Product Complexity and Search

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Abstract

In many situations, consumers buy complex products without being aware of what they are actually buying: goods are simply too difficult to understand for them. I study the incentives of firms to obfuscate their products and the effects of such product complexity on profits and welfare in a duopoly search model. I show that when firms can simultaneously choose prices and complexities of their products, competition is not effective under fairly general assumptions: equilibria in which firms do not charge monopoly prices cannot exist. Consumers suffer from complexity because it prevents them from finding out about which deal is best for them. Moreover, it keeps them from searching which in turn softens competition. Neither competitive pressure nor a decrease in search cost lead to better information for consumers.

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1 Introduction

There are numerous examples in real life where consumers buy goods or sign contracts without being aware of what they get for the money they spend or which price they ultimately end up paying. While this clearly applies to goods that cannot be evaluated before purchase (experience goods) this also often happens with products for which this could generally be done (search goods). Mobile phone contracts, bank accounts, credit offers, and insurance contracts are just a few examples. What all of them have in common is that in principle it would be possible to acquire all relevant information before purchasing. All contract terms are available to consumers and in most instances it is not even complicated to get access to them: information can be found online and hence is just a couple of clicks away. The way in which information is presented, however, makes it difficult or even impossible for consumers to understand and compare offers.

These markets are also characterized by surprisingly little search for better deals. Empirical evidence shows that people often do not compare alternatives and do not know about the conditions of the contracts they signed. OFT (2008), for instance, provides evidence that 70% of consumers do not shop around for credit card offers and 75% of consumers do not know the annual percentage rate (APR) of their credit cards. Moreover, even those people who do search for better offers often fail to select the best deal available (see e.g. Wilson and Price (2007) for a study of switching behavior in the electricity market).

The question arises why firms want to make it difficult for consumers to find out about what exactly they have to offer in the first place and what role competition plays in this context. The next step is then whether and how firm's behavior differs from social interests. This paper sheds some light on these questions.

The point it emphasizes is that in the presence of search costs, firms have no incentives to provide consumers with more information than they anticipate to obtain once they have incurred search costs. The argument goes as follows. Suppose a consumer needs to buy a good. Goods are horizontally differentiated and thus may match her tastes or not. There are several firms, each offering one alternative of the good and the consumer selects a first firm to visit. Suppose moreover that firms can obfuscate their products such that a consumer cannot tell to which degree it is suitable for her or not. If products were transparent, a consumer would evaluate the first product and then, depending on how it matches her tastes, decide to buy or visit another firm. If all products are so complex that the consumer does not understand any them, her sole objective for searching would be to find a lower price (given that she is at least able to understand prices). However, if prices are the same (or if she does not understand prices at all), which is the case in a symmetric equilibrium, a consumer has no incentive to do so and always buys at the first firm she visits. By unilaterally making its own product transparent, a firm only allows the consumer to find out about bad matches. In case the product fits her, she buys it, if it does not fit, she goes on to search other firms. However, she would have bought the product if she did not understand it knowing that she wouldn't understand the other products in the market.

Moreover, firms may benefit from unilaterally hiding information even if consumers anticipate to understand their offer beforehand. If a consumer does not find it worthwhile to search other products and is willing to settle with a product she does not understand, a firm never finds it profitable to provide product information.

In traditional models of product differentiation, the prevailing view is that firms benefit from increased perceived differentiation of their products. The present paper highlights that in the presence of search costs, the opposite is true. By offering complex products, firms can eliminate consumers' incentives to search and thus soften competition.

The rest of the article is organized as follows. The next section briefly reviews the related literature. Section 3 introduces the basic model. Section 4 analyzes the monopoly case. The subsequent section then analyzes the price and complexity choice game. Section 6 discusses the results and comments on the modeling assumptions. The final section offers some concluding remarks.

2 Related literature

In terms of modeling, this paper is most closely related to work in the areas of search, advertising and product design.

There has been a large literature on the effects of search costs on firm's pricing behavior. The main focus of it has been to explain price dispersion of homogenous goods. Stahl (1989) for instance shows that firms' equilibrium price distributions change smoothly from competitive marginal cost pricing to monopoly pricing as the distribution of search costs shifts towards higher search costs.[1] However, only recently Ellison and Wolitzky (2009) have proposed a model where obfuscation in the sense of unilaterally increasing search cost is individually rational for firms. Assuming convex search costs for

[1]In the literature on search with homogenous goods, equilibria are in mixed strategies only. Hence there are only equilibrium price distributions and not single equilibrium prices.

consumers, they show that firms deliberately choose to increase search cost to maximize their profits. All this literature has to assume that there are some consumers without any search cost to overcome the Diamond paradox: even if search costs are arbitrarily small for all consumers, having each firm charging monopoly prices is an equilibrium.

An alternative specification to avoid this and achieve pure strategy equilibria at the same time is to allow for product heterogeneity. Anderson and Renault (1999), extending Wolinsky (1986), study the role of product differentiation and search costs in such an environment. In the limit, their model yields the Diamond paradox (as product differentiation vanishes), monopolistic competition (as search cost become negligible) and the Bertrand paradox (as search costs and differentiation disappears).

Another literature has investigated the role of advertising as a mean to inform about product characteristics and prices. Lewis and Sappington (1994) show that a monopolist either perfectly informs consumers about their valuation for its product or provides no information at all. Johnson and Myatt (2006) study product design choices of a monopolist in the sense of altering the taste variance for its product. They show that a firm always chooses extreme designs, appealing to as many consumers as possible or produce the most controversial design possible. Moreover, the firm supplies consumers with either full information about its product or no information at all before they start searching. Related to the present paper is the work by Bar-Isaac et al. (2011). They study firms' product design choices in a competitive environment with sequential search.[2] Their results suggest that low quality firms choose extremal designs with large taste heterogeneity whereas high quality firms try to appeal to a broad mass of consumers. A similar point is made by Anderson and Renault (2009) in the context of advertisement: quality disadvantaged firms would like to differentiate themselves from their competitor by informing consumers about product attributes through comparative advertising. While for similar qualities the advantaged firm also prefers to provide consumers with their product attributes, for large quality differentials, the high quality firm prefers consumers to have as little information as possible.

Moreover, there have been a couple of papers about product complexity in different modeling contexts. Carlin (2009), for instance, studies firms' complexity choices and pricing strategies in a model of all-or-nothing search with homogenous products. Complexity increases the cost of finding out about the best deal in the market in his model. He shows that there exists a mixed-strategy equilibrium in this game where firms ran-

[2] Larson (2011) uses a similar set-up to study endogenous product differentiation.

domize over complexity and prices. In this equilibrium, high complexity goes along with high prices. When a firm charges a high price (above some cutoff), it obfuscates its product as much as possible whereas for low prices, it makes its product as transparent as possible.

