_{F_r}$. On the other hand, if a buyer chooses to buy a non-tested product model, her expected utility is probabilistic since she does not know the true quality of this product model prior to purchase. Thus, her expected utility simplifies to the second summand of equation 2, i.e., to $\mathbb{E}\Big(u_h(\theta_h, q_{F_r}, p_{F_r})\Big) = \theta_h \mathbb{E}(q_{F_r}) - p_{F_r}$. Finally, if a would-be buyer chooses not to purchase a product model, her utility is zero. Note that we assume any buyer indifferent to purchasing versus not purchasing will buy the respective product model. For simplicity, we assume a buyer will choose the seller with the lower index among sellers providing the same expected utility. Indexes are assigned randomly to sellers and are uniformly distributed. Note that this assumption does not influence seller behavior as sellers are not aware of their index. Buyers are assumed to have complete information about prices and valuations of quality, but only information on product model quality that has been revealed by the product testing organization. Furthermore, we assume buyers know the quality distribution. Again for simplicity, we assume buyers know that the correlation between price and quality equals zero.

Product testing organization The product testing organization provides credible information about product quality for a limited sample of product models selected according to its maximum testing capacity $k \in \mathbb{N}$, and according to its product model selection mechanism. The set of sellers whose product models are tested is denoted with $K' \subseteq F$. $\forall F_r \in K'$, with $r \in \{1, \ldots, n\}$, q_{F_r} is perfectly revealed. We model two different product model selection mechanisms: BESTSELLERS and SELLERSAPPLY. Note that, in subsection 2.2.2, we model BESTSELLERS as a stylized version of current product model selection mechanisms. Since Stiftung Warentest, Consumer Reports, and Which? all use product model's sales as their main selection criterion (see appendix B for details), we focus on bestsellers in our game. However, this set could, in principle, be determined by any other combination of current criteria. In subsection 2.2.3, we model our mechanism SELLERSAPPLY. Since we model the product testing organization as an algorithm without its own surplus function, we do not call it a player.

Sequence of the game The sequence of the game occurs over three stages.

Stage 1 Sellers are given the price and quality of their single product model, and, if applicable, they also decide whether, and if so, with which quality, to apply for testing of their product model.

Stage 2 The product testing organization selects a sample of product models according to its product model selection mechanism (BESTSELLERS or SELLERSAPPLY) and then tests the selected product models.

Stage 3 Buyers observe the quality of the tested product models as well as the prices of all product models, and then decide which product model to buy (if any).

Basic definitions Before analyzing the three different versions of the game, we need to establish a set of basic definitions. We begin by defining local and global dominance to distinguish if a product model is dominated within the whole market (as in subsection 2.2.1 when analyzing a world of complete information), or within a certain submarket like the set of tested product models (as in subsections 2.2.2 and 2.2.3 when analyzing worlds of incomplete information with different product model selection mechanisms), respectively. Also note that we use the terms "seller with (non-)dominated product model" and "(non-)dominated seller" equivalently.

Definition 1 (Locally (non-)dominated product models)**.** *Let* $\emptyset \neq Q \subseteq F$ *be a non-empty set of sellers. A seller* $F_r \in Q$ *offers a locally dominated product model in* Q *if* $\exists F_j \in Q$ *with* $\Big((p_{F_j} \leqslant p_{F_r}) \wedge (q_{F_j} > q_{F_r})\Big) \vee \Big((p_{F_j} < p_{F_r}) \wedge (q_{F_j} \geqslant q_{F_r})\Big)$.
A seller $F_r \in Q$ *offers a locally non-dominated product model in* Q *if* $\forall F_j \in Q$

- *if* $p_{F_j} < p_{F_r}$, *then* $q_{F_j} < q_{F_r}$,
- *if* $q_{F_j} > q_{F_r}$, *then* $p_{F_j} > p_{F_r}$.

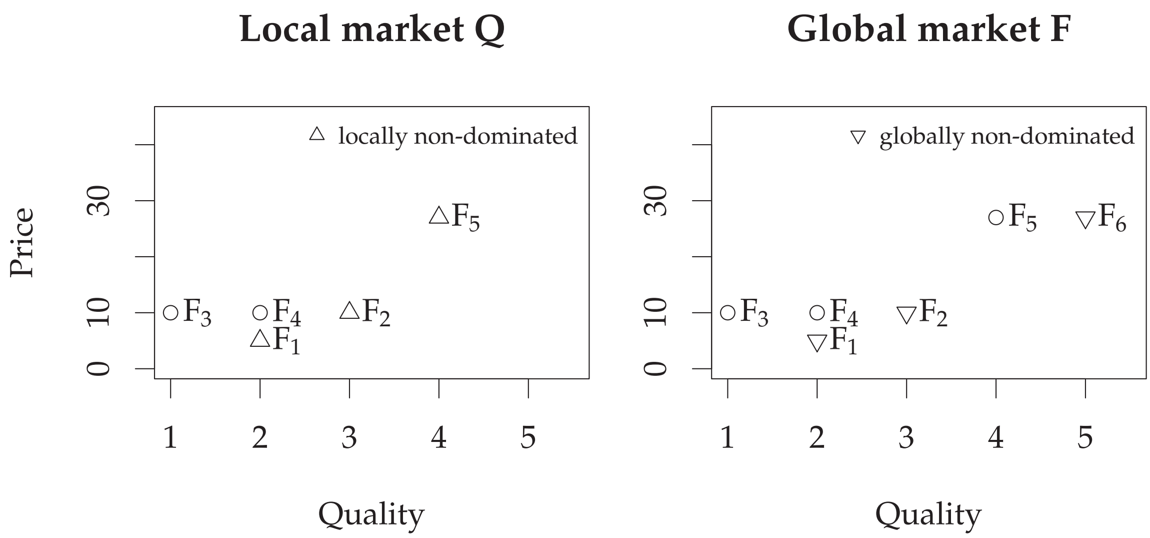
Essentially, a product model is locally dominated in the same set (or market) if at least one seller in this set offers a strictly higher product quality without being more expensive, or a strictly lower price without offering a lower product quality. By comparison, a product model is locally non-dominated in a set if every seller in this set offering a strictly higher product quality also has a strictly higher price, and every seller offering a strictly lower price also offers a strictly lower quality.

We next define a product model vis-à-vis all competitors.

Definition 2 (Globally (non-)dominated product models)**.** *A seller* $F_r \in \{F_1, \ldots, F_n\}$ *who is locally dominated according to definition 1 with* $Q = F$ *offers a globally dominated product model. A seller* $F_r \in \{F_1, \ldots, F_n\}$ *who is locally non-dominated according to definition 1 with* $Q = F$ *offers a globally non-dominated product model.*

To illustrate definitions 1 and 2, consider the following local market (see figure 1): $Q = \{F_1, F_2, F_3, F_4, F_5\}$ with
$q_{F_1} = 2$, $p_{F_1} = 5$,
$q_{F_2} = 3$, $p_{F_2} = 10$,
$q_{F_3} = 1$, $p_{F_3} = 10$,
$q_{F_4} = 2$, $p_{F_4} = 10$,
$q_{F_5} = 4$, $p_{F_5} = 27$.
Furthermore, consider the following global market: $F = \{Q \cup F_6\}$, with $q_{F_6} = 5$ and $p_{F_6} = 27$. While sellers F_1, F_2, and F_5 are locally non-dominated in market Q, sellers F_1, F_2, and F_6 are globally non-dominated in market F.

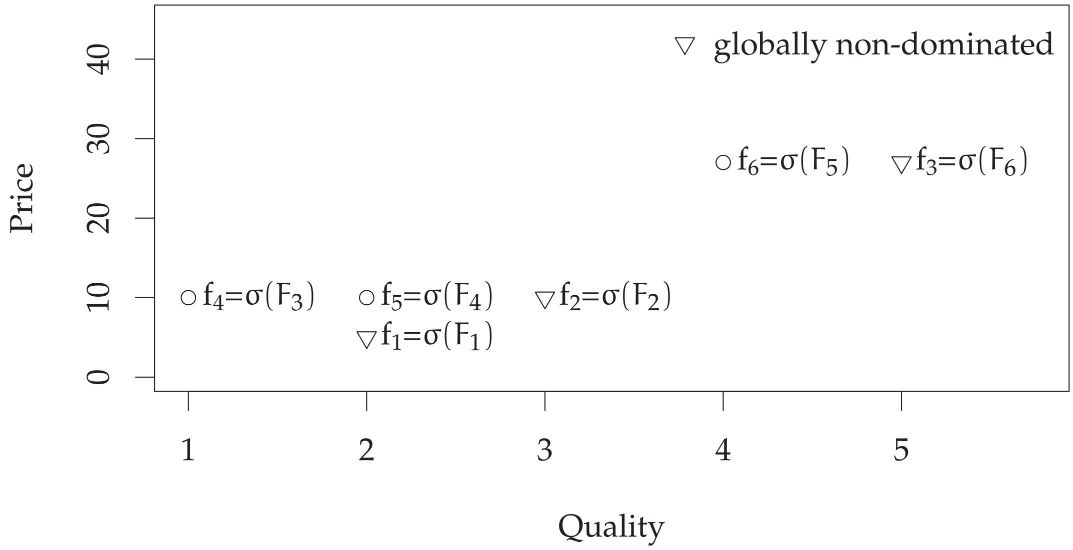
Figure 1: Example markets



Having defined local and global dominance, we now partition any set of sellers Q into two sets of sellers: $ND_Q \subseteq Q$, the set of locally non-dominated sellers in Q, and $D_Q \subseteq Q$, the set of locally dominated sellers in Q, with $ND_Q \cup D_Q = Q$. If $Q = F$, we use the notation D instead of D_F, and ND instead of ND_F. Subsequently, we sort all sellers according to these two disjoint sets. More precisely, let $\sigma : F \to F$ be a permutation of a global set of sellers F with $\sigma(F) = \{f_1, \ldots, f_n\} = ND \cup D$, with $\emptyset \neq ND := \{f_1, \ldots, f_m\} \subseteq \sigma(F)$ as the set of globally non-dominated sellers, and with $\emptyset \neq D := \{f_{m+1}, \ldots, f_n\} \subseteq \sigma(F)$ as the set of globally dominated sellers, with $m \in \mathbb{N}$. For seller $f_t \in \sigma(F)$, with $t \in \{1, \ldots, n\}$, $0 \leqslant q_t \in \mathbb{R}$ represents the quality of the corresponding product model, and $0 \leqslant p_t \in \mathbb{R}$ its price. We distinguish index-based seller global (non-)dominance by referring to sellers with the notation $f_t \in \sigma(F)$. Figure 2 uses both f_t and F_r to indicate sellers, illustrating how using $\sigma(F)$ changes our sellers' notation. Note that, given at least one globally dominated and one globally non-dominated seller, we can split any global set of sellers into two respective disjunct sets and sort the sellers accordingly (see lemma 1 in appendix C.1).

Given the previous definitions and assumptions, we are now able to describe the properties of our product models in more detail. First, any product model locally non-dominated in a certain market is also locally non-dominated in any of its submarkets containing this product model (see lemma 2 in appendix C.1). Intuitively, then, sellers offering globally non-dominated product models in market $Q' = \sigma(F)$ are also locally non-dominated in any global market's submarket containing these sellers. Note that this does not apply to locally dominated product models since glob-

Figure 2: Permutation $\sigma(F)$ of global example market F



ally dominated product models are not always locally dominated in every set $Q \subseteq \sigma(F)$ (see counter-example 1 in appendix C.2). Second, a product model locally dominated in a global market's submarket is also locally dominated in any larger market containing this submarket (see lemma 3 in appendix C.1). Intuitively, then, sellers offering a locally dominated product model in Q are also globally dominated. Note that this does not apply to locally non-dominated product models as these product models are not always among the locally non-dominated product models within a larger set, especially those that are among the globally dominated product models (see counter-example 2 in appendix C.2). Third, the property of being dominated is transitive (see lemma 4 in appendix C.1).

We next examine the relationship between a product model and its rivals defined as below.

Definition 3 (Rivals of a certain seller in a *global* market)**.** *We call the set* $\left\{f_j \in \sigma(F) | \left((q_j > q_t \wedge p_j \leqslant p_t)\right) \vee \left((q_j \geqslant q_t) \wedge (p_j < p_t)\right)\right\} =: R_t \subseteq \sigma(F)$ *the set of rivals of globally dominated seller* $f_t \in D$.

Definition 3 implies that seller f_t is globally dominated by every seller in R_t. We do not define sets of rivals for globally non-dominated sellers as such sets would be empty. Combining definition 3 and lemma 4 allows us to conclude that, if $f_j \in R_t$, $R_j \subsetneq R_t$. Thus, a globally dominated seller's rival set contains at least one globally non-dominated seller; it may also contain one or more globally dominated sellers (see lemma 5 in appendix C.1). Moreover, note that any seller $f_t \in D$ is locally dominated in $Q \longleftrightarrow \{R_t \cap Q\} \neq \emptyset \; \forall f_t \in D$, i.e., if, and only if, the local market Q contains both f_t and at least one of the seller's rivals, any globally dominated seller f_t will also be locally dominated in market Q.

Finally, building on definition 3, we introduce the concept of "critical sets of sellers."

Definition 4 (Critical sets of sellers in a certain *global* market)**.** *We call the superset*

$$ND_{Crit} := \left\{\{ND_{crit}\}\right\}$$
$$= \left\{ ND_{crit} \subseteq \bigcup_{i=m+1}^{n} R_i \cap ND \subseteq ND \,|\, \forall f_j \in ND_{crit} \quad \exists f_l \in \left\{ D \cap ND_{\left\{f_l \cup \{ND_{crit} \setminus f_j\}\right\}} \right\} \right\}$$

the superset of critical sets of sellers in a certain global market.

Definition 4 implies that ND_{crit} is a critical combination of globally non-dominated rivals that makes every globally dominated seller also locally dominated in every set containing this subset. If one single seller were removed from ND_{crit}, the set would lose its characteristic. Note that ND_{crit} may contain fewer sellers than ND. Furthermore, all possible sets ND_{crit} form a superset ND_{Crit} whose elements are all sets ND_{crit}. As an example, consider the following global market: $\sigma(F) = \{f_1, f_2, f_3, f_4, f_5\} = \{f_1, f_2, f_3\} \cup \{f_4, f_5\} = ND \cup D$ with
$q_1 = 2, p_1 = 5,$
$q_2 = 3, p_2 = 10,$
$q_3 = 4, p_3 = 27,$
$q_4 = 1, p_4 = 10,$
$q_5 = 2, p_5 = 10.$
In this market, $ND_{Crit} = \left\{\{f_1\}, \{f_2\}\right\}$, while $ND = \{f_1, f_2, f_3\}$.

2.2 Three different versions of the game

Having established our basic definitions in the previous subsection, we are now able to analyze our three different versions of the game. We start with an ideal world that contains complete information about product quality and then examine two worlds comprised of incomplete information about product quality that therefore require a product testing organization. Specifically, subsection 2.2.2 examines BESTSELLERS, a stylized version of current product model selection mechanisms. Subsection 2.2.3 examines SELLERSAPPLY, our proposed product model selection mechanism. Note that while we include the version with complete information as a benchmark, our incomplete information versions provide the basis for our experimental treatments.

Since sellers are passive in our benchmark case and the BESTSELLERS mechanism, we analyze only buyer behavior. By contrast, since sellers are active in our proposed SELLERSAPPLY mechanism, we analyze both buyer and seller behavior by applying backward induction. We calculate equilibrium payoffs for both buyers and sellers in all three games.

2.2.1 An ideal world with complete information about product quality

In this subsection, we present our benchmark case of a world with complete product quality information. Since information is complete, there is no need for a product testing organization. Therefore, the game reduces to the following stages.

Stage 1 Sellers are given the price and quality of their single product model.

(Stage 2 is excluded because no product testing organization is present.)

Stage 3 Buyers observe the quality and price of all product models, and then decide which product model to buy (if any).

Buyers maximize their utility according to equation 2. Because they have complete information about product quality, equation 2 simplifies to $u_h(\theta_h, q_t, p_t) = \theta_h q_t - p_t$. Hence, a buyer's maximization condition is given by:

$$\underset{f_t \in \{\sigma(F) \cup f_0\}}{\arg\max} \ \theta_h q_t - p_t \tag{3}$$

with f_0 representing a non-existing seller with $q_0 = 0$ and $p_0 = 0$, denoting a would-be buyer's choice not to purchase a product model. Equation 3 implies that a buyer will choose the product model among all those yielding a non-negative utility which maximizes her utility. If all available product models yield a negative utility, she will refrain from buying. Therefore, buyer b_h receives her maximum possible utility in equilibrium

$$\begin{aligned} & u_h\left(\theta_h, q^h_{\{\sigma(F)\cup f_0\}^*}, p^h_{\{\sigma(F)\cup f_0\}^*}\right) \\ & \qquad = \theta_h q^h_{\{\sigma(F)\cup f_0\}^*} - p^h_{\{\sigma(F)\cup f_0\}^*} = \theta_h q^h_{\{\overline{ND}\cup f_0\}^*} - p^h_{\{\overline{ND}\cup f_0\}^*} \end{aligned} \tag{4}$$

with $f^h_{Q^*}$ denoting the seller who maximizes buyer b_h's utility in the set Q, and with $q^h_{Q^*}$ and $p^h_{Q^*}$ denoting the respective quality and price, and $\overline{ND}$ denoting the set of sellers whose product models are sold under complete information. Note that a globally dominated product model cannot maximize buyer b_h's utility under complete information since each rival product model would generate a higher surplus for buyer b_h. Therefore, $f^h_{\{\sigma(F)\cup f_0\}^*} = f^h_{\{\overline{ND}\cup f_0\}^*}$. In addition, under complete information, buyer b_h's utility is always non-negative in equilibrium. We now use equation 4 to define the market areas, i.e., the sets of valuations of quality $\theta_h \in \{\theta_1, \ldots, \theta_s\}$ whose buyers prefer the quality level of seller $f_t \in ND$ given the vector of prices $(p_1, \ldots, p_n)^T$ with $c'(q_i) < p_i \ \forall f_i \in \sigma(F)$ and vector of qualities $(q_1, \ldots, q_n)^T$:

$$\Theta_t(q_t, p_t) = \left\{ \theta_h | u_h(\theta_h, q_t, p_t) \geqslant \max\left\{0, u_h(\theta_h, q_j, p_j)\right\} \forall f_j \in \sigma(F) \right\} \tag{5}$$

with $h \in \{1, \ldots, s\}$. Here, all globally non-dominated sellers f_t with at least one buyer for the market area $\Theta_t(q_t, p_t)$ will sell at least one product model while no globally dominated seller will do so. Equilibrium profits of globally dominated sellers equal zero. If seller f_t offers a globally non-dominated product model, his equilibrium profit can be calculated as:

$$\pi_t(q_t, p_t) = d(q_t, p_t)\Big(p_t - c(q_t)\Big)$$
$$= \sum_{h=1}^{s} \frac{\mathbb{1}_{\left\{f_t = f^h_{\{\overline{ND} \cup f_0\}^*}\right\}}\Big(p_t - c(q_t)\Big)}{\#\Big\{f_j \in \overline{ND} | u_h\big(\theta_h, q_j, p_j\big) = u_h\big(\theta_h, q_t, p_t\big)\Big\}}. \quad (6)$$

Note that the demand for seller f_t's product model can be calculated by counting his buyers using a sum, and dividing this sum by the number of all sellers whose product models maximize a certain buyer's utility. The above equation implies that a product model maximizes buyer b_h's utility by taking into account all sellers who would sell at least one product model under complete information and the option of not buying.

The following definition summarizes the aggregate consumer surplus and seller expected profits.

Definition 5 (Consumer surplus and seller expected profits in a world of complete information)**.** *Consumer surplus equals*

$$\sum_{h=1}^{s} \theta_h q^h_{\{\overline{ND} \cup f_0\}^*} - p^h_{\{\overline{ND} \cup f_0\}^*}. \quad (7)$$

Globally dominated seller profits equal zero. Globally non-dominated seller profits equal

$$\sum_{t=1}^{m} \sum_{h=1}^{s} \frac{\mathbb{1}_{\left\{f_t = f^h_{\{\overline{ND} \cup f_0\}^*}\right\}}\Big(p_t - c(q_t)\Big)}{\#\Big\{f_j \in \overline{ND} | u_h\big(\theta_h, q_j, p_j\big) = u_h\big(\theta_h, q_t, p_t\big)\Big\}}. \quad (8)$$

2.2.2 A world with incomplete information about product quality and the BESTSELLERS mechanism

In this subsection, we analyze a world with incomplete information about product quality where a product testing organization perfectly reveals information about a sample of product models using the BESTSELLERS mechanism. Here, we assume $\emptyset \neq$ *Bestsellers* $\subsetneq \sigma(F)$, the non-empty set of bestselling product models, is the only and exogeneously given selection criterion.[11] Therefore, $K' =$ *Bestsellers*. In this world, sellers are unable to influence directly whether a testing organization will test their product model. Thus, the game consists of three stages.

Stage 1 Sellers are given the price and quality of their single product model.

Stage 2 The product testing organization selects a sample of product models according to BESTSELLERS, and then tests the selected product models.

[11] Again, we make this assumption because we are interested in analyzing short-term behavior.

Stage 3 Buyers observe the quality of the tested product models and the prices of all product models, and then decide which product model to buy (if any).

Buyers maximize their utility according to equation 2. Hence, buyer b_h's maximization condition is given by:

$$\arg\max_{f_t \in \{\sigma(F) \cup f_0\}} \theta_h \mathbb{E}(q_t) - p_t = \arg\max_{f_t \in \{\sigma(F) \cup f_0\}} \left\{ \max_{f_t \in \{K' \cup f_0\}} \theta_h q_t - p_t, \max_{f_t \in \{\sigma(F) \setminus K'\}} \theta_h \mathbb{E}(q_t) - p_t \right\}. \tag{9}$$

This maximization condition implies that, among all product models yielding a non-negative expected utility, a buyer will choose either the optimal tested one, or the cheapest non-tested one. Note that, since θ_h is given and $\mathbb{E}(q_t)$ is the same for all non-tested product models, price is the only decision parameter for these product models. Therefore, the lowest price of all non-tested product models maximizes the expected utility among those for all buyers. However, if all available product models yield a negative expected utility, a buyer will refrain from buying. Next, we define $f_{Q^c} := \arg\min_{f_k \in Q} p_k \in Q$ with $Q \subseteq \sigma(F)$ as the seller offering the cheapest product model in market Q. Thus, equilibrium payoffs can be calculated as:

$$\begin{aligned} & u_h\left(\theta_h, q^h_{\widetilde{\{\sigma(F) \cup f_0\}}}, p^h_{\widetilde{\{\sigma(F) \cup f_0\}}}\right) \\ &= \theta_h q^h_{\widetilde{\{\sigma(F) \cup f_0\}}} - p^h_{\widetilde{\{\sigma(F) \cup f_0\}}} = \theta_h q^h_{\widetilde{\left\{ND_{K'} \cup f_{\{\sigma(F) \setminus K'\}^c} \cup f_0\right\}}} - p^h_{\widetilde{\left\{ND_{K'} \cup f_{\{\sigma(F) \setminus K'\}^c} \cup f_0\right\}}} \end{aligned} \tag{10}$$

with $f^h_{\tilde{Q}}$ denoting the seller who maximizes buyer b_h's *expected* utility in the set Q, and with $q^h_{\tilde{Q}}$ and $p^h_{\tilde{Q}}$ denoting the respective quality and price.

Regarding sellers' equilibrium payoffs, we first examine the case where seller $f_t \in D$ offers a locally dominated bestselling product model in K' which is tested by the product testing organization, which implies $f_t \in D_{K'}$. Since f_t's product model is locally dominated in K', it does not maximize any buyer's expected utility. It follows that $f_t \neq \arg\max_{f_l \in \sigma(F)} \mathbb{E}\big(u_h(\theta_h, q_l, p_l)\big) \forall b_h \in B$. Therefore, $d(q_t, p_t) = 0$, and $\pi_t(q_t, p_t)\big[D_{K'}\big] = 0$.

In the second case, seller $f_t \in \sigma(F)$ offers a locally non-dominated bestselling product model in K' which is tested by the product testing organization, which implies $f_t \in ND_{K'}$. Here, we make no restriction on whether our seller is globally dominated or globally non-dominated. Expected profits can be calculated as

$$\begin{aligned} & \mathbb{E}\Big(\pi_t\big(q_t, p_t\big)\Big)\big[ND_{K'}\big] = \mathbb{E}\Big(d\big(q_t, p_t\big)\Big)\big[ND_{K'}\big]\Big(p_t - c\big(q_t\big)\Big) \\ &= \sum_{h=1}^{s} \frac{\mathbb{1}\left\{\left\{f_t = f^h_{\{K' \cup f_0\}^*}\right\} \cap \left\{\theta_h q_t - p_t > \theta_h \mathbb{E}\left(q_{\{\sigma(F) \setminus K'\}^c}\right) - p_{\{\sigma(F) \setminus K'\}^c}\right\}\right\}\Big(p_t - c\big(q_t\big)\Big)}{\#\Big\{f_j \in \sigma(F) | \mathbb{E}\big(u_h(\theta_h, q_j, p_j)\big) = \mathbb{E}\big(u_h(\theta_h, q_t, p_t)\big)\Big\}}. \end{aligned} \tag{11}$$

Again, note that the expected demand for seller f_t's product model can be calculated by counting his buyers using a sum, and dividing this sum by the number of all sellers whose product models maximize a certain buyer's utility. The above equation implies that a tested product model maximizes the buyer's utility by taking into account both the full set of tested product models yielding a non-negative utility (first pair of braces in the indicator function) and the cheapest non-tested product model (second pair of braces).

In the third case, seller $f_t \in \sigma(F)$ offers a non-bestselling (and thus not tested) product model, which implies $f_t \in \left\{\sigma(F) \setminus K'\right\}$. Again, we make no restriction on whether our seller is globally dominated or globally non-dominated since buyers consider only the expected quality of non-tested product models. The expected demand and expected profits can be calculated similarly to equation 11, with the difference being that non-tested product models compete among themselves on price. A selected product model in this case must be the cheapest non-tested one yielding a non-negative utility (first pair of braces) with an expected utility higher than that of every tested product model (second pair of braces).

$$\begin{aligned}
&\mathbb{E}\Big(\pi_t(q_t,p_t)\Big)\left[\sigma(F)\setminus K'\right] = \mathbb{E}\Big(d(q_t,p_t)\Big)\left[\sigma(F)\setminus K'\right]\Big(p_t - c(q_t)\Big) \\
&= \sum_{h=1}^{s} \frac{\mathbb{1}_{\left\{\left\{f_t = f^{h}_{\widetilde{\{\{\sigma(F)\setminus K'\}^c \cup f_0\}}}\right\} \cap \left\{\theta_h \mathbb{E}(q_t) - p_t > \theta_h q^h_{(K')^*} - p^h_{(K')^*}\right\}\right\}} \Big(p_t - c(q_t)\Big)}{\#\left\{f_j \in \sigma(F) | \mathbb{E}\Big(u_h(\theta_h, q_j)\Big) = \mathbb{E}\Big(u_h(\theta_h, q_t)\Big)\right\}}
\end{aligned} \tag{12}$$

Note that, if seller f_t's product model is not tested and he does not offer the cheapest price of all non-tested product models (first pair of braces), his profit will equal zero, regardless of whether his product model is globally dominated or not.

We can now compare the consumer aggregate surplus and sellers' aggregate profits in our incomplete information world to those under complete information (see definition 5).

Proposition 1 (Expected consumer surplus and seller profits under BESTSELLERS)**.** BESTSELLERS *leads to a lower consumer surplus (and higher (lower) profits of globally dominated (globally non-dominated) sellers) compared to a world of complete information for all but two possible combinations in which product models are bestsellers and thus tested. In only two cases,* BESTSELLERS *leads to the same consumer surplus (and same seller profits for globally dominated and non-dominated product models) as in a world of complete information. These two cases are as follows:*

(i) $K'_{Bestsellers} = \overline{ND}$, *and* $\forall b_l \in \{b_1, \ldots, b_s\}$ *the following holds:* $\max\left\{\mathbb{E}\left(u_l\left(\theta_l, q_{\{\sigma(F)\setminus\overline{ND}\}^c}, p_{\{\sigma(F)\setminus\overline{ND}\}^c}\right)\right), 0\right\} < \max_{f_j \in \overline{ND}} u(\theta_l, q_j, p_j)$, *or*

(ii) $K'_{Bestsellers} \neq \overline{ND}$, *and* $\exists! f_j \in \overline{ND}$ *such that* $\forall b_l \in \{b_1, \ldots, b_s\}$ *with* $f_j \notin K'_{Bestsellers}$ *and* $f_j = \arg\max_{f_k \in \left\{f_{\{\sigma(F)\setminus\overline{ND}\}^c} \cup \overline{ND} \cup f_0\right\}} \mathbb{E}\Big(u_l(\theta_l, q_k, p_k)\Big)$, *the fol-*

lowing holds: $f_j = \arg\max_{f_k \in \left\{ \left\{ \sigma(F) \setminus K'_{Bestsellers} \right\}^c \cup K'_{Bestsellers} \cup f_0 \right\}} \mathbb{E}\Big(u_l(\theta_l, q_k, p_k)\Big)$.
In addition, $\forall f_x \in \{\overline{ND} \setminus f_j\}$, *let* $\mathbb{E}\Big(d(q_x, p_x)\Big)[\textit{completeInformation}] = \mathbb{E}\Big(d(q_x, p_x)\Big)[\textit{Bestsellers}]$.

The proof of proposition 1 can be found in appendix C.1. Proposition 1 implies that, except for two possible cases, BESTSELLERS always leads to *lower* consumer surplus than does a world of complete information. In the two exceptions, BESTSELLERS leads to the same consumer surplus. In the first case, all globally non-dominated product models sold under complete information are the bestselling product models, and no buyer prefers the cheapest non-tested product model over her optimal tested one. In the second case, all but one globally non-dominated product model sold under complete information are the bestselling product models, but the exception product model is cheapest non-tested product model which is selected by every buyer who would have selected it in a world of complete information. In addition, in the second case, all other buyers prefer their complete-information optimal product model over the cheapest non-tested product model, and prefer to buy versus not buy. Note that it is not possible in this mechanism to have two sellers with the cheapest non-tested product model and selected by all buyers who would select their product model under complete information. In this case, we assume buyers will select the product model of the seller with the lower index (see subsection 2.1).

2.2.3 A world with incomplete information about product quality and the SELLERSAPPLY mechanism

In this subsection, we analyze another world with incomplete information about product quality where a product testing organization perfectly reveals information about a sample of product models but with the SELLERSAPPLY mechanism. This game consists of the following stages:

Stage 1 Sellers are first given the price and quality of their single product model. They then decide whether to apply to have their product model tested, and if so, whether to state a true or false quality about their product model.

Stage 2 The product testing organization selects a sample of product models according to the SELLERSAPPLY mechanism, and then tests the selected product models.

Stage 3 Buyers observe the quality of the tested product models and the prices of all product models, and then decide which product model to buy (if any).

The SELLERSAPPLY mechanism is based on the following algorithm (see appendix C.3 for a formal description).

Algorithm step 1 Among the set of applicants, select the cheapest product model per stated quality level. If applicable, exclude locally dominated product models.

Algorithm step 2 Test all remaining, non-tested, locally non-dominated product models to determine the current set of tested product models.

Algorithm step 3 If no false quality statements are detected, or if all applicants' product models are tested, stop. Otherwise, combine the set of tested product models (using revealed qualities) with the remaining untested product models, update the set of locally non-dominated product models, and return to step 2.

We assume the testing organization is able to test non-tested product models as long as there are still promising non-tested product models remaining (in equilibrium, only the product models sold under complete information are tested (see proposition 2); see appendix D for a simplified version of the game with a predetermined testing capacity). Note that the algorithm stops at the beginning of step 3 if all sellers provide true qualities when applying to be tested (which they are predicted to do in equilibrium; again, see proposition 2). The SELLERSAPPLY mechanism requires all applicants to pay an *application_fee* > 0. If an applicant seller's product model is chosen for testing and the submitted quality is found to be false, this seller must also pay a *punishment_fee* > 0. After the final test, the true qualities of all tested product models are published.

To determine buyer b_h's maximized utility, we use equation 2 to obtain the following:

$$\arg\max_{f_t \in \{\sigma(F) \cup f_0\}} \theta_h \mathbb{E}(q_t) - p_t = \arg\max_{f_t \in \{\sigma(F) \cup f_0\}} \left\{ \max_{f_t \in \{K' \cup f_0\}} \theta_h q_t - p_t, \max_{f_t \in \{\sigma(F) \setminus K'\}} \theta_h \mathbb{E}(q_t) - p_t \right\}. \tag{13}$$

Note that this maximization condition is identical to equation 9. Note also that equation 13 implies that among all product models yielding a non-negative expected utility, a buyer will select either the optimal tested or cheapest non-tested product model. If all available product models yield a negative expected utility, she will refrain from buying.

Sellers maximize their profits according to equation 1. Since quality and price are set, sellers make decisions regarding only the product test. More precisely, sellers have three possible strategies: apply for testing with a true quality, apply for testing with a false quality, or do not apply for testing. To examine which conditions provide a testing incentive, we begin by identifying whether globally dominated sellers are locally dominated as well. If all sellers with globally non-dominated product models apply to be tested, a globally dominated seller f_t applying with q_t would also be locally dominated within the set of applicants and his product model would not be tested, i.e., $f_t \notin K'$ (see lemma 6 in appendix C.1). Examining this condition further, definition 4 implies that if all sellers in a certain ND_{crit} apply to be tested, a globally dominated seller f_t applying with q_t would also be locally dominated and his product model would not be tested, i.e., $f_t \notin K'$. Thus, applying to be tested with q_t is a strictly dominated strategy for a globally dominated seller f_t if all sellers in a certain ND_{crit} apply to be tested. Specifically, seller f_t pays the *application_fee* > 0, but would not be tested and, therefore, would receive neither any additional demand nor additional profit. Under certain conditions, applying with q_t remains a strictly dominated strategy for a globally dominated seller f_t even when all but the cheapest seller of a certain ND_{crit} apply to be tested (see Benndorf et al., 2015, for a similar idea). According to definition 2, if one globally non-dominated seller offers a strictly cheaper product model than another non-dominated seller, he also offers a strictly lower quality. Therefore, the cheapest globally non-dominated product model also reflects the strictly lowest quality of all globally non-dominated product models.