Gabaix and Laibson (2003) model product complexity as spurious product differentiation in a model without search. Despite the latter difference, it yields qualitatively similar predictions to Bar-Isaac et al. (2011): low quality firms prefer their product to be excessively complex (equivalent to have a high taste variance) while high quality firms want their products to be overly simplistic (low taste variance).

In Bar-Isaac et al. (2010) a monopolist can choose the easiness with which consumers can acquire information about its product. Search costs are modeled as costs of obtaining information and consumers can buy without being informed about the product's characteristics. This contrasts the notion of search costs being transportation costs (and hence necessary to incur in order to purchase) that is used in the literature on search and product design and also in this paper. They show that it might be optimal to choose an intermediate strategy, i.e. impose intermediate costs on consumers to find out about product characteristics in order facilitate price discrimination or to commit to producing a high quality product.

This paper takes a different view and assumes that product differentiation is exogenously given. It then studies firms' decisions to make information about their products accessible through search or not.[3] Contrary to the previous literature, search does not necessarily yield information about horizontal product characteristics. The core question is how firms want to use their ability to conceal information.

3 The model

There are two profit-maximizing firms, denoted by $j = 1,2$, each selling one variant of a horizontally differentiated good of the same quality.[4] The price they charge consumers is given by p_j. For simplicity, firms do not face fixed costs and marginal costs for production are normalized to zero.

[3] Anderson and Renault (2012) take a step in the opposite direction and consider a model where also quality is not an experience characteristic but observable through search.

[4] The basic setup shares elements with Wolinsky (1986), Anderson and Renault (1999) and in particular, Anderson and Renault (2000). The new component is that firms have the possibility to obfuscate consumers as detailed later on.

There is a continuum of risk-neutral consumers with mass normalized to one. Consumers have inelastic unit demand and buy at most one product. When buying from firm j, a consumer i obtains utility (ignoring search costs detailed later on):

$$u_{ij}(p_j) = v - p_j + \epsilon_{ij}$$

where the fixed utility from buying either good is denoted by v and ϵ_{ij} captures the idiosyncratic match value of consumer i for product j. The ϵ's are realizations of random variables which are independently and identically distributed across consumers and firms over the interval $\left[\underline{\epsilon}, \overline{\epsilon}\right]$. The common density function $f(\epsilon)$ is assumed to be log-concave and twice continuously differentiable. The corresponding distribution function is denoted by $F(\epsilon)$ and the expectation of ϵ_{ij} by $\mathbb{E}(\epsilon)$.

In order to sample a firm, consumers incur a non-monetary search cost c. Search costs can thus be seen as transportation costs of consumers to reach a firm. For simplicity, the first visit is assumed to be costless and thus does not play any role as in most of the literature.[5] Returning to a firm later on is assumed to be costless. Consumer's search is directed and sequential. Depending on their beliefs about prices and complexities of firms, denoted by $\tilde{p}_j$ and $\tilde{\theta}_j$, consumers visit the firm first where they assume to find the better deal. In case of indifference, they visit each firm first with equal probability. After that, they decide whether to search the other firm or not.

Upon sampling firm j, consumers see the price p_j. Contrary to the existing literature, depending on the complexity $\theta_j \in \{0,1\}$ of the product, consumers either understand the product or not. If $\theta_j = 0$, firm j's product has a low level of complexity: consumers are able to evaluate the product upon sampling, they learn their idiosyncratic match value when visiting the firm. On the contrary, if $\theta_j = 1$, consumers are not able to do so and keep the correct belief that $\epsilon_{ij} = \mathbb{E}(\epsilon)$.[6] Complexity choices are assumed to be costless.

This setup can be reinterpreted in the following way. Consider a situation where con-

[5] Note that the assumption of a free first visit plays a role for whether the Diamond paradox results in consumer purchasing at monopoly prices or market breakdown as noted by Stiglitz (1979) but does not change any results of the present paper. It allows me to focus on consumers decisions to shop around and abstract from the possibility of hold-up on the first visit. Moreover, there are other ways to circumvent market breakdown in situations where the Diamond paradox holds by either introducing a mass of sophisticated consumers who cannot be obfuscated or by treating the fixed utility as income as in Anderson and Renault (2000). An exception is Anderson and Renault (2006) which focuses on a monopolist's optimal way to solve the hold-up problem through advertisement.

[6] In several papers (e.g. Armstrong et al. (2009) or Schultz (2005)) some consumers are assumed not to observe prices rather than not observing characteristics. Hence they have inelastic demand for one product.

sumers are confronted with a set of usage prices, e.g. a mobile phone contract. Product differentiation can be thought of as different firms charging different prices for different services and the contract being a bundle of all these services (calls, messages, roaming etc.). What matters is that consumers derive different levels of utility from the same good. Whether the utility of having the good is the same for all consumers but they pay different prices because of different usage, they differ in their utility of having the good only, or they differ in both dimensions is irrelevant. If the offer a consumer faces is complex ($\theta_j = 1$), she is not able to evaluate the effective price she ends up paying when signing a contract. The assumption that she holds correct beliefs about it means that despite not understanding a product, she is right "on average" and cannot be fooled systematically. Modeling uncertainty on product characteristics rather than price allows to keep prices as the strategic variables of firms.

Alternatively, the model can be interpreted as one of product design where firms face the choice of offering a homogenous mass market product or a differentiated product targeting a niche of the market.

To fix ideas, consider the following timing of the game:

Figure 1: Timing

In the first stage, firms choose product complexities and prices simultaneously. After that, depending on their beliefs about prices and complexity levels, consumers pick one firm for their first search. They either buy there, continue to search the other firm or leave the market. In case they visit the other firm, they either buy there, return to the first firm to buy there or don't buy at all.

The simultaneity of firms' decisions on prices and complexity captures the idea that deviations could occur on both dimensions: firms can change their product complexity and adjust their price at the same time. In the literature on product design which is mainly concerned with physical goods, it is reasonable to assume that design and price choices are sequential: once a product is built, it is easy to change the price but not its characteristics. The present paper, however, rather aims at explaining the complexity of contracts and studies firms' incentives to hide product information. The simultaneous decision about complexity and price can be interpreted as giving sales advice in this context. Absent advice, a consumer is not able to understand the product since, e.g. the relevant information is buried in the fine print of a contract and the consumer has no chance to find it by herself. The firm has the choice to inform the consumer upon her visit about the product or not. Clearly this decision can be made as easy as changing the price. Moreover, if we think about interactions taking place online, it is straightforward that all information on a webpage, price and product description, can be changed at the same time.

The solution concept that will be used throughout the paper is that of a Perfect Bayesian Equilibrium with passive beliefs. Hence, an equilibrium is characterized by :

- Firms maximize their own profits given the expected price of the rival and consumer search behavior.
- Consumer behavior is utility maximizing given prices and product characteristics observed and anticipated.
- Anticipated prices and complexities are consistent with equilibrium strategies and independent of those already observed.

4 Monopoly case

Before turning to the main analysis, let us examine the complexity choice of a monopolist, i.e. under which conditions a monopolist would like to provide consumers with information about the product it sells. This will help to understand the results of the competitive setting. Lewis and Sappington (1994) study a similar problem and hence the main intuition carries over to this analysis.

If a monopolist offers a complex product to consumers (equivalent to a homogenous product), it can charge a price $p_c^m = v + \mathbb{E}(\epsilon)$ equal to the mean valuation and sell to all consumers, resulting in profits

$$\pi_c^m = v + \mathbb{E}(\epsilon) \tag{1}$$

On the contrary, if a monopolist provides consumers with information about the product and charges a price p_t^m, it sells to all consumers who derive positive utility ($U_{ij} \geq 0$) from the good. Only consumers whose idiosyncratic match value is sufficiently high, i.e. those with $\epsilon_{ij} \geq p_t^m - v$, buy in this case. The monopolist's demand is hence given by $1-F(p_t^m-v)$ and its profits by

$$\pi_t^m = p_t^m D_t^m = p_t^m(1-F(p_t^m-v)) \tag{2}$$

where p_t^m optimally solves $p_t^m = \max\{\frac{1-F(p_t^m-v)}{f(p_t^m-v)}; v+\underline{\epsilon}\}$. Note that p_t^m is well defined due to the assumption of log-concavity of the density $f(\epsilon)$ which ensures strict quasi-concavity of the profit function.

We can now turn to the question in which situations a monopolist prefers to supply or hide information about its product. The following lemma will be useful for the subsequent analysis.

Lemma 1 *Depending on the fixed valuation v and the distribution $F(\epsilon)$, a monopolist prefers to offer a complex product and hide information if and only if π_c^m given by (1) exceeds π_t^m given by (2).*

Comparing the profits under the two strategies shows that the higher the fixed valuation v and the lower the taste variance, the more profitable it is to obfuscate the product. Moreover, by imposing the following condition on the skewness, I can be more precise when this is the case. The property of skewness I exploit in this paper is that a right-skewed distribution has a mean exceeding the median whereas for a left-skewed distribution the opposite holds. Strictly speaking, this holds if the measure of skewness taken is Pearson's second skewness coefficient which ranks the mean and the median in this way. The standard definition of skewness as the third standardized moment yields the same ranking of the mean and the median of a distribution for almost all distributions that are log-concave and continuous (except for e.g. the Weibull distribution over a small set of parameters, see von Hippel (2005)). As shown in MacGillivray (1981) the ranking of mean and median according to the skewness is valid for the entire Pearson family of distributions which encompasses all examples mentioned in this paper.

Lemma 2 *If the distribution $F(\epsilon)$ is skewed to the right or symmetric and $v \geq \frac{\overline{\epsilon}}{2} - \frac{3\mathbb{E}(\epsilon)}{2}$ (or $v \geq -\frac{\overline{\epsilon}}{4} - \frac{3\underline{\epsilon}}{4}$), the condition of Lemma 1 is satisfied.*

Proof. To start, note that it is more profitable to provide information for the monopolist the more high valuation consumers there are. Given the assumption of log-concavity and right-skewness or symmetry, the distribution that puts most weight on the upper tail is the uniform distribution. Hence, any condition that satisfies Lemma 1 for the uniform distribution is sufficient to guarantee it for any other symmetric or right-skewed log-concave distribution.

Targeting a niche can only be profitable if $p_t^m > p_c^m = v + \mathbb{E}(\epsilon)$ since the demand captured with a transparent product is below 1. Using log-concavity and the uniform distribution:

$$\pi_t^m = p_t^m(1-F(p_t^m - v)) = \frac{(1-F(p_t^m - v))^2}{f(p_t^m - v)} \leq \frac{(1-F(p_t^c - v))^2}{f(p_t^c - v)} = \frac{1}{4f(\mathbb{E}(\epsilon))}$$

Hence it is profitable to offer a complex product if

$$\frac{1}{4f(\mathbb{E}(\epsilon))} \leq v + \mathbb{E}(\epsilon) = v + \frac{\overline{\epsilon}+\underline{\epsilon}}{2}$$
$$v \geq -\frac{\overline{\epsilon}}{4} - \frac{3\underline{\epsilon}}{4} \Leftrightarrow v \geq \frac{\overline{\epsilon}}{2} - \frac{3\mathbb{E}(\epsilon)}{2}$$

■

Note that most of the commonly used log-concave distributions are either symmetric or right-skewed, e.g. the uniform, the (log-)normal, the exponential, and the logistic distribution.

Moreover, the following holds:

Corollary 3 *If the product is considered a "good" for all realizations of ϵ, i.e. $v + \underline{\epsilon} \geq 0$, obfuscation is strictly profitable.*

This says that if the utility from the product is positive for all realizations of the idiosyncratic match value, then a monopolist prefers to hide all information. This is due to the fact that by hiding information, a firm can extract all expected surplus from consumers (see also Lewis and Sappington (1994)). Hence a necessary condition for firms preferring to inform consumers is that there are some consumer types with which trade would be inefficient. From lemma 2, the mass of consumer types for which this is the case has to be substantial.

Almost all of the recent literature assumes full coverage of the market, the fixed utility is high enough such that all consumers buy in equilibrium. Hence, under this assumption and the most commonly used distributions, the prediction is that a monopolist chooses to offer a complex product. More generally speaking this holds if a monopolist could profitably sell to the vast majority of consumers.

5 Price/Complexity choices

Depending on the beliefs of consumers about the chosen complexity of each firm, different demand structures arise. The beliefs about whether to find a complex product at a firm or not affect the search behavior of consumers. In order to check for the existence of equilibria for each possible complexity configuration (both firms transparent, only one firm transparent, both complex), I start by assuming that firms set complexity levels equal to consumers' beliefs. I then derive candidate equilibria for each case by maximizing firms' profits for given consumer beliefs about prices. Afterwards, I check for the profitability of possible deviations on both dimensions, complexity and price. I will focus on non-trivial equilibria in my analysis. Having both firms charging prices above any consumer's valuation for its good and consumers not visiting any firm are such trivial equilibria that always exist. Let us now turn to the competitive setting and start with the case where consumers believe that they understand both products. This corresponds to the standard case that has been treated in the literature (e.g. Wolinsky (1986) and Anderson and Renault (2000)).