We now compare the respective cheapest globally non-dominated and globally dominated product models. There is no globally dominated seller who offers a strictly cheaper product model than the seller offering the strictly cheapest product of all globally non-dominated sellers (see lemma 7 in appendix C.1). Using lemma 7, we can now prove the conditions under which applying with q_t remains a strictly dominated strategy for a globally dominated seller f_t if seller $f_{\sigma(F)^c}$ does not have an incentive to apply to be tested. We denote the set of sellers $f_t \in ND$ with an application incentive as $ND_{apply} \subseteq ND$. We define this set for globally non-dominated sellers only because, if $\exists ND_{crit} \subseteq ND_{apply}$, no globally dominated seller will apply to be tested. Furthermore, we define $(\hat{s}_1, \ldots, \hat{s}_{t-1}, \hat{s}_{t+1}, \ldots, \hat{s}_n)^T$ as an arbitrary, but fixed, strategy vector of all sellers in $\{\sigma(F) \setminus f_t\}$. Note that any lemma holding for this strategy vector $(\hat{s}_1, \ldots, \hat{s}_{t-1}, \hat{s}_{t+1}, \ldots, \hat{s}_n)^T$ will hold for all strategy vectors

$$\begin{pmatrix} \hat{s}_1 \\ \vdots \\ \hat{s}_{t-1} \\ \hat{s}_{t+1} \\ \vdots \\ \hat{s}_n \end{pmatrix} \in \left\{ \begin{array}{c} \textit{do not apply},\ \textit{apply with } q_1,\ \textit{apply with } q_1^{\textit{false}} \in \{\mathbb{R} \setminus q_1\} \\ \vdots \\ \textit{do not apply},\ \textit{apply with } q_{t-1},\ \textit{apply with } q_{t-1}^{\textit{false}} \in \{\mathbb{R} \setminus q_{t-1}\} \\ \textit{do not apply},\ \textit{apply with } q_{t+1},\ \textit{apply with } q_{t+1}^{\textit{false}} \in \{\mathbb{R} \setminus q_{t+1}\} \\ \vdots \\ \textit{do not apply},\ \textit{apply with } q_n,\ \textit{apply with } q_n^{\textit{false}} \in \{\mathbb{R} \setminus q_n\} \end{array} \right\}.$$

An even weaker condition under which globally dominated sellers would not have an incentive to apply to be tested is as follows. If a globally dominated seller f_t is dominated in expectation by the seller offering a strictly cheaper product model than all other globally non-dominated sellers, and if all sellers in a critical set of sellers except the one offering the cheapest product model apply to be tested, seller f_t would not have an incentive to apply for testing (see lemma 8 in appendix C.1).

When analyzing the conditions that discourage applying when sellers state a false quality, it turns out that it is not possible to lie in way to congest all of a seller's rivals' testing slots. Moreover, if none of a seller's rivals apply, applying with a false quality would decrease profits by the *punishment_fee* compared to applying stating a true quality. Applying with a false quality such that a seller's product model is not tested would not increase demand, but would decrease profits by the *application_fee* compared to not applying. Therefore, applying to be tested stating a false product quality is a strictly dominated strategy for any seller $f_t \in \sigma(F)$ (see lemma 9 in appendix C.1).

By contrast, we now examine the conditions that encourage applying when sellers state their true quality. In general, the demand for seller f_t's product model can be calculated as follows:

$$\mathbb{E}\Big(d(q_t, p_t)\Big) = \sum_{h=1}^{s} \frac{\mathbb{1}_{\left\{f_t = f^h_{\widetilde{\{\sigma(F)\cup f_0\}}}\right\}}}{\#\Big\{f_j \in \sigma(F) | \mathbb{E}\Big(u_h(\theta_h, q_j, p_j)\Big) = \mathbb{E}\Big(u_h(\theta_h, q_t, p_t)\Big)\Big\}}. \tag{14}$$

We know that the other sellers' application behavior influences whether a globally dominated seller is also locally dominated in the set of applicants K. Therefore, we compare a seller's situation if $f_t \in K$ with his situation if $f_t \in \{\sigma(F) \setminus K\}$. With $\Delta_t\mathbb{E}\Big(d(q_t, p_t)| (\hat{s}_1, \ldots, \hat{s}_{t-1}, \hat{s}_{t+1}, \ldots, \hat{s}_n)^T\Big)$, we denote the change of expected demand for f_t's product model after he applies to be tested with q_t compared to the change if he does not apply to be tested, given an arbitrary, but fixed, strategy vector of all sellers in $\{\sigma(F) \setminus f_t\}$. In the following, we use $\Delta_t\mathbb{E}(d(q_t, p_t))$ as short notation for $\Delta_t\mathbb{E}\Big(d(q_t, p_t)| (\hat{s}_1, \ldots, \hat{s}_{t-1}, \hat{s}_{t+1}, \ldots, \hat{s}_n)^T\Big)$.

A seller has an incentive to apply for testing with a true quality if, and only if, the additional profits after applying exceed the *application_fee* (see lemma 10 in appendix C.1). Note that this condition never holds for a globally dominated seller f_t if a critical set $ND_{crit} \in ND_{Crit}$ apply to be tested and state their true qualities, as f_t's product model would be locally dominated in K, and would not be tested. As such, there would be no additional demand, making an application with a true quality a strictly dominated strategy. Furthermore, seller $f_{\sigma(F)^c}$ offering the cheapest product model is the only seller from whom buyers would have bought under complete information who may not have an incentive to apply to be tested. Recall that there is no globally dominated seller offering a strictly cheaper product model according to lemma 7. Therefore, seller $f_j = f_{\sigma(F)^c}$ may garner positive demand even without applying and $\Delta_j\mathbb{E}(d(q_j, p_j))[f_j \in K]$ may be negative. Finally, if at least one non-tested seller offers a strictly cheaper price than seller f_t, the application criterion can be simplified for seller f_t to $(p_t - c(q_t))d(q_t, p_t)[f_t \in K] >$ *application_fee*.

We now sort the globally non-dominated sellers such that the ones with (without) an incentive to apply with q_t are listed first (last). We denote this permutation with ν.

$$\begin{aligned}
&\nu : \{f_1, \ldots, f_m\} \longrightarrow \{f_1, \ldots, f_m\} \\
&f_t \mapsto \mathbb{1}_{\{f_t \in ND_{apply}\}}\nu\Big(\textstyle\sum_{j=1}^{t} \mathbb{1}_{\{f_j \in ND_{apply}\}}\Big) \\
&\qquad\qquad + \mathbb{1}_{\{f_t \in \{ND \setminus ND_{apply}\}\}}\nu\Big(\#ND_{apply} + \textstyle\sum_{j=1}^{t} \mathbb{1}_{\{f_j \in \{ND \setminus ND_{apply}\}\}}\Big)
\end{aligned} \tag{15}$$

Using this permutation, the first $\#ND_{apply}$ entries in the following vector in proposition 2 represent the strategies of sellers with an incentive to apply with a true quality. The next $\#\{\mathrm{ND} \setminus \mathrm{ND}_{apply}\}$ entries represent the strategies of globally non-dominated sellers without an application incentive. The next $(n - m)$ entries represent strategies of globally dominated sellers without an application incentive. The next #B entries represent strategies of buyers b_1 to b_s who choose the product model that maximizes their expected utility given the tested product models in ND_{apply}, and the cheapest non-tested product model in $\{\sigma(F) \setminus \mathrm{ND}_{apply}\}$.

Proposition 2 (Unique Nash equilibrium). *Let $(\hat{s}_1, \ldots, \hat{s}_{t-1}, \hat{s}_{t+1}, \ldots, \hat{s}_n)^T$ be an arbitrary, but fixed, strategy vector of all sellers in $\{\sigma(F) \setminus f_t\}$. Furthermore, we assume $\exists \mathrm{ND}_{crit} \in \mathrm{ND}_{Crit}$, with $\mathrm{ND}_{crit} \subseteq \overline{\mathrm{ND}}$ and all buyers know that $\mathrm{ND}_{apply} = \overline{\mathrm{ND}}$. Since we assume that the product testing organization tests all remaining non-tested product models after each iteration of the algorithm until there are no more promising non-tested product models remaining, it follows that a unique Nash equilibrium*

$$\Big(\textit{apply with } q_1, \ldots, \textit{apply with } q_{(\#\mathrm{ND}_{apply})}, \textit{do not apply}, \ldots, \textit{do not apply}, \\ \textit{buy product model of seller } f^1_{\widetilde{\sigma(F)}}, \ldots, \textit{buy product model of seller } f^s_{\widetilde{\sigma(F)}}\Big)^T$$

exists, with $f^1_{\widetilde{\sigma(F)}}, \ldots, f^s_{\widetilde{\sigma(F)}} \in \mathrm{ND}_{apply}$. In equilibrium, all sellers of product models that buyers would have bought under complete information apply to be tested while stating their true quality, and are tested. All other sellers do not apply to be tested.

The proof of proposition 2 can be found in appendix C.1. Note that proposition 2 also holds if all buyers know that $\mathrm{ND}_{apply} = \overline{\mathrm{ND}} \setminus f_{\sigma(F)^c}$ since buyers know that $f_{\sigma(F)^c}$ must be globally non-dominated, according to lemma 7, and since it is sufficient for globally dominated sellers not to have an incentive to apply for testing if $\mathrm{ND}_{apply} = \mathrm{ND}_{crit} \setminus f_{\sigma(F)^c}$, given the assumptions of lemma 8. We now compare the aggregate consumer surplus and seller profits resulting from proposition 2 to those in a world of complete information (see definition 5).

Proposition 3 (Expected consumer surplus and seller profits under SELLERSAPPLY). *Given the assumptions of proposition 2 (Unique Nash equilibrium), it follows that* SELLERSAPPLY *leads to the identical consumer surplus (and profits for globally dominated and non-dominated sellers) that would occur under complete information.*

The proof of proposition 3 can be found in appendix C.1. Note that proposition 3 also holds if all buyers know that $\mathrm{ND}_{apply} = \overline{\mathrm{ND}} \setminus f_{\sigma(F)^c}$ since buyers know that $f_{\sigma(F)^c}$ must be globally non-dominated, according to lemma 7, and since it is sufficient for globally dominated sellers not to have an incentive to apply for testing if $\mathrm{ND}_{apply} = \mathrm{ND}_{crit} \setminus f_{\sigma(F)^c}$, given the assumptions of lemma 8.

2.3 Comparing consumer surplus resulting from the BESTSELLERS versus SELLERSAPPLY mechanism

We end this section with a comparison of the consumer surplus generated from the two mechanisms. The proof of proposition 4 can be found in appendix C.1.

Proposition 4 (Comparing consumer surplus resulting from BESTSELLERS and from SELLERSAPPLY)**.** *Given the assumptions of proposition 3 and given the same number of testing slots,* SELLERSAPPLY *outperforms* BESTSELLERS *by leading to the optimal, higher consumer surplus in all possible cases but two. In the two exceptions stated in proposition 1, both* SELLERSAPPLY *and* BESTSELLERS *lead to the same optimal consumer surplus.*

3 Experimental design and hypotheses

Based on the product testing game introduced in the previous section, we design a laboratory experiment to test our theoretical predictions and ascertain the extent to which these predictions are observed with human decision makers. In particular, unraveling has been shown to decrease in more complex experimental settings (see Hagenbach and Perez-Richet, 2018, and Jin, Luca, and Martin, 2018). Recall that our mechanism includes *two* product model dimensions (quality and price) as well as the option for sellers to state a false quality when applying to be tested. We design four experimental treatments. The first two represent two versions of BESTSELLERS, while the latter two represent two versions of SELLERSAPPLY (see section 2 for details). We include two versions of BESTSELLERS as different scenarios may exist in which different samples of available product models are tested.

BESTSELLERS-WORSTCASE To model a scenario in which the market functions extremely poorly, we design a worst-case-scenario regarding bestselling product models, i.e., bestsellers are the product models vertically furthest away from globally non-dominated ones.[12]

BESTSELLERS-RANDOM We also design an intermediate bestseller scenario where bestsellers are chosen randomly among all product models. We include this treatment to investigate whether our new mechanism outperforms chance.[13]

SELLERSAPPLY-LYINGPOSS(IBLE) This treatment represents the scenario where sellers may apply for testing and provide a false quality. While the option of providing a false quality does not change the equilibrium predictions (see lemma 9), it makes the SELLERSAPPLY mechanism more complex. Therefore, we consider it important to investigate this treatment in the lab.

SELLERSAPPLY-TRUTH This treatment represents the scenario where sellers may apply for testing and are *not* allowed to provide a false quality.

[12]We are aware that this presents an extreme scenario. In this scenario, sellers with the most dominated product models would earn relatively high profits per sold unit given that their prices are highest among product models of the same quality. This relatively greater profit could be spent on advertising to attract more buyers.

[13]The share of globally non-dominated product models among all bestsellers is 21.7 %. Note that we consider this to be a fair test of choosing bestsellers randomly because the mean share of globally non-dominated product models in all markets is 23.3 %.

In the following, we describe a simplified version of the (general) product testing game introduced in section 2 which provides the basis for our experimental design. For simplicity, we assume that *#quality levels* $< \infty$. Furthermore, we assume that there is no pair of sellers offering their respective product models at the same price, i.e., $\forall f_t, f_s \in \sigma(F)$ with $t \neq s$, we require that $p_t \neq p_s$. The product testing organization is assumed to provide at least as many testing slots as there are quality levels, i.e., $k \geqslant$ *#quality levels*. Moreover, we assume the *punishment_fee* to be strictly higher than the maximal additional profit a globally non-dominated seller could make by applying to be tested with a false quality given other sellers' arbitrary, but fixed, strategies. Given these assumptions, we show in appendix D that proposition 2 (Unique Nash equilibrium) still holds.

In our experiment, we use a between-subject design, i.e., per session, we conduct one treatment. Each session consists of twelve rounds/markets with different quality-price combinations. At the end of a session, one of the twelve rounds is chosen randomly for payment (4 ECU = 1 EUR). In each session, we include 15 sellers ($n = 15$), 8 buyers ($s = 8$) and one product testing organization which is implemented as a computer algorithm rather than a participant. Player roles are assigned randomly at the beginning of a session and remain constant afterwards. The product testing organization selects at most five product models to be tested ($k = 5$).

During the experiment, sellers are assigned product models at one of five different quality levels, $q_t \in \{1, 2, 3, 4, 5\}$. This range allows for a balance between experimental simplicity and the ability to distinguish seller behavior across product model quality levels.[14] Furthermore, we choose one of the simplest possible unit costs functions fulfilling $c'(q_t) > 0$ and $c''(q_t) > 0$, namely the quadratic unit costs of production, i.e., $c(q_t) = q_t^2$. In our experiment, buyers are assigned across four quality valuations, $\theta_h \in \{3, 7, 11, 15\}$, with two subjects per θ_h. While buyers know that there are three sellers per quality level, they do not know if price is related to quality. They learn a product model's quality only if the product testing organization has revealed this or if they have purchased the product model. Our product testing organization charges sellers an *application_fee* of 0.5 ECU and a *punishment_fee* of 24 ECU if a false quality statement is detected.

To ensure that our experiment yields only positive total payoffs, each subject receives an initial endowment of 100 ECU. Sellers earn 0.5 ECU per correct answer when we ask them their beliefs about other sellers' behavior. For a variation of SELLERSAPPLY-TRUTH, we ask sellers for their beliefs about both seller and buyer behavior.

In all treatments, participants are informed in the instructions that they should assume that there are five product models per round which were bought most frequently in the past, while the reasons for this are unknown. Note that the random bestsellers displayed in appendix F are used for the treatment BESTSELLERS-RANDOM, and the worst-case bestsellers are used for all other treatments.

Among the 12 different markets, there are four different types: markets with

[14] Our experiment is conducted in Germany, where Stiftung Warentest uses five different verbal quality ratings (very good, good, satisfactory, fair and poor) for product models; thus, subjects are likely familiar with a five-item rating scale. In addition to these verbal ratings, Stiftung Warentest also publishes more precise numerical ratings ranging from 1.0 to 5.0.

Table 1: Number of sellers and buyers per session, and number of sessions and participants per treatment

Treatment	Sellers per session	Buyers per session	Number of sessions/ independent observations	Partici-pants
BESTSELLERS-WORSTCASE	15	8	5	115
BESTSELLERS-RANDOM	15	8	5	115
SELLERSAPPLY-LYINGPOSS	15	8	5	115
SELLERSAPPLY-TRUTH	15	8	5	115
SELLERSAPPLY-TRUTH (with beliefs about buyer behavior)	15	8	5	115
Total			25	575

5, 4, 3, or 2 globally non-dominated product models (markets 1-3, 4-6, 7-9, and 10-12, respectively; see appendix F for a graphical overview). Within a session, one type of market is played for 3 rounds in the same random order to exclude learning about market types. Moreover, all 12 markets differ in their quality-price combinations, which are assigned exogeneously. For all globally non-dominated product models in each market, prices are slightly higher than marginal costs. In addition, the price-quality combinations of these product models are chosen such that, under complete information, two buyers with the same theta would either buy the globally non-dominated product model with optimal quality if available ($\theta_1 = \theta_2 = 3 \rightarrow q^* = 2$, $\theta_3 = \theta_4 = 7 \rightarrow q^* = 3$, $\theta_5 = \theta_6 = 11 \rightarrow q^* = 4$, $\theta_7 = \theta_8 = 15 \rightarrow q^* = 5$), or refrain from buying otherwise. Thus, we ensure that, under complete information, no buyer would choose a product model with $q = 1$, which corresponds to Stiftung Warentest's "poor" rating. This rating is given when a product model is considered unacceptable for all, as when it does not suit its claimed purpose and/or entails unacceptable risks such as high toxic material levels. Again to prevent learning across rounds, we choose quality-price combinations for globally dominated product models such that there are three product models per quality level and the correlation between quality and price is below 0.01.

We base our hypotheses on our theoretical results from section 2 and appendix D. In particular, H1, H2, and H3 are consequences of propositions 2, 5, and 6, while H4 is a consequence of proposition 4.

H1: Seller behavior Under SELLERSAPPLY-LYINGPOSS and SELLERSAPPLY-TRUTH

- globally dominated sellers will not apply to be tested.
- with the exception of $q_t = 1$, globally non-dominated sellers will apply to be tested and will, if applicable, state their true quality.

H2: Content of the product test The product test will contain the following:

– no information on globally non-dominated product models under BESTSELLERS-WORSTCASE,

– information on 21.7 % of globally non-dominated product models under BESTSELLERS-RANDOM, and

– information on all globally non-dominated product models under both SELLERSAPPLY-TRUTH and SELLERSAPPLY-LYINGPOSS.

H3: Buyer behavior Buyers will choose the least number of globally non-dominated product models under BESTSELLERS-WORSTCASE, more under BESTSELLERS-RANDOM, and only globally non-dominated product models under both SELLERSAPPLY-TRUTH and SELLERSAPPLY-LYINGPOSS.

H4: Surplus and profits Per capita, the following will hold:

– consumer surplus as well as globally non-dominated seller profits are lowest under BESTSELLERS-WORSTCASE, higher under BESTSELLERS-RANDOM, and highest under both SELLERSAPPLY-TRUTH and SELLERSAPPLY-LYINGPOSS.

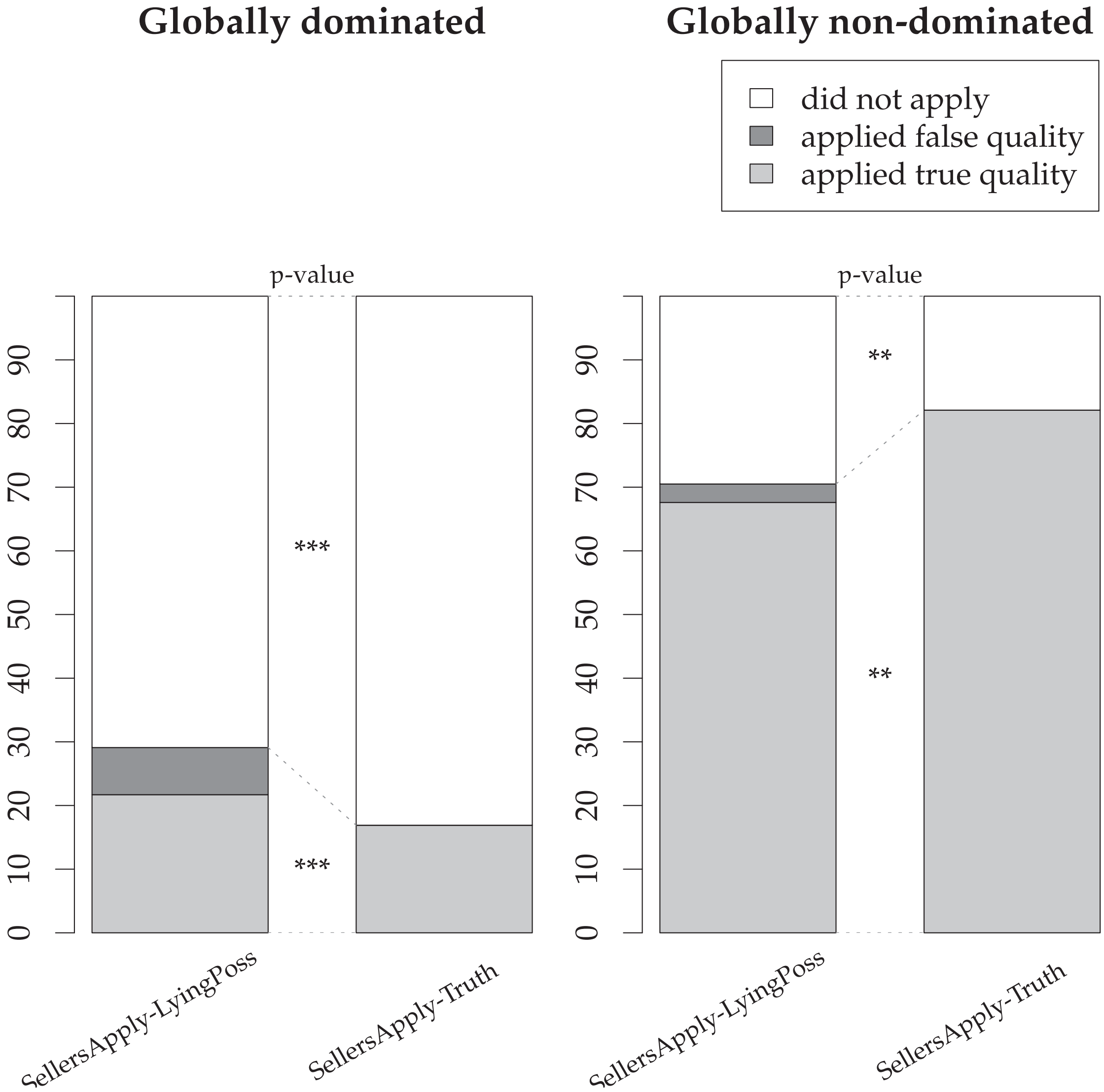
– globally dominated seller profits are highest under BESTSELLERS-WORSTCASE, lower under BESTSELLERS-RANDOM, and lowest under both SELLERSAPPLY-TRUTH and SELLERSAPPLY-LYINGPOSS.

Our experiment was comprised of 25 sessions and was conducted between January 2017 and December 2018 at the Essen Laboratory for Experimental Economics (elfe), Germany. We conducted five sessions per treatment, with the exception of SELLERSAPPLY-TRUTH, where we conducted an additional five sessions in which sellers were asked for their beliefs about buyer behavior. In total, 575 subjects participated in the experiment. On average, a session lasted two hours, and a subject earned 27.39 EUR. More details on the number of participants are displayed in table 1. Participants were invited to participate in the experiment using ORSEE (Greiner, 2015). The experiment was programmed and conducted with zTree (Fischbacher, 2007). A translated version of the instructions can be found in appendix G. Translated screenshots of the main decision situations in z-Tree can be found in appendix H.

4 Experimental results

We analyze the data with R 3.5.1 (R Core Team, 2018). Unless stated otherwise, we report the results of two-sided Mann-Whitney-U tests for all treatment comparisons, conservatively counting one experimental session as one independent observation. Since we did not find any significant differences between SELLERSAPPLY-TRUTH with and without asking for beliefs about buyer behavior, we pool these data in our subsequent analyses.

Figure 3: Share of sellers who do or do not apply to be tested, stating a true or false quality (if applicable)



Note: For all treatment comparisons, we report the results of two-sided Mann-Whitney-U tests, conservatively counting one experimental session as one independent observation. We denote p-values as follows: *** < 0.01, ** < 0.05, and * < 0.1.

4.1 Seller behavior

Figure 3 depicts the share of sellers who do and do not apply to be tested, split by sellers with globally dominated versus globally non-dominated product models.[15] In line with our first hypothesis H1, figure 3 shows that most globally dominated sellers do not apply to be tested (70.9 % under SELLERSAPPLY-LYINGPOSS, 83.1 % under SELLERSAPPLY-TRUTH). Also in line with H1, we see from figure 3 that most globally non-dominated sellers do apply to be tested (70.5 % under SELLERSAPPLY-LYINGPOSS, 82.1 % under SELLERSAPPLY-TRUTH). Moreover, under SELLERSAPPLY-LYINGPOSS, we see that only 7.4 % (2.9 %) of globally dominated (globally non-dominated) sellers apply stating their false quality, which is marginally significantly (not significantly) different from zero (sign test, p-values 0.06 and 0.12, respectively).

Interestingly, we further see from figure 3 that more globally dominated sellers apply to be tested under SELLERSAPPLY-LYINGPOSS compared to SELLERSAPPLY-TRUTH, but fewer globally non-dominated sellers do so. Thus, we see that SELLERSAPPLY-LYINGPOSS reflects a greater degree of out-of-equilibrium behavior. We summarize our first main result as follows.

Result 1 In line with H1, under SELLERSAPPLY-LYINGPOSS and SELLERSAPPLY-TRUTH:

- most globally dominated sellers do not apply to be tested.
- most globally non-dominated sellers do apply to be tested and, if applicable, state their true quality.

However, not in line with H1, there is more out-of-equilibrium behavior under SELLERSAPPLY-LYINGPOSS than under SELLERSAPPLY-TRUTH.

Result 1 is consistent with previous experimental findings (see, for example, Bendorf et al., 2015) which show that participants behave largely but not completely in line with theoretical predictions.

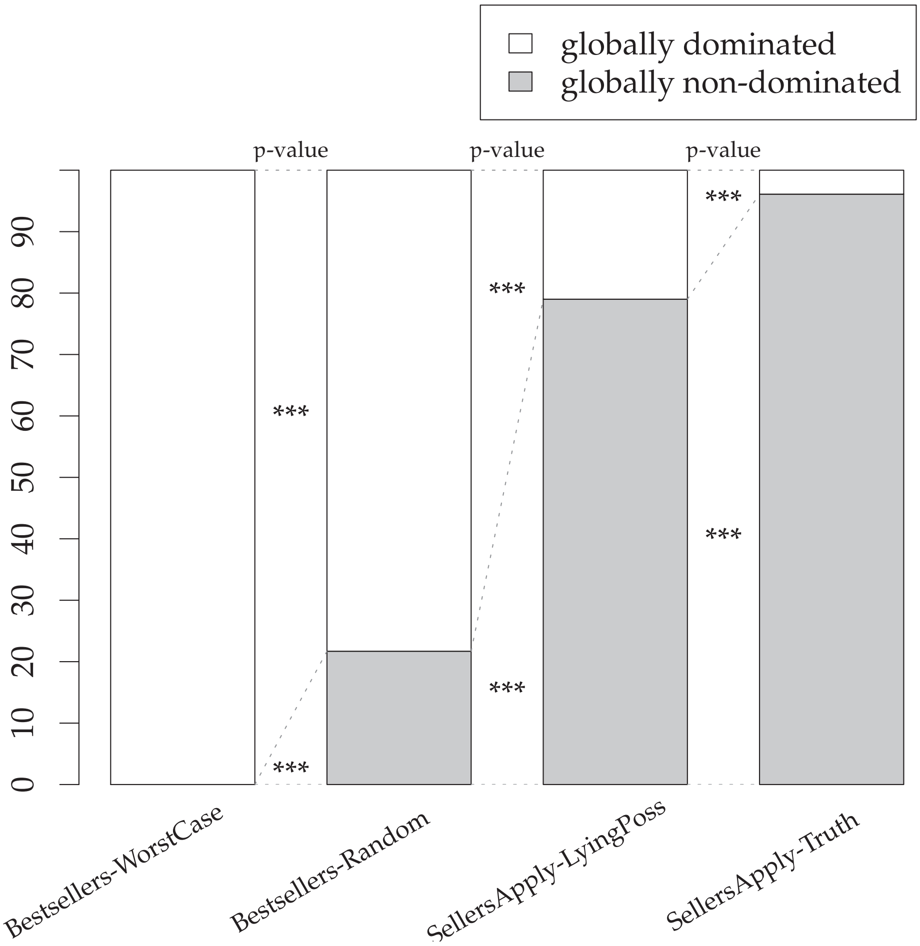
The finding that SELLERSAPPLY-LYINGPOSS elicits greater out-of-equilibrium behavior means that the number of sellers with globally non-dominated product models who apply to be tested will impact the number that are tested. It further implies that if sellers with globally dominated product models apply stating false qualities to the extent that they create testing congestion, globally non-dominated product models may end up being squeezed out of the testing pool. The next subsection presents the degree to which this actually happens.

4.2 Content of the product test

Figure 4 shows the respective shares of globally dominated and non-dominated product models in the product test pool. In line with our second hypothesis

[15] Note that "globally non-dominated" includes sellers with $q_t = 1$ for markets 1 to 3 in which *five* globally non-dominated product models exist. While we do not expect these sellers to apply for testing, we include them in our analysis to be consistent with markets 4 to 12 in which *all* sellers with globally non-dominated product models are predicted to apply to be tested.

Figure 4: Share of globally (non-)dominated product models in the product test



Note: For all treatment comparisons, we report the results of two-sided Mann-Whitney-U tests, conservatively counting one experimental session as one independent observation. We denote p-values as follows: *** < 0.01, ** < 0.05, and * < 0.1.

H2, the product test yields the least globally non-dominated product model information under BESTSELLERS-WORSTCASE (0 %), more under BESTSELLERS-RANDOM (21.7 %), more still under SELLERSAPPLY-LYINGPOSS (79 %), and most under SELLERSAPPLY-TRUTH (96.1 %). Note that the shares under BESTSELLERS-RANDOM and BESTSELLERS-WORSTCASE are determined by design. In particular, under BESTSELLERS-WORSTCASE, since the bestsellers are all globally dominated, no globally non-dominated product models are tested. Also note that, by design, 21.7 % of globally non-dominated product models are tested under BESTSELLERS-RANDOM as this reflects the share of globally non-dominated product models in all markets (23.3 %).

Figure 4 further shows that the product test pool contains fewer globally non-dominated product models under SELLERSAPPLY-LYINGPOSS than under SELLERSAPPLY-TRUTH (difference: 17.1 percentage points), but more than under BESTSELLERS-RANDOM (difference: 57.3 percentage points). Thus, we find that although out-of-equilibrium behavior under SELLERSAPPLY-LYINGPOSS decreases the share of globally non-dominated product models in the test, this share remains higher than that under BESTSELLERS-RANDOM. We summarize our second main result as follows.

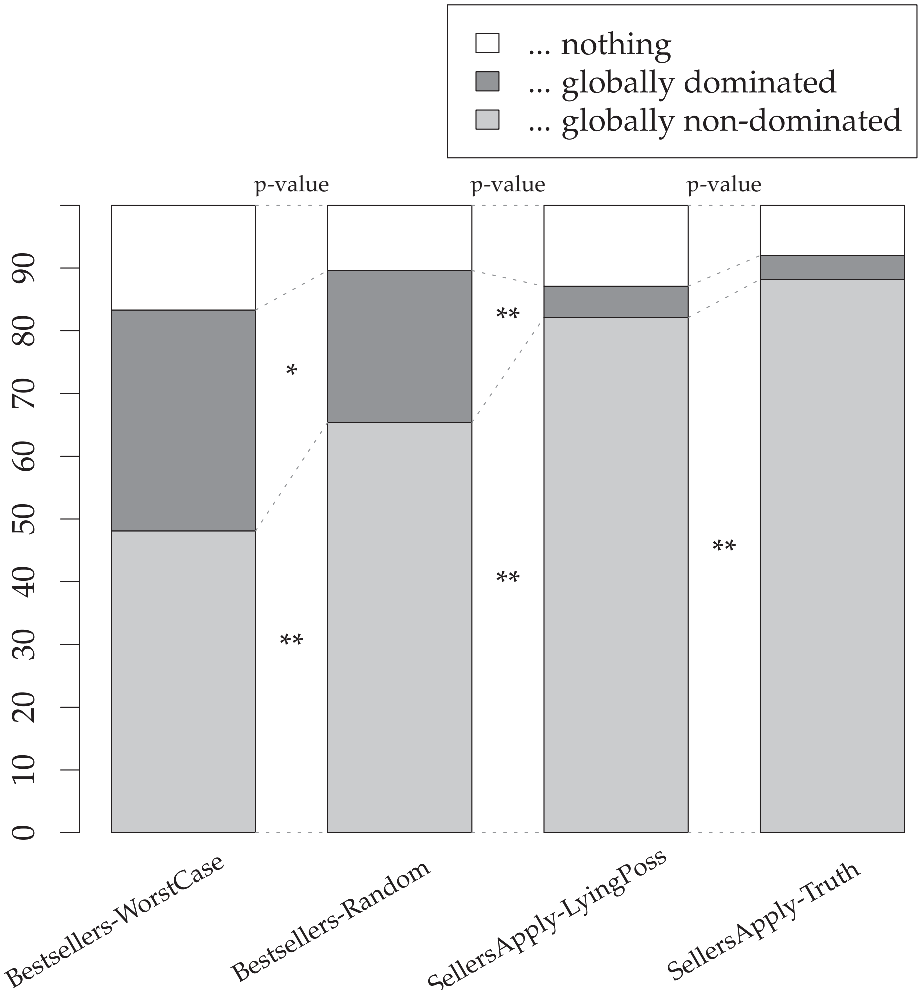
Result 2 In line with H2, the product test provides the least information on globally non-dominated product models under BESTSELLERS-WORSTCASE, more under BESTSELLERS-RANDOM, and more still under SELLERSAPPLY-LYINGPOSS. However, not in line with H2, the product test provides even more information on globally non-dominated product models under SELLERSAPPLY-TRUTH.