5.1 Benchmark: full transparency

In the following I am looking for a symmetric equilibrium where both firms offer transparent products and charge the same price. I will concentrate on the case where the market is fully covered, i.e. I assume that the fixed utility from buying either good is sufficiently high such that all consumers would buy in equilibrium. At least some consumer find it worthwhile to search for equal prices, search costs are not prohibitively high.

Consumers search firms sequentially with costless recall. This leads them to optimally use a simple stopping rule as follows. Since I am focusing on a symmetric equilibrium, consumers randomly choose one firm to visit first. They then buy from that firm if their match value is sufficiently high. If not, they go on to search the second firm. If they find a better match there, they buy at the second firm, otherwise they return to the first firm and buy there.

Consider a consumer who starts at firm 1. Intuitively, a consumer wants to search the second firm if the expected gain from doing so exceeds the search costs. Throughout the paper I assume that a consumer does not carry out another search unless it is strictly better to do so. This tie breaking rule simplifies the exposition but does not affect the

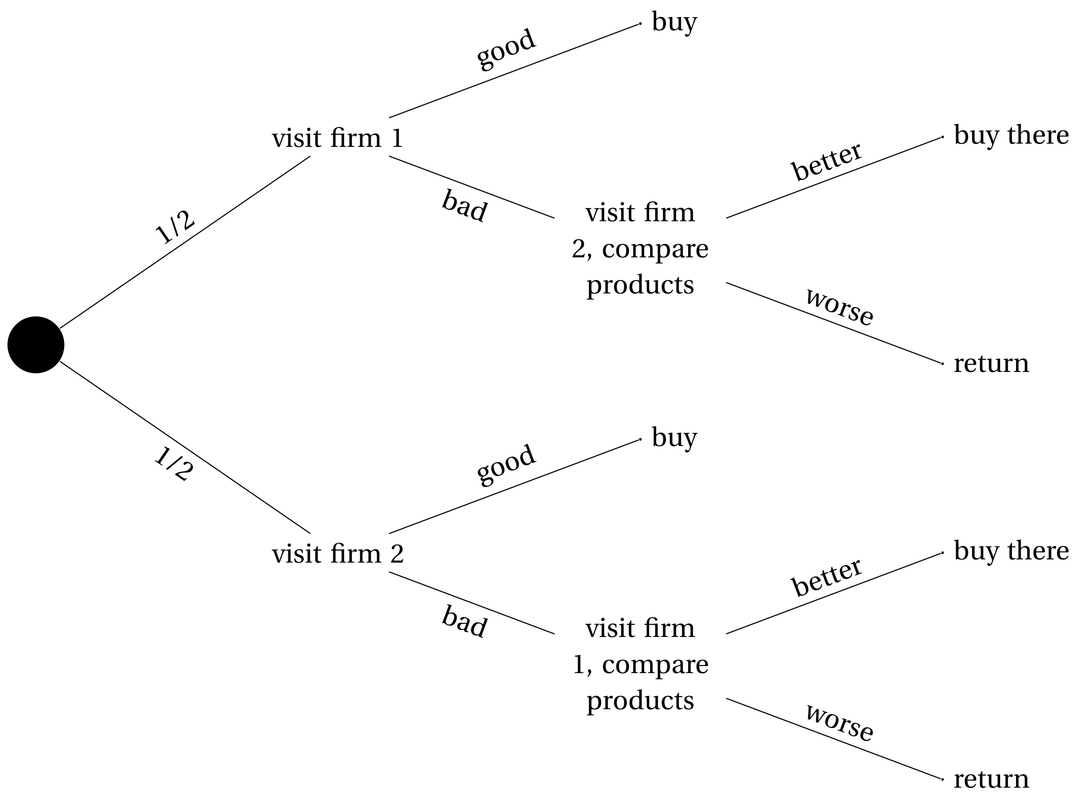

Figure 2: Consumer decision under full transparency

results qualitatively. A consumer will buy the second product if $\epsilon_2 - p_2 > \epsilon_1 - p_1$. The gains from search hence accrue from finding a higher match value and/or a lower price. Formally, the expected gain from search for a consumer is given by (see Wolinsky (1986) and Anderson and Renault (2000)):

$$\int_{\epsilon_1 - p_1 + \tilde{p}_2}^{\bar{\epsilon}} (\epsilon - \epsilon_1 + p_1 - \tilde{p}_2) f(\epsilon) d\epsilon$$

the expected increase in utility given that the consumer indeed prefers the second product over the first one. In order to derive the demand for a firm, let us start with the search behavior of consumers. After seeing the first product, a consumer wants to search the other firm if the gains from doing so exceed the search cost. Define $\hat{\epsilon}_1(p_1, \tilde{p}_2)$ as the match value a consumer visiting firm 1 first has to hold to be indifferent between buying from firm 1 and searching the other firm. For notational simplicity I will drop the arguments and simply write $\hat{\epsilon}_1$ in the following. Since the gains from search are decreasing in the match value the consumer currently holds, all consumers seeing $\epsilon_1 < \hat{\epsilon}_1$ at their first visit will go on to search the other firm, while those with $\epsilon_1 \geq \hat{\epsilon}_1$ buy upon their first visit. $\hat{\epsilon}_1$ is given by:

$$\int_{\hat{\epsilon}_1}^{\overline{\epsilon}} (\epsilon - \hat{\epsilon}_1) f(\epsilon) d\epsilon = c$$

Since the left-hand side is continuous and decreasing in $\hat{\epsilon}_1$ and between ∞ (at $\hat{\epsilon}_1 = -\infty$) and 0 (at $\hat{\epsilon}_1 = \overline{\epsilon}$), $\hat{\epsilon}_1$ is uniquely defined.

Demand for firm 1 is given as follows. Since the first search of consumers is random, one half of all consumers visit it first. Out of those consumers, those who learn about a match value of at least $\hat{\epsilon}_1$ do not want to search the other firm and buy directly from firm 1. Thus firm 1 sells to $\frac{1}{2}[1 - F(\hat{\epsilon}_1)]$, its first visitors that buy directly upon their first visit.

Firm 1's other first visitors go on to search firm 2. They then return and buy from firm 1 if they find a worse match at firm 2. The probability of a consumer finding a worse match at firm 2 given that they were willing to search it is given by $\int_{\underline{\epsilon}}^{\hat{\epsilon}_1} F(\epsilon - p_1 + p_2) f(\epsilon) d\epsilon$. The demand firm 1 captures is thus one half of this expression since this applies only to consumers visiting firm 1 first. Note that the expected price of firm 2 influences the decision to visit it but for the purchasing decision, only the actual price charged matters.

Finally, firm 1 sells to all consumers that initially visit its rival but then decide to visit firm 1 and find a better match there. This demand equals the conditional probability of finding a better match at firm 1 given that the match at firm 2 was sufficiently low to induce further search. It is given by $\frac{1}{2}\int_{\underline{\epsilon}}^{\hat{\epsilon}_2} \left[1 - F(\epsilon - p_2 + p_1)\right] f(\epsilon) d\epsilon$. Putting these parts together yields the total demand for firm 1:[7]

$$D_1 = \frac{1}{2}[1 - F(\hat{\epsilon}_1)] + \frac{1}{2}\int_{\underline{\epsilon}}^{\hat{\epsilon}_1} F(\epsilon - p_1 + p_2) f(\epsilon) d\epsilon + \frac{1}{2}\int_{\underline{\epsilon}}^{\hat{\epsilon}_2} \left[1 - F(\epsilon - p_2 + p_1)\right] f(\epsilon) d\epsilon$$

Taking the FOCs and using symmetry yields

$$p^* = \frac{1}{[1 - F(\hat{\epsilon})] f(\hat{\epsilon}) + 2\int_{\underline{\epsilon}}^{\hat{\epsilon}} f(\epsilon)^2 d\epsilon}$$

as the unique candidate equilibrium (see also proposition 3 in Anderson and Renault (2000)). Since prices are equal for both firms and demand is symmetric, firms share the market equally and profits are thus $\pi_1^* = \pi_2^* = \pi^* = \frac{1}{2\{[1-F(\hat{\epsilon})] f(\hat{\epsilon}) + 2\int_{\underline{\epsilon}}^{\hat{\epsilon}} f(\epsilon)^2 d\epsilon\}}$.

[7] Despite the different way of deriving and formulating demand, it is equivalent to the demand function derived in Anderson and Renault (2000) (equation (8)).

5.2 Symmetric equilibria

5.2.1 Full transparency

To check whether this candidate constitutes indeed an equilibrium, consider a deviation by one firm towards complexity while keeping the same price p^*. Without loss of generality the deviating firm will be firm 1 in the following. This affects consumers in the following way. All first visitors of firm 1 do not understand the product they see upon their first visit and hence keep the belief that their match value is equal to the expectation. Moreover, all consumers attach the same match value to product 1. Hence, all consumers make the same decision to search the rival firm or not: either they all go or they all stay. Their decision to visit firm 2 boils down to whether $\hat{\epsilon}(p^*, \tilde{p}^*)$, the match value for which they would be indifferent between buying and searching the other firm, is larger or smaller than their current match $\mathbb{E}(\epsilon)$. If $\mathbb{E}(\epsilon) \geq \hat{\epsilon}$, then all consumers do not want to search the other firm and directly buy from the deviating firm, otherwise all consumers go to see the rival.

The consumers visiting firm 2 first do not see this deviation and base their decision to visit firm 1 upon the expectation of understanding firm 1's product and finding p^* there. Hence, the fraction of consumers that decides to visit firm 1 after seeing firm 2 is unchanged.

The conditions under which such a deviation is profitable and hence there cannot be an equilibrium in which both firms offer transparent products are given in the following proposition.

Proposition 1 *There exists no full transparency equilibrium if search costs are sufficiently high such that $\hat{\epsilon} \leq \mathbb{E}(\epsilon)$. Moreover, there exists no such equilibrium for any level of search costs if the distribution $F(\epsilon)$ is skewed to the right or symmetric.*

Proof. For the first part of the proposition, consider a deviation by one firm towards complexity while keeping p^*. Since $\hat{\epsilon} \leq \mathbb{E}(\epsilon)$, all consumers starting at the now complex firm do not find it worthwhile to visit the rival firm and buy directly upon their first visit. Moreover, it must be that all the deviating firm's second visitors have learned a valuation below the expected value at the other firm. Hence it sells to all of them as well. The demand captured with such a deviation strictly exceeds $1/2$, each firm's demand in the candidate equilibrium. Thus becoming complex is strictly profitable if $\hat{\epsilon} \leq \mathbb{E}(\epsilon)$, independent of the skewness of the distribution of taste values.

What is left to show is that if $F(\epsilon)$ is skewed to the right or symmetric, this equilibrium does not exist even for lower values of search costs. Let us turn to the case where search costs are sufficiently low such that $\hat{\epsilon} > \mathbb{E}(\epsilon)$. This means that a consumer seeing a complex product upon her first visit and expecting the other firm to be transparent and to charge the same price finds it worthwhile to search. Once again, consider a deviation from the candidate equilibrium towards complexity without a change in price. As noted before, this induces all first visitors of the deviating firm to search the rival. Those consumers, however, who learn about a bad valuation at the other firm return. To be precise, $F(\mathbb{E}(\epsilon))$ of those consumers return. The second visitors of the deviating firm have learned about a relatively low valuation upon their first visit. However, since $\hat{\epsilon} > \mathbb{E}(\epsilon)$, those consumers with valuations above the expected value return to the firm they initially visited. This means that by such a deviation, a firm sells to $F(\mathbb{E}(\epsilon))$ of *all* consumers. Right-skewness implies that $F(\mathbb{E}(\epsilon)) > 1/2$, the mean value is above the median of the distribution. Hence such a deviation strictly increases demand. For symmetric distributions, $F(\mathbb{E}(\epsilon)) = 1/2$ and thus such a deviation towards complexity without changing price does not alter profits. Now consider a change in price accompanying the deviation to complexity. Taking the total differential of profits with respect to price evaluated at the candidate equilibrium price yields:

$$\left.\frac{d\pi}{dp^d}\right|_{p^d=p^*} = D^* + p^* \frac{\partial D^d}{\partial p^d} = \frac{1}{2} - \frac{f(\mathbb{E}(\epsilon))}{[1-F(\hat{\epsilon})]f(\hat{\epsilon}) + 2\int_{\underline{\epsilon}}^{\hat{\epsilon}} f(\epsilon)^2 d\epsilon} \leq 0 \tag{3}$$

This expression is negative by the following argument. As shown in Anderson and Renault (2000) (Corollary 1), p^* is increasing in search costs, hence attains its minimum at c=0 which is given by $\frac{1}{2\int_{\underline{\epsilon}}^{\overline{\epsilon}} f(\epsilon)^2 d\epsilon}$ as $\hat{\epsilon} = \overline{\epsilon}$, all consumers search both firms. Since $f(\epsilon)$ is symmetric and log-concave, it has its maximum at $\mathbb{E}(\epsilon)$. Thus $\int_{\underline{\epsilon}}^{\overline{\epsilon}} f(\epsilon)^2 d\epsilon \leq f(\mathbb{E}(\epsilon)) \int_{\underline{\epsilon}}^{\overline{\epsilon}} f(\epsilon) d\epsilon = f(\mathbb{E}(\epsilon))$ (see also Anderson and Renault (2009), Proposition 2). The denominator of the second part of (3) is thus smaller or equal than $2f(\mathbb{E}(\epsilon))$ and hence the whole expression is negative. Thus for $c > 0$, deviating to complexity and simultaneously slightly lowering price is strictly profitable. ■