4.3 Buyer behavior

We next examine the relation between buyer information and behavior under the different mechanisms. Figure 5 shows that, consistent with H3, buyers choose the fewest globally non-dominated product models under BESTSELLERS-WORSTCASE (48.1 %), more under BESTSELLERS-RANDOM (65.4 %), more still under SELLERSAPPLY-LYINGPOSS (82.1 %), and the most under SELLERSAPPLY-TRUTH (88.2 %). Note that the relatively large shares of buyers choosing globally non-dominated product models under BESTSELLERS-RANDOM and BESTSELLERS-WORSTCASE can be explained by the large share of buyers who choose the cheapest product model, which is always globally non-dominated (53.5 % of all buyers who choose globally non-dominated product models under BESTSELLERS-RANDOM, 90.9 % under BESTSELLERS-WORSTCASE).

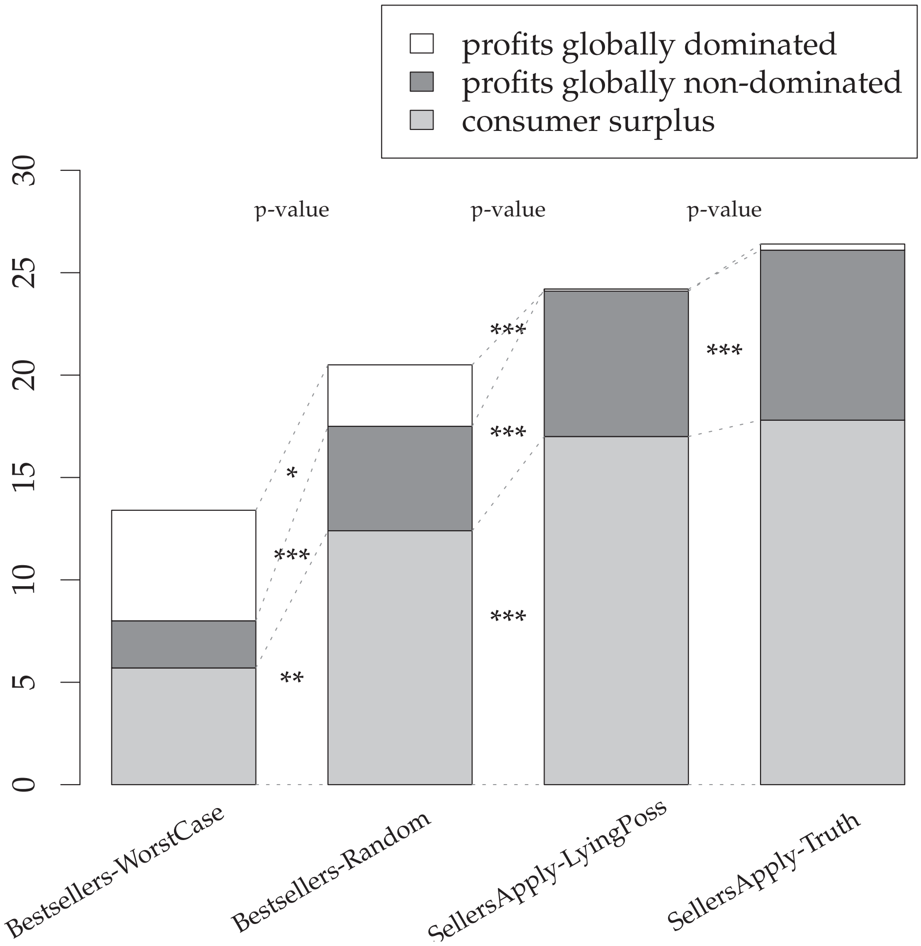
Figure 5 further shows that buyers choose fewer globally non-dominated product models under SELLERSAPPLY-LYINGPOSS (82.1 %) compared to SELLERSAPPLY-TRUTH, but more than under BESTSELLERS-RANDOM. Figure 5 also shows a positive share of non-buyers for each treatment, but no significant difference across treatments. We do find that buyers choose the highest number of globally dominated product models under BESTSELLERS-WORSTCASE (35.2 %), fewer under BESTSELLERS-RANDOM (24.2 %), and the fewest under

Figure 5: Share of buyers choosing…



Note: For all treatment comparisons, we report the results of two-sided Mann-Whitney-U tests, conservatively counting one experimental session as one independent observation. We denote p-values as follows: *** < 0.01, ** < 0.05, and * < 0.1.

Figure 6: Mean per capita consumer surplus and profits



Note: For all treatment comparisons, we report the results of two-sided Mann-Whitney-U tests, conservatively counting one experimental session as one independent observation. We denote p-values as follows: *** < 0.01, ** < 0.05, and * < 0.1.

SELLERSAPPLY-LYINGPOSS and SELLERSAPPLY-TRUTH (5 % and 3.8 %, respectively). Thus, we summarize our third main result as follows.

Result 3 In line with H3, buyers choose the fewest globally non-dominated product models under BESTSELLERS-WORSTCASE, more under BESTSELLERS-RANDOM, and more still under SELLERSAPPLY-LYINGPOSS. However, not in line with H3, buyers choose an even greater number of globally non-dominated product models under SELLERSAPPLY-TRUTH.

4.4 Surplus and profits

In our final set of experimental results, we examine participant payoffs across different treatments. From figure 6, we see that, consistent with H4, per capita consumer surplus is lowest under BESTSELLERS-WORSTCASE (5.7 ECU), higher under BESTSELLERS-RANDOM (12.4 ECU), and highest under SELLERSAPPLY-LYINGPOSS and SELLERSAPPLY-TRUTH (17 ECU and 17.8 ECU, respectively).

Figure 6 further shows that globally non-dominated seller profits are lowest under BESTSELLERS-WORSTCASE (2.3 ECU), higher under BESTSELLERS-RANDOM (5.1 ECU), and highest under SELLERSAPPLY-TRUTH (8.3 ECU). Figure 6 also shows that globally non-dominated seller profits are lower under SELLERSAPPLY-LYINGPOSS (7.2 ECU) compared to SELLERSAPPLY-TRUTH, but still higher than under BESTSELLERS-RANDOM. Again in line with H4, figure 6 shows that globally dominated seller profits are highest under BESTSELLERS-WORSTCASE (5.4 ECU), lower under BESTSELLERS-RANDOM (3 ECU), and lowest under SELLERSAPPLY-LYINGPOSS and SELLERSAPPLY-TRUTH (0.3 ECU in both treatments). Thus, we summarize our fourth main result as follows.

Result 4 In line with H4, per capita

- consumer surplus is lowest under BESTSELLERS-WORSTCASE , higher under BESTSELLERS-RANDOM, and highest under SELLERSAPPLY-LYINGPOSS and SELLERSAPPLY-TRUTH.
- globally non-dominated seller profits are lowest under BESTSELLERS-WORSTCASE, higher under BESTSELLERS-RANDOM, and highest under SELLERSAPPLY-TRUTH and SELLERSAPPLY-LYINGPOSS.
- globally dominated seller profits are highest under BESTSELLERS-WORSTCASE, lower under BESTSELLERS-RANDOM, and lowest under SELLERSAPPLY-TRUTH and SELLERSAPPLY-LYINGPOSS.

5 Discussion and conclusion

In this study, we develop and test a novel product model selection mechanism designed to provide more valuable information to consumers in the context of limited testing organization capacity. Our mechanism relies on the unraveling prediction as it allows sellers to indicate a product model's quality when applying for testing. We first develop a product testing game to derive testable predictions for different product model selection mechanisms and show theoretically that our mechanism yields optimal buyer information under certain conditions. We then use an experimental setting to test the predictions derived from our game. The results of our experiment show that, under our new mechanism, most sellers with globally non-dominated product models apply for testing, suggesting that information unraveling is sufficient for increasing the information provided on globally non-dominated product models. Buyers benefit from the superior information as they buy more globally non-dominated product models. Thus, our experimental results confirm that our mechanism improves consumer surplus compared to current mechanisms. Our results further show that globally non-dominated seller profits increase while those of globally dominated sellers decrease under our mechanism.

Our experimental results are consistent with those of previous studies that find that unraveling is usually incomplete in complex settings (see Hagenbach and Perez-Richet, 2018, and Jin et al., 2018). Nevertheless, we show that even in our two-dimensional context that allows for false quality statements, our mechanism outperforms a stylized version of current mechanisms. In particular, our mechanism provides greater buyer information and helps sellers of globally non-dominated product models. However, there may be concerns about adopting our mechanism for three reasons: its sensitivity to the set of weights used to aggregate the different quality sub-dimensions to one overall quality measure, its influence on the perceived credibility of the testing organizations, and its influence on product testing organizations' publication sales.

While all product tests are based on a, to some degree, arbitrary set of weights in order to create a uni-dimensional overall quality measure, we acknowledge that our mechanism is particularly sensitive to the set of weights used as it also determines which product models are globally dominated or non-dominated. However, since test results published by Consumer Reports show that more than half of all tested product models are globally dominated on *all* quality sub-dimensions (Hjorth-Andersen, 1984), this may mitigate the concern about the weights used to determine quality. In addition, our mechanism could be extended to include more than one set of weights. For example, a testing organization could issue different calls for applications based on different sets of weights if it identifies separate groups of buyers with different preferences. Thus, a testing organization could provide customized information for each group of buyers.

Regarding the second aspect, the role of sellers in the application process in our mechanism may raise the concern that product testing organizations will incur a reduction in their perceived credibility. To mitigate this concern, product testing organizations could provide a transparent explanation of the product model selection process to buyers. This information could emphasize that the role of sellers does not present a conflict of interest and that the testing process continues to include anonymous test buyers and objective testing methods. Note that a related organization, Blauer Engel, already allows sellers to apply with a certain product model to be certified.[16]

Finally, product testing organizations may be concerned about the effect of our mechanism on their publication sales, particularly in a market in which bestsellers receive low ratings. Under the BESTSELLERS mechanism, all bestsellers are tested, letting buyers know only what *not* to buy if all bestsellers receive low ratings. On the other hand, low ratings under this mechanism may elicit surprise and media attention, leading to increased interest in testing organization publications. By contrast, under the SELLERSAPPLY mechanism, none of the bestsellers may be included in the test. Buyers would then know what to buy, i.e., which globally non-dominated product models to choose from, but buyers would not know *how* globally dominated the bestsellers actually are. However, it is also possible that our mechanism would generate increased interest in testing organi-

[16] In contrast to organizations like Stiftung Warentest, Consumer Reports, and Which?, the label Blauer Engel provides information about a distinct subset of quality dimensions. It does not aim to provide a comprehensive quality rating. Blauer Engel has been the ecolabel of the federal government of Germany since 1978 (see https://www.blauer-engel.de/en for more information). Another difference between product testing organizations and Blauer Engel is that Blauer Engel does not select a sample among its applicants. Instead, it considers and, if applicable, certifies each applicant, although applicants may have to wait a certain amount of time for certification.

zation publications since it yields a more helpful portrait of what to purchase. It is also possible for testing organizations to use a hybrid of our mechanism and the BESTSELLERS mechanism depending on their objectives. Overall, our paper presents an alternative to current product model selection mechanisms with the ultimate goal of reducing the level of information asymmetry between buyers and sellers.

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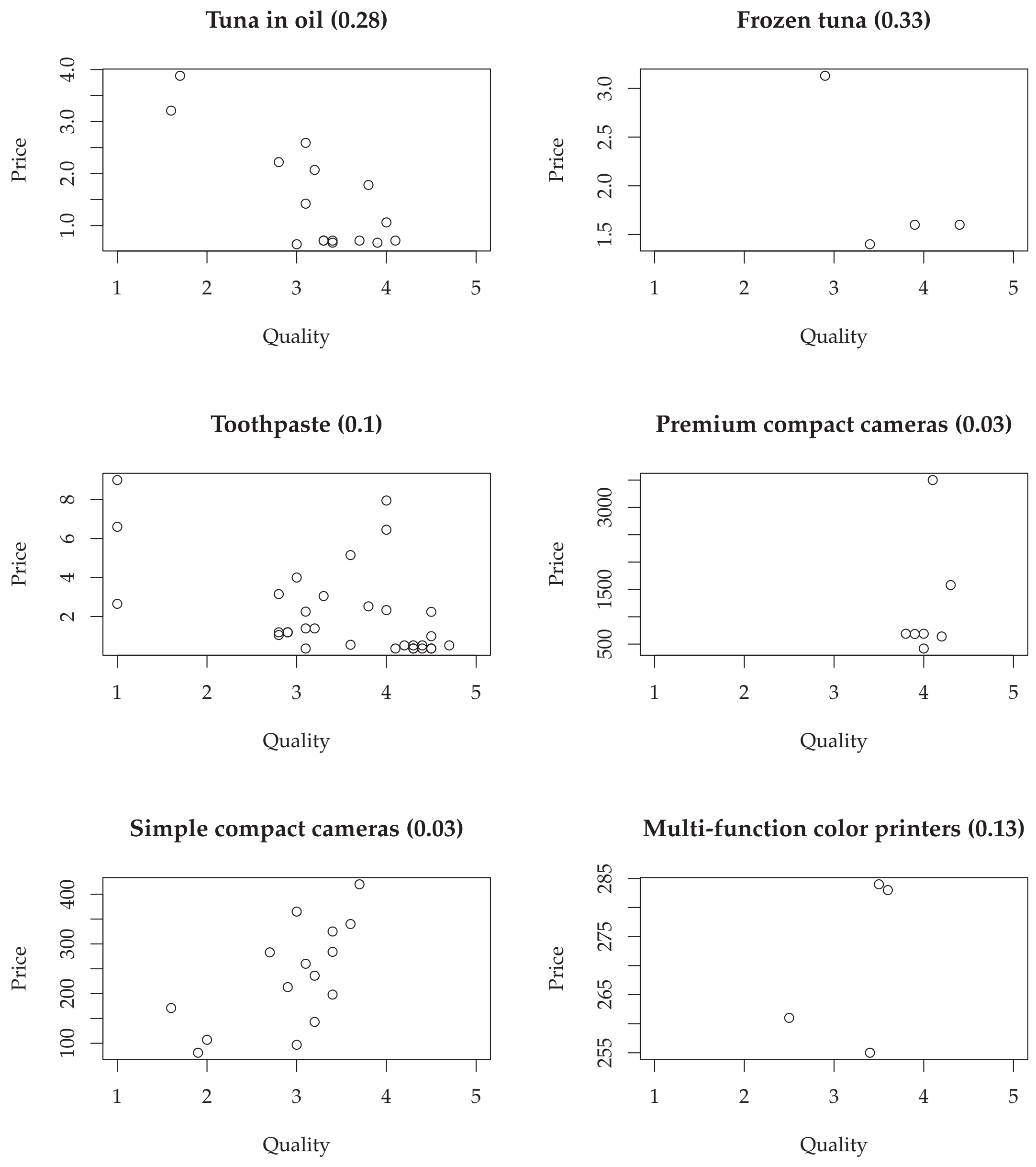
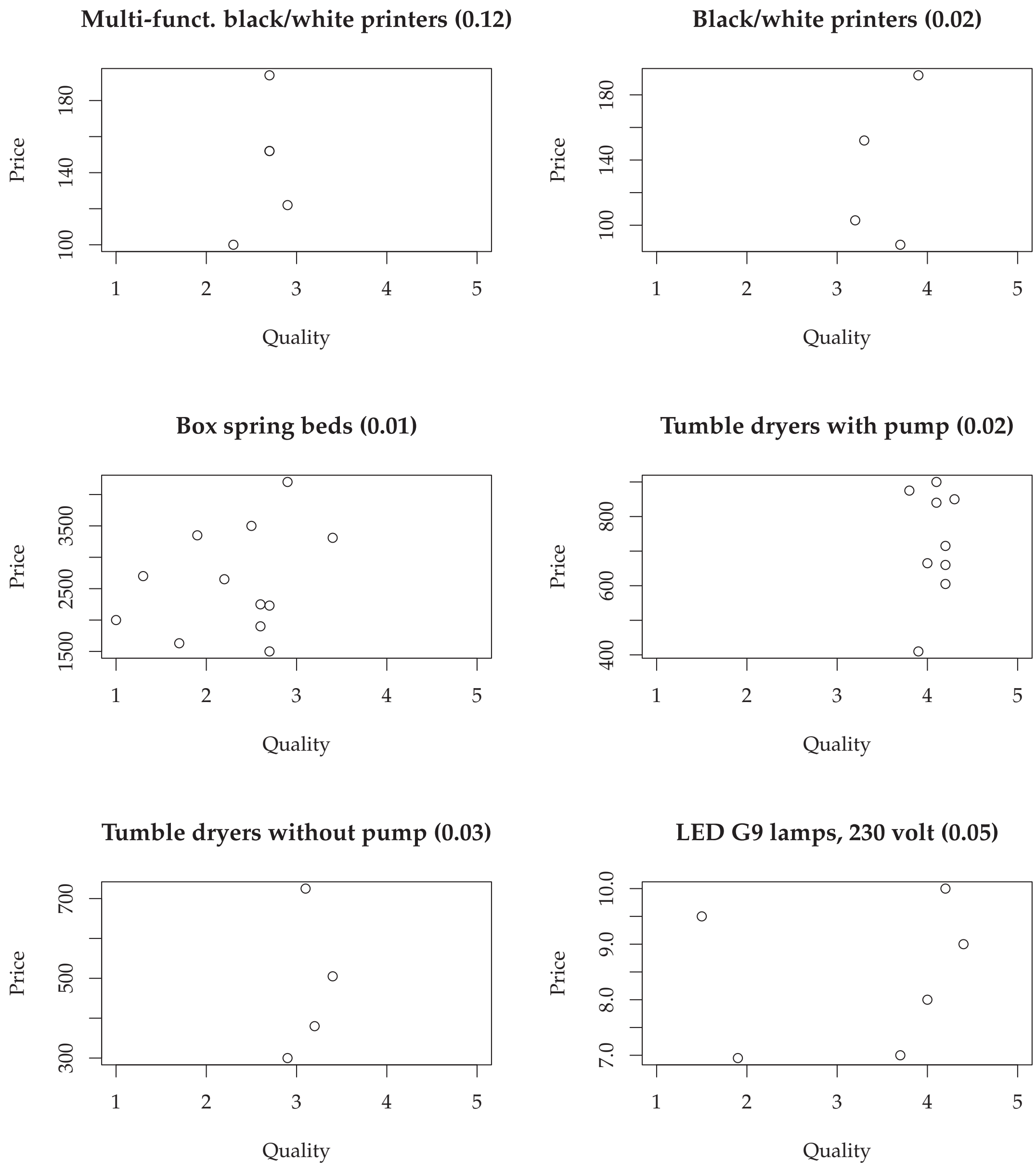
A Sample of products

Figure 7: Sample of products tested by Stiftung Warentest 09/2016



Note: Each dot represents one product model. The numbers in parentheses denote the shares of tested product models relative to all available product models in Germany (source: GfK SE).

Figure 8: Sample of products tested by Stiftung Warentest 09/2016



Note: Each dot represents one product model. The numbers in parentheses denote the shares of tested product models relative to all available product models in Germany (source: GfK SE).

B Current product model selection mechanisms

Table 2: Current product model selection mechanisms

	Product model selection criteria	Product model selection standardized?
Stiftung Warentest (Germany)	main criterion: sales numbers/bestsellers; if applicable, organic product models and/or product models with new features will be selected even if they are not among the bestsellers	yes
Consumer Reports (US)	spectrum of models: wide availability, incl. sales numbers wide range of prices if applicable, new features	not clear
Which? (UK)	popularity, incl. sales numbers brand reliability price if applicable, innovation	no

Sources:
https://www.test.de/unternehmen/testablauf-5017344-0/ (last accessed Dec 5, 2019); The website provides an overview of how Stiftung Warentest selects product models. In addition, we contacted them via telephone on December 16, 2014. Heike van Laak (head of the communication department) confirmed that they use a standardized product model selection mechanism.
http://www.consumerreports.org/cro/about-us/whats-behind-the-ratings/testing/appliances-home/index.htm (last accessed Dec 5, 2019); The website provides an overview of how Consumer Reports selects product models. It seems likely that they use a standardized product model selection mechanism, but it is not completely clear. Therefore, we contacted them via e-mail on October 6, 2016, but Nicole Sarrubbo (events and organizational communications manager; public affairs, events and outreach manager; associate editor) informed us that they do not provide additional information regarding their mechanism.
http://www.which.co.uk/about-which/research-methods/lab-testing/ (last accessed Dec 5, 2019); The website provides an overview of how Which? selects product models. However, it is not clear whether Which? uses a standardized product model selection mechanism. Therefore, we contacted them via telephone. On September 30, 2016, Kim Culver (corporate affairs) informed us that they do *not* use a standardized product model selection mechanism.

C Additional formal descriptions of section 2

C.1 Lemmas and proofs of section 2

Lemma 1 (Existence of a permutation $\sigma(F)$)**.** *A permutation* $\sigma(F)$ *of the global set of sellers F always exists.*

Proof of lemma 1 (Existence of a permutation $\sigma(F)$*).* We prove existence by explicitly stating one general permutation. Consider $\sigma : F \longrightarrow F$, with

$$F_r \mapsto \mathbb{1}_{\left\{F_r \in ND\right\}} F_{\sum_{j=1}^{r} \mathbb{1}_{\left\{F_j \in ND\right\}}} + \mathbb{1}_{\left\{F_r \in D\right\}} F_{\#ND + \sum_{j=1}^{r} \mathbb{1}_{\left\{F_j \in D\right\}}}.$$

$\square$

Lemma 2 (Properties of locally *non*-dominated product models within *sub*markets)**.** *Let* $f_t \in ND_{Q'}$ *with* $f_t \in \{f_1, \ldots, f_n\}$ *and* $Q' \subseteq \sigma(F)$*. It follows that* $f_t \in ND_Q$ $\forall Q \subseteq Q'$ *with* $f_t \in Q$*.*

Proof of lemma 2 (Properties of locally non-dominated product models in submarkets). Let seller $f_t \in \{f_1, \ldots, f_n\}$ offer a locally non-dominated product model in $Q' \subseteq \sigma(f)$. It follows that $\forall f_j \in Q'$, with $j \in \{1, \ldots, n\}$ and $p_j < p_t$, it is fulfilled that $q_j < q_t$, and $\forall f_j \in Q'$, with $j \in \{1, \ldots, n\}$ and $q_j \geqslant q_t$, it is fulfilled that $p_j > p_t$. It follows that $\forall f_j \in Q \subseteq Q'$, with $j \in \{1, \ldots, n\}$, $f_t \in Q$ and $p_j < p_t$, it is fulfilled that $q_j < q_t$, and $\forall f_j \in Q$, with $j \in \{1, \ldots, n\}$, $f_t \in Q$ and $q_j \geqslant q_t$, it is fulfilled that $p_j > p_t$. It follows that seller f_j's product model is locally non-dominated in Q. Since we make no further requirements for Q, our last conclusion holds $\forall Q \subseteq Q'$ with $f_t \in Q$. It follows that seller f_t's product model is locally non-dominated $\forall Q \subseteq Q'$ with $f_t \in Q$. $\square$

Lemma 3 (Properties of locally *dominated* product models within *larger* markets containing a certain submarket)**.** *Let* $f_t \in D_Q$ *with* $f_t \in \{f_1, \ldots, f_n\}$ *and* $Q \subseteq \sigma(f)$*. It follows that* $f_t \in D_{Q'}$ $\forall Q \subseteq Q' \subseteq \sigma(F)$*.*

Proof of lemma 3 (Properties of locally dominated product models within larger markets containing a certain submarket). Let seller $f_t \in \{f_1, \ldots, f_n\}$ offer a locally dominated product model in $Q \subseteq \sigma(f)$.
$\longleftrightarrow \exists f_j \in Q$ fulfilling $p_j \leqslant p_t$ and $q_j > q_t$, or $p_j < p_t$ and $q_j \geqslant q_t$.
Since $Q \subseteq Q'$, we know that $\exists f_j \in Q'$ fulfilling $p_j \leqslant p_t$ and $q_j > q_t$, or $p_j < p_t$ and $q_j \geqslant q_t$. It follows that $f_t \in D_{Q'}$ $\forall Q \subseteq Q' \subseteq \sigma(F)$. $\square$

Lemma 4 (Transitivity of being (locally or globally) dominated)**.** *Let* f_t *be dominated by* f_j *in* $Q \subseteq \sigma(F)$*, and let* f_j *be dominated by* f_k *in* Q*. It follows that* f_t *is also dominated by* f_k *in* Q*.*

Proof of lemma 4 (Transitivity of being (locally or globally) dominated). Let f_t be dominated by f_j in Q. It follows that $p_t \geqslant p_j$ and $q_t < q_j$, or $p_t > p_j$ and $q_t \leqslant q_j$. We also know that f_j is dominated by f_k in Q. It follows that $p_j \geqslant p_k$ and $q_j < q_k$, or $p_j > p_k$ and $q_j \leqslant q_k$. Combining both conclusions, we have four possible options:
$p_t \geqslant p_j \geqslant p_k$ and $q_t < q_j < q_k$,
$p_t \geqslant p_j > p_k$ and $q_t < q_j \leqslant q_k$,
$p_t > p_j \geqslant p_k$ and $q_t \leqslant q_j < q_k$, or
$p_t > p_j > p_k$ and $q_t \leqslant q_j \leqslant q_k$.
Thus, it follows that:
$p_t \geqslant p_k$ and $q_t < q_k$,
$p_t > p_k$ and $q_t < q_k$,
$p_t > p_k$ and $q_t < q_k$, or
$p_t > p_k$ and $q_t \leqslant q_k$.
In each case, it follows that f_t is dominated by f_k in Q. $\square$

Lemma 5 (Relationship between local dominance and composition of a set of rivals)**.** *Assume* $f_t \in D_Q$*. It follows that* $\{R_t \cap ND_Q\} \neq \emptyset$*.*

Proof of lemma 5 (Relationship between local dominance and composition of a set of rivals). Assume $f_t \in D_Q$. Since $Q = ND_Q \cup D_Q$, $\exists$ seller $f_j \in \{R_t \cap Q\}$, with either $f_j \in \{R_t \cap ND_Q\}$, or $f_j \in \{R_t \cap D_Q\}$. If $f_j \in \{R_t \cap ND_Q\}$, our proof would be complete. Therefore, let us consider $f_j \in \{R_t \cap D_Q\}$. We know about the globally dominated seller f_j that $\exists$ seller $f_k \in \{R_j \cap Q\}$, with either $f_k \in \{R_j \cap ND_Q\}$, or $f_k \in \{R_j \cap D_Q\}$. Again, if $f_k \in \{R_j \cap ND_Q\}$, our proof would be complete. Therefore, we consider $f_k \in \{R_j \cap D_Q\}$. We continue this procedure as long as there are no more locally dominated sellers in Q remaining. Recall from subsection 2.1 that the number of locally dominated sellers in Q is finite since the number of global sellers is finite. At the maximum, the procedure consists of $(\#D_Q - 1)$ steps. Let $f_l \in D_Q$ be the last seller in this procedure to be dominated by a seller $f_x \in ND_Q$. It follows that $f_x \in \{R_l \cap Q\}$. Due to the transitivity of being dominated (see lemma 4), we can conclude that $f_x \in \{R_t \cap Q\}$. It follows that $\{R_t \cap ND_Q\} \neq \emptyset$. □

Proof of proposition 1 (Expected consumer surplus and seller profits under BESTSELLERS*).* The expected consumer surplus equals

$$\sum_{h=1}^{s} \theta_h q^h_{\overbrace{\left\{ND_{K'} \cup f_{\{\sigma(F)\setminus K'\}^c} \cup f_0\right\}}} - p^h_{\overbrace{\left\{ND_{K'} \cup f_{\{\sigma(F)\setminus K'\}^c} \cup f_0\right\}}}.$$

The expected profits of globally dominated sellers equal

$$\sum_{t=m+1}^{n} \sum_{h=1}^{s} \frac{\mathbb{1}_{\left\{f_t = f^h_{\overbrace{\left\{ND_{K'} \cup f_{\{\sigma(F)\setminus K'\}^c} \cup f_0\right\}}}\right\}} \Big(p_t - c\big(q_t\big)\Big)}{\#\Big\{f_j \in \sigma(F) | \mathbb{E}\big(u_h(\theta_h, q_j, p_j)\big) = \mathbb{E}\big(u_h(\theta_h, q_t, p_t)\big)\Big\}}.$$

The expected profits of globally non-dominated sellers equal

$$\sum_{t=1}^{m} \sum_{h=1}^{s} \frac{\mathbb{1}_{\left\{f_t = f^h_{\overbrace{\left\{ND_{K'} \cup f_{\{\sigma(F)\setminus K'\}^c} \cup f_0\right\}}}\right\}} \Big(p_t - c\big(q_t\big)\Big)}{\#\Big\{f_j \in \sigma(F) | \mathbb{E}\big(u_h(\theta_h, q_j, p_j)\big) = \mathbb{E}\big(u_h(\theta_h, q_t, p_t)\big)\Big\}}.$$

Lower consumer surplus

Let $K'_{Bestsellers} \neq \overline{ND}$, and $\forall f_j \in \overline{ND}$ with $f_j \notin K'_{Bestsellers}\ \exists b_l \in \{b_1, \ldots, b_s\}$, with $f_j = \arg\max_{f_k \in \left\{f_{\{\sigma(F)\setminus \overline{ND}\}^c} \cup \overline{ND} \cup f_0\right\}} \mathbb{E}\Big(u_l(\theta_l, q_k, p_k)\Big)$, and $f_j \notin \arg\max_{f_k \in \left\{f_{\{\sigma(F)\setminus K'_{Bestsellers}\}^c} \cup K'_{Bestsellers} \cup f_0\right\}} \mathbb{E}\Big(u_l(\theta_l, q_k, p_k)\Big)$. According to $f_j \in \overline{ND}$,

$\exists b_l \in \{b_1, \dots, b_s\}$ with $f_j = \arg\max_{f_k \in \left\{ f_{\{\sigma(F) \setminus \overline{ND}\}^c} \cup \overline{ND} \cup f_0 \right\}} \mathbb{E}\Big(u_l\big(\theta_l, q_k, p_k\big)\Big)$ and with

$$\max_{f_k \in \left\{ f_{\{\sigma(F) \setminus \overline{ND}\}^c} \cup \overline{ND} \cup f_0 \right\}} \mathbb{E}\Big(u_l\big(\theta_l, q_k, p_k\big)\Big) > \max_{f_k \in \left\{ f_{\left\{\sigma(F) \setminus K'_{Bestsellers}\right\}^c} \cup K'_{Bestsellers} \cup f_0 \right\}} \mathbb{E}\Big(u_l\big(\theta_l, q_k, p_k\big)\Big).$$

This inequality holds since b_l must deviate from selecting her complete information optimal product model to a different product model according to our requirements that $f_j \notin K'_{Bestsellers}$ and $\arg\max_{f_k \in \left\{ f_{\{\sigma(F) \setminus \overline{ND}\}^c} \cup \overline{ND} \cup f_0 \right\}} \mathbb{E}\Big(u_l\big(\theta_l, q_k, p_k\big)\Big) \neq f_{\left\{\sigma(F) \setminus K'_{Bestsellers}\right\}^c}$. Therefore, it follows that b_l's utility is strictly lower under BESTSELLERS compared to a world of complete information, and consequently, so is the aggregate consumer surplus.

Identical consumer surplus

(i) Let $K'_{Bestsellers} = \overline{ND}$, and $\forall b_l \in \{b_1, \dots, b_s\}$ the following holds: $\max\left\{ \mathbb{E}\left(u_l\left(\theta_l, q_{\{\sigma(F) \setminus \overline{ND}\}^c}, p_{\{\sigma(F) \setminus \overline{ND}\}^c}\right)\right), 0 \right\} < \max_{f_j \in \overline{ND}} u\big(\theta_l, q_j, p_j\big)$. This leads to an identical optimization problem in a world of complete information and with BESTSELLERS for each buyer, i.e., $\arg\max_{f_k \in \left\{ f_{\{\sigma(F) \setminus \overline{ND}\}^c} \cup \overline{ND} \cup f_0 \right\}} \mathbb{E}\Big(u_l\big(\theta_l, q_k, p_k\big)\Big) = \arg\max_{f_k \in \left\{ f_{\left\{\sigma(F) \setminus K'_{Bestsellers}\right\}^c} \cup K'_{Bestsellers} \cup f_0 \right\}} \mathbb{E}\Big(u_l\big(\theta_l, q_k, p_k\big)\Big)$ $\forall b_l \in \{b_1, \dots, b_s\}$. Therefore, b_l's utility under BESTSELLERS is identical to that in a world of complete information. It follows that the consumer surplus is also identical.