The corollary of this proposition is that only if the distribution of taste values is left-skewed and search costs are sufficiently low, a full transparency equilibrium can exist. The conditions for non-existence are, however, sufficient but not necessary. Note that if search costs are such that $\hat{\epsilon}$ is just marginally larger than $\mathbb{E}(\epsilon)$, there exists no such equilibrium since a firm could deviate to deviate to a price to make its first visitors just indifferent between staying and searching. Such a deviation discontinuously increases demand and thus could be profitable. The situations in which a full transparency equilibrium can exist are hence very limited.

The intuition why a full transparency equilibrium cannot exist in most cases when firms can simultaneously choose their prices and transparency is the following. For high search costs, a firm can deviate to complexity and keep all its first visitors without having to lower its price. Since it also sells to all its second visitors at the same price, such a deviation is profitable independent of the distribution of taste values. Moreover, just by obfuscating its product and charging the candidate equilibrium price, a firm is able to increase its demand if $F(\epsilon)$ is skewed to the right. If the distribution is symmetric, a deviation to complexity rotates the demand curve for the deviating firm (demand becomes more elastic) where the rotation point is given by the candidate equilibrium price. Hence a deviation becomes strictly profitable if the change in complexity is accompanied by a slight decrease in price. If the distribution of taste values is skewed to the left, just moving to complexity results in lower demand, there is a disadvantage of being the firm whose match values are unknown to consumers. However, by changing the price as well as complexity, such a deviation could also be profitable. Hence only in such situations a full transparency equilibrium can exist.

By using the same argument, we can also rule out equilibria with partial coverage and asymmetric prices using the same conditions as in Proposition . In the former case, any candidate that implies a market coverage between 1/2 and full coverage cannot exist. By moving towards complexity, the deviating firm captures all consumers that otherwise would not buy at all. Hence, it is strictly profitable to do so. For the latter case, consider a situation where both firms offer transparent products but one firm charges a low price p_l and the other firm a higher price p_h. This means that all consumers visit firm l first. If search costs are sufficiently high ($\hat{\epsilon}_l \leq \mathbb{E}(\epsilon)$) the supposedly lower price firm can move to complexity and raise its price just to make consumers indifferent between searching and staying, thus increasing demand, price and hence profits. If search costs are low, the lower price firm can profitably deviate to complexity since such a move either increases demand elasticity (symmetric distributions) or increases demand (right skewed distributions).

5.2.2 Full complexity

Let us now consider the opposite case where both products are complex and thus perceived as homogenous by consumers. Since consumers understand neither product, their sole objective for searching would be to find a lower price. For any prices lower than the monopoly price $p_c^m = v + \mathbb{E}(\epsilon)$ there is a profitable deviation for the cheaper firm. Assume that one firm charges a lower price than its rival. Consumers, correctly anticipating that they find a better deal there, all initially decide to visit the cheaper firm. Once at the cheaper firm, they are still willing to buy there as long as the current price does not exceed the rival's one by less than the search cost, provided that the utility offered by the firm is positive. Hence for any price below p_c^m, the cheaper firm can increase its price without losing customers. The rival firm cannot do better than matching this price. Hence the only candidate equilibrium where both firms offer complex products entails monopoly prices $p_c^m = v + \mathbb{E}(\epsilon)$ by both firms, the Diamond paradox.

Now consider a deviation from such a candidate equilibrium towards transparency. By becoming transparent, a firm only gives its consumers the possibility to find out about a bad match in which case they would leave the market. The consumers starting at the other firm do not see this deviation. Hence, such a deviation can only be profitable if a monopolist would prefer its customers to understand its product and the condition in Lemma 1 does not hold. We thus have the following result.

Proposition 2 *A symmetric full complexity equilibrium entailing monopoly prices $p_c^m = v + \mathbb{E}(\epsilon)$ exists if and only if the condition of Lemma 1 is satisfied.*

Proof. Follows from the discussion above. ■

Moreover, using Lemma 2, we can state that:

Proposition 3 *If the distribution $F(\epsilon)$ is symmetric or right-skewed and $v \geq \frac{\bar{\epsilon}}{2} - \frac{3\mathbb{E}(\epsilon)}{2}$ (or $v \geq -\frac{\bar{\epsilon}}{4} - \frac{3\epsilon}{4}$), there exists a pure strategy equilibrium of the price/complexity game: each firm offers a complex product and charges monopoly prices p_c^m.*

Proof. Follows from Lemma 2 and the previous proposition. ■

As mentioned in Corollary 3, this result has a simple economic interpretation. If firms could profitably sell to the vast majority of consumer types, there exists a pure strategy equilibrium which entails complex products and monopoly prices by both firms.

5.3 Asymmetric equilibria

In this section, I examine possible equilibria when consumers believe that they understand only one product. There are two cases to consider: consumers either correctly anticipate each firm to stick to one complexity choice and hence take that into account for their search order or they anticipate firms to randomize over both strategies and thus randomly choose one firm for their first visit. Let us start with the former case.

5.3.1 Pure strategies

For these asymmetric equilibria, it is instructive to start with the question how consumers choose their search order (see Weitzman (1979) who discusses the optimal order in which to explore alternatives).

Assume there is one firm t offering a transparent product and one firm c offering a complex product, charging p_t and p_c respectively. Consumers correctly anticipate which firm is offering which product. Upon visiting a complex firm a consumer does not learn anything about the product characteristics and only sees a price which, in equilibrium, she expected to find before. Hence it never makes sense for a consumer to visit a complex firm first, knowing that she wants to visit the other firm as well. A consumer choosing to visit a complex firm must buy there with probability 1 in equilibrium. The utility a consumer obtains from buying from a complex firm is

$$U_c = v - p_c + \mathbb{E}(\epsilon)$$

and, as given before, when buying from a transparent firm

$$U_{it} = v - p_t + \epsilon_{it}$$

When visiting a transparent firm first, a consumer has the (outside) option of buying the complex product if she learns about a bad valuation at the transparent firm. Thus the expected utility she gets from searching, starting at the transparent firm is given by:

$$U_s = \int_{\hat{\epsilon}}^{\overline{\epsilon}} U_{it} f(\epsilon) d\epsilon + F(\hat{\epsilon}) \max\{U_c - c; 0\}$$

where

$$\hat{\epsilon} = \max\{p_t - \tilde{p}_c + \mathbb{E}(\epsilon) - c; 0\} \tag{4}$$

In case she finds a good match at the transparent firm, which happens with probability $[1-F(\hat{\epsilon})]$, she buys upon her first visit. She does not buy there if she prefers to incur search costs and buy the complex product or if the utility she gets from the product is negative.

Thus possible consumer equilibrium strategies where beliefs are consistent with firms' strategies are

- Visit firm t first if $U_s > U_c$ and $U_s \geq 0$; buy there if $\epsilon \geq \hat{\epsilon}$; go on to buy from firm c if $\epsilon < \hat{\epsilon}$ and $U_c - c \geq 0$; leave the market otherwise.

- Visit each firm with equal probability if $U_s = U_c \geq 0$; if t is visited first, buy there if $\epsilon \geq \hat{\epsilon}$, if $\epsilon < \hat{\epsilon}$ and $U_c - c \geq 0$ go to firm c to buy there, leave the market otherwise; if c is visited first, buy there.

- Buy from firm c if $U_c > U_s$ and $U_c \geq 0$.

In principal, there could be equilibria for each of these three strategies. However, examining these cases the following result holds.

Proposition 4 *There can only be asymmetric pure strategy equilibria in which only one firm sells to consumers and charges the respective monopoly price. If lemma 1 does (not) hold, there exists an equilibrium in which the one firm offers a complex (transparent) product and charges p_c^m (p_t^m). In this equilibrium, the rival firm offers a transparent (complex) product and charges a price sufficiently high such that no consumer ever visits it.*

Proof. Let us start with the first case where all consumers initially visit the transparent firm. By construction, the complex firm only gets visitors who visit it second. However, all those consumers must have learned a valuation that is sufficiently low such that they were willing to incur search costs to buy the complex product. Once at the complex firm, they are willing to pay a price up to $v + \mathbb{E}(\epsilon)$. The search cost is sunk and the complex firm can hold-up its visitors. Anticipating that they will be held-up if visiting firm c, no consumer will ever want to do so. This in turn gives firm t monopoly power over all consumers: they either buy from firm t or not at all. It thus depends on whether a monopolist would want to reveal product information or hide it. If a monopolist prefers a niche strategy, an equilibrium exists in which one firm offers a transparent product and charges monopoly prices p_t^m and the other firm offers a complex product and charges a price above $v+\mathbb{E}(\epsilon)-c$ such that $U_s > U_c$. If a monopolist prefers a mass market strategy, this equilibrium does not exist as the transparent firm prefers a deviation to complexity and a price equal to the expected valuation $v+\mathbb{E}(\epsilon)$.

Now consider the case where consumers visit each firm with equal probability. For this to be the case, $U_s = U_c \geq 0$. To see why such an equilibrium cannot exist, consider the following argument. If the expected utility from going to either firm is strictly positive, a consumer arriving at firm c holds an offer that she strictly prefers to not buying at all. Since she was indifferent between going to either firm at the beginning, she is still willing to buy at firm c if the price is slightly increased. She now weighs the gains from searching the transparent firm against the search cost. Initially, she was comparing the gains from searching the transparent and paying the search cost for the second visit only in case of finding out about a bad match. This means that the gains from searching the transparent firm when holding the offer from the complex firm are negative.[8] To see this formally, recall that the gains from searching the transparent firm when at the complex firm, taking into account search costs, are given by:

$$\int_{\mathbb{E}(\epsilon)-p_c+\tilde{p}_t}^{\bar{\epsilon}} (\epsilon - \mathbb{E}(\epsilon) + p_c - \tilde{p}_t) f(\epsilon) d\epsilon - c$$

Factoring out the constants, this yields:

$$\int_{\mathbb{E}(\epsilon)-p_c+\tilde{p}_t}^{\bar{\epsilon}} \epsilon f(\epsilon) d\epsilon + [1 - F(\mathbb{E}(\epsilon) - p_c + \tilde{p}_t)][\mathbb{E}(\epsilon) - p_c + \tilde{p}_t] - c \tag{5}$$

Moreover, since $U_s = U_c$,

$$U_s - U_c = \int_{\hat{\epsilon}}^{\bar{\epsilon}} U_{it} f(\epsilon) d\epsilon + F(\hat{\epsilon}) \max\{U_c - c; 0\} - (v - p_c + \mathbb{E}(\epsilon)) = 0 \tag{6}$$

In the first case where $U_c - c \leq 0$, the gains from searching are trivially below the search cost and p_c can be increased by $\min\{c, U_c\}$ without the losing any customers: an increase by c would make the complex firms' first visitors indifferent between buying there and visiting the transparent firm but clearly no consumer would buy if the price is increased such that product c yields negative utility. In the other case where $U_c - c > 0$, equation

[8] This argument also holds if the first visit is costly, thus also ruling out the existence of such an equilibrium if the first visit is not free.

(6) can be rewritten as

$$\int_{\hat{\epsilon}}^{\overline{\epsilon}} \epsilon f(\epsilon) d\epsilon - [1-F(\hat{\epsilon})](c+\hat{\epsilon}) - F(\hat{\epsilon})c = 0 \tag{7}$$

Taking the difference between (5) and (7) and using (4), yields:

$$\left\{ \int_{\hat{\epsilon}+c}^{\overline{\epsilon}} \epsilon f(\epsilon) d\epsilon - \int_{\hat{\epsilon}}^{\overline{\epsilon}} \epsilon f(\epsilon) d\epsilon \right\} + \{[1-F(\hat{\epsilon}+c)](-c-\hat{\epsilon}) - [1-F(\hat{\epsilon})](-c-\hat{\epsilon})\} - [1-F(\hat{\epsilon})]c < 0$$

Both terms in curly brackets as well as the last part are negative, showing that the whole expression is negative as explained before.

The only candidate that is thus left is $U_s = U_c = 0$. However, for $U_s = 0$, it must be that $p_t = v + \overline{\epsilon}$, even the highest realization of ϵ brings zero surplus for consumers at the transparent firm. Charging such a price, firm t does not sell at all which clearly cannot be optimal given that some consumers visit it. Thus there cannot be an asymmetric pure strategy equilibrium in which consumers randomize over which firm to visit first.