(ii) Let $K'_{Bestsellers} \neq \overline{ND}$ and $\exists! f_j \in \overline{ND}$ such that $\forall b_l \in \{b_1, \dots, b_s\}$ with $f_j \notin K'_{Bestsellers}$ and $f_j = \arg\max_{f_k \in \left\{ f_{\{\sigma(F) \setminus \overline{ND}\}^c} \cup \overline{ND} \cup f_0 \right\}} \mathbb{E}\Big(u_l\big(\theta_l, q_k, p_k\big)\Big)$, the following holds: $f_j = \arg\max_{f_k \in \left\{ \left\{\sigma(F) \setminus K'_{Bestsellers}\right\}^c \cup K'_{Bestsellers} \cup f_0 \right\}} \mathbb{E}\Big(u_l\big(\theta_l, q_k, p_k\big)\Big)$. In addition, $\forall f_x \in \left\{\overline{ND} \setminus f_j\right\}$, let $\mathbb{E}\Big(d\big(q_x, p_x\big)\Big)\big[\textit{completeInformation}\big] = \mathbb{E}\Big(d\big(q_x, p_x\big)\Big)\big[\textit{Bestsellers}\big]$. In this case, we know that except $\forall b_l \in \{b_1, \dots, b_s\}$ with $f_j = \arg\max_{f_k \in \left\{ f_{\{\sigma(F) \setminus \overline{ND}\}^c} \cup \overline{ND} \cup f_0 \right\}} \mathbb{E}\Big(u_l\big(\theta_l, q_k, p_k\big)\Big)$, every buyer selects the same optimal product model as under complete information per our assumption. Therefore, the utility of these buyers is identical in a world of complete information and with BESTSELLERS. $\forall b_l \in \{b_1, \dots, b_s\}$ with $f_j = \arg\max_{f_k \in \left\{ f_{\{\sigma(F) \setminus \overline{ND}\}^c} \cup \overline{ND} \cup f_0 \right\}} \mathbb{E}\Big(u_l\big(\theta_l, q_k, p_k\big)\Big)$, we assume $f_j =$

$$f_{\{\sigma(F)\setminus K'_{Bestsellers}\}^c} = \arg\max_{f_k \in \left\{ f_{\{\sigma(F)\setminus K'_{Bestsellers}\}^c} \cup K'_{Bestsellers} \cup f_0 \right\}} \mathbb{E}\Big(u_l(\theta_l, q_k, p_k)\Big).$$

Therefore, these buyers also select the same optimal product model as they do under complete information. It follows that all buyers select the same optimal product model as under complete information, and that the consumer surplus is identical.

□

Lemma 6 (A first condition under which globally dominated sellers would also be locally dominated in a set of sellers). *Let $f_t \in D$. It follows that $\forall ND \subseteq Q \subseteq \sigma(F)$, with $f_t \in Q$, seller f_t's product model is also locally dominated in Q, i.e., $f_t \in D_Q$.*

Proof of lemma 6 (A first condition under which globally dominated sellers would also be locally dominated in a set of sellers). Let $f_t \in D$, and let $ND \subseteq Q \subseteq \sigma(F)$ be a set with $f_t \in Q$. Let $f_j \in \{R_t \cap ND\} \subseteq ND \subseteq Q$. (Note that the set R_t is non-empty since $f_t \in D$. The set $\{R_t \cap ND\}$ is also non-empty since R_t cannot consist of only globally dominated sellers because dominating another seller is transitive according to lemma 4 (Transitivity of being (locally or globally) dominated), and each globally dominated seller is rivalled by at least one globally non-dominated seller.) Therefore, it follows that $f_j \in Q$. Since $f_j \in R_t$, it follows that $\{R_t \cap Q\}$ is non-empty, and that f_t is locally dominated in Q. □

Lemma 7 (Comparing the prices of the respective cheapest globally non–dominated and globally dominated product models). *Let $f_{\sigma(F)^c} = f_{ND^c} = \arg\min_{f_k \in ND} p_k$ be the seller offering a strictly cheaper product model than all other globally non-dominated sellers, and let $f_t \in D$ be a globally dominated seller. It follows that $p_{\sigma(F)^c} \leqslant p_t\ \forall f_t \in D$.*

Proof of lemma 7 (Comparing the prices of the respective cheapest globally non-dominated and globally dominated product models). Let $f_{\sigma(F)^c} = f_{ND^c} = \arg\min_{f_k \in ND} p_k$ be the seller offering a strictly cheaper product model than all other globally non-dominated sellers, and let $f_t \in D$ be a globally dominated seller. Seller f_t cannot offer a strictly cheaper price than $f_{\sigma(F)^c}$ because he would be globally non-dominated otherwise, irrespective of his quality q_t. This argument applies to all globally dominated sellers, i.e., also to the one with the lowest price of all globally dominated sellers. It follows that $p_{\sigma(F)^c} \leqslant p_t\ \forall f_t \in D$. Thus, the cheapest globally dominated product model can offer either the same or a higher price than the cheapest globally non-dominated product model. □

Lemma 8 (A weaker condition under which globally dominated sellers would not have an incentive to apply to be tested). *Let $(\hat{s}_1, \ldots, \hat{s}_{t-1}, \hat{s}_{t+1}, \ldots, \hat{s}_n)^T$ be an arbitrary, but fixed, strategy vector of all sellers in $\{\sigma(F) \setminus f_t\}$. Furthermore, let $f_{\sigma(F)^c} = \arg\min_{f_k \in ND} p_k \in ND$ be the seller offering a strictly cheaper product model than all other globally non-dominated sellers, and let $f_t \in D$ be a globally dominated seller. Let seller $f_{\sigma(F)^c}$ dominate seller f_t in expectation, i.e., $\Big(\big(p_{\sigma(F)^c} \leqslant p_t\big) \wedge \big(\mathbb{E}(q_{\sigma(F)^c}) > q_t\big)\Big) \vee \Big(\big(p_{\sigma(F)^c} < p_t\big) \wedge \big(\mathbb{E}(q_{\sigma(F)^c}) \geqslant q_t\big)\Big)$. In addition, let $ND_{crit} \in ND_{Crit}$, with $f_{\sigma(F)^c} \in ND_{crit}$, and $\{ND_{crit} \setminus f_{\sigma(F)^c}\} \subseteq ND_{apply}$. It follows that seller f_t does not have an incentive to apply to be tested with q_t.*

Proof of lemma 8 (A weaker condition under which globally dominated sellers would not have an incentive to apply to be tested). Let $f_{\sigma(F)^c} = \arg\min_{f_k \in ND} p_k \in ND$ be the seller offering a strictly cheaper product model than all other globally non-dominated sellers, and let $f_t \in D$ be a globally dominated seller. Let seller $f_{\sigma(F)^c}$ dominate seller f_t in expectation, i.e., $\Big(\big(p_{\sigma(F)^c} \leqslant p_t\big) \wedge \big(\mathbb{E}(q_{\sigma(F)^c}) > q_t\big)\Big) \vee \Big(\big(p_{\sigma(F)^c} < p_t\big) \wedge \big(\mathbb{E}(q_{\sigma(F)^c}) \geqslant q_t\big)\Big)$. Furthermore, let $ND_{crit} \in ND_{Crit}$, with $f_{\sigma(F)^c} \in ND_{crit}$, let $\{ND_{crit} \setminus f_{\sigma(F)^c}\} \subseteq ND_{apply}$, and let $f_{\sigma(F)^c} \in \big\{\sigma(F) \setminus ND_{apply}\big\}$. If seller f_t applies to be tested stating q_t, we can distinguish two cases: either $f_t \notin K'$, or $f_t \in K'$. In the first case, seller f_t's product model would not be tested, but f_t would have to pay the *application_fee*. Therefore, his profit would be lower compared to the case had he not applied for testing.

In the second case, seller f_t's product model would be tested, but would not receive additional demand since, according to lemma 7 (Comparing the prices of the cheapest globally non-dominated and the cheapest globally dominated product model), the cheapest globally non-dominated seller also offers the cheapest product model among all sellers. Therefore, buyers know the price and the expected quality of the cheapest globally non-tested product model. Since f_t is assumed to be dominated by $f_{\sigma(F)^c}$ in expectation, f_t would not receive any additional profit, but would have to pay the *application_fee* > 0. It follows that seller f_t does not have an incentive to apply to be tested with q_t. □

Lemma 9 (Applying to be tested stating a false product quality)**.** *For seller* $f_t \in \sigma(F)$*, applying to be tested stating a false product quality* q_t^{false} *is a strictly dominated strategy.*

Proof of lemma 9 (Applying to be tested stating a false product quality). Since a global market consists of globally dominated and non-dominated sellers, we show for both types that applying to be tested stating a false quality q_t^{false} is a strictly dominated strategy. Let us start with $f_t \in \{D \cap K_{false}\}$. Since $\Big\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\Big\} = ND_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}} \cup D_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}$, we can separate expected profits after applying with a falsely stated quality into two disjoint cases. The first (second) summand represents the case where seller f_t^{false} is locally dominated (locally non-dominated) within the set of applicants. It follows that

$$
\begin{aligned}
& \mathbb{E}\big(\pi_t(q_t, p_t)\big)\Big[f_t \in \big\{D \cap K_{false}\big\}\Big] \\
=& \mathbb{1}_{\left\{f_t^{false} \in D_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}\right\}} \\
& \times \left(\mathbb{E}\big(\pi_t(q_t, p_t)\big)\left[f_t^{false} \in D_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}\right] - \textit{application\_fee}\right) \\
& + \mathbb{1}_{\left\{f_t^{false} \in ND_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}\right\}}
\end{aligned}
$$

$$
\begin{aligned}
&\quad \times \left(\mathbb{E}\big(\pi_t(q_t, p_t)\big)\left[f_t^{false} \in ND_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}\right] - application\_fee\right) \\
=&\mathbb{1}\left\{\left\{f_t^{false} \in D_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}\right\} \cap \left\{\{K_1' \cap K_{false}\} = \emptyset\right\}\right\} \\
&\quad \times \left(\mathbb{E}\big(\pi_t(q_t, p_t)\big)\left[\left\{f_t^{false} \in D_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}\right\} \cap \left\{\{K_1' \cap K_{false}\} = \emptyset\right\}\right] - application\_fee\right) \\
&+ \mathbb{1}\left\{\left\{f_t^{false} \in D_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}\right\} \cap \left\{\{K_1' \cap K_{false}\} \neq \emptyset\right\}\right\} \\
&\quad \times \left(\mathbb{E}\big(\pi_t(q_t, p_t)\big)\left[\left\{f_t^{false} \in D_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}\right\} \cap \left\{\{K_1' \cap K_{false}\} \neq \emptyset\right\}\right] - application\_fee\right) \\
&+ \mathbb{1}\left\{\left\{f_t^{false} \in ND_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}\right\} \cap \left\{f_t \in D_{K_1'}\right\}\right\} \\
&\quad \times \left(\mathbb{E}\big(\pi_t(q_t, p_t)\big)\left[\left\{f_t^{false} \in ND_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}\right\} \cap \left\{f_t \in D_{K_1'}\right\}\right] - application\_fee\right) \\
&+ \mathbb{1}\left\{\left\{f_t^{false} \in ND_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}\right\} \cap \left\{f_t \in ND_{K_1'}\right\}\right\} \\
&\quad \times \left(\mathbb{E}\big(\pi_t(q_t, p_t)\big)\left[\left\{f_t^{false} \in ND_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}\right\} \cap \left\{f_t \in ND_{K_1'}\right\}\right] - application\_fee\right) \\
=&\mathbb{1}\left\{\left\{f_t^{false} \in D_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}\right\} \cap \left\{\left\{K_1' \cap K_{false}\right\} = \emptyset\right\}\right\} \\
&\quad \times \left(\mathbb{E}\big(\pi_t(q_t, p_t)\big)\left[\left\{f_t^{false} \in D_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}\right\} \cap \left\{\{K_1' \cap K_{false}\} = \emptyset\right\}\right]\right. \\
&\qquad \left. - application\_fee\right) \\
&+ \mathbb{1}\left\{\left\{f_t^{false} \in D_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}\right\} \cap \left\{\left\{K_1' \cap K_{false}\right\} \neq \emptyset\right\} \cap \left\{f_t^{false} \in D_{\left\{K_{true} \cup \left\{f_o^{false} | f_o \in \{K_{false} \setminus K_1'\}\right\} \cup K_1'\right\}}\right\}\right\} \\
&\quad \times \left(\mathbb{E}\big(\pi_t(q_t, p_t)\big)\left[\left\{f_t^{false} \in D_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}\right\} \cap \left\{\{K_1' \cap K_{false}\} \neq \emptyset\right\} \cap\right.\right. \\
&\qquad \left.\left.\left\{f_t^{false} \in D_{\left\{K_{true} \cup \left\{f_o^{false} | f_o \in \{K_{false} \setminus K_1'\}\right\} \cup K_1'\right\}}\right\}\right] - application\_fee\right)
\end{aligned}
$$

$$+\mathbb{1}_{\left\{\left\{f_t^{false}\in D_{\left\{K_{true}\cup\{f_o^{false}|f_o\in K_{false}\}\right\}}\right\}\cap\left\{\left\{K_1'\cap K_{false}\right\}\neq\emptyset\right\}\cap\left\{f_t^{false}\in ND_{\left\{K_{true}\cup\left\{f_o^{false}|f_o\in\{K_{false}\setminus K_1'\}\right\}\cup K_1'\right\}}\right\}\right\}}$$

$$\times\left(\mathbb{E}\big(\pi_t(q_t,p_t)\big)\left[\left\{f_t^{false}\in D_{\left\{K_{true}\cup\{f_o^{false}|f_o\in K_{false}\}\right\}}\right\}\cap\left\{\{K_1'\cap K_{false}\}\neq\emptyset\right\}\cap\left\{f_t^{false}\in ND_{\left\{K_{true}\cup\left\{f_o^{false}|f_o\in\{K_{false}\setminus K_1'\}\right\}\cup K_1'\right\}}\right\}\right]-\textit{application\_fee}\right)$$

$$+\mathbb{1}_{\left\{\left\{f_t^{false}\in ND_{\left\{K_{true}\cup\{f_o^{false}|f_o\in K_{false}\}\right\}}\right\}\cap\left\{f_t\in D_{K'}\right\}\right\}}$$

$$\times\left(\mathbb{E}\big(\pi_t(q_t,p_t)\big)\left[\left\{f_t^{false}\in ND_{\left\{K_{true}\cup\{f_o^{false}|f_o\in K_{false}\}\right\}}\right\}\cap\left\{f_t\in D_{K'}\right\}\right]-\textit{application\_fee}\right)$$

$$+\mathbb{1}_{\left\{\left\{f_t^{false}\in ND_{\left\{K_{true}\cup\{f_o^{false}|f_o\in K_{false}\}\right\}}\right\}\cap\left\{f_t\in ND_{K_1'}\right\}\cap\left\{f_t\in ND_{K'}\right\}\right\}}$$

$$\times\left(\mathbb{E}\big(\pi_t(q_t,p_t)\big)\left[\left\{f_t^{false}\in ND_{\left\{K_{true}\cup\{f_o^{false}|f_o\in K_{false}\}\right\}}\right\}\cap\left\{f_t\in ND_{K_1'}\right\}\cap\left\{f_t\in ND_{K'}\right\}\right]-\textit{application\_fee}\right)$$

$$+\mathbb{1}_{\left\{\left\{f_t^{false}\in ND_{\left\{K_{true}\cup\{f_o^{false}|f_o\in K_{false}\}\right\}}\right\}\cap\left\{f_t\in ND_{K_1'}\right\}\cap\left\{f_t\in D_{K'}\right\}\right\}}$$

$$\times\left(\mathbb{E}\big(\pi_t(q_t,p_t)\big)\left[\left\{f_t^{false}\in ND_{\left\{K_{true}\cup\{f_o^{false}|f_o\in K_{false}\}\right\}}\right\}\cap\left\{f_t\in ND_{K_1'}\right\}\cap\left\{f_t\in D_{K'}\right\}\right]-\textit{application\_fee}\right)$$

From this point on, the next iteration of the algorithm would start again if applicable, analogously to shown above. Note that each iteration works analogously since the product testing organization is assumed to test all remaining non-tested product models after each iteration $i\in\left\{1,\dots,\min\left\{\arg\min_{l\in\{1,\dots,\#K\}}\{l\,|\{K_l'\cap K_{false}\}=\emptyset\},\#K\right\}\right\}$ until there are no more promising non-tested product models remaining, i.e. until $\left\{ND_{\left\{K_{true}\cup\left\{f_o^{false}|f_o\in\{K_{false}\setminus K_i'\}\right\}\cup K_i'\right\}}\right\}=\emptyset$. Therefore, we omit the following up to $\left(\min\left\{\arg\min_{l\in\{1,\dots,\#K\}}\{l\,|\{K_l'\cap K_{false}\}=\emptyset\},\#K\right\}-1\right)$ iterations since $K'_1 \subseteq K'_2 \subseteq \ldots \subseteq K'_{\arg\min_{l\in\{1,\ldots,\#K\}}\left\{l \,|\left\{K'_l \cap K_{false}\right\}=\emptyset\right\}} = K'$. It follows that

$$
\begin{aligned}
=&\mathbb{1}_{\left\{\forall i\in\left\{1,\ldots,\min\left\{\arg\min_{l\in\{1,\ldots,\#K\}}\left\{l\,|\{K'_l\cap K_{false}\}=\emptyset\right\},\#K\right\}\right\}\middle| f_t^{false}\in D_{\left\{K_{true}\cup\left\{f_o^{false}|f_o\in\{K_{false}\setminus K'_i\}\right\}\cup K'_i\right\}}\right\}}\\
&\times\Bigg(\mathbb{E}\big(\pi_t(q_t,p_t)\big)\Bigg[\forall i\in\left\{1,\ldots,\min\left\{\arg\min_{l\in\{1,\ldots,\#K\}}\left\{l\,|\{K'_l\cap K_{false}\}=\emptyset\right\},\#K\right\}\right\}\Bigg|\\
&\qquad f_t^{false}\in D_{\left\{K_{true}\cup\left\{f_o^{false}|f_o\in\{K_{false}\setminus K'_i\}\right\}\cup K'_i\right\}}\Bigg]-\textit{application\_fee}\Bigg)\\
&+\mathbb{1}_{\left\{\left\{\exists j\in\left\{1,\ldots,\min\left\{\arg\min_{l\in\{1,\ldots,\#K\}}\left\{l\,|\{K'_l\cap K_{false}\}=\emptyset\right\},\#K\right\}\right\}\middle| f_t^{false}\in ND_{\left\{K_{true}\cup\left\{f_o^{false}|f_o\in\{K_{false}\setminus K'_j\}\right\}\cup K'_j\right\}}\right\}\cap\left\{f_t\in ND_{K'}\right\}\right\}}\\
&\times\Bigg(\mathbb{E}\big(\pi_t(q_t,p_t)\big)\Bigg[\Bigg\{\exists j\in\left\{1,\ldots,\min\left\{\arg\min_{l\in\{1,\ldots,\#K\}}\left\{l\,|\{K'_l\cap K_{false}\}=\emptyset\right\},\#K\right\}\right\}\Bigg|\\
&\qquad f_t^{false}\in ND_{\left\{K_{true}\cup\left\{f_o^{false}|f_o\in\{K_{false}\setminus K'_j\}\right\}\cup K'_j\right\}}\Bigg\}\cap\left\{f_t\in ND_{K'}\right\}\Bigg]-\textit{application\_fee}\Bigg)\\
&+\mathbb{1}_{\left\{\left\{\exists j\in\left\{1,\ldots,\min\left\{\arg\min_{l\in\{1,\ldots,\#K\}}\left\{l\,|\{K'_l\cap K_{false}\}=\emptyset\right\},\#K\right\}\right\}\middle| f_t^{false}\in ND_{\left\{K_{true}\cup\left\{f_o^{false}|f_o\in\{K_{false}\setminus K'_j\}\right\}\cup K'_j\right\}}\right\}\cap\left\{f_t\in D_{K'}\right\}\right\}}\\
&\times\Bigg(\mathbb{E}\big(\pi_t(q_t,p_t)\big)\Bigg[\Bigg\{\exists j\in\left\{1,\ldots,\min\left\{\arg\min_{l\in\{1,\ldots,\#K\}}\left\{l\,|\{K'_l\cap K_{false}\}=\emptyset\right\},\#K\right\}\right\}\Bigg|\\
&\qquad f_t^{false}\in ND_{\left\{K_{true}\cup\left\{f_o^{false}|f_o\in\{K_{false}\setminus K'_j\}\right\}\cup K'_j\right\}}\Bigg\}\cap\left\{f_t\in D_{K'}\right\}\Bigg]-\textit{application\_fee}\Bigg)
\end{aligned}
$$

If the condition of the first indicator function is true, f_t's product model will not be tested because our algorithm excludes dominated applicants. Thus, seller f_t will have to pay the *application_fee*, but will not have to pay the *punishment_fee* because his falsely stated quality will not be revealed. In this first case, seller f_t makes the same expected profits as if he did not apply at all and, in addition, has to pay the *application_fee* > 0.

If the condition of either the second or the third indicator function is true, seller f_t has to pay the *application_fee*, and his product model will be tested. After f_t's product model is tested, f_t has to pay the *punishment_fee* because his falsely stated product quality will have been revealed. Note that we do not include the *punishment_fee* in the above equation because f_t's product model has not yet been tested. Once f_t's product model has been tested, it may be either locally non-dominated or locally dominated in K'.

Let us now analyze whether, and if so, under which circumstances, the condition of the second indicator function in the previous equation can be true. To begin, it can only be true if none of f_t's rivals are in K'. This, in turn, can only be true if none of f_t's rivals are among $ND_{\left\{K_{true} \cup \left\{f_o^{false} | f_o \in \{K_{false} \setminus K'_i\}\right\} \cup K'_i\right\}}$ $\forall i \in \left\{1, \ldots, \min\left\{\arg\min_{l \in \{1,\ldots,\#K\}}\{l \,|\{K'_l \cap K_{false}\} = \emptyset\}, \#K\right\}\right\}$ since we assume the testing organization will test non-tested product models in $ND_{\left\{K_{true} \cup \left\{f_o^{false} | f_o \in \{K_{false} \setminus K'_i\}\right\} \cup K'_i\right\}}$ $\forall i \in \left\{1, \ldots, \min\left\{\arg\min_{l \in \{1,\ldots,\#K\}}\{l \,|\{K'_l \cap K_{false}\} = \emptyset\}, \#K\right\}\right\}$ as long as there are still non-tested product models in $ND_{\left\{K_{true} \cup \left\{f_o^{false} | f_o \in \{K_{false} \setminus K'_i\}\right\} \cup K'_i\right\}}$ remaining. Therefore, the condition of the second indicator function can only be true if

$$\left\{R_t \cap ND_{\left\{K_{true} \cup \left\{f_o^{false} | f_o \in \{K_{false} \setminus K'_i\}\right\} \cup K'_i\right\}}\right\} = \emptyset$$

$\forall i \in \left\{1, \ldots, \min\left\{\arg\min_{l \in \{1,\ldots,\#K\}}\{l \,|\{K'_l \cap K_{false}\} = \emptyset\}\right\}\right\}$. This, in turn, can only be true if either $\left\{R_t \cap \left\{K_{true} \cup \left\{f_o^{false} | f_o \in \{K_{false} \setminus K'_i\}\right\} \cup K'_i\right\}\right\} \subseteq D_{\left\{K_{true} \cup \left\{f_o^{false} | f_o \in \{K_{false} \setminus K'_i\}\right\} \cup K'_i\right\}}$, or $\left\{R_t \cap \left\{K_{true} \cup \left\{f_o^{false} | f_o \in \{K_{false} \setminus K'_i\}\right\} \cup K'_i\right\}\right\} = \emptyset$ $\forall i \in \left\{1, \ldots, \min\left\{\arg\min_{l \in \{1,\ldots,\#K\}}\{l \,|\{K'_l \cap K_{false}\} = \emptyset\}\right\}\right\}$. The first case cannot be true according to lemma 5 (Relationship between local dominance and composition of a set of rivals) with $Q = K_{true} \cup \left\{f_o^{false} | f_o \in \{K_{false} \setminus K'_i\}\right\} \cup K'_i$. It follows that the condition of the second indicator function can only be true if, and only if, none of f_t's rivals apply to be tested, meaning $\{R_t \cap K\} = \emptyset$. If none of f_t's rivals apply to be tested and f_t applies with q_t^{false}, he will have to pay the *punishment_fee* > 0, but will make the same expected profits had he applied stating his true quality. Since, if no rivals apply, $\exists j \in \left\{1, \ldots, \min\left\{\arg\min_{l \in \{1,\ldots,\#K\}}\{l \,|\{K'_l \cap K_{false}\}\right\}\right.$ such that f_t is locally non-dominated in K and is tested. Seller f_t is then revealed to be locally non-dominated in K'.

If the condition of the third indicator function were true, no buyer would buy f_t's product model because it would be revealed to be locally dominated among all tested product models. It follows that

$$
\begin{aligned}
=&\mathbb{1}_{\left\{f_t\in\{\sigma(F)\setminus K\}\right\}}\left(\mathbb{E}\big(\pi_t(q_t,p_t)\big)\Big[f_t\in\{\sigma(F)\setminus K\}\Big]-\textit{application\_fee}\right)\\
&+\mathbb{1}_{\left\{f_t\in\{D\cap K_{\textit{true}}\}\right\}}\\
&\quad\times\left(\mathbb{E}\big(\pi_t(q_t,p_t)\big)\,[f_t\in\{D\cap K_{\textit{true}}\}]-\textit{application\_fee}-\textit{punishment\_fee}\right)\\
&+\mathbb{1}_{\left\{\left\{\exists j\in\left\{1,\dots,\min\left\{\arg\min_{l\in\{1,\dots,\#K\}}\left\{l\,|\{K_l'\cap K_{\textit{false}}\}=\emptyset\right\},\#K\right\}\right\}\Big|\; f_t^{\textit{false}}\in ND_{\left\{K_{\textit{true}}\cup\left\{f_o^{\textit{false}}|f_o\in\{K_{\textit{false}}\setminus K_j'\}\right\}\cup K_j'\right\}}\right\}\cap\left\{f_t\in D_{K'}\right\}\right\}}\\
&\quad\times\left(-\textit{application\_fee}-\textit{punishment\_fee}\right).
\end{aligned}
$$

Since *application_fee* > 0 and *punishment_fee* > 0, it follows that

$$
\begin{aligned}
<&\mathbb{1}_{\left\{f_t\in\left\{\sigma(F)\setminus K\right\}\right\}}\left(\mathbb{E}\big(\pi_t(q_t,p_t)\big)\big[f_t\in\{\sigma(F)\setminus K\}\big]\right)\\
&+\mathbb{1}_{\left\{f_t\in\{D\cap K_{\textit{true}}\}\right\}}\left(\mathbb{E}\big(\pi_t(q_t,p_t)\big)\big[f_t\in\{D\cap K_{\textit{true}}\}\big]-\textit{application\_fee}\right)\\
&+\mathbb{1}_{\left\{\left\{\exists j\in\left\{1,\dots,\min\left\{\arg\min_{l\in\{1,\dots,\#K\}}\left\{l\,|\{K_l'\cap K_{\textit{false}}\}=\emptyset\right\},\#K\right\}\right\}\Big|\; f_t^{\textit{false}}\in ND_{\left\{K_{\textit{true}}\cup\left\{f_o^{\textit{false}}|f_o\in\{K_{\textit{false}}\setminus K_j'\}\right\}\cup K_j'\right\}}\right\}\cap\left\{f_t\in D_{K'}\right\}\right\}}\\
&\quad\times\left(-\textit{application\_fee}\right)\\
\leqslant&\mathbb{1}_{\left\{f_t\in\left\{\sigma(F)\setminus K\right\}\right\}}\left(\mathbb{E}\big(\pi_t(q_t,p_t)\big)\big[f_t\in\{\sigma(F)\setminus K\}\big]\right)\\
&+\mathbb{1}_{\left\{f_t\in\{D\cap K_{\textit{true}}\}\right\}}\left(\mathbb{E}\big(\pi_t(q_t,p_t)\big)\,[f_t\in\{D\cap K_{\textit{true}}\}]-\textit{application\_fee}\right).
\end{aligned}
$$

The above equals f_t's profit when not applying with $q_t^{\textit{false}}$, i.e., when not applying at all, or when applying with q_t. It follows that, for seller $f_t \in D$, applying to be tested stating a false product quality $q_t^{\textit{false}}$ is a strictly dominated strategy.

Having analyzed a globally dominated seller's incentives to apply with $q_t^{\textit{false}}$ above, let us now continue with $f_t \in \{ND \cap K_{\textit{false}}\}$, and let him apply to be tested with $q_t^{\textit{false}}$. Since $\left\{K_{\textit{true}} \cup \{f_o^{\textit{false}} | f_o \in K_{\textit{false}}\}\right\} = ND_{\left\{K_{\textit{true}}\cup\{f_o^{\textit{false}}|f_o\in K_{\textit{false}}\}\right\}} \cup$

$D_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}$, we can separate expected profits after applying with a falsely stated quality into two disjoint cases. The first (second) summand represents the case where seller f_t^{false} is locally dominated (locally non-dominated) within the set of applicants. It follows that

$$
\begin{aligned}
&\mathbb{E}\big(\pi_t(q_t, p_t)\big)\left[f_t \in \{ND \cap K_{false}\}\right] \\
=&\mathbb{1}_{\left\{f_t^{false} \in D_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}\right\}} \\
&\quad \times \left(\mathbb{E}\big(\pi_t(q_t, p_t)\big)\left[f_t^{false} \in D_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}\right] - \mathit{application\_fee}\right) \\
&+ \mathbb{1}_{\left\{f_t^{false} \in ND_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}\right\}} \\
&\quad \times \left(\mathbb{E}\big(\pi_t(q_t, p_t)\big)\left[f_t^{false} \in ND_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}\right] - \mathit{application\_fee}\right) \\
=&\mathbb{1}_{\left\{\left\{f_t^{false} \in D_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}\right\} \cap \left\{\{K_1' \cap K_{false}\} = \emptyset\right\}\right\}} \\
&\quad \times \left(\mathbb{E}\big(\pi_t(q_t, p_t)\big)\left[\left\{f_t^{false} \in D_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}\right\} \cap \left\{\left\{K_1' \cap K_{false}\right\} = \emptyset\right\}\right] - \mathit{application\_fee}\right) \\
&+ \mathbb{1}_{\left\{\left\{f_t^{false} \in D_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}\right\} \cap \left\{\{K_1' \cap K_{false}\} \neq \emptyset\right\}\right\}} \\
&\quad \times \left(\mathbb{E}\big(\pi_t(q_t, p_t)\big)\left[\left\{f_t^{false} \in D_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}\right\} \cap \left\{\left\{K_1' \cap K_{false}\right\} \neq \emptyset\right\}\right] - \mathit{application\_fee}\right) \\
&+ \mathbb{1}_{\left\{\left\{f_t^{false} \in ND_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}\right\} \cap \left\{f_t \in ND_{K_1'}\right\}\right\}} \\
&\quad \times \left(\mathbb{E}\big(\pi_t(q_t, p_t)\big)\left[\left\{f_t^{false} \in ND_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}\right\} \cap \left\{f_t \in ND_{K_1'}\right\}\right] - \mathit{application\_fee}\right) \\
=&\mathbb{1}_{\left\{\left\{f_t^{false} \in D_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}\right\} \cap \left\{\left\{K_1' \cap K_{false}\right\} = \emptyset\right\}\right\}} \\
&\quad \times \Bigg(\mathbb{E}\big(\pi_t(q_t, p_t)\big)\left[\left\{f_t^{false} \in D_{\left\{K_{true} \cup \{f_o^{false} | f_o \in K_{false}\}\right\}}\right\} \cap \left\{\left\{K_1' \cap K_{false}\right\} = \emptyset\right\}\right] \\
&\qquad - \mathit{application\_fee}\Bigg)
\end{aligned}
$$

$$
\begin{aligned}
&+\mathbb{1}_{\left\{\left\{f_t^{false}\in D_{\left\{K_{true}\cup\{f_o^{false}|f_o\in K_{false}\}\right\}}\right\}\cap\left\{\left\{K_1'\cap K_{false}\right\}\neq\emptyset\right\}\cap\left\{f_t^{false}\in D_{\left\{K_{true}\cup\left\{f_o^{false}|f_o\in\{K_{false}\setminus K_1'\}\right\}\cup K_1'\right\}}\right\}\right\}}\\
&\quad\times\Bigg(\mathbb{E}\big(\pi_t(q_t,p_t)\big)\Bigg[\left\{f_t^{false}\in D_{\left\{K_{true}\cup\{f_o^{false}|f_o\in K_{false}\}\right\}}\right\}\cap\left\{\left\{K_1'\cap K_{false}\right\}\neq\emptyset\right\}\cap\\
&\qquad\left\{f_t^{false}\in D_{\left\{K_{true}\cup\left\{f_o^{false}|f_o\in\{K_{false}\setminus K_1'\}\right\}\cup K_1'\right\}}\right\}\Bigg]-\mathit{application\_fee}\Bigg)\\
&+\mathbb{1}_{\left\{\left\{f_t^{false}\in D_{\left\{K_{true}\cup\{f_o^{false}|f_o\in K_{false}\}\right\}}\right\}\cap\left\{\left\{K_1'\cap K_{false}\right\}\neq\emptyset\right\}\cap\left\{f_t^{false}\in ND_{\left\{K_{true}\cup\left\{f_o^{false}|f_o\in\{K_{false}\setminus K_1'\}\right\}\cup K_1'\right\}}\right\}\right\}}\\
&\quad\times\Bigg(\mathbb{E}\big(\pi_t(q_t,p_t)\big)\Bigg[\left\{f_t^{false}\in D_{\left\{K_{true}\cup\{f_o^{false}|f_o\in K_{false}\}\right\}}\right\}\cap\left\{\left\{K_1'\cap K_{false}\right\}\neq\emptyset\right\}\cap\\
&\qquad\left\{f_t^{false}\in ND_{\left\{K_{true}\cup\left\{f_o^{false}|f_o\in\{K_{false}\setminus K_1'\}\right\}\cup K_1'\right\}}\right\}\Bigg]-\mathit{application\_fee}\Bigg)\\
&+\mathbb{1}_{\left\{\left\{f_t^{false}\in ND_{\left\{K_{true}\cup\{f_o^{false}|f_o\in K_{false}\}\right\}}\right\}\cap\left\{f_t\in ND_{K'}\right\}\right\}}\\
&\quad\times\Bigg(\mathbb{E}\big(\pi_t(q_t,p_t)\big)\Bigg[\left\{f_t^{false}\in ND_{\left\{K_{true}\cup\{f_o^{false}|f_o\in K_{false}\}\right\}}\right\}\cap\left\{f_t\in ND_{K'}\right\}\Bigg]-\mathit{application\_fee}\Bigg)
\end{aligned}
$$

From this point on, the next iteration of the algorithm would start again if applicable, analogously to shown above. Note that each iteration works analogously since the product testing organization is assumed to test all remaining non-tested product models after each iteration $i\in\left\{1,\dots,\min\left\{\arg\min_{l\in\{1,\dots,\#K\}}\{l\,|\{K_l'\cap K_{false}\}=\emptyset\},\#K\right\}\right\}$ until there are no more promising non-tested product models remaining, i.e. if $\left\{ND_{\left\{K_{true}\cup\left\{f_o^{false}|f_o\in\{K_{false}\setminus K_i'\}\right\}\cup K_i'\right\}}\right\}=\emptyset$. Therefore, we omit the following up to $\left(\min\left\{\arg\min_{l\in\{1,\dots,\#K\}}\{l\,|\{K_l'\cap K_{false}\}=\emptyset\},\#K\right\}-1\right)$ iterations since $K_1'\subseteq K_2'\subseteq\ldots\subseteq K'_{\arg\min_{l\in\{1,\dots,\#K\}}\left\{l|\left\{K_l'\cap K_{false}\right\}=\emptyset\right\}}=K'$. It follows that

$$
\begin{aligned}
=&\mathbb{1}_{\left\{\forall i\in\left\{1,\dots,\min\left\{\arg\min_{l\in\{1,\dots,\#K\}}\{l\,|\{K_l'\cap K_{false}\}=\emptyset\},\#K\right\}\right\}|f_t^{false}\in D_{\left\{K_{true}\cup\left\{f_o^{false}|f_o\in\{K_{false}\setminus K_i'\}\right\}\cup K_i'\right\}}\right\}}\\
&\quad\times\Bigg(\mathbb{E}\big(\pi_t(q_t,p_t)\big)\Bigg[\forall i\in\left\{1,\dots,\min\left\{\arg\min_{l\in\{1,\dots,\#K\}}\{l\,|\{K_l'\cap K_{false}\}=\emptyset\},\#K\right\}\right\}\Bigg|
\end{aligned}
$$

$$f_t^{\mathit{false}} \in D_{\left\{K_{\mathit{true}} \cup \left\{f_o^{\mathit{false}} | f_o \in \{K_{\mathit{false}} \setminus K_i'\}\right\} \cup K_i'\right\}}\Bigg] - \mathit{application\_fee}\Bigg)$$

$$+ \mathbb{1}_{\left\{\left\{\exists j \in \left\{1,\ldots,\min\left\{\arg\min_{l\in\{1,\ldots,\#K\}}\left\{l \,|\{K_l' \cap K_{\mathit{false}}\} = \emptyset\right\},\#K\right\}\right\}\middle| f_t^{\mathit{false}} \in ND_{\left\{K_{\mathit{true}} \cup \left\{f_o^{\mathit{false}}|f_o \in \{K_{\mathit{false}} \setminus K_j'\}\right\} \cup K_j'\right\}}\right\} \cap \left\{f_t \in ND_{K'}\right\}\right\}}$$

$$\times \Bigg(\mathbb{E}(\pi_t(q_t, p_t)) \Bigg[\Bigg\{\exists j \in \left\{1,\ldots,\min\left\{\arg\min_{l\in\{1,\ldots,\#K\}}\left\{l \,|\{K_l' \cap K_{\mathit{false}}\} = \emptyset\right\},\#K\right\}\right\}\Bigg|$$

$$f_t^{\mathit{false}} \in ND_{\left\{K_{\mathit{true}} \cup \left\{f_o^{\mathit{false}}|f_o \in \{K_{\mathit{false}} \setminus K_j'\}\right\} \cup K_j'\right\}}\Bigg\} \cap \left\{f_t \in ND_{K'}\right\}\Bigg] - \mathit{application\_fee}\Bigg)$$

If the condition of the first indicator function is true, f_t makes the same profits compared to not applying, but has to pay the *application_fee*. If the condition of the second indicator function is true, f_t's product model must be locally non-dominated in K' (see lemma 2: Properties of locally *non*-dominated product models within *sub*markets) since we assume the testing organization will test non-tested product models in $ND_{\left\{K_{\mathit{true}} \cup \left\{f_o^{\mathit{false}}|f_o \in \{K_{\mathit{false}} \setminus K_i'\}\right\} \cup K_i'\right\}}$ $\forall i \in \left\{1,\ldots,\min\left\{\arg\min_{l\in\{1,\ldots,\#K\}}\left\{l \,|\{K_l' \cap K_{\mathit{false}}\} = \emptyset\right\},\#K\right\}\right\}$ as long as there are still non-tested product models in $ND_{\left\{K_{\mathit{true}} \cup \left\{f_o^{\mathit{false}}|f_o \in \{K_{\mathit{false}} \setminus K_i'\}\right\} \cup K_i'\right\}}$ remaining. It follows that

$$= \mathbb{1}_{\left\{f_t \in \{\sigma(F) \setminus K\}\right\}}\Big(\mathbb{E}(\pi_t(q_t, p_t))\left[f_t \in \{\sigma(F) \setminus K\}\right] - \mathit{application\_fee}\Big)$$

$$+ \mathbb{1}_{\left\{\left\{f_t \in ND_{K'}\right\} \cap \left\{\exists j \in \left\{1,\ldots,\min\left\{\arg\min_{l\in\{1,\ldots,\#K\}}\left\{l \,|\{K_l' \cap K_{\mathit{false}}\} = \emptyset\right\},\#K\right\}\right\}\middle| f_t^{\mathit{false}} \in ND_{\left\{K_{\mathit{true}} \cup \left\{f_o^{\mathit{false}}|f_o \in \{K_{\mathit{false}} \setminus K_j'\}\right\} \cup K_j'\right\}}\right\}\right\}}$$

$$\times \Bigg(\mathbb{E}(\pi_t(q_t, p_t)) \Bigg[\left\{f_t \in ND_{K'}\right\} \cap \Bigg\{\exists j \in \left\{1,\ldots,\min\left\{\arg\min_{l\in\{1,\ldots,\#K\}}\left\{l \,|\{K_l' \cap K_{\mathit{false}}\} = \emptyset\right\},\#K\right\}\right\}\Bigg|$$

$$f_t^{\mathit{false}} \in ND_{\left\{K_{\mathit{true}} \cup \left\{f_o^{\mathit{false}}|f_o \in \{K_{\mathit{false}} \setminus K_j'\}\right\} \cup K_j'\right\}}\Bigg\}\Bigg] - \mathit{application\_fee}\Bigg).$$

According to lemma 2 (Properties of locally *non*-dominated product models within *sub*markets), a globally non-dominated seller applying with q_t will also be locally non-dominated in K. Since we assume the testing organization will test non-tested product models in $ND_{\left\{K_{\mathit{true}} \cup \left\{f_o^{\mathit{false}}|f_o \in \{K_{\mathit{false}} \setminus K_i'\}\right\} \cup K_i'\right\}}$ $\forall i \in$

$\left\{1,\ldots,\min\left\{\arg\min_{l\in\{1,\ldots,\#K\}}\{l\,|\{K_l'\cap K_{false}\}=\emptyset\},\#K\right\}\right\}$ as long as there are still non-tested product models in $ND_{\left\{K_{true}\cup\left\{f_o^{false}|f_o\in\{K_{false}\setminus K_i'\}\right\}\cup K_i'\right\}}$ remaining, it follows that f_t's product model will be tested. Furthermore, it will also be locally non-dominated in K' (again, see lemma 2). It follows that

$$
\begin{aligned}
&= \mathbb{1}_{\left\{f_t\in\{\sigma(F)\setminus K\}\right\}}\Big(\mathbb{E}\big(\pi_t(q_t,p_t)\big)\left[f_t\in\{\sigma(F)\setminus K\}\right]-\mathit{application\_fee}\Big)\\
&\quad+\mathbb{1}_{\left\{f_t\in\left\{ND\cap K_{true}\right\}\right\}}\left(\mathbb{E}\big(\pi_t(q_t,p_t)\big)\left[f_t\in\left\{ND\cap K_{true}\right\}\right]-\mathit{application\_fee}-\mathit{punishment\_fee}\right)\\
&< \mathbb{1}_{\left\{f_t\in\{\sigma(F)\setminus K\}\right\}}\left(\mathbb{E}\big(\pi_t(q_t,p_t)\big)\left[f_t\in\{\sigma(F)\setminus K\}\right]\right)\\
&\quad+\mathbb{1}_{\left\{f_t\in\left\{ND\cap K_{true}\right\}\right\}}\left(\mathbb{E}\big(\pi_t(q_t,p_t)\big)\left[f_t\in\left\{ND\cap K_{true}\right\}\right]-\mathit{application\_fee}\right).
\end{aligned}
$$

The above equals f_t's expected profits when applying with q_t. It follows that, for every seller $f_t\in ND$, applying to be tested stating a false product quality q_t^{false} is also a strictly dominated strategy. □

Lemma 10 (Applying to be tested stating the true product quality)**.** *Let $(\hat{s}_1,\ldots,\hat{s}_{t-1},\hat{s}_{t+1},\ldots,\hat{s}_n)^T$ be an arbitrary, but fixed, strategy vector of all sellers in $\{\sigma(F)\setminus f_t\}$. For seller $f_t\in\sigma(F)$, applying to be tested stating his true quality q_t is a strictly dominant strategy $\longleftrightarrow$ $(p_t-c(q_t))\Delta_t\mathbb{E}\big(d(q_t,p_t)\big)>\mathit{application\_fee}$.*

Proof of lemma 10 (Applying to be tested stating the true product quality). According to lemma 9 (Applying to be tested stating a false product quality), applying with a false quality q_t^{false} is a strictly dominated strategy for all sellers. Therefore, we compare the two remaining strategies with each other. For seller $f_t\in\sigma(F)$, applying to be tested stating his true quality q_t is a strictly dominant strategy

$$
\begin{aligned}
&\longleftrightarrow \mathbb{E}\big(\pi_t(q_t,p_t)\big)\left[f_t\in K\right]-\mathit{application\_fee}>\mathbb{E}\big(\pi_t(q_t,p_t)\big)\left[f_t\in\{\sigma(F)\setminus K\}\right]\\
&\longleftrightarrow (p_t-c(q_t))\mathbb{E}\big(d(q_t,p_t)\big)\left[f_t\in K\right]-\mathit{application\_fee}\\
&\qquad>(p_t-c(q_t))\mathbb{E}\big(d(q_t,p_t)\big)\left[f_t\in\{\sigma(F)\setminus K\}\right]\\
&\longleftrightarrow (p_t-c(q_t))\mathbb{E}\big(d(q_t,p_t)\big)\left[f_t\in K\right]-(p_t-c(q_t))\mathbb{E}\big(d(q_t,p_t)\big)\left[f_t\in\{\sigma(F)\setminus K\}\right]\\
&\qquad>\mathit{application\_fee}\\
&\longleftrightarrow (p_t-c(q_t))\Delta_t\mathbb{E}\big(d(q_t,p_t)\big)>\mathit{application\_fee}.
\end{aligned}
$$

□

Proof of proposition 2 (Unique Nash equilibrium). According to lemma 9 (Applying to be tested stating a false product quality), applying with a q_t^{false} is a strictly dominated strategy for all sellers. Furthermore, according to lemma 10 (Applying to be tested stating the true product quality), applying to be tested with q_t is a strictly dominant strategy for every globally non-dominated seller f_t fulfilling the application criterion, $\big(p_t - c(q_t)\big)\Delta_t \mathbb{E}\big(d(q_t, p_t)\big) > \mathit{application\_fee}$. For sellers not fulfilling this criterion, not applying to be tested is a strictly dominant strategy. In particular, globally dominated sellers will not apply to be tested because we assume the applicant pool will contain a critical set of globally non-dominated sellers, and because $\mathit{application\_fee} > 0$.

According to lemma 2 (Properties of locally *non*-dominated product models within *sub*markets), the globally non-dominated sellers in ND_{apply} are also locally non-dominated in $K = K_{\mathit{true}}$, meaning $ND_{\mathit{apply}} = ND_K$. Since we assume the testing organization will test non-tested product models in $ND_{\left\{K_{\mathit{true}} \cup \left\{f_o^{\mathit{false}} | f_o \in \{K_{\mathit{false}} \setminus K_i'\}\right\} \cup K_i'\right\}} = ND_{K_{\mathit{true}}}$ $\forall i \in \left\{1, \ldots, \min\left\{\arg\min_{l \in \{1,\ldots,\#K\}}\left\{l \,|\{K_l' \cap K_{\mathit{false}}\} = \emptyset\right\}, \#K\right\}\right\}$ as long as there are still non-tested product models in $ND_{K_{\mathit{true}}}$ remaining, i.e. until $\left\{ND_{\left\{K_{\mathit{true}} \cup \left\{f_o^{\mathit{false}} | f_o \in \{K_{\mathit{false}} \setminus K_i'\}\right\} \cup K_i'\right\}}\right\} = \emptyset$, it follows that $K' = ND_{\mathit{apply}}$. Thus, it follows that only globally non-dominated product models are tested since $ND_{\mathit{apply}} \subseteq ND$.

Buyers maximize their expected utility choosing among all product models whose quality has been revealed, i.e. ND_{apply}, not taking non-tested product models into account since they are assumed to know that $ND_{\mathit{apply}} = \overline{ND}$. Therefore, every buyer has a strictly dominant strategy. To conclude, since all players have a strictly dominant strategy, the Nash equilibrium is unique. □

Proof of proposition 3 (Expected consumer surplus and seller profits under SellersApply*).* The consumer surplus equals

$$\sum_{h=1}^{s} \theta_h q^h_{\widetilde{\{\sigma(F) \cup f_0\}}} - p^h_{\widetilde{\{\sigma(F) \cup f_0\}}} = \sum_{h=1}^{s} \theta_h q^h_{\widetilde{\left\{ND_{K'} \cup f_{\{\sigma(F) \setminus K'\}^c} \cup f_0\right\}}} - p^h_{\widetilde{\left\{ND_{K'} \cup f_{\{\sigma(F) \setminus K'\}^c} \cup f_0\right\}}}.$$

According to proposition 2 (Unique Nash equilibrium), only globally non-dominated sellers apply in equilibrium (not necessarily all globally non-dominated sellers). According to lemma 2 (Properties of locally *non*-dominated product models within *sub*markets), all of these sellers are also locally non-dominated in the subset K and in the subset K'. Thus, it follows that $D_{K'} = \emptyset$. Furthermore, it follows that

$$= \sum_{h=1}^{s} \theta_h q^h_{\widetilde{\left\{K' \cup f_{\{\sigma(F) \setminus K'\}^c} \cup f_0\right\}}} - p^h_{\widetilde{\left\{K' \cup f_{\{\sigma(F) \setminus K'\}^c} \cup f_0\right\}}}.$$

Since we assume the testing organization will test non-tested product models in $ND_{\left\{K_{\mathit{true}} \cup \left\{f_o^{\mathit{false}} | f_o \in \{K_{\mathit{false}} \setminus K_i'\}\right\} \cup K_i'\right\}}$ $\forall i \in \Big\{1, \ldots, \min\Big\{\arg\min_{l \in \{1,\ldots,\#K\}}\Big\{l \,|\{K_l' \cap$

$K_{false}\} = \emptyset\Big\}, \#K\Big\}\Bigg\}$ as long as there are still non-tested product models in $ND_{\left\{K_{true} \cup \left\{f_o^{false} | f_o \in \{K_{false} \setminus K_i'\}\right\} \cup K_i'\right\}}$ remaining, and since, in equilibrium (again, see lemma 2), sellers that do apply state their true quality, it follows that $K' = ND_K$. Furthermore, according to proposition 2 (Unique Nash equilibrium), only globally non-dominated sellers apply in equilibrium. According to lemma 2 (Properties of locally *non*-dominated product models within *sub*markets), these sellers are also locally non-dominated in K, i.e., $ND_K = K$. It follows that

$$= \sum_{h=1}^{s} \theta_h q^h_{\left\{K \cup f_{\{\sigma(F) \setminus K'\}^c} \cup f_0\right\}} - p^h_{\left\{K \cup f_{\{\sigma(F) \setminus K'\}^c} \cup f_0\right\}}.$$

According to lemma 2, K consists of only globally non-dominated sellers in ND_{apply} in equilibrium. (Note that we would be able to exchange the term $f_l \in \left\{\sigma(F) \setminus K'\right\}$ with $f_l \in \left\{\sigma(F) \setminus K\right\}$ at this point. However, we will keep the current version in order to be able to compare it with BESTSELLERS below.) It follows that

$$= \sum_{h=1}^{s} \theta_h q^h_{\left\{ND_{apply} \cup f_{\{\sigma(F) \setminus K'\}^c} \cup f_0\right\}} - p^h_{\left\{ND_{apply} \cup f_{\{\sigma(F) \setminus K'\}^c} \cup f_0\right\}}.$$

Using the assumptions that, first, $ND_{apply} = \overline{ND}$, second, all buyers know that $\big(p_t - c(q_t)\big)\Delta_t \mathbb{E}\big(d(q_t, p_t)\big) >$ *application_fee* holds for all globally non-dominated sellers $f_t \in \overline{ND}$, and third, the testing organization tests non-tested product models in $ND_{\left\{K_{true} \cup \left\{f_o^{false} | f_o \in \{K_{false} \setminus K_i'\}\right\} \cup K_i'\right\}}$ $\forall i \in \Bigg\{1, \ldots, \min\Big\{\arg\min_{l \in \{1,\ldots,\#K\}}\Big\{l \,|\{K_l' \cap K_{false}\} = \emptyset\Big\}, \#K\Big\}\Bigg\}$ as long as there are still non-tested product models in $ND_{\left\{K_{true} \cup \left\{f_o^{false} | f_o \in \{K_{false} \setminus K_i'\}\right\} \cup K_i'\right\}}$ remaining, it follows that buyers know that all globally non-dominated product models they would have bought under complete information are among the tested product models. Therefore, buyers also know that all non-tested product models are either globally dominated, or globally non-dominated, but would not be bought under complete information, and thus cannot maximize their utility. It follows that

$$= \sum_{h=1}^{s} \theta_h q^h_{\{\overline{ND} \cup f_0\}^*} - p^h_{\{\overline{ND} \cup f_0\}^*}.$$

This equals the consumer surplus that would occur if all product models in the market would have been tested since, in this case, the buyer would also choose one of the globally non-dominated product models (see equation 4 in subsection 2.2.1).

The expected surplus of globally dominated sellers equals, in general,

$$\sum_{t=m+1}^{n}\sum_{h=1}^{s}\frac{\mathbb{1}_{\left\{f_t=f^h_{\widetilde{\left\{ND_{apply}\cup f_{\{\sigma(F)\setminus K'\}^c}\cup f_0\right\}}}\right\}}\Big(p_t-c\big(q_t\big)\Big)}{\#\Big\{f_j\in\sigma(F)|\mathbb{E}\big(u_h(\theta_h,q_j,p_j)\big)=\mathbb{E}\big(u_h(\theta_h,q_t,p_t)\big)\Big\}}.$$

Note that the condition of the indicator function is true for a globally dominated seller f_t only if his product model is the cheapest product model among the non-tested ones since it cannot fulfil the application criterion, i.e., if $\big(p_t - c(q_t)\big)\Delta_t\mathbb{E}\big(d(q_t,p_t)\big) \leqslant$ *application_fee*. It follows that

$$=\sum_{t=m+1}^{n}\sum_{h=1}^{s}\frac{\mathbb{1}_{\left\{\left\{f_t=f_{\{\sigma(F)\setminus K'\}^c}\right\}\cap\left\{0\leqslant\theta_h q^h_{ND^*_{apply}}-p^h_{ND^*_{apply}}\leqslant\theta_h\mathbb{E}(q_t)-p_t\right\}\right\}}\Big(p_t-c\big(q_t\big)\Big)}{\#\Big\{f_j\in\sigma(F)|\mathbb{E}\big(u_h(\theta_h,q_j,p_j)\big)=\mathbb{E}\big(u_h(\theta_h,q_t,p_t)\big)\Big\}}.$$

If, in turn, we assume $ND_{apply}=\overline{ND}$, the expected surplus equals zero since buyers know that the cheapest, non-tested product model is either a globally dominated product model, or a globally non-dominated product model, that no buyer would select under complete information. Therefore, its demand equals zero. The expected surplus of globally non-dominated sellers equals

$$\sum_{t=1}^{m}\sum_{h=1}^{s}\frac{\mathbb{1}_{\left\{f_t=f^h_{\widetilde{\left\{ND_{apply}\cup f_{\{\sigma(F)\setminus K'\}^c}\cup f_0\right\}}}\right\}}\Big(p_t-c\big(q_t\big)\Big)}{\#\Big\{f_j\in\sigma(F)|\mathbb{E}\big(u_h(\theta_h,q_j,p_j)\big)=\mathbb{E}\big(u_h(\theta_h,q_t,p_t)\big)\Big\}}.$$

If, in turn, we assume $ND_{apply}=\overline{ND}$, the expected surplus equals, in general

$$\sum_{t=1}^{m}\sum_{h=1}^{s}\frac{\mathbb{1}_{\left\{f_t=f^h_{\{\overline{ND}\cup f_0\}^*}\right\}}\Big(p_t-c\big(q_t\big)\Big)}{\#\Big\{f_j\in\sigma(F)|\mathbb{E}\big(u_h(\theta_h,q_j,p_j)\big)=\mathbb{E}\big(u_h(\theta_h,q_t,p_t)\big)\Big\}}.$$

□

Proof of proposition 4 (Comparing consumer surplus resulting from BESTSELLERS *and from* SELLERSAPPLY*).* Here, we require capacity-neutrality, i.e., the product testing organization uses the same number of testing slots under SELLERSAPPLY as under BESTSELLERS. According to proposition 1, BESTSELLERS leads to a lower consumer surplus than a world of complete information for all but two possible combinations consisting of product models which are bestsellers. In those two exceptions, BESTSELLERS leads to the same consumer surplus as a world of complete information. According to proposition 3, SELLERSAPPLY always leads to the optimal consumer surplus of a world of complete information. It follows that, for all but two possible combinations consisting of product models which are bestsellers, SELLERSAPPLY outperforms BESTSELLERS by leading to a higher consumer surplus. In the two exceptions stated in proposition 1, both SELLERSAPPLY and BESTSELLERS lead to the same, optimal consumer surplus. □

C.2 Counter-examples of section 2

Counter-example 1. *Consider the following local market:* $Q' = \{f_1, f_2, f_3\} = \{f_1, f_2\} \cup \{f_3\} = ND_{Q'} \cup D_{Q'}$ *with*
$q_1 = 2$, $p_1 = 5$,
$q_2 = 3$, $p_2 = 10$,
$q_3 = 2$, $p_3 = 6$.
Seller f_3*'s product model is locally dominated in* Q' *because of his rival* f_1*. However, it is no longer locally dominated in the absence of seller* f_1*. Instead, it is locally non-dominated in* $Q = Q' \setminus \{f_1\} = \{f_2, f_3\}$*, meaning that* $f_3 \in ND_Q$*.*

Counter-example 2. *Consider the following local market (the same as in counter-example 1):* $Q' = \{f_1, f_2, f_3\} = \{f_1, f_2\} \cup \{f_3\} = ND_{Q'} \cup D_{Q'}$ *with*
$q_1 = 2$, $p_1 = 5$,
$q_2 = 3$, $p_2 = 10$,
$q_3 = 2$, $p_3 = 6$.
While seller f_3*'s product model is locally non-dominated in* $Q = \{f_2, f_3\}$*, it is no longer non-dominated in* Q'*.*

C.3 Formal algorithm description of subsection 2.2.3

We first partition the set of applicants K into two subsets: $K_{true} := \left\{f_j \in K \middle| \textit{stating } q_j = q_j^{true}\right\}$, the set of applicants who state a true product model quality, and $K_{false} := \left\{f_j \in K \middle| \textit{stating } q_j = q_j^{false}\right\}$, the set of applicants who state a false product model quality, with $K = K_{true} \cup K_{false}$. We denote a seller f_t's falsely stated quality with $q_t^{false} = q_t + \epsilon$, with $-q_t \leqslant \epsilon \in \mathbb{R}$ and $\epsilon \neq 0$. The variable ϵ indicates the extent to which the falsely stated quality deviates from the true product quality. The vector of features (q_t^{false}, p_t) is associated with the product model of a non-existing seller f_t^{false}. We define K_i' with $i \in \left\{1, \ldots, \arg\min_{l \in \{1,\ldots,\#K\}} \left\{ l \middle| \left\{K_l' \cap K_{false}\right\} = \emptyset \right\} \right\}$ as the set of all tested product models remaining after the algorithm step 3 (see below) has been performed for the i^{th} time. Furthermore, we define

$$K_1' \subseteq K_2' \subseteq \ldots \subseteq K'_{\arg\min_{l \in \{1,\ldots,\#K\}} \left\{ l \middle| \left\{K_l' \cap K_{false}\right\} = \emptyset \right\}} = K'$$

as a sequence of these sets. We define $K_0' := \emptyset$. The algorithm proceeds until either step 3 is reached without detecting a false quality statement or there are no more promising non-tested applicants, i.e. $i \in \Big\{1, \ldots, \min\Big\{\arg\min_{l \in \{1,\ldots,\#K\}}\{l \,|\{K'_l \cap K_{false}\} = \emptyset\}, \#K\Big\}\Big\}$. Note that the algorithm stops after the first iteration if all sellers provide true qualities, i.e., $K = K_{true}$.

Algorithm step 1 Initialize $i = 1$. Among the set of applicants $K \subseteq \sigma(F)$, generate the set $ND_{\left\{K_{true} \cup \left\{f_j^{false} | f_j \in \{K_{false} \setminus K'_{i-1}\}\right\} \cup K'_{i-1}\right\}}$.

Algorithm step 2 Test the product models of sellers in the set $\left\{ND_{\left\{K_{true} \cup \left\{f_j^{false} | f_j \in \{K_{false} \setminus K'_{i-1}\}\right\} \cup K'_{i-1}\right\}} \setminus K'_{i-1}\right\}$, and store the sellers of these product models together with the sellers of the previously tested product models in the set K'_i.

Algorithm step 3 If $\left(\left\{\{K'_i \setminus K'_{i-1}\} \cap K_{false}\right\} = \emptyset\right) \vee \left(i = \#K\right)$, stop, and define $K' = K'_i$. Otherwise, set $i = i + 1$, and return to step 2.

D A simplified version of the product testing game for the experiment

In this section, we analyze a simplified version of the (general) product testing game (see section 2) which provides the basis for our experimental design. In particular, we show that, under certain conditions, it is sufficient for the product testing organization to provide at least as many testing slots as there are quality levels, i.e., $k \geqslant \#quality\,levels$ in order for proposition 2 (Unique Nash equilibrium) to still be true. In the following, we assume all notation, definitions and lemmas introduced in section 2 to be given, and describe only the differences which characterize this simplified version of the game.

Sellers We assume that $\#quality\,levels < \infty$ (general model: $0 \leqslant q_t \in \mathbb{R}$). Furthermore, we assume that there is no pair of sellers offering their product model at the same price, i.e., $\forall f_t, f_s \in \sigma(F)$ with $t \neq s$, we require that $p_t \neq p_s$ (general model: there are no sellers offering the same quality at the same price, i.e., $\forall f_t, f_s \in \sigma(F)$ with $q_t = q_s$ and $t \neq s$, we require that $p_t \neq p_s$).

Product testing organization The product testing organization is assumed to provide at least as many testing slots as there are quality levels, i.e., $k \geqslant \#quality\,levels$. (General model: We assume that the testing organization tests all remaining non-tested product models after each iteration $i \in \Big\{1, \ldots, \min\Big\{\arg\min_{l \in \{1,\ldots,\#K\}}\{l \,|\{K'_l \cap K_{false}\} = \emptyset\}, \#K\Big\}\Big\}$ until there are no more promising non-tested product models remaining, i.e. until $\left\{\mathrm{ND}_{\left\{K_{\mathit{true}} \cup \left\{f_o^{\mathit{false}} | f_o \in \{K_{\mathit{false}} \setminus K_i'\}\right\} \cup K_i'\right\}}\right\} = \emptyset \Big)$.

Moreover, we assume the *punishment_fee* to be strictly higher than the maximal additional profit a globally non-dominated seller could make by applying to be tested stating a false quality given all other sellers' arbitrary, but fixed, strategies, i.e.

$$\begin{aligned}
\max\Big\{ &\mathbb{E}\Big(\pi_t(q_t, p_t) | (\hat{s}_1, \dots, \hat{s}_{t-1}, \hat{s}_{t+1}, \dots, \hat{s}_n)^T\Big)\left[f_t \in K_{\mathit{true}}\right], \\
&\mathbb{E}\Big(\pi_t(q_t, p_t) | (\hat{s}_1, \dots, \hat{s}_{t-1}, \hat{s}_{t+1}, \dots, \hat{s}_n)^T\Big)\left[f_t \in \{\sigma(F) \setminus K\}\right]\Big\} \\
>&\mathbb{E}\Big(\pi_t(q_t, p_t) | (\hat{s}_1, \dots, \hat{s}_{t-1}, \hat{s}_{t+1}, \dots, \hat{s}_n)^T\Big)\left[f_t \in K_{\mathit{false}}\right]
\end{aligned}$$

$\forall f_t \in \mathrm{ND}$ and for all strategy vectors

$$\begin{pmatrix} \hat{s}_1 \\ \vdots \\ \hat{s}_{t-1} \\ \hat{s}_{t+1} \\ \vdots \\ \hat{s}_n \end{pmatrix} \in \left\{ \begin{array}{c} \textit{do not apply, apply with } q_1, \textit{ apply with } q_1^{\mathit{false}} \in \{\mathbb{R} \setminus q_1\} \\ \vdots \\ \textit{do not apply, apply with } q_{t-1}, \textit{ apply with } q_{t-1}^{\mathit{false}} \in \{\mathbb{R} \setminus q_{t-1}\} \\ \textit{do not apply, apply with } q_{t+1}, \textit{ apply with } q_{t+1}^{\mathit{false}} \in \{\mathbb{R} \setminus q_{t+1}\} \\ \vdots \\ \textit{do not apply, apply with } q_n, \textit{ apply with } q_n^{\mathit{false}} \in \{\mathbb{R} \setminus q_n\} \end{array} \right\}$$

(general model: *punishment_fee* > 0).

The product model selection algorithm is identical to the one described in the general model (see subsection 2.2.3), except for one additional sentence (printed in bold below).

Algorithm step 1 Among the set of applicants, select the cheapest product model per stated quality level. If applicable, exclude locally dominated product models.

Algorithm step 2 Test all remaining, non-tested, locally non-dominated product models. This leads to the current set of tested product models. **Should there ever be more product models selected than the number of remaining testing slots, select randomly among these product models.**

Algorithm step 3 If no false quality statements are detected, or if all applicants' product models are tested, stop. Otherwise, combine the set of tested product models (using revealed qualities) with the remaining untested product models, update the set of locally non-dominated product models, and return to step 2.

The first $\#\mathrm{ND}_{apply}$ entries in the following vector in proposition 5 are strategies of sellers having an incentive to apply to be tested stating their true quality. The next $\#\{\mathrm{ND} \setminus \mathrm{ND}_{apply}\}$ entries are strategies of globally non-dominated sellers not having an incentive to apply to be tested. The next $(n-m)$ entries are strategies of globally dominated sellers not having an incentive to apply to be tested. The next $\#B$ entries are strategies of buyers b_1 to b_s choosing the product model that maximizes their expected utility given the tested product models in ND_{apply}, and the cheapest non-tested product model in $\{\sigma(F) \setminus \mathrm{ND}_{apply}\}$.

Proposition 5 (Unique Nash equilibrium pre-determined testing capacity)**.** *Let* $(\hat{s}_1, \ldots, \hat{s}_{t-1}, \hat{s}_{t+1}, \ldots, \hat{s}_n)^T$ *be an arbitrary, but fixed, strategy vector of all sellers in* $\{\sigma(F) \setminus f_t\}$*. Furthermore, we assume* $\exists \mathrm{ND}_{crit} \in \mathrm{ND}_{Crit}$*, with* $\mathrm{ND}_{crit} \subseteq \overline{\mathrm{ND}}$ *and* $\mathrm{ND}_{apply} = \overline{\mathrm{ND}}$*. Since we assume that the testing organization provides at least as many testing slots as there are quality levels, i.e., #quality levels* $\leqslant k < \infty$*, it follows that a unique Nash equilibrium*

$$\Big(\textit{apply with } q_1, \ldots, \textit{apply with } q_{(\#\mathrm{ND}_{apply})}, \textit{do not apply}, \ldots, \textit{do not apply},$$
$$\textit{buy product model of seller } f^1_{\widetilde{\sigma(F)}}, \ldots, \textit{buy product model of seller } f^s_{\widetilde{\sigma(F)}}\Big)^T$$

exists, with $K = \mathrm{ND}_{apply}$ *and* $f^1_{\widetilde{\sigma(F)}}, \ldots, f^s_{\widetilde{\sigma(F)}} \in \Big\{\mathrm{ND}_{apply} \cup f_{\{\sigma(F)\setminus \mathrm{ND}_{apply}\}^c}\Big\}$*. In equilibrium,* $K_{false} = \emptyset$ *and* $K' = \mathrm{ND}_{apply}$*, with each tested product model being globally non-dominated.*

Proof of proposition 5 (Unique Nash equilibrium pre-determined testing capacity). In the following, we analyze whether any, and if so, which sellers may have an incentive to apply to be tested stating a false quality: (1) globally non-dominated sellers, (2.1) a single globally dominated seller, and (2.2) more than one globally dominated seller.

(1) Applying with q_t^{false} is a strictly dominated strategy for $f_t \in \mathrm{ND}$ since we assume the *punishment_fee* to be strictly higher than the maximal additional profit a globally non-dominated seller could make by applying to be tested stating a false quality given all other sellers' arbitrary, but fixed, strategies. It follows that $\{K_{false} \cap \mathrm{ND}\} = \emptyset$.

(2.1) The expected profit of seller $f_t \in D$ who is the only seller applying while stating a false quality can be calculated as follows.

$$\begin{aligned}
&\mathbb{E}\big(\pi_t(q_t)\big)\ \big[f_t \in K_{false}\big] \\
=&\mathbb{1}_{\Big\{f_t^{false} \in D_{\{K_{true} \cup f_t^{false}\}}\Big\}} \Big(\mathbb{E}\big(\pi_t(q_t)\big)\ \Big[f_t^{false} \in D_{\{K_{true} \cup f_t^{false}\}}\Big] - \textit{application_fee}\Big) \\
&+ \mathbb{1}_{\Big\{f_t^{false} \in \mathrm{ND}_{\{K_{true} \cup f_t^{false}\}}\Big\}} \Big(\mathbb{E}\big(\pi_t(q_t)\big)\ \Big[f_t^{false} \in \mathrm{ND}_{\{K_{true} \cup f_t^{false}\}}\Big] - \textit{application_fee}\Big)
\end{aligned}$$

Since we assume that there is no pair of sellers offering their product model at the same price, i.e., $p_t \neq p_s \; \forall f_t, f_s \in \sigma(F)$ with $t \neq s$, it follows that there is at most one non-dominated product model per quality level. Therefore, $\#ND_{\left\{K_{true} \cup f_t^{false}\right\}} \leqslant \#\textit{quality levels}$. Furthermore, since we assume that the testing organization provides at least as many testing slots as there are quality levels, i.e., $\#\textit{quality levels} \leqslant k < \infty$, it follows that $\#ND_{\left\{K_{true} \cup f_t^{false}\right\}} \leqslant \#\textit{quality levels} \leqslant k$. In addition, since we assume that there is no pair of sellers offering their product model at the same price, seller f_t is not able to state a false quality in a way that f_t^{false} would dominate any of f_t's rivals, i.e. $f_t^{false} \notin \left\{K \cap R_j\right\}$, with $f_j \in R_t$, and therefore also not all rivals, i.e. $f_t^{false} \notin \left\{K \cap \bigcap_{\substack{i \in \{1,\dots,n\}: \\ f_i \in R_t}} R_i\right\}$. However, since $ND_{crit} \subseteq K$, it follows that $\{K \cap R_t\} \neq \emptyset$. It follows that

$$
\begin{aligned}
=&\mathbb{1}_{\left\{f_t^{false} \in D_{\left\{K_{true} \cup f_t^{false}\right\}} \cap \left\{\{K_1' \cap K_{false}\} = \emptyset\right\}\right\}} \\
&\times \left(\mathbb{E}\big(\pi_t(q_t)\big)\left[f_t^{false} \in D_{\left\{K_{true} \cup f_t^{false}\right\}} \cap \left\{\{K_1' \cap K_{false}\} = \emptyset\right\}\right] - \textit{application\_fee}\right) \\
&+ \mathbb{1}_{\left\{f_t \in D_{K_1'}\right\}} \left(\mathbb{E}\big(\pi_t(q_t)\big)\left[f_t \in D_{K_1'}\right] - \textit{application\_fee}\right).
\end{aligned}
$$

Note that, regarding the first summand, it is not possible for $\left\{K_1' \cap K_{false}\right\} \neq \emptyset$ since $\#K_{false} = 1$ and $K_{false} \subseteq D_{\left\{K_{true} \cup f_t^{false}\right\}}$.

If no false quality statements are detected, the algorithm stops. This leads to the first summand below. In the second summand below, $f_t \in D_{K'}$ since $K_1' \subseteq K'$, and according to lemma 3 (Properties of locally *dominated* product models within *larger* markets containing a certain submarket).

$$
\begin{aligned}
=&\mathbb{1}_{\left\{f_t \in \{\sigma(F) \setminus K\}\right\}} \Big(\mathbb{E}\big(\pi_t(q_t)\big)\big[f_t \in \{\sigma(F) \setminus K\}\big] - \textit{application\_fee}\Big) \\
&+ \mathbb{1}_{\left\{f_t \in D_{K'}\right\}} \Big(-\textit{application\_fee} - \textit{punishment\_fee}\Big) \\
\leqslant& \max\Big\{\mathbb{E}\big(\pi_t(q_t)\big)\big[f_t \in \{\sigma(F) \setminus K\}\big] - \textit{application\_fee}, \\
&\quad - \textit{application\_fee} - \textit{punishment\_fee}\Big\}
\end{aligned}
$$

Since $\mathbb{E}\big(\pi_t(q_t)\big)\big[f_t \in \{\sigma(F) \setminus K\}\big] \geqslant 0$ and $\textit{punishment\_fee} > 0$, it follows that $\mathbb{E}\big(\pi_t(q_t)\big)\big[f_t \in \{\sigma(F) \setminus K\}\big] > -\textit{punishment\_fee}$. Therefore,

$$
= \mathbb{E}\big(\pi_t(q_t)\big)\big[f_t \in \{\sigma(F) \setminus K\}\big] - \textit{application\_fee}.
$$

Since $\textit{application\_fee} > 0$, it follows that

$$
< \mathbb{E}\big(\pi_t(q_t)\big)\big[f_t \in \{\sigma(F) \setminus K\}\big].
$$

These are the profits f_t makes by not applying. Therefore, it follows that, if $f_t \in D$ is the only seller who applies to be tested stating a false quality, i.e., if $K_{\mathit{false}} = \{f_t\}$, applying to be tested stating a false quality is a strictly dominated strategy for f_t.

(2.2) In this section, we analyze whether a globally dominated seller f_t may have an incentive to apply to be tested stating a false quality if at least one other globally dominated seller f_k applies stating a false quality. For this purpose, we distinguish the following cases: (2.2.1) at least one product model of globally dominated seller f_t's rivals is tested, (2.2.2) no product model of globally dominated seller f_t's rivals is tested, but at least one product model of globally dominated seller f_k's rivals ist tested, (2.2.3) no product models of rivals of any of the globally dominated sellers who apply stating a false quality are tested.

(2.2.1) Let $f_t \in K_{\mathit{false}}$ with $\#K_{\mathit{false}} \geqslant 2$. We assume $\exists f_j \in \{R_t \cap K\} : f_j \in ND_{\left\{K_{\mathit{true}} \cup \left\{f_o^{\mathit{false}} : f_o \in K_{\mathit{false}}\right\}\right\}}$. Note that $f_j \in K$ since $ND_{\mathit{crit}} \subseteq ND_{\mathit{apply}}$. The expected profit of seller $f_t \in D$ who is one of at least two sellers applying while stating a false quality can be calculated as follows.

$$
\begin{aligned}
&\mathbb{E}\big(\pi_t(q_t)\big)\ \big[f_t \in K_{\mathit{false}}\big] \\
=&\mathbb{1}_{\left\{f_t^{\mathit{false}} \in D_{\left\{K_{\mathit{true}} \cup \left\{f_o^{\mathit{false}} \middle| f_o \in K_{\mathit{false}}\right\}\right\}}\right\}} \\
&\times \left(\mathbb{E}\big(\pi_t(q_t)\big)\ \left[f_t^{\mathit{false}} \in D_{\left\{K_{\mathit{true}} \cup \left\{f_o^{\mathit{false}} \middle| f_o \in K_{\mathit{false}}\right\}\right\}}\right] - \mathit{application\_fee}\right) \\
&+ \mathbb{1}_{\left\{f_t^{\mathit{false}} \in ND_{\left\{K_{\mathit{true}} \cup \left\{f_o^{\mathit{false}} \middle| f_o \in K_{\mathit{false}}\right\}\right\}}\right\}} \\
&\times \left(\mathbb{E}\big(\pi_t(q_t)\big)\ \left[f_t^{\mathit{false}} \in ND_{\left\{K_{\mathit{true}} \cup \left\{f_o^{\mathit{false}} \middle| f_o \in K_{\mathit{false}}\right\}\right\}}\right] - \mathit{application\_fee}\right)
\end{aligned}
$$

The first and second summands below are necessary to distinguish whether a false quality statement is detected in iteration $i = 1$. The following reasoning leads to the third summand below. Since we assume that there is no pair of sellers offering their product model at the same price, i.e., $p_t \neq p_s \ \forall f_t, f_s \in \sigma(F)$ with $t \neq s$, it follows that there is at most one non-dominated product model per quality level. Therefore, $\#ND_{\left\{K_{\mathit{true}} \cup \left\{f_o^{\mathit{false}} \middle| f_o \in K_{\mathit{false}}\right\}\right\}} \leqslant \#\mathit{quality\ levels}$. Furthermore, since we assume that the testing organization provides at least as many testing slots as there are quality levels, i.e., $\#\mathit{quality\ levels} \leqslant k < \infty$, it follows that $\#ND_{\left\{K_{\mathit{true}} \cup \left\{f_o^{\mathit{false}} \middle| f_o \in K_{\mathit{false}}\right\}\right\}} \leqslant \#\mathit{quality\ levels} \leqslant k$. Furthermore, since we assume $\exists f_j \in \{R_t \cap K\} : f_j \in ND_{\left\{K_{true} \cup \left\{f_o^{false} \middle| f_o \in K_{false}\right\}\right\}}$, it follows that

$$
\begin{aligned}
=&\mathbb{1}_{\left\{\left\{f_t^{false} \in D_{\left\{K_{true}\cup\{f_o^{false}\middle|f_o \in K_{false}\}\right\}}\right\}\cap\left\{\{K_1' \cap K_{false}\} = \emptyset\right\}\right\}} \\
&\times\left(\mathbb{E}\big(\pi_t(q_t)\big)\left[\left\{f_t^{false} \in D_{\left\{K_{true}\cup\{f_o^{false}\middle|f_o \in K_{false}\}\right\}}\right\}\cap\left\{\{K_1' \cap K_{false}\} = \emptyset\right\}\right]\right. \\
&\left.\quad - \mathit{application\_fee}\right) \\
&+\mathbb{1}_{\left\{\left\{f_t^{false} \in D_{\left\{K_{true}\cup\left\{f_o^{false}\middle|f_o \in K_{false}\right\}\right\}}\right\}\cap\left\{\{K_1' \cap K_{false}\} \neq \emptyset\right\}\right\}} \\
&\times\left(\mathbb{E}\big(\pi_t(q_t)\big)\left[\left\{f_t^{false} \in D_{\left\{K_{true}\cup\left\{f_o^{false}\middle|f_o \in K_{false}\right\}\right\}}\right\}\cap\{\{K_1' \cap K_{false}\} \neq \emptyset\}\right]\right. \\
&\left.\quad - \mathit{application\_fee}\right) \\
&+\mathbb{1}_{\left\{f_t \in D_{K_1'}\right\}}\left(\mathbb{E}\big(\pi_t(q_t)\big)\left[f_t \in D_{K_1'}\right] - \mathit{application\_fee}\right)
\end{aligned}
$$

In the first summand, since no false quality statements are detected, the algorithm stops. As to the second summand, note that, according to the algorithm, a product model may be selected with a probability < 1 if a greater number of promising product models than testing slots remain. Therefore, we define $prob \in [0,1]$ as the aggregate probability that seller f_t's product model is tested before the algorithm stops, i.e., that $\exists K_i', i \in \left\{2, \ldots, \min\left\{\arg\min_{l \in \{1,\ldots,\#K\}}\{l \,|\{K_l' \cap K_{false}\} = \emptyset\}, \#K\right\}\right\}$, with $f_t \in K_i'$. In addition, since $f_j \in K_i' \subseteq K'$, it follows that $f_t \in D_{K'}$. While the second summand captures the situation in which f_t's product model is tested before the algorithm stops, the third summand captures the opposite case, i.e., f_t's product model is not tested. In the fourth summand below, $f_t \in D_{K'}$ since $K_1' \subseteq K'$, and according to lemma 3 (Properties of locally *dominated* product models within *larger* markets containing a certain submarket).

$$
\begin{aligned}
=&\mathbb{1}_{\left\{f_t \in \{\sigma(F)\setminus K\}\right\}}\left(\mathbb{E}\big(\pi_t(q_t)\big)\left[f_t \in \{\sigma(F)\setminus K\}\right] - \mathit{application\_fee}\right) \\
&+ prob \times \mathbb{1}_{\left\{\left\{f_t^{false} \in D_{\left\{K_{true}\cup\left\{f_o^{false}\middle|f_o \in K_{false}\right\}\right\}}\right\}\cap\left\{\{K_1' \cap K_{false}\} \neq \emptyset\right\}\cap\left\{\exists K_i', i \in \left\{2,\ldots,\min\left\{\arg\min_{l \in \{1,\ldots,\#K\}}\{l \,|\{K_l' \cap K_{false}\} = \emptyset\}, \#K\right\}\right\}, \mathit{with}\ f_t \in K_i'\right\}\right\}} \\
&\quad\times\left(-\mathit{application\_fee} - \mathit{punishment\_fee}\right)
\end{aligned}
$$

$$
\begin{aligned}
&+ (1-\mathit{prob}) \times \mathbb{1}_{\left\{\left\{ f_t^{\mathit{false}} \in D_{\left\{K_{\mathit{true}} \cup \left\{ f_o^{\mathit{false}} \,\middle|\, f_o \in K_{\mathit{false}} \right\}\right\}} \right\} \cap \left\{ \{K_1' \cap K_{\mathit{false}}\} \neq \emptyset \right\} \cap \left\{ \forall K_i', i \in \left\{ 2,\dots,\min\left\{ \arg\min_{l \in \{1,\dots,\#K\}} \left\{ l \,|\{K_l' \cap K_{\mathit{false}}\} = \emptyset \right\}, \#K \right\} \right\}, \mathit{holds}\ f_t \notin D_{K_i'} \right\}\right\}} \\
&\quad \times \Big(\mathbb{E}\big(\pi_t(q_t)\big)[f_t \in \{\sigma(F) \setminus K\}] - \mathit{application\_fee} \Big) \\
&+ \mathbb{1}_{\{f_t \in D_{K'}\}} \Big(-\mathit{application\_fee} - \mathit{punishment\_fee} \Big)
\end{aligned}
$$

The following inequality holds since, if f_t's product model is not tested before the algorithm stops, f_t's profit is equal to the profit had he not applied to be tested, minus *application_fee*. If f_t's product model is tested, buyers will know that it is globally dominated. Therefore, no buyer will select this product model, and f_t's profit equals $-\mathit{application\_fee} - \mathit{punishment\_fee}$.

$$
\begin{aligned}
\leqslant \max\Big\{ &\mathbb{E}\big(\pi_t(q_t)\big) \big[f_t \in \{\sigma(F) \setminus K\} \big] - \mathit{application\_fee}, \\
&- \mathit{application\_fee} - \mathit{punishment\_fee} \Big\}
\end{aligned}
$$

Since $\mathbb{E}\big(\pi_t(q_t)\big) \big[f_t \in \{\sigma(F) \setminus K\} \big] \geqslant 0$ and $\mathit{punishment\_fee} < 0$, it follows that $\mathbb{E}\big(\pi_t(q_t)\big) \big[f_t \in \{\sigma(F) \setminus K\} \big] > -\mathit{punishment\_fee}$. Therefore, it follows that

$$
\begin{aligned}
&= \mathbb{E}\big(\pi_t(q_t)\big) \Big[\big\{ f_t \in \{\sigma(F) \setminus K\} \big\} \Big] - \mathit{application\_fee} \\
&< \mathbb{E}\big(\pi_t(q_t)\big) \Big[\big\{ f_t \in \{\sigma(F) \setminus K\} \big\} \Big].
\end{aligned}
$$

The above represents the profits f_t makes by not applying to be tested. It follows that applying with q_t^{false} is a strictly dominated strategy for $f_t \in D$. (Note that (2.1) is a special case of (2.2.1) if we allow for $\#K_{\mathit{false}} \geqslant 1$.)

(2.2.2) Seller f_k does not have an incentive to apply to be tested stating q_k^{false} if the product model of one his rivals is tested, i.e., seller $f_k \in K_{\mathit{false}}$, with a rival $f_j \in \{R_k \cap K\}$ fulfilling $f_j \in ND_{\left\{K_{\mathit{true}} \cup \{f_o^{\mathit{false}} : f_o \in K_{\mathit{false}}\}\right\}}$ contradicts $f_k \in K_{\mathit{false}}$ according to (2.2.1).

(2.2.3) Let $f_t \in K_{\mathit{false}}$ with $\#K_{\mathit{false}} \geqslant 2$. In contrast to (2.2.1), we now assume $\forall f_j \in \{R_t \cap K\} : f_j \in D_{\left\{K_{\mathit{true}} \cup \{f_o^{\mathit{false}} : f_o \in K_{\mathit{false}}\}\right\}}$, $\forall f_t \in K_{\mathit{false}}$. We know that f_j exists because $ND_{\mathit{crit}} \subseteq ND_{\mathit{apply}}$.

In the following, we show that it is impossible that $f_j \in D_{\left\{K_{\mathit{true}} \cup \{f_o^{\mathit{false}} : f_o \in K_{\mathit{false}}\}\right\}}$ holds $\forall f_j \in \{R_t \cap K\}$ and $\forall f_t \in K_{\mathit{false}}$ using a similar argument as Bendorf et al. (2015). We start by assuming that there is a set of globally dominated sellers fulfilling this property, and denote the cheapest among them with $f_{(K_{\mathit{false}})^c} \in K_{\mathit{false}}$, meaning $p_{(K_{\mathit{false}})^c} > p_l\ \forall f_l \in K_{\mathit{false}}$. Since we assume $ND_{\mathit{crit}} \subseteq ND_{\mathit{apply}}$, it follows that $\{ND_{\mathit{crit}} \cap K\} \neq \emptyset$. It follows that $\exists f_a \in \{ND_{\mathit{crit}} \cap K\}$, with $f_a \in R_{(K_{\mathit{false}})^c}$, meaning $\Big(p_a < p_{(K_{\mathit{false}})^c}\Big) \wedge$

$\left(q_a \geqslant q_{(K_{false})^c}\right)$. This implies that $p_a < p_{(K_{false})^c} < p_l \; \forall f_l \in K_{false}$. It follows that $f_a \in ND_{\left\{K_{true} \cup \left\{f_o^{false} \middle| f_o \in K_{false}\right\}\right\}} \; \forall f_l \in K_{false}$ and $\forall q_l^{false} \in \mathbb{R}^+$. This contradicts the assumption that $\forall f_j \in \{R_t \cap K\} : f_j \in D_{\left\{K_{true} \cup \{f_o^{false} : f_o \in K_{false}\}\right\}}$, $\forall f_t \in K_{false}$ since it does not hold for $f_{(K_{false})^c} \in K_{false}$. Using (2.1) and (2.2.1), it follows that applying with q_t^{false} is a strictly dominated strategy for $f_t \in D$. Using this result combined with (1) leads to the conclusion that applying to be tested with q_t^{false} is a strictly dominated strategy for $f_t \in \sigma(F)$. It follows that, for sellers fulfilling the application criterion according to lemma 10, applying to be tested stating their true quality is a strictly dominant strategy. For all other sellers, i.e., those who do not fulfill the application criterion according to lemma 10, in particular for all globally dominated sellers, applying to be tested stating their true quality is a strictly dominated strategy. Therefore, the remaining and thus strictly dominant strategy for these sellers is to not apply to be tested. Buyers also have a strictly dominant strategy, namely to select the product model which maximizes their expected utility. It follows that every player has a strictly dominant strategy. Using the permutation defined in equation 15, it follows that a unique Nash equilibrium

$$\Big(\textit{apply with } q_1, \ldots, \textit{apply with } q_{(\#ND_{apply})}, \textit{do not apply}, \ldots, \textit{do not apply},$$
$$\textit{buy product model of seller } f^1_{\widetilde{\sigma(F)}}, \ldots, \textit{buy product model of seller } f^s_{\widetilde{\sigma(F)}}\Big)^T$$

exists, with $K = ND_{apply}$ and $f^1_{\widetilde{\sigma(F)}}, \ldots, f^s_{\widetilde{\sigma(F)}} \in \left\{ND_{apply} \cup f_{\{\sigma(F) \setminus ND_{apply}\}^c}\right\}$. In equilibrium, $K_{false} = \emptyset$ and $K' = ND_{apply}$, with each tested product model being globally non-dominated.

$\square$

The results of proposition 5 also hold if, instead of requiring $\exists ND_{crit} \in ND_{Crit}$, with $ND_{crit} \subseteq \overline{ND}$ and $ND_{apply} = \overline{ND}$, we make the assumptions at the beginning of the following proposition 6.

Proposition 6 (Unique Nash equilibrium pre-determined testing capacity with $ND_{apply} = \left\{\overline{ND} \setminus f_{\sigma(F)^c}\right\}$). *Let $(\hat{s}_1, \ldots, \hat{s}_{t-1}, \hat{s}_{t+1}, \ldots, \hat{s}_n)^T$ be an arbitrary, but fixed, strategy vector of all sellers in $\{\sigma(F) \setminus f_t\}$. Furthermore, we assume $\exists ND_{crit} \in ND_{Crit}$, with $ND_{crit} \subseteq \overline{ND}$ and $ND_{apply} = \left\{\overline{ND} \setminus f_{\sigma(F)^c}\right\}$. We require $\forall f_t \in D$ that either $\exists f_j \in \left\{\overline{ND} \setminus f_{\sigma(F)^c}\right\} = ND_{apply}$ which locally dominates f_t in K, or that f_t is dominated in expectation by seller $f_{\sigma(F)^c}$ according to lemma 8 (A weaker condition under which globally dominated sellers would not have an incentive to apply to be tested). Since we assume that the testing organization provides at least as many testing slots as there are quality levels, i.e., #quality levels $\leqslant k < \infty$, it follows that a unique Nash equilibrium exists with*

$$=\Big(\textit{apply with } q_1, \ldots, \textit{apply with } q_{(\#ND_{apply})}, \textit{do not apply}, \ldots, \textit{do not apply},$$
$$\textit{buy product model of seller } f^1_{\widetilde{\sigma(F)}}, \ldots, \textit{buy product model of seller } f^s_{\widetilde{\sigma(F)}}\Big)^T,$$

with $K = ND_{apply}$ *and* $f^1_{\widetilde{\sigma(F)}}, \ldots, f^s_{\widetilde{\sigma(F)}} \in \left\{ND_{apply} \cup f_{\{\sigma(F) \setminus ND_{apply}\}^c}\right\}$. *In equilibrium,* $K_{false} = \emptyset$ *and* $K' = ND_{apply}$*, with each tested product model being globally non-dominated.*

Proof of lemma 6 (Unique Nash equilibrium pre-determined testing capacity with $ND_{apply} = \left\{\overline{ND} \setminus f_{\sigma(F)^c}\right\}$*).*

(1) Analogous to the proof of proposition 5.

(2.1) Analogous to the proof of proposition 5, except for seller $f_u \in D$ being dominated in expectation by $f_{\sigma(F)^c}$ or by another seller $f_l \in \left\{\overline{ND} \setminus f_{\sigma(F)^c}\right\}$. After being tested, seller f_u can be in either $D_{K'_1}$ or $ND_{K'_1}$, but makes the same profits as in the previous proposition 5.

(2.2.1) Analogous to the proof of proposition 5, except that we assume $\exists f_j \in \{R_t \cap K\} : f_j \in ND_{\left\{K_{true} \cup \left\{f_o^{false} : f_o \in K_{false}\right\}\right\}}$, or f_t is dominated by $f_{\sigma(F)^c}$ in expectation.

(2.2.2) Analogous to the proof of proposition 5, except that we assume $\forall f_j \in \{R_t \cap K\} : f_j \in D_{\left\{K_{true} \cup \{f_o^{false} : f_o \in K_{false}\}\right\}}$, or not being dominated in expectation by $f_{\sigma(F)^c}$ $\forall f_t \in K_{false}$ (otherwise, they would not have an incentive to apply to be tested stating a false quality according to (2.2.1) which would contradict $f_t \in K_{false}$). We know that, according to the requirements $\exists f_j \in \{R_t \cap K\}$, or f_t is dominated by $f_{\sigma(F)^c}$ in expectation. The proof is analogous to the proof of proposition 5 (2.2.2) for the set of globally dominated sellers being dominated in K by a seller in $\overline{ND}$. The globally dominated sellers who potentially dominate f_a (see proposition 5 (2.2.2)) do not have an incentive to apply to be tested since they are globally dominated in expectation by $f_{\sigma(F)^c}$. The rest of the proof is analogous.

□

Lemma 11 (Equilibrium behavior of globally dominated sellers)**.** *Let* $f_t \in \left\{ND \setminus ND_{apply}\right\}$*. Furthermore, we assume that* $d(q_t, p_t)\,[f_t \in K] = 0$*. It follows that* $\forall f_k \in D$ *with* $f_t \in R_k$ *there is no incentive to apply to be tested stating their true quality* q_k*.*

Proof of lemma 11 (Equilibrium behavior of globally dominated sellers). Let $f_t \in \left\{ND \setminus ND_{apply}\right\}$. First, we show that the expected demand for f_k's product model after having applied to be tested stating his true quality q_k is always lower than or equal to the expected demand for f_t's product model had f_t applied to be tested stating his true quality q_t. We assume that $\exists b_l \in \{b_1, \ldots, b_s\}$ exists with

$$\left(\underset{f_m \in \left\{K' \cup f_{\{\sigma(F)\setminus K'\}^c} \cup f_0\right\}}{\arg\max} \mathbb{E}\Big(u_l\big(\theta_l, q_m, p_m\big)\Big) = f_k \textit{ with } f_k \in K\right) \wedge$$
$$\left(\underset{f_m \in \left\{K' \cup f_{\{\sigma(F)\setminus K'\}^c} \cup f_0\right\}}{\arg\max} \mathbb{E}\Big(u_l\big(\theta_l, q_m, p_m\big)\Big) \neq f_t \textit{ with } f_t \in K\right).$$

It follows that $\exists f_j \in \sigma(F)$ with $\mathbb{E}\Big(u_l\big(\theta_l, q_j, p_j\big)\Big) > \mathbb{E}\Big(u_l\big(\theta_l, q_t, p_t\big)\Big)$ and $\mathbb{E}\Big(u_l\big(\theta_l, q_j, p_j\big)\Big) = \mathbb{E}\Big(u_l\big(\theta_l, q_k, p_k\big)\Big)\,[f_k \in K]$. Therefore, it follows that $\mathbb{E}\Big(u_l\big(\theta_l, q_k, p_k\big)\Big)\,[f_k \in K] = \mathbb{E}\Big(u_l\big(\theta_l, q_j, p_j\big)\Big) > \mathbb{E}\Big(u_l\big(\theta_l, q_t, p_t\big)\Big)\,[f_t \in K]$. This contradicts $f_t \in R_k$ with $\theta_l > 0$ since buyer b_l's expected utility remains constant with increasing quality (buyer b_l's utility increases monotonically with increasing quality) and increases monotonically with decreasing price. Therefore, it follows that

$$\mathbb{E}\Big(d\big(q_t, p_t\big)\Big)\,[f_t \in K] \geqslant \mathbb{E}\Big(d\big(q_k, p_k\big)\Big)\,[f_k \in K]\,. \tag{16}$$

Second, since we assume $d\big(q_t, p_t\big)\,[f_t \in K] = 0$, it follows that

$$\mathbb{E}\Big(d\big(q_t, p_t\big)\Big)\,[f_t \in K] = 0. \tag{17}$$

From equations 16 and 17 it follows that

$$0 = \mathbb{E}\Big(d\big(q_t, p_t\big)\Big)\,[f_t \in K] \geqslant \mathbb{E}\Big(d\big(q_k, p_k\big)\Big)\,[f_k \in K]\,. \tag{18}$$

Since the expected demand of any seller's product model is always non-negative, it follows that equation 18 can only be true if

$$\mathbb{E}\Big(d\big(q_k, p_k\big)\Big)\,[f_k \in K] = 0. \tag{19}$$

Third, we show that for f_k there is no incentive to apply to be tested stating their true quality q_k. From equation 19 it follows that $\Delta_k \mathbb{E}\Big(d\big(q_k, p_k\big)\Big)\,[f_k \in K]\,\big(p_k - c(q_k)\big) = -\mathbb{E}\Big(d\big(q_k, p_k\big)\Big)\,[f_k \in \{\sigma(F) \setminus K\}]\,\big(p_k - c(q_k)\big)$. Since $\mathbb{E}\Big(d\big(q_k, p_k\big)\Big)\,[f_k \in \{\sigma(F) \setminus K\}] \geqslant 0$, it follows that $-\mathbb{E}\Big(d\big(q_k, p_k\big)\Big)\,[f_k \in \{\sigma(F) \setminus K\}] \leqslant 0$. And since $\big(p_k - c(q_k)\big) > 0$, it follows that $-\mathbb{E}\Big(d\big(q_k, p_k\big)\Big)\,[f_k \in \{\sigma(F) \setminus K\}]\,\big(p_k - c(q_k)\big) \leqslant 0$, and therefore, strictly lower than the *application_fee* < 0. Therefore, there is no incentive for f_k to apply to be tested stating their true quality q_k. □

E The experimental markets

We show for experimental markets 1, 4, 7, and 10 that all sellers whose product models would have been bought under complete information have an incentive to apply to be tested stating their true quality. Consequently, proposition 5 or 6, respectively, hold and a unique Nash equilibrium exists in each of these markets. (As appendix F shows, structurally similar markets, i.e., markets with the same number of globally non-dominated product models, are sorted into groups of three, e.g., markets 1, 2, and 3 are structurally similar to each other. Therefore, we provide tables for the first market in each group of similar markets. Tables for the remaining markets are available upon request.) For each of the markets 1, 4, 7, and 10, we present two tables. Using the first table, we begin by determining ND_{Crit} according to definition 4 and, if applicable, exclude any sellers whose profits under complete information are non-positive. Note that $ND_{Crit} = \{\{ND\}\}$ in all experimental markets. Second, we check whether the profits under complete information of the remaining sellers are strictly higher than the *application_fee* $= 0.5$. Third, we analyze whether seller $f_{\sigma(F)^c} = f_1$, the seller offering the overall cheapest product model in each experimental market, has any incentive to apply to be tested. Using the second table, we subsequently analyze whether $(p_t - c(q_t))\Delta_t\mathbb{E}(d(q_t, p_t)) >$ *application_fee* holds for all remaining sellers. Note that, in equilibrium, globally dominated sellers never have an incentive to apply for testing (according to lemma 11).

Table 3: Experimental market 1

$f_t \in \sigma(F)$		q_t	p_t	R_t	$\pi_t(p_t, q_t) = \left(p_t - c(q_t)\right) d(q_t, p_t)$ under complete information	b_h with $f_t = f^h_{\sigma(F)^*}$ under complete information
f_1	ND	1	2.9	$\{\emptyset\}$	0	$\emptyset$
$\mathbf{f_2}$	ND	2	5	$\{\emptyset\}$	$(5-4)2 = 2 > 0.5$	$b_1, b_2\ (\theta_1 = \theta_2 = 3)$
$\mathbf{f_3}$	ND	3	10.9	$\{\emptyset\}$	$(10.9-9)2 = 3.8 > 0.5$	$b_3, b_4\ (\theta_3 = \theta_4 = 7)$
$\mathbf{f_4}$	ND	4	21	$\{\emptyset\}$	$(21-16)2 = 10 > 0.5$	$b_5, b_6\ (\theta_5 = \theta_6 = 11)$
$\mathbf{f_5}$	ND	5	35.3	$\{\emptyset\}$	$(35.5-25)2 = 21 > 0.5$	$b_7, b_8\ (\theta_7 = \theta_8 = 15)$
f_6	D	1	4.5	$\{f_1\}$	0	$\emptyset$
f_7	D	1	91.7	$\{f_1, f_2, f_3, f_4, f_5, f_6, f_8, f_9, f_{10}, f_{11}, f_{12}, f_{13}, f_{14}, f_{15}\}$	0	$\emptyset$
f_8	D	2	10.6	$\{f_2\}$	0	$\emptyset$
f_9	D	2	89.9	$\{f_2, f_3, f_4, f_5, f_8, f_{10}, f_{11}, f_{12}, f_{13}, f_{14}, f_{15}\}$	0	$\emptyset$
f_{10}	D	3	11.1	$\{f_3\}$	0	$\emptyset$
f_{11}	D	3	20.7	$\{f_3, f_{10}\}$	0	$\emptyset$
f_{12}	D	4	30	$\{f_4\}$	0	$\emptyset$
f_{13}	D	4	31	$\{f_4, f_{12}\}$	0	$\emptyset$
f_{14}	D	5	37	$\{f_5\}$	0	$\emptyset$
f_{15}	D	5	40.3	$\{f_5, f_{14}\}$	0	$\emptyset$

First, $ND_{Crit} = \left\{\{f_1, f_2, f_3, f_4, f_5\}\right\}$. Profits under complete information are positive for all sellers in $ND_{crit} = \{f_1, f_2, f_3, f_4, f_5\}$ except for seller f_1. Second, profits under complete information are strictly higher than the *application_fee* $= 0.5$ for all remaining sellers f_2, f_3, f_4, f_5. Third, if f_1 does not apply to be tested, $\mathbb{E}(q_1) \geqslant q_1$ always holds. Therefore, the demand for f_1's product model will never be strictly higher should he apply to be tested. It follows that f_1 never has an incentive to apply to be tested.

In table 4, we check whether $\left(p_t - c(q_t)\right)\Delta_t \mathbb{E}\left(d(q_t, p_t)\right) >$ *application_fee* holds for all sellers $f_t \in \{f_2, f_3, f_4, f_5\}$ (printed in bold in the table above).

Table 4: Experimental market 1 continued

f_2	f_3	f_4	f_5	$\mathbb{E}(q_1)$
—	—	—	$\mathbb{E}\big(u_7(\theta_7, q_1, p_1)\big) = \mathbb{E}\big(u_8(\theta_8, q_1, p_1)\big)$ $\leqslant 15 \times 2.5 - 2.9 = 34.6$ $< u_7(\theta_7, q_5, p_5) = u_8(\theta_8, q_5, p_5)$ $= 15 \times 5 - 35.3 = 39.7$	$\leqslant 2.5$
—	—	$\mathbb{E}\big(u_5(\theta_5, q_1, p_1)\big) = \mathbb{E}\big(u_6(\theta_6, q_1, p_1)\big)$ $\leqslant 11 \times 2.0 - 2.9 = 19.1$ $< u_5(\theta_5, q_4, p_4) = u_6(\theta_6, q_4, p_4)$ $= 11 \times 4 - 21 = 23$	$u_7(\theta_7, q_5, p_5) = u_8(\theta_8, q_5, p_5)$ $= 15 \times 5 - 35.3 = 39.7$	$\leqslant 2.0$
—	$\mathbb{E}\big(u_3(\theta_3, q_1, p_1)\big) = \mathbb{E}\big(u_4(\theta_4, q_1, p_1)\big)$ $\leqslant 7 \times 1.5 - 2.9 = 7.6$ $< u_3(\theta_3, q_3, p_3) = u_4(\theta_4, q_3, p_3)$ $= 7 \times 3 - 10.9 = 10.1$	$u_5(\theta_5, q_4, p_4) = u_6(\theta_6, q_4, p_4)$ $= 11 \times 4 - 21 = 23$	$u_7(\theta_7, q_5, p_5) = u_8(\theta_8, q_5, p_5)$ $= 15 \times 5 - 35.5 = 39.7$	$\leqslant 1.5$
$\mathbb{E}\big(u_1(\theta_1, q_1, p_1)\big) = \mathbb{E}\big(u_2(\theta_2, q_1, p_1)\big)$ $\leqslant 3 \times 1.0 - 2.9 = 0.1$ $< u_1(\theta_1, q_2, p_2) = u_2(\theta_2, q_2, p_2)$ $= 3 \times 2 - 5.0 = 1.0$	$u_3(\theta_3, q_3, p_3) = u_4(\theta_4, q_3, p_3)$ $= 7 \times 3 - 10.9 = 10.1$	$u_5(\theta_5, q_4, p_4) = u_6(\theta_6, q_4, p_4)$ $= 11 \times 4 - 21 = 23$	$u_7(\theta_7, q_5, p_5) = u_8(\theta_8, q_5, p_5)$ $= 15 \times 5 - 35.5 = 39.7$	$\leqslant 1.0$

From table 3, it follows that seller $f_{\sigma(F)^c} = f_1$ offering the overall cheapest product model never has an incentive to apply to be tested. Therefore, we analyze whether, for any possible combination of remaining sellers f_2, f_3, f_4, and f_5, all of these have an incentive to apply to be tested stating their true quality. Each line in the above table represents one or more combinations of sellers applying to be tested stating their true quality, or not applying to be tested. Cells marked with "–" represent sellers who may choose either of these two strategies. Cells marked with entries other than "–" represent sellers who do apply to be tested stating their true quality. When analyzing line by line, we always use the reasoning that, if a buyer's optimal product model under complete information has been tested, a buyer will consider only this product model among all tested ones, and the overall cheapest product model (if non-tested), and among these two select the one maximizing her expected utility. If a buyer's optimal product model under complete information has not been tested, a buyer will consider all tested product models and the overall cheapest (tested or non-tested) product model, and select the one maximizing her expected utility. Note that when calculating the expected quality of the cheapest non-tested product model $\mathbb{E}(q_1)$, our reasoning is as follows. Since p_1 is the overall lowest price in market 1, p_1 is also lower than p_2, p_3, p_4, and p_5. Therefore, since in equilibrium, globally dominated sellers do not apply to be tested (see lemmas 8, 9, and 2), buyers will conclude that any seller whose product model has been tested can only be globally non-dominated since the respective seller would not have applied otherwise. Since p_1 is strictly lower than all other prices, $\mathbb{E}(q_1)$ also must be lower than the lowest quality among all tested product models, e.g., lower than q_5 if only f_5 applied to be tested, lower than q_4 if f_4 (and possibly f_5) applied to be tested etc.

In the first line, we start with the globally non-dominated seller f_5 offering the highest quality. We analyze whether the buyers who would buy from f_5 under complete information, i.e. buyers b_7 and b_8 (see table 3), would prefer to buy the overall cheapest product model, or f_5's product model had he applied to be tested, irrespective of whether f_2, f_3, and f_4 do or do not apply to be tested. Since $\mathbb{E}\big(u_7(\theta_7, q_1, p_1)\big) = \mathbb{E}\big(u_8(\theta_8, q_1, p_1)\big) < u_7(\theta_7, q_5, p_5) = u_8(\theta_8, q_5, p_5)$, it follows that b_7 and b_8 would buy from f_5 if he applied to be tested instead of selecting the overall cheapest product model from f_1. Seller f_5 would make zero profits if he does not apply to be tested since buyers do not consider non-tested product models except for the overall cheapest one. Therefore, if f_5 does apply to be tested stating his true quality, it follows that his profits would be at least as high as his profits under complete information minus the *application_fee*. Therefore, $\big(p_5 - c(q_5)\big)\Delta_5\mathbb{E}\big(d(p_5, q_5)\big) >$ *application_fee*.

In the second line, we use this result, i.e., that in equilibrium f_5 always has an incentive to apply to be tested stating his true quality, and continue with the globally non-dominated seller f_4 offering the second-highest quality. Since $\mathbb{E}\big(u_5(\theta_5, q_1, p_1)\big) = \mathbb{E}\big(u_6(\theta_6, q_1, p_1)\big) < u_5(\theta_5, q_4, p_4) = u_6(\theta_6, q_4, p_4)$, it follows that $\big(p_4 - c(q_4)\big)\Delta_4\mathbb{E}\big(d(p_4, q_4)\big) >$ *application_fee*.

We reason analogously in the third and fourth lines of the above table. Therefore, $\big(p_t - c(q_t)\big)\Delta_t\mathbb{E}\big(d(p_t, q_t)\big) >$ *application_fee* holds for all sellers $f_t \in \{f_2, f_3, f_4, f_5\}$.

Table 5: Experimental market 4

$f_t \in \sigma(F)$		q_t	p_t	R_t	$\pi_t(p_t, q_t) = (p_t - c(q_t))d(q_t, p_t)$ under complete information	b_h with $f_t = f^h_{\sigma(F)^*}$ under complete information
$\mathbf{f_1}$	ND	2	5.4	$\{\emptyset\}$	$(5.4 - 4)2 = 2.8 > 0.5$	b_1, b_2 $(\theta_1 = \theta_2 = 3)$
$\mathbf{f_2}$	ND	3	11.4	$\{\emptyset\}$	$(11.4 - 9)2 = 4.8 > 0.5$	b_3, b_4 $(\theta_3 = \theta_4 = 7)$
$\mathbf{f_3}$	ND	4	21.8	$\{\emptyset\}$	$(21.8 - 16)2 = 11.6 > 0.5$	b_5, b_6 $(\theta_5 = \theta_6 = 11)$
$\mathbf{f_4}$	ND	5	36	$\{\emptyset\}$	$(36 - 25)2 = 22 > 0.5$	b_7, b_8 $(\theta_7 = \theta_8 = 15)$
f_5	D	1	7.3	$\{f_1\}$	0	$\emptyset$
f_6	D	1	13.1	$\{f_1, f_2, f_8\}$	0	$\emptyset$
f_7	D	1	90.5	$\{f_1, f_2, f_3, f_4, f_5, f_6, f_8, f_9, f_{10}, f_{11}, f_{12}, f_{13}, f_{14}, f_{15}\}$	0	$\emptyset$
f_8	D	2	6.1	$\{f_1\}$	0	$\emptyset$
f_9	D	2	88	$\{f_1, f_2, f_3, f_4, f_8, f_{10}, f_{11}, f_{12}, f_{13}, f_{14}, f_{15}\}$	0	$\emptyset$
f_{10}	D	3	35.1	$\{f_2, f_3\}$	0	$\emptyset$
f_{11}	D	3	40.3	$\{f_2, f_3, f_4, f_{10}, f_{12}, f_{15}\}$	0	$\emptyset$
f_{12}	D	4	23.5	$\{f_3\}$	0	$\emptyset$
f_{13}	D	4	41	$\{f_3, f_4, f_{12}, f_{15}\}$	0	$\emptyset$
f_{14}	D	5	44.9	$\{f_4, f_{15}\}$	0	$\emptyset$
f_{15}	D	5	36.2	$\{f_4\}$	0	$\emptyset$

First, $ND_{Crit} = \{\{f_1, f_2, f_3, f_4\}\}$. Profits under complete information are positive for all sellers in ND_{crit}. Second, profits under complete information are strictly higher than the *application_fee* $= 0.5$ for all sellers in ND_{crit}. Third, if f_1 does not apply to be tested, $\mathbb{E}(q_1)$ may be higher, lower or equal to q_1. Therefore, the demand for f_1's product model may be strictly higher should he apply to be tested. It follows that f_1 may have an incentive to apply to be tested stating his true quality.

In table 6, we check whether $(p_t - c(q_t))\Delta_t\mathbb{E}(d(q_t, p_t)) >$ *application_fee* holds for all sellers $f_t \in \{f_1, f_2, f_3, f_4\}$ (printed in bold in the table above).

Table 6: Experimental market 4 continued

f_1	f_2	f_3	f_4	$\mathbb{E}(q_1)$
—	—	—	$\mathbb{E}\big(u_7(\theta_7, q_1, p_1)\big) = \mathbb{E}\big(u_8(\theta_8, q_1, p_1)\big)$ $\leqslant 15 \times 2.5 - 5.4 = 32.1$ $< u_7(\theta_7, q_4, p_4) = u_8(\theta_8, q_4, p_4)$ $= 15 \times 5 - 36 = 39$	$\leqslant 2.5$
—	—	$\mathbb{E}\big(u_5(\theta_5, q_1, p_1)\big) = \mathbb{E}\big(u_6(\theta_6, q_1, p_1)\big)$ $\leqslant 11 \times 2.0 - 5.4 = 16.6$ $< u_5(\theta_5, q_3, p_3) = u_6(\theta_6, q_3, p_3)$ $= 11 \times 4 - 21.8 = 22.2$	$u_7(\theta_7, q_4, p_4) = u_8(\theta_8, q_4, p_4)$ $= 15 \times 5 - 36 = 39$	$\leqslant 2.0$
—	$\mathbb{E}\big(u_3(\theta_3, q_1, p_1)\big) = \mathbb{E}\big(u_4(\theta_4, q_1, p_1)\big)$ $\leqslant 7 \times 1.5 - 5.4 = 5.1$ $< u_3(\theta_3, q_2, p_2) = u_4(\theta_4, q_2, p_2)$ $= 7 \times 3 - 11.4 = 9.6$	$u_5(\theta_5, q_3, p_3) = u_6(\theta_6, q_3, p_3)$ $= 11 \times 4 - 21.8 = 22.2$	$u_7(\theta_7, q_4, p_4) = u_8(\theta_8, q_4, p_4)$ $= 15 \times 5 - 36 = 39$	$\leqslant 1.5$
$\mathbb{E}\big(u_1(\theta_1, q_1, p_1)\big) = \mathbb{E}\big(u_2(\theta_2, q_1, p_1)\big)$ $= 3 \times 1.5 - 5.4 = -0.9 < 0$ $< u_1(\theta_1, q_1, p_1) = u_2(\theta_2, q_1, p_1)$ $= 3 \times 2 - 5.4 = 0.6$	$u_3(\theta_3, q_2, p_2) = u_4(\theta_4, q_2, p_2)$ $= 7 \times 3 - 11.4 = 9.6$	$u_5(\theta_5, q_3, p_3) = u_6(\theta_6, q_3, p_3)$ $= 11 \times 4 - 21.8 = 22.2$	$u_7(\theta_7, q_4, p_4) = u_8(\theta_8, q_4, p_4)$ $= 15 \times 5 - 36 = 39$	1.5 or 2, respectively

From table 5, it follows that seller $f_{\sigma(F)^c} = f_1$ offering the overall cheapest product model may have an incentive to apply to be tested. Therefore, we analyze whether, for any possible combination of sellers f_1, f_2, f_3, and f_4, all of these have an incentive to apply to be tested stating their true quality. Each line in the above table represents one or more combinations of sellers applying to be tested stating their true quality, or not applying to be tested. Cells marked with "–" represent sellers who may choose either of these two strategies. Cells marked with entries other than "–" represent sellers who do apply to be tested stating their true quality. When analyzing line by line, we always use the reasoning that, if a buyer's optimal product model under complete information has been tested, a buyer will consider only this product model among all tested ones, and the overall cheapest product model (if non-tested), and among these two select the one maximizing her expected utility. If a buyer's optimal product model under complete information has not been tested, a buyer will consider all tested product models and the overall cheapest (tested or non-tested) product model, and select the one maximizing her expected utility. Note that when calculating the expected quality of the cheapest non-tested product model $\mathbb{E}(q_1)$, our reasoning is as follows. Since p_1 is the overall lowest price in market 4, p_1 is also lower than p_2, p_3, and p_4. Therefore, since in equilibrium, globally dominated sellers do not apply to be tested (see lemmas 8, 9, and 2), buyers will conclude that any seller whose product model has been tested can only be globally non-dominated since the respective seller would not have applied otherwise. Since p_1 is strictly lower than all other prices, $\mathbb{E}(q_1)$ also must be lower than the lowest quality among all tested product models, e.g., lower than q_4 if only f_4 applied to be tested, lower than q_3 if f_3 (and possibly f_4) applied to be tested etc.

In the first line, we start with the globally non-dominated seller f_4 offering the highest quality. We analyze whether the buyers who would buy from f_4 under complete information, i.e. buyers b_7 and b_8 (see table 5), would prefer to buy the overall cheapest product model, or f_4's product model had he applied to be tested, irrespective of whether f_1, f_2, and f_3 do or do not apply to be tested. Since $\mathbb{E}\big(u_7(\theta_7, q_1, p_1)\big) = \mathbb{E}\big(u_8(\theta_8, q_1, p_1)\big) < u_7(\theta_7, q_4, p_4) = u_8(\theta_8, q_4, p_4)$, it follows that b_7 and b_8 would buy from f_4 if he applied to be tested instead of selecting the overall cheapest product model from f_1. Seller f_4 would make zero profits if he does not apply to be tested since buyers do not consider non-tested product models except for the overall cheapest one. Therefore, if f_4 does apply to be tested stating his true quality, it follows that his profits would be at least as high as his profits under complete information minus the *application_fee*. Therefore, $\big(p_4 - c(q_4)\big)\Delta_4\mathbb{E}\big(d(p_4, q_4)\big) >$ *application_fee*.

In the second line, we use this result, i.e., that in equilibrium f_4 always has an incentive to apply to be tested stating his true quality, and continue with the globally non-dominated seller f_3 offering the second-highest quality. Since $\mathbb{E}\big(u_5(\theta_5, q_1, p_1)\big) = \mathbb{E}\big(u_6(\theta_6, q_1, p_1)\big) < u_5(\theta_5, q_3, p_3) = u_6(\theta_6, q_3, p_3)$, it follows that $\big(p_3 - c(q_3)\big)\Delta_3\mathbb{E}\big(d(p_3, q_3)\big) >$ *application_fee*. We reason analogously in the third line of the above table.

In the fourth and last line, we analyze whether seller $f_{\sigma(F)^c} = f_1$ has an incentive to apply to be tested stating his true quality. If he does not apply to be tested, $\mathbb{E}\big(u_1(\theta_1, q_1, p_1)\big) = \mathbb{E}\big(u_2(\theta_2, q_1, p_1)\big) < 0$. It follows that buyers b_1 and b_2 would refrain from buying f_1's product model if he does not apply to be tested. However, if f_1 does apply, $u_1(\theta_1, q_1, p_1) = u_2(\theta_2, q_1, p_1) = 0.6$. Therefore, if f_1 does apply to be tested stating his true quality, it follows that his profits would be at least as high as his profits under complete information minus the *application_fee*. It follows that $\big(p_1 - c(q_1)\big)\Delta_1\mathbb{E}\big(d(p_1, q_1)\big) >$ *application_fee*.

Therefore, $\big(p_t - c(q_t)\big)\Delta_t\mathbb{E}\big(d(p_t, q_t)\big) >$ *application_fee* holds for all sellers $f_t \in \{f_1, f_2, f_3, f_4\}$.

Table 7: Experimental market 7

$f_t \in \sigma(F)$		q_t	p_t	R_t	$\pi_t(p_t, q_t) = (p_t - c(q_t))d(q_t, p_t)$ under complete information	b_h with $f_t = f^h_{\sigma(F)^*}$ under complete information
$\mathbf{f_1}$	ND	3	10.6	$\{\emptyset\}$	$(10.6 - 9)2 = 3.2 > 0.5$	$b_3, b_4\ (\theta_3 = \theta_4 = 7)$
$\mathbf{f_2}$	ND	4	18.8	$\{\emptyset\}$	$(18.8 - 16)2 = 5.6 > 0.5$	$b_5, b_6\ (\theta_5 = \theta_6 = 11)$
$\mathbf{f_3}$	ND	5	30.3	$\{\emptyset\}$	$(30.3 - 25)2 = 10.6 > 0.5$	$b_7, b_8\ (\theta_7 = \theta_8 = 15)$
f_4	D	1	13.9	$\{f_1\}$	0	$\emptyset$
f_5	D	1	65.6	$\{f_1, f_2, f_3, f_4, f_7, f_8, f_9, f_{10}, f_{11}, f_{12}, f_{13}, f_{14}, f_{15}\}$	0	$\emptyset$
f_6	D	1	70.5	$\{f_1, f_2, f_3, f_4, f_5, f_7, f_8, f_9, f_{10}, f_{11}, f_{12}, f_{13}, f_{14}, f_{15}\}$	0	$\emptyset$
f_7	D	2	14.6	$\{f_1\}$	0	$\emptyset$
f_8	D	2	15.8	$\{f_1, f_7\}$	0	$\emptyset$
f_9	D	2	25.6	$\{f_1, f_2, f_7, f_8\}$	0	$\emptyset$
f_{10}	D	3	55.6	$\{f_1, f_2, f_3, f_{12}, f_{13}, f_{14}, f_{15}\}$	0	$\emptyset$
f_{11}	D	3	57.2	$\{f_1, f_2, f_3, f_{10}, f_{12}, f_{13}, f_{14}, f_{15}\}$	0	$\emptyset$
f_{12}	D	4	55.4	$\{f_2, f_3, f_{13}, f_{14}, f_{15}\}$	0	$\emptyset$
f_{13}	D	4	35.2	$\{f_2, f_3\}$	0	$\emptyset$
f_{14}	D	5	43.5	$\{f_3\}$	0	$\emptyset$
f_{15}	D	5	50.5	$\{f_3, f_{14}\}$	0	$\emptyset$

First, $ND_{Crit} = \left\{\{f_1, f_2, f_3\}\right\}$. Profits under complete information are positive for all sellers in ND_{crit}. Second, profits under complete information are strictly higher than the *application_fee* $= 0.5$ for all sellers in ND_{crit}. Third, if f_1 does not apply to be tested, $\mathbb{E}(q_1)$ may be higher, lower or equal to q_1. Therefore, the demand for f_1's product model may be strictly higher should he apply to be tested. It follows that f_1 may have an incentive to apply to be tested stating his true quality.

In table 8, we check whether $(p_t - c(q_t))\Delta_t \mathbb{E}(d(q_t, p_t)) >$ *application_fee* holds for all sellers $f_t \in \{f_1, f_2, f_3\}$ (printed in bold in the table above).

Table 8: Experimental market 7 continued

f_1	f_2	f_3	$\mathbb{E}(q_1)$
—	—	$\mathbb{E}\big(u_7(\theta_7, q_1, p_1)\big) = \mathbb{E}\big(u_8(\theta_8, q_1, p_1)\big)$ $\leqslant 15 \times 2.5 - 10.6 = 26.9$ $< u_7(\theta_7, q_3, p_3) = u_8(\theta_8, q_3, p_3)$ $= 15 \times 5 - 30.3 = 44.7$	$\leqslant 2.5$
—	$\mathbb{E}\big(u_5(\theta_5, q_1, p_1)\big) = \mathbb{E}\big(u_6(\theta_6, q_1, p_1)\big)$ $\leqslant 11 \times 2.0 - 10.6 = 11.4$ $< u_5(\theta_5, q_2, p_2) = u_6(\theta_6, q_2, p_2)$ $= 11 \times 4 - 18.8 = 25.2$	$u_7(\theta_7, q_3, p_3) = u_8(\theta_8, q_3, p_3)$ $= 15 \times 5 - 30.3 = 44.7$	$\leqslant 2.0$
$\mathbb{E}\big(u_3(\theta_3, q_1, p_1)\big) = \mathbb{E}\big(u_4(\theta_4, q_1, p_1)\big)$ $= 7 \times 2.0 - 10.6 = 3.4$ $< u_3(\theta_3, q_2, p_2) = u_4(\theta_4, q_2, p_2)$ $= 7 \times 4 - 18.8 = 9.2$ $< u_3(\theta_3, q_1, p_1) = u_4(\theta_4, q_1, p_1)$ $= 7 \times 3 - 10.6 = 10.4$	$u_5(\theta_5, q_2, p_2) = u_6(\theta_6, q_2, p_2)$ $= 11 \times 4 - 18.8 = 25.2$	$u_7(\theta_7, q_3, p_3) = u_8(\theta_8, q_3, p_3)$ $= 15 \times 5 - 30.3 = 44.7$	2.0 or 3, respectively

From table 7, it follows that seller $f_{\sigma(F)^c} = f_1$ offering the overall cheapest product model may have an incentive to apply to be tested. Therefore, we analyze whether, for any possible combination of sellers f_1, f_2, and f_3, all of these have an incentive to apply to be tested stating their true quality. Each line in the above table represents one or more combinations of sellers applying to be tested stating their true quality, or not applying to be tested. Cells marked with "–" represent sellers who may choose either of these two strategies. Cells marked with entries other than "–" represent sellers who do apply to be tested stating their true quality. When analyzing line by line, we always use the reasoning that, if a buyer's optimal product model under complete information has been tested, a buyer will consider only this product model among all tested ones, and the overall cheapest product model (if non-tested), and among these two select the one maximizing her expected utility. If a buyer's optimal product model under complete information has not been tested, a buyer will consider all tested product models and the overall cheapest (tested or non-tested) product model, and select the one maximizing her expected utility. Note that when calculating the expected quality of the cheapest non-tested product model $\mathbb{E}(q_1)$, our reasoning is as follows. Since p_1 is the overall lowest price in market 7, p_1 is also lower than p_2 and p_3. Therefore, since in equilibrium, globally dominated sellers do not apply to be tested (see lemmas 8, 9, and 2), buyers will conclude that any seller whose product model has been tested can only be globally non-dominated since the respective seller would not have applied otherwise. Since p_1 is strictly lower than all other prices, $\mathbb{E}(q_1)$ also must be lower than the lowest quality among all tested product models, e.g., lower than q_3 if only f_3 applied to be tested, and lower than q_2 if f_2 (and possibly f_3) applied to be tested.

In the first line, we start with the globally non-dominated seller f_3 offering the highest quality. We analyze whether the buyers who would buy from f_3 under complete information, i.e. buyers b_7 and b_8 (see table 7), would prefer to buy the overall cheapest product model, or f_3's product model had he applied to be tested, irrespective of whether f_1 and f_3 do or do not apply to be tested. Since $\mathbb{E}\big(u_7(\theta_7, q_1, p_1)\big) = \mathbb{E}\big(u_8(\theta_8, q_1, p_1)\big) < u_7(\theta_7, q_3, p_3) = u_8(\theta_8, q_3, p_3)$, it follows that b_7 and b_8 would buy from f_3 if he applied to be tested instead of selecting the overall cheapest product model from f_1. Seller f_3 would make zero profits if he does not apply to be tested since buyers do not consider non-tested product models except for the overall cheapest one. Therefore, if f_3 does apply to be tested stating his true quality, it follows that his profits would be at least as high as his profits under complete information minus the *application_fee*. Therefore, $\big(p_3 - c(q_3)\big)\Delta_3\mathbb{E}\big(d(p_3, q_3)\big) >$ *application_fee*.

In the second line, we use this result, i.e., that in equilibrium f_3 always has an incentive to apply to be tested stating his true quality, and continue with the globally non-dominated seller f_2 offering the second-highest quality. Since $\mathbb{E}\big(u_5(\theta_5, q_1, p_1)\big) = \mathbb{E}\big(u_6(\theta_6, q_1, p_1)\big) < u_5(\theta_5, q_2, p_2) = u_6(\theta_6, q_2, p_2)$, it follows that $\big(p_2 - c(q_2)\big)\Delta_2\mathbb{E}\big(d(p_2, q_2)\big) >$ *application_fee*.

In the third and last line, we analyze whether seller $f_{\sigma(F)^c} = f_1$ has an incentive to apply to be tested stating his true quality. If he does not apply to be tested, $\mathbb{E}\big(u_3(\theta_3, q_1, p_1)\big) = \mathbb{E}\big(u_4(\theta_4, q_1, p_1)\big) < u_3(\theta_3, q_2, p_2) = u_4(\theta_4, q_2, p_2)$. It follows that buyers b_1 and b_2 would refrain from buying f_1's product model if he does not apply to be tested. However, if f_1 does apply, $u_1(\theta_1, q_1, p_1) = u_2(\theta_2, q_1, p_1) = 10.4$. Therefore, if f_1 does apply to be tested stating his true quality, it follows that his profits would be at least as high as his profits under complete information minus the *application_fee*. It follows that $\big(p_1 - c(q_1)\big)\Delta_1\mathbb{E}\big(d(p_1, q_1)\big) >$ *application_fee*.

Therefore, $\big(p_t - c(q_t)\big)\Delta_t\mathbb{E}\big(d(p_t, q_t)\big) >$ *application_fee* holds for all sellers $f_t \in \{f_1, f_2, f_3\}$.

Table 9: Experimental market 10

$f_t \in \sigma(F)$		q_t	p_t	R_t	$\pi_t(p_t, q_t) = (p_t - c(q_t))d(q_t, p_t)$ under complete information	b_h with $f_t = f^h_{\sigma(F)^*}$ under complete information
$\mathbf{f_1}$	ND	4	17.6	$\{\emptyset\}$	$(17.6 - 16)2 = 3.2 > 0.5$	$b_3, b_4\ (\theta_3 = \theta_4 = 7)$, $b_5, b_6\ (\theta_5 = \theta_6 = 11)$
$\mathbf{f_2}$	ND	5	29.3	$\{\emptyset\}$	$(29.3 - 25)2 = 8.6 > 0.5$	$b_7, b_8\ (\theta_7 = \theta_8 = 15)$
f_3	D	1	50.3	$\{f_1, f_2, f_6, f_9\}$	0	$\emptyset$
f_4	D	1	55.3	$\{f_1, f_2, f_3, f_6, f_7, f_9\}$	0	$\emptyset$
f_5	D	1	59	$\{f_1, f_2, f_3, f_4, f_6, f_7, f_8, f_9, f_{12}\}$	0	$\emptyset$
f_6	D	2	47	$\{f_1, f_2, f_9\}$	0	$\emptyset$
f_7	D	2	53.5	$\{f_1, f_2, f_6, f_9\}$	0	$\emptyset$
f_8	D	2	57.3	$\{f_1, f_2, f_6, f_7, f_9, f_{12}\}$	0	$\emptyset$
f_9	D	3	29.4	$\{f_1, f_2\}$	0	$\emptyset$
f_{10}	D	3	61.9	$\{f_1, f_2, f_9, f_{12}, f_{14}\}$	0	$\emptyset$
f_{11}	D	3	75	$\{f_1, f_2, f_9, f_{10}, f_{12}, f_{14}\}$	0	$\emptyset$
f_{12}	D	4	55.6	$\{f_1, f_2\}$	0	$\emptyset$
f_{13}	D	4	79.1	$\{f_1, f_2, f_{12}, f_{14}, f_{15}\}$	0	$\emptyset$
f_{14}	D	5	60.3	$\{f_2\}$	0	$\emptyset$
f_{15}	D	5	77.8	$\{f_2, f_{14}\}$	0	$\emptyset$

First, $ND_{Crit} = \{\{f_1, f_2\}\}$. Profits under complete information are positive for all sellers in ND_{crit}. Second, profits under complete information are strictly higher than the *application_fee* $= 0.5$ for all sellers ND_{crit}. Third, if f_1 does not apply to be tested, $\mathbb{E}(q_1)$ may be higher, lower or equal to q_1. Therefore, the demand for f_1's product model may be strictly higher should he apply to be tested. It follows that f_1 may have an incentive to apply to be tested stating his true quality. In table 10, we check whether $(p_t - c(q_t))\Delta_t\mathbb{E}(d(q_t, p_t)) >$ *application_fee* holds for all sellers $f_t \in \{f_1, f_2\}$ (printed in bold in the table above).

Table 10: Experimental market 10 continued

f_1	f_2	$\mathbb{E}(q_1)$
—	$\mathbb{E}\Big(u_7(\theta_7, q_1, p_1)\Big) = \mathbb{E}\Big(u_8(\theta_8, q_1, p_1)\Big)$ $\leqslant 15 \times 2.5 - 17.6 = 19.9$ $< u_7(\theta_7, q_2, p_2) = u_8(\theta_8, q_2, p_2)$ $= 15 \times 5 - 29.3 = 45.7$	$\leqslant 2.5$
$\mathbb{E}\Big(u_3(\theta_3, q_1, p_1)\Big) = \mathbb{E}\Big(u_4(\theta_4, q_1, p_1)\Big) = 7 \times 2.5 - 17.6 = -0.1 < 0$ $< u_3(\theta_3, q_1, p_1) = u_4(\theta_4, q_1, p_1) = 7 \times 4 - 17.6 = 10.4$ $\mathbb{E}\Big(u_5(\theta_5, q_1, p_1)\Big) = \mathbb{E}\Big(u_6(\theta_6, q_1, p_1)\Big) = 11 \times 2.5 - 17.6 = 9.9 > 0$ $u_5(\theta_5, q_1, p_1) = u_6(\theta_6, q_1, p_1) = 11 \times 4 - 17.6 = 26.4$	$u_7(\theta_7, q_2, p_2) = u_8(\theta_8, q_2, p_2)$ $= 15 \times 5 - 29.3 = 45.7$	2.5 or 4, respectively

From table 9, it follows that seller $f_{\sigma(F)^c} = f_1$ offering the overall cheapest product model may have an incentive to apply to be tested. Therefore, we analyze whether, for any combination of sellers f_1 and f_2, both of these have an incentive to apply to be tested stating their true quality. Each line in the above table represents one or more combinations of sellers applying to be tested stating their true quality, or not applying to be tested. Cells marked with "–" represent sellers who may choose either of these two strategies. Cells marked with entries other than "–" represent sellers who do apply to be tested stating their true quality. When analyzing line by line, we always use the reasoning that, if a buyer's optimal product model under complete information has been tested, a buyer will consider only this product model among all tested ones, and the overall cheapest product model (if non-tested), and among these two select the one maximizing her expected utility. If a buyer's optimal product model under complete information has not been tested, a buyer will consider all tested product models and the overall cheapest (tested or non-tested) product model, and select the one maximizing her expected utility. Note that when calculating the expected quality of the cheapest non-tested product model $\mathbb{E}(q_1)$, we reason as follows. Since p_1 is the overall lowest price in market 10, p_1 is also lower than p_2. Therefore, since in equilibrium, globally dominated sellers do not apply to be tested (see lemmas 8, 9, and 2), buyers will conclude that any seller whose product model has been tested can only be globally non-dominated since the respective seller would not have applied otherwise. Since p_1 is strictly lower than all other prices, $\mathbb{E}(q_1)$ also must be lower than the lowest quality among all tested product models, e.g., lower than q_2 if only f_2 applied to be tested.

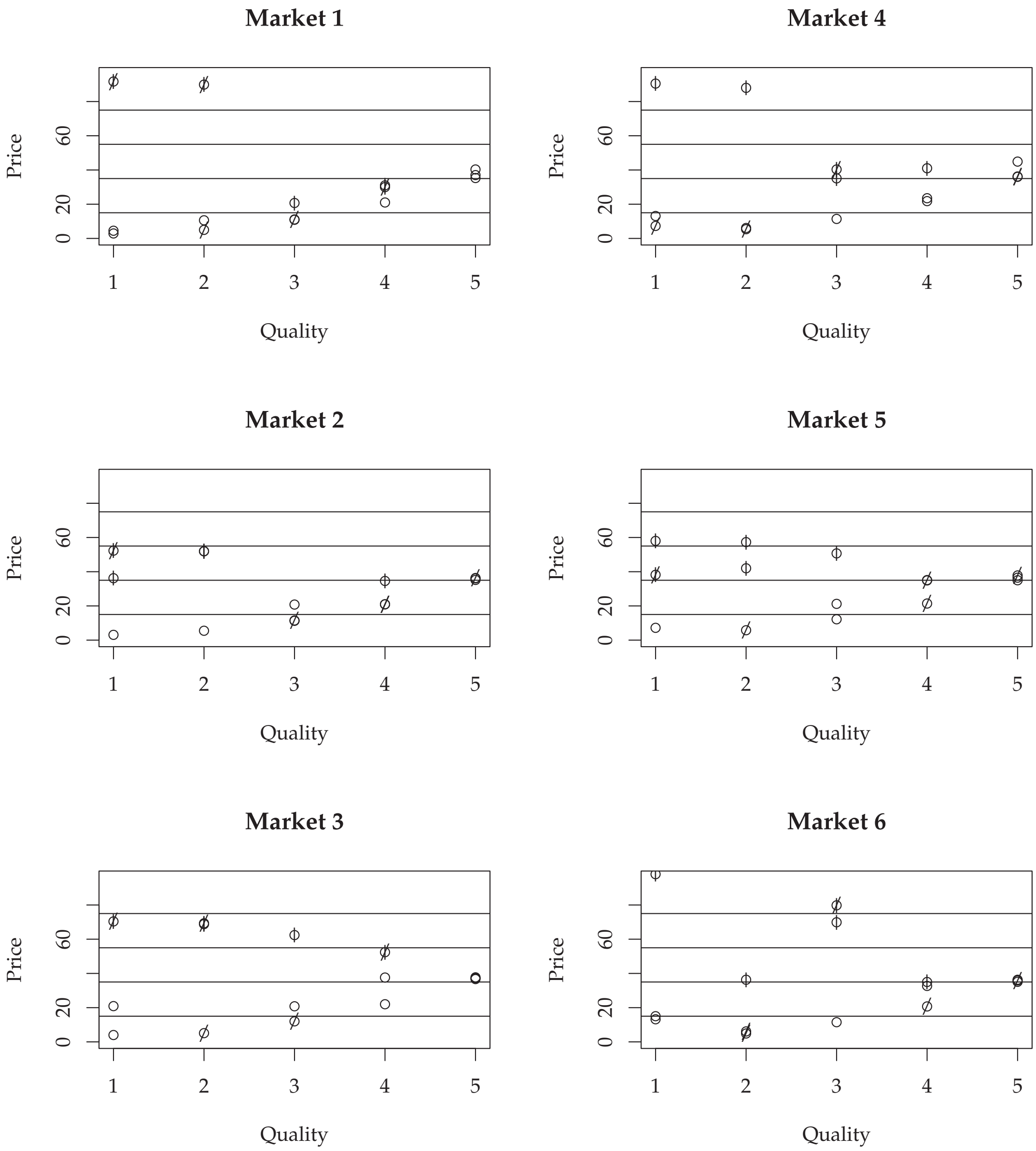
In the first line, we start with the globally non-dominated seller f_2 offering the highest quality. We analyze whether the buyers who would buy from f_2 under complete information, i.e. buyers b_7 and b_8 (see table 9), would prefer to buy the overall cheapest product model, or f_2's product model had he applied to be tested, irrespective of whether f_1 does or does not apply to be tested. Since $\mathbb{E}\Big(u_7(\theta_7, q_1, p_1)\Big) = \mathbb{E}\Big(u_8(\theta_8, q_1, p_1)\Big) < u_7(\theta_7, q_2, p_2) = u_8(\theta_8, q_2, p_2)$, it follows that b_7 and b_8 would buy from f_2 if he applied to be tested instead of selecting the overall cheapest product model from f_1. Seller f_2 would make zero profits if he does not apply to be tested since buyers do not consider non-tested product models except for the overall cheapest one. Therefore, if f_2 does apply to be tested stating his true quality, it follows that his profits would be at least as high as his profits under complete information minus the *application_fee*. Therefore, $\Big(p_2 - c(q_2)\Big)\Delta_2\mathbb{E}\Big(d(p_2, q_2)\Big) >$ *application_fee*.

In the second and last line, we use this result, i.e., that in equilibrium f_2 always has an incentive to apply to be tested stating his true quality, and continue with the globally non-dominated seller $f_{\sigma(F)^c} = f_1$. If he does not apply to be tested, $\mathbb{E}\Big(u_3(\theta_3, q_1, p_1)\Big) = \mathbb{E}\Big(u_4(\theta_4, q_1, p_1)\Big) = -0.1 < 0$. It follows that buyers b_3 and b_4 would refrain from buying f_1's product model if he does not apply to be tested. However, if f_1 does apply, $u_3(\theta_3, q_1, p_1) = u_4(\theta_4, q_1, p_1) = 10.4$. Therefore, if f_1 does apply to be tested stating his true quality, it follows that his profits would be at least as high as his profits under complete information minus the *application_fee*. It follows that $\Big(p_1 - c(q_1)\Big)\Delta_1\mathbb{E}\Big(d(p_1, q_1)\Big) >$ *application_fee*.

Therefore, $\Big(p_t - c(q_t)\Big)\Delta_t\mathbb{E}\Big(d(p_t, q_t)\Big) >$ *application_fee* holds for all sellers $f_t \in \{f_1, f_2\}$.

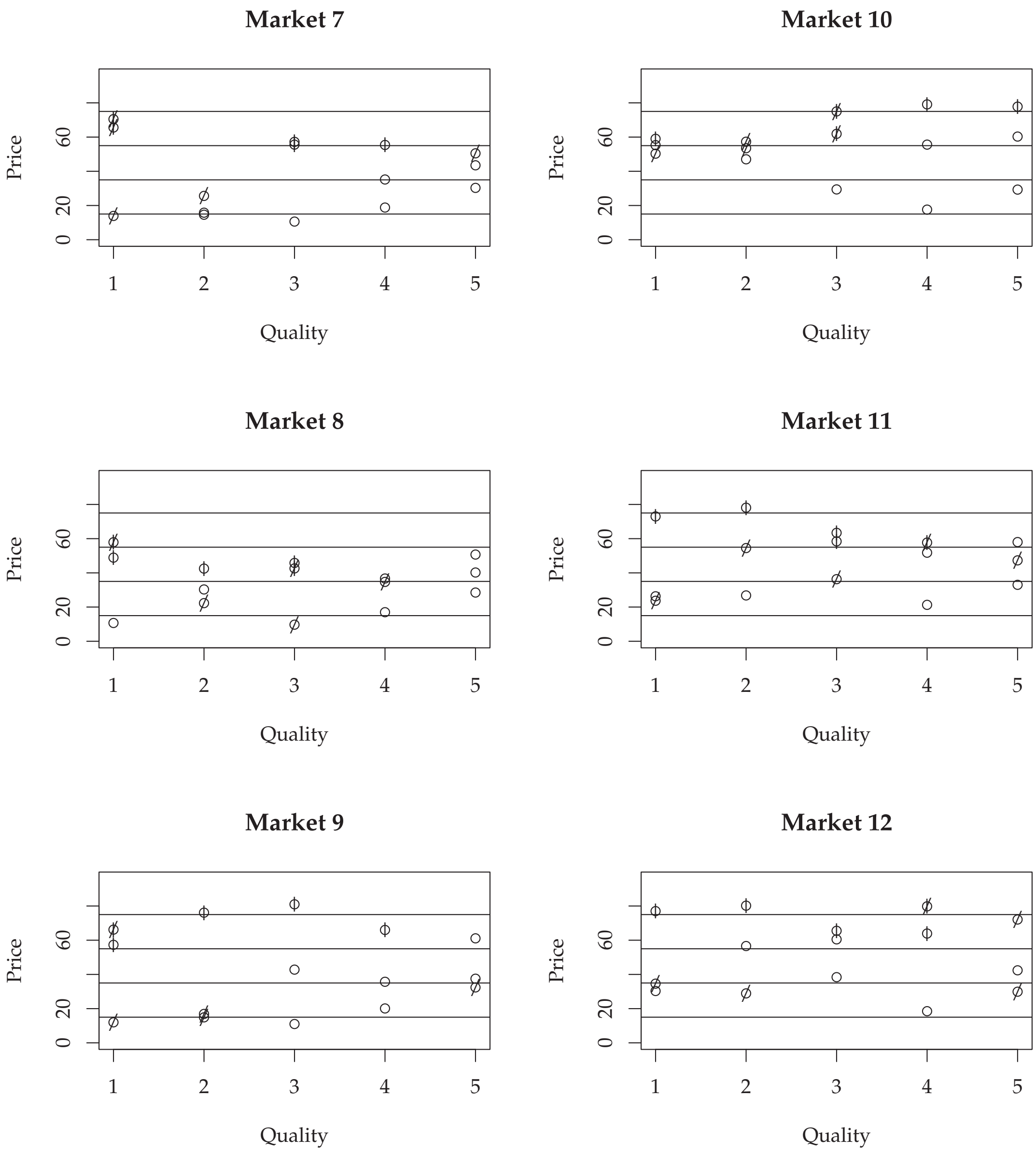
F Graphical overview of experimental markets

Figure 9: Overview of experimental markets



Note: Each dot represents one product model. Worst-case bestsellers are marked with |, random bestsellers are marked with /. Markets were played in the following random order: 3, 8, 6, 2, 11, 7, 1, 5, 9, 4, 12, 10.

Figure 10: Overview of experimental markets



Note: Each dot represents one product model. Worst-case bestsellers are marked with |, random bestsellers are marked with /. Markets were played in the following random order: 3, 8, 6, 2, 11, 7, 1, 5, 9, 4, 12, 10.

G Experimental instructions

This is a translated version of the instructions for SELLERSAPPLY-LYINGPOSS (original in German). Differences to the other treatments are included below.

Welcome to the experiment

You are participating in a study on decision-making behavior in experimental economics. During the experiment, you and the other participants will be asked to make decisions. You can earn money in doing so. The amount you will earn depends on your and on the other participants' decisions. At the end of the experiment, your earnings will be paid to you in cash. During the experiment, all amounts will be stated in the experimental currency "thaler" and will be converted into EUR at the end (4 thalers = 1 EUR). None of the other participants will receive information on your decisions or on your payoffs. All data will be used exclusively for research.

The experiment will last approximately 2.5 hours. Please read the following instructions carefully. Should you have questions at any point in time, please raise your hand. (Participants who are in one of the cubicles with doors, please open the door so that we can see you raising your hand.) We will come to you and answer your question at your cubicle.

Participants' roles The experiment consists of twelve rounds. There are two roles: sellers and buyers. First, it will be determined randomly which participants will be sellers and which will be buyers, and which sellers and buyers, respectively, receive which ID. You will keep your role and ID throughout the whole experiment. This means, if you were seller 1 in round 1, for example, you will remain seller 1 in all remaining rounds, or if you were buyer 1 in round 1, you will remain buyer 1 in all remaining rounds. There are 15 sellers an 8 buyers in total.

Sellers Sellers offer *identical* products each at a certain price, a certain quality and certain unit costs. A product belongs to one of five potential quality levels: 1 (poor), 2 (fair), 3 (satisfactory), 4 (good), 5 (very good), i.e., the higher the number, the higher a product's quality. Sellers are not able to influence price, quality and unit costs. These will be assigned to them each round.

Buyers Buyers select one seller per round, from whom they can buy at most one product. (They also have the option not to buy a product.) Buyers value the quality of a product differently. You can find the buyers' individual valuations in the following table. A buyer's individual valuation is multiplied by the quality of the product purchased, thus influencing the earnings per round (for details, see paragraph "Earnings per round"). It remains the same for each buyer throughout the experiment. Once a buyer has selected a product, it is considered purchased; the seller's consent is not required. It is possible for multiple buyers to buy from the same seller.

Available information At the beginning of each round, sellers are informed on the screen about their own price, unit costs and quality as well as the prices, unit costs and qualities of the other sellers. At the beginning of each round, buyers are informed about their own valuation of product quality (according to their buyer no. and the information in the table) and the prices of the products offered. It is also known that, in each round, 3 sellers offer products per quality level. This means that there are three sellers with poor product quality, three sellers with fair product quality, three sellers with satisfactory product quality, three sellers with good product quality and three sellers with very good product quality. In no round is it known whether there is a relationship between the price and quality of a product. In each round, assume that there are five sellers from whom purchases were made most frequently in the past, but the reasons for this are unknown. At the beginning of each round, you will be informed which these five sellers are .

Buyer ID	Individual valuation of quality
1	3
2	3
3	7
4	7
5	11
6	11
7	15
8	15

Product test The sellers are not able to influence price, quality and unit costs, but they have the opportunity to apply to a product testing organization such as Stiftung Warentest each round. The task of the testing organisation is to check the product quality and to disclose it to all buyers. This happens before the buyers decide which products to buy. If applicable, sellers must state the price and quality of their product (it is possible to lie about the quality) when applying, and pay an application fee of 0.50 thalers to the testing organization. Should the product test disclose that a seller stated a false quality, he will have to pay costs of 24.00 thalers for this false quality statement.

Testing capacity The capacity of the product testing organization is limited. Among the applicants, it selects a maximum of five sellers whose products it tests.
Step 1: The product testing organization first selects the sellers with the cheapest product per quality level for the test.
Step 2: Among these, should there be sellers with products that cost the same or more than a product of a lower stated quality than a product of a better stated quality, these products are excluded again. Only the remaining non-tested products will be tested. Products that have already been tested will never lose their testing slot.
Step 3: If, after the product test, it turns out that in this iteration at least one seller stated a false quality and if the maximum testing capacity has not yet been reached, the product testing organization re-starts with step 1. If, after

the product test, it turns out that all sellers stated the true quality in this iteration, no further products will be tested.

For step 1 and step 2, the product testing organization uses the stated qualities of non-tested products (because their true quality is not yet known). From the second iteration onwards, if applicable, it uses the true qualities of the products already tested (because their true quality is then known). If less than five products are selected by step 1 and step 2, fewer products will be tested accordingly. Should there ever be more applicants selected than the number of remaining testing slots, a random selection will be made among these applicants. The application fee of 0.50 thalers must be paid regardless of whether a product will eventually be tested or not. You can find an overview on page 4.

Earnings per round Each participant receives an initial endowment of 100 thalers. The earnings are determined as follows.

$$
\begin{aligned}
& Earnings\,seller\,per\,round: \\
& initial\,endowment \\
+ & (price \times number\,sold\,products) \\
- & (unit\,costs \times number\,sold\,products) \\
- & if\,applicable,\,application fee \\
- & if\,applicable,\,fee\,for\,stating\,false\,quality
\end{aligned}
$$

$$
\begin{aligned}
& Earnings\,buyer\,per\,round: \\
& initial\,endowment \\
+ & (quality \times ind.\,valuation\,of\,quality) \\
- & price
\end{aligned}
$$

In the course of the experiment, sellers will be asked how they think other participants will behave. For each answer that is correct, a seller will receive additional 0.50 thaler in the corresponding round. Sellers only receive feedback on how many of their beliefs were correct for the payoff-relevant round at the end of the experiment.

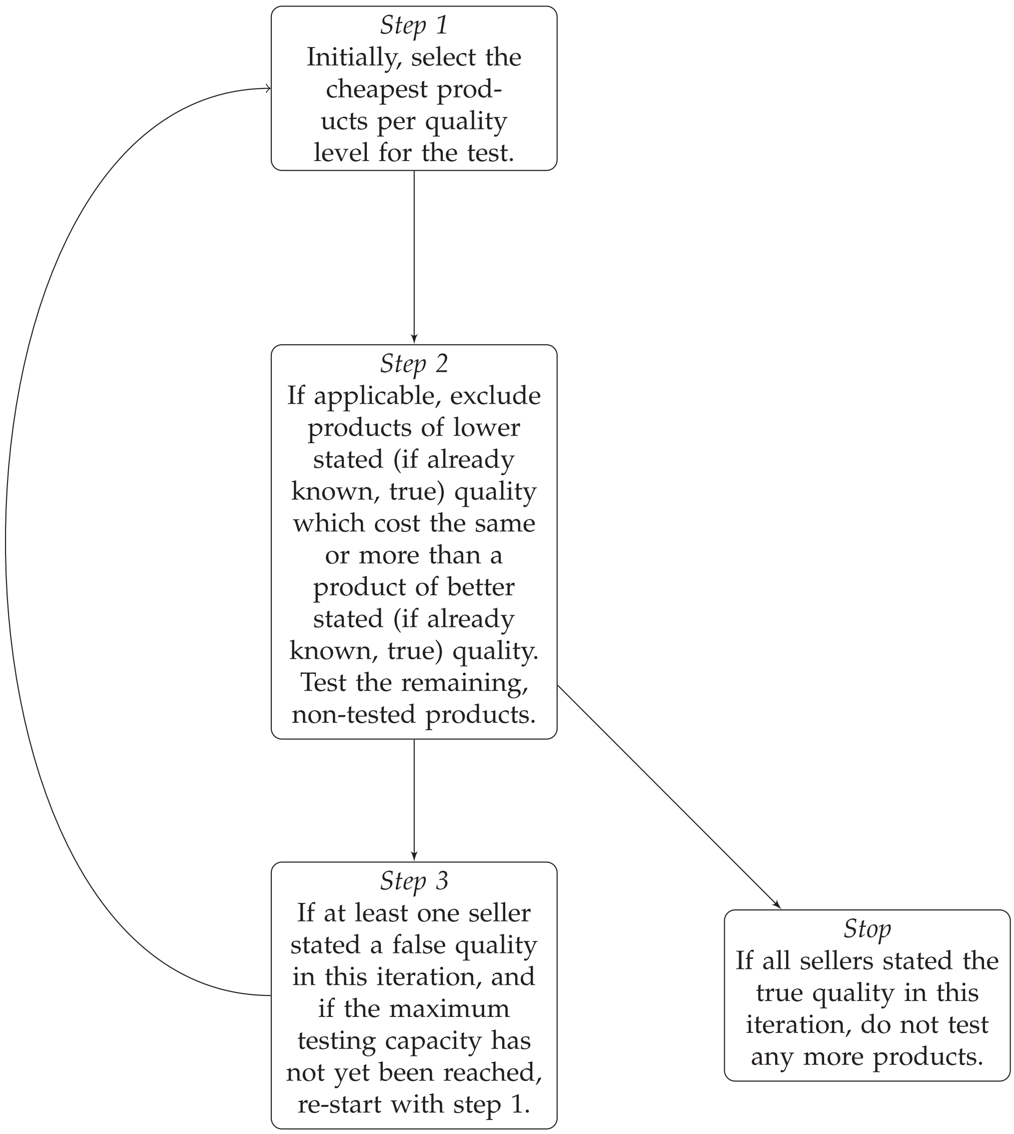
Payment When all twelve rounds will have been completed, the computer randomly selects one of the twelve rounds to be payoff-relevant for all participants. The other rounds are not taken into account for the payment. At the end of the experiment, each participant will receive the amount of money they have earned in the payoff-relevant round, converted into EUR (4 thalers = 1 EUR). If applicalbe, the amount is rounded up to a multiple of 0.10 EUR.

Comprehension questions Please click on "continue" on the screen when you will have finished reading the instructions and have no further questions until here. The experiment starts on the screen with comprehension questions. These comprehension questions are supposed to make it easier for you to become familiar with the decision-making situation. If you have any questions, please raise your hand. (Participants who are in one of the cubicles with doors today, please open the door so that we can see you raising your hand.) We will then come to you and answer your question at your cubicle. Once all participants will have correctly answered the comprehension questions, round 1 of the experiment will start.

Technical note For technical reasons, please enter a dot instead of a comma to separate decimal places in numbers if applicable.

We wish you success in the experiment!

Testing capacity and selection of products to be tested



Differences to other treatments

SELLERSAPPLY-TRUTH

Product test The sellers are not able to influence price, quality and unit costs, but they have the opportunity to apply to a product testing organization such as Stiftung Warentest each round. The task of the testing organisation is to check the product quality and to disclose it to all buyers. This happens before the buyers decide which products to buy. If applicable, sellers must state the price and quality of their product (it is *not* possible to lie) when applying, and pay an application fee of 0.50 thalers to the testing organization.

Testing capacity The capacity of the product testing organization is limited. Among the applicants, it selects a maximum of five sellers whose products it tests. The product testing organization first selects the sellers with the cheapest product per quality level for the test. Among these, should there be sellers with products that cost the same or more than a product of a lower stated quality than a product of a better stated quality, these products will not be tested. If less than five products are selected via this method, fewer products will be tested accordingly. The application fee of 0.50 thalers must be paid regardless of whether a product will eventually be tested or not.

$$\begin{aligned}
&Earnings\,seller\,per\,round:\\
&initial\,endowment\\
+&(price\ \times number\,sold\,products)\\
-&(unit\,costs\ \times\ number\,sold\,products)
\end{aligned}$$

The figure “Testing capacity and selection of products to be tested” was not included.

BESTSELLERS-WORSTCASE and BESTSELLERS-RANDOM

Product test Each round, a product testing organization such as Stiftung Warentest tests certain products. The task of the testing organisation is to check the product quality and to disclose it to all buyers. This happens before the buyers decide which products to buy.

Testing capacity The capacity of the product testing organization is limited. It selects five sellers whose products it tests, namely each round the five sellers from whom the most frequent purchases were made in the past.

$$\begin{aligned}
&Earnings\,seller\,per\,round:\\
&initial\,endowment\\
+&(price\ \times number\,sold\,products)\\
-&(unit\,costs\ \times\ number\,sold\,products)
\end{aligned}$$

The figure “Testing capacity and selection of products to be tested” was not included.

H Screenshots of main decision situations in z-Tree

These are translated z-Tree screenshots of the main decision situations for BESTSELLERS-WORSTCASE and SELLERSAPPLY-LYINGPOSS (original in German).

Figure 11: BESTSELLERS-WORSTCASE seller's screenshot

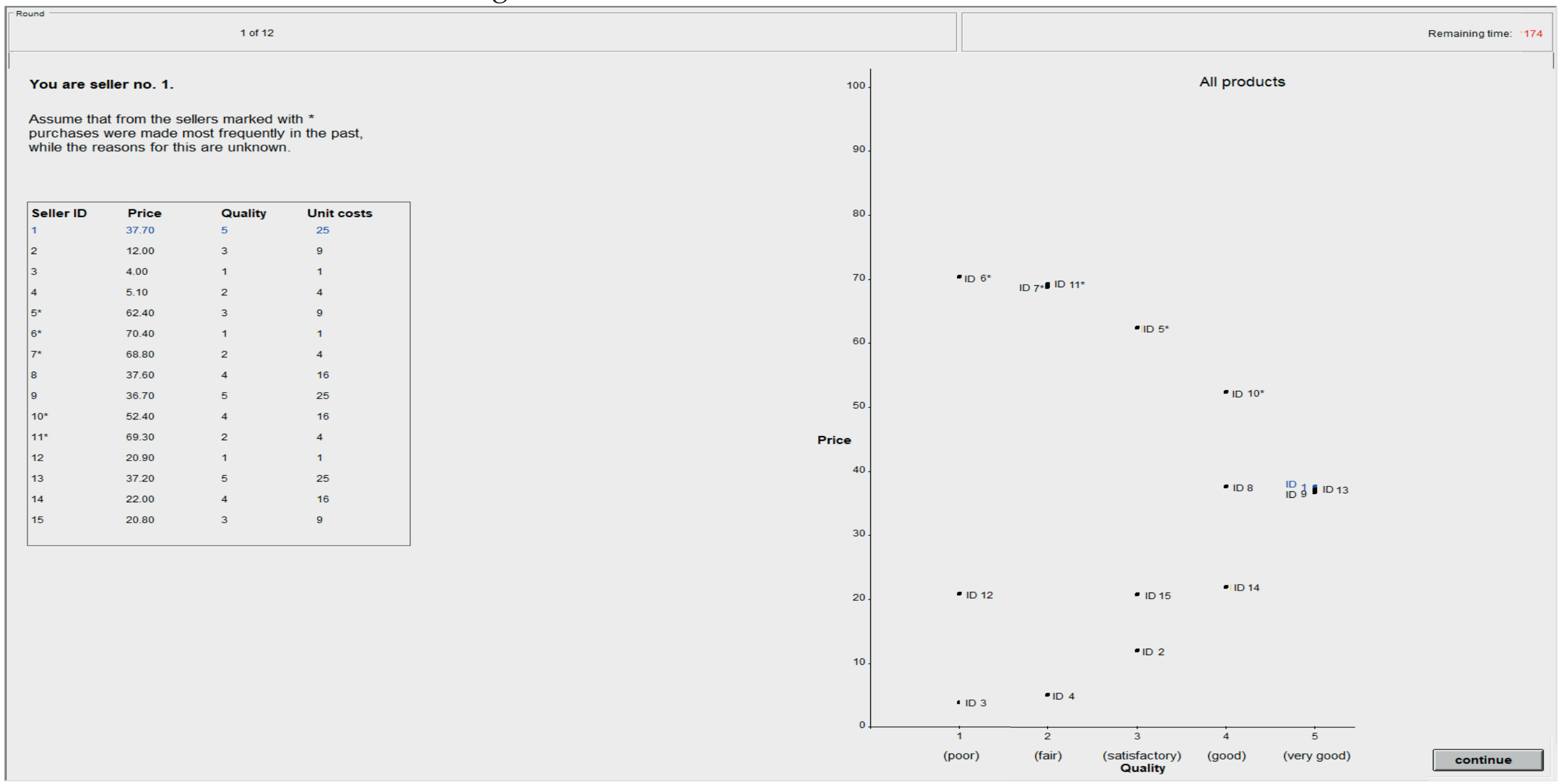


Figure 12: BESTSELLERS-WORSTCASE buyer's screenshot

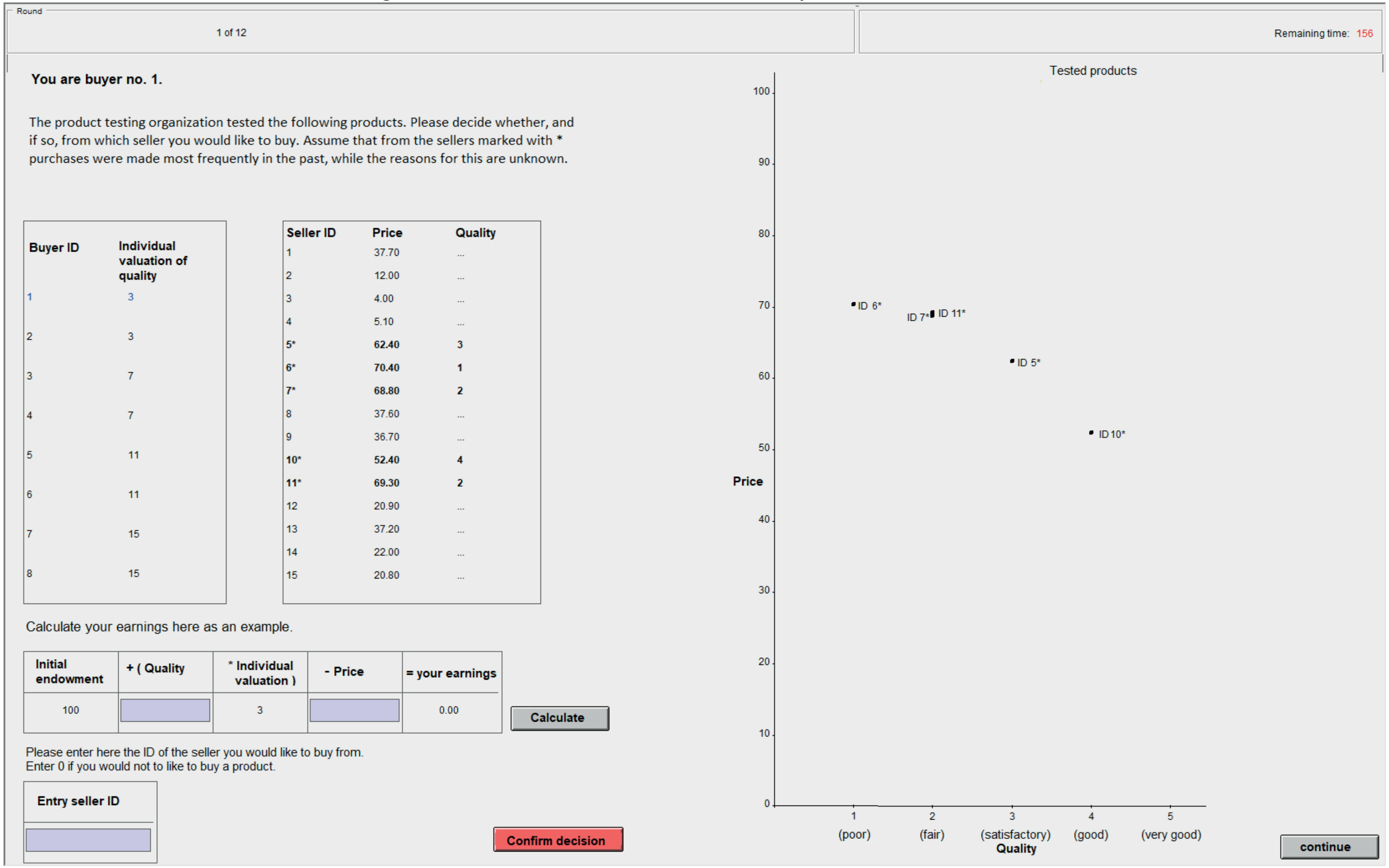


Figure 13: SELLERSAPPLY-LYINGPOSS seller's screenshot

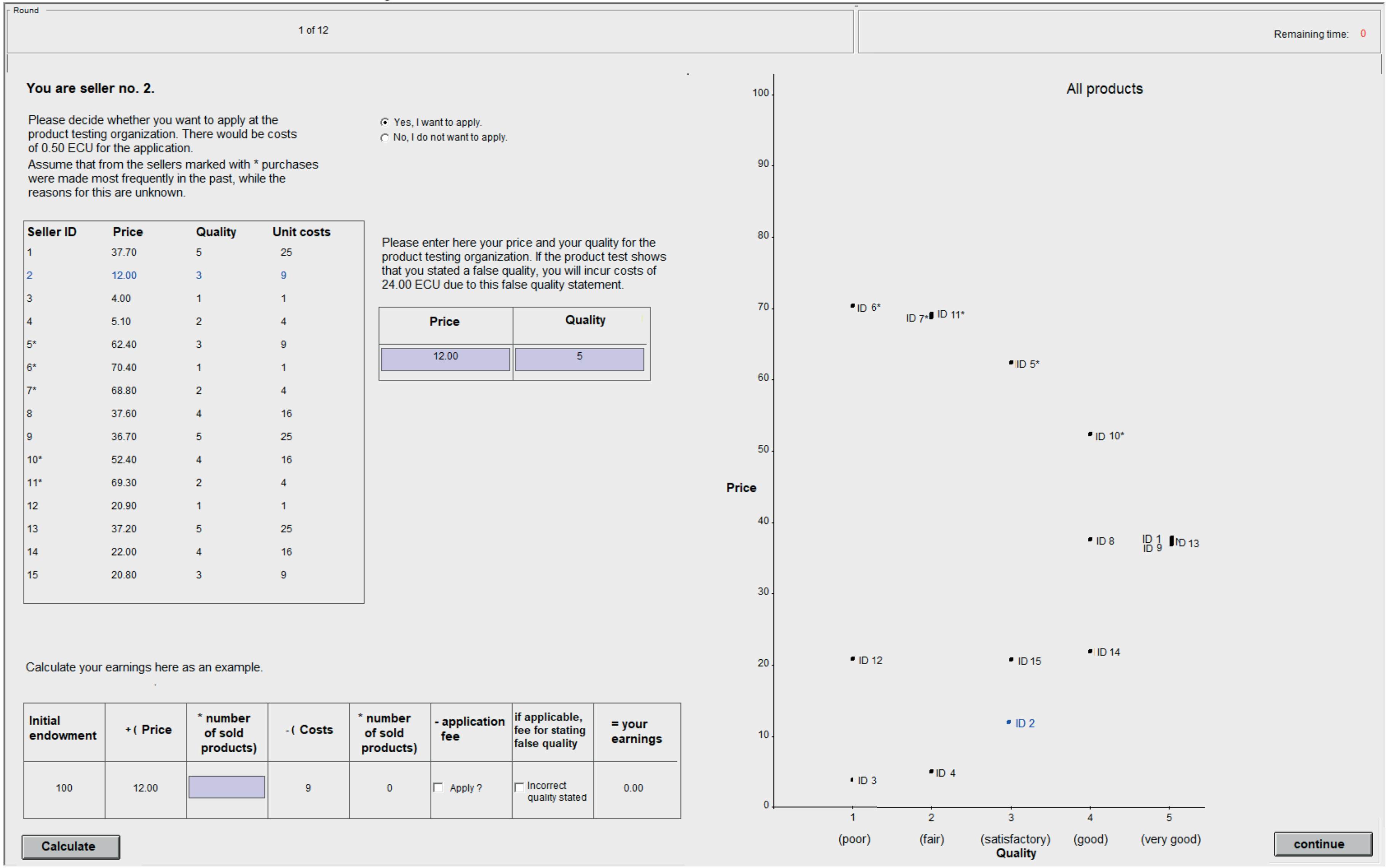


Figure 14: SELLERSAPPLY-LYINGPOSS buyer's screenshot