Last, let us turn to the case where all consumers initially visit firm c and buy there. As in the previous cases, due to the existence of search cost, the only candidate equilibrium price p_c is $v + \mathbb{E}(\epsilon)$ leaving zero surplus to consumers. At any price below and the same search behavior, firm c could raise its price without losing any sales. Hence in such an equilibrium it must be that $U_t < 0$, i.e. p_t must be above $v + \overline{\epsilon}$. Whether this is indeed an equilibrium depends again on the monopolist's complexity choice. ■

The corollary of this is that if we restrict attention to cases where both firms charge non-prohibitive prices, i.e. prices are so high that no consumer would ever want to visit that firm, no asymmetric pure strategy equilibrium exists. Only equilibria where (at least) one firm is inactive in the sense of not making any sales exist.

5.3.2 Correlated equilibria

The second way to think of asymmetries is to have firms randomize over both strategies and consumers hence randomly choosing one firm for their first visit. I will focus on correlated equilibria here in which firms offer a complex product and charge a price p_c or a transparent product for a price p_t with equal probability. The reason for doing so is that I want to see whether we can find prices such that offering a complex product is the best response to a transparent product offered by the other firm and vice versa. Such correlated equilibria are equivalent to consumers not observing the identity of the firms ex ante and correctly anticipating them to play the same strategy. The following result is then immediate, assuming that all consumers eventually buy one of the two products offered.

Lemma 4 *Each firm i can secure a payoff of $\frac{1}{2}p_{-i}$ by mimicking the rival firm's strategy.*

Proof. Since consumers arriving at either firm have the same beliefs about the other firm's strategy, they behave in the same way. Moreover, each firm is initially visited with the same probability. Hence each firm sells to half of all consumers. ∎

There are two sub-cases to consider depending on the behavior of consumers when seeing a complex product. As mentioned before, consumers all attach the same valuation to a complex product. Hence all must make the same decision as to whether to search the other firm which they expect to offer a transparent product. Consider first the case where all consumers visiting the firm which offers a complex product, find it worthwhile to search the supposedly transparent firm after. That means, that all consumers eventually see the product of the transparent firm. For a correlated equilibrium to exist, the following constraints have to be satisfied:

$$p_t D_t \geq \frac{1}{2} p_c \tag{8}$$

$$p_c D_c \geq \frac{1}{2} p_t \tag{9}$$

$$p_t D_t \geq p_c - \epsilon \tag{10}$$

The first two constraints follow from the previous lemma, the third one is a standard Bertrand argument: since all consumers see the supposedly transparent firm, it can deviate to complexity, offer a slightly better deal than the other firm and sell to everyone.

Let us check whether we can find prices to support such an equilibrium. From (10), $p_t D_t \geq p_c - \epsilon$ and thus $p_t \gg p_c$. From (9), $p_c D_c \geq \frac{1}{2} p_t$ and hence $D_c \gg \frac{1}{2}$ and $D_t = 1 - D_c \ll \frac{1}{2}$. Combining these two inequalities, however, yields a contradiction since the right-hand side of (10) strictly exceeds the left-hand side of (9) but the right-hand side of (9) is strictly higher than the left-hand side of (10), $p_t D_t \not> \frac{1}{2} p_t$. Hence there cannot be a correlated equilibrium in which consumers search the transparent rival after visiting the complex firm.

In the second sub-case all first visitors stay at the complex firm. Once again the constraints (8) and (9) have to be satisfied. The demand for the transparent firm is given by all its first visitors that have a valuation of at least $\mathbb{E}(\epsilon) - \Delta - c$ (i.e. do not prefer to go to the complex firm to buy there) where $\Delta = p_c - p_t$. By construction it does not have any second visitors. Hence, $D_t = \frac{1}{2}(1 - F(\mathbb{E}(\epsilon) - \Delta - c))$. The complex firm sells to all other consumers. Substituting these demand functions in (8) yields

$$\frac{1}{2}p_t\left[1 - F(\mathbb{E}(\epsilon) - \Delta - c)\right] \geq \frac{1}{2}p_c \Leftrightarrow p_t \geq \frac{p_c}{1 - F(\mathbb{E}(\epsilon) - \Delta - c)}$$

(9) is given by:

$$p_c\left[\frac{1}{2} + \frac{1}{2}F(\mathbb{E}(\epsilon) - \Delta - c)\right] \geq \frac{1}{2}p_t \Leftrightarrow p_t \leq p_c\left[1 + F(\mathbb{E}(\epsilon) - \Delta - c)\right]$$

Combining the two inequalities, p_t has to satisfy:

$$\frac{p_c}{1 - F(\mathbb{E}(\epsilon) - \Delta - c)} \leq p_t \leq p_c\left[1 + F(\mathbb{E}(\epsilon) - \Delta - c)\right]$$

However, comparing the left-hand and the right-hand side of this inequality, shows that the upper bound on p_t is strictly below the lower bound:

$$\frac{p_c}{1 - F(\mathbb{E}(\epsilon) - \Delta - c)} > p_c\left[1 + F(\mathbb{E}(\epsilon) - \Delta - c)\right] \Leftrightarrow$$
$$p_c > p_c\left[1 - F(\mathbb{E}(\epsilon) - \Delta - c)\right]\left[1 + F(\mathbb{E}(\epsilon) - \Delta - c)\right] = p_c\left[1 - (F(\mathbb{E}(\epsilon) - \Delta - c))^2\right]$$

Hence there cannot be any p_t satisfying all constraints. The intuition in both cases is that the transparent firm must charge a high price in order not to be induced to deviate to complexity and keep all its visitors. However, such a high price makes it too attractive for the complex firm to imitate that strategy. The following proposition summarizes these findings.

Proposition 5 *There exists no correlated equilibrium in which one firm offers a complex product and the other one a transparent product with equal probability.*

Gathering the results of the previous sections, we can thus conclude that if the distribution $F(\epsilon)$ is symmetric or right-skewed and a monopolist can profitably sell to most consumer types, there exists a unique pure strategy equilibrium of the price/complexity game where both firms are active: each firm offers a complex product and charges monopoly prices p_c^m. Moreover, there exists always one asymmetric pure strategy equilibrium in which only one firm is active: if lemma 1 does (not) hold, one firm offers a complex (transparent) product and charges the respective monopoly price while the other firm offers a transparent (complex) product and a sufficiently high price that it doesn't sell.

6 Discussion

This result shows that competition does not lead to improved information about products for consumers which would be socially desirable. In this section I want to discuss the relationship of my results with those of the existing literature and comment on the assumptions used.

The results of the duopoly model used in this paper do not all generalize to competition among any number of firms as modeling competition as a duopoly stresses the importance of returning customers. However, the conditions for existence of a full complexity equilibrium where several firms offer complex products and charge monopoly prices are the same. Only the uniqueness results do not carry over. The second part of proposition 1 relies on many consumers returning to their initially visited firm after visiting the rival. With more than two firms in the market, consumers would not return until having searched all other firms. Hence offering a complex product with a price that induces consumers to visit rivals becomes less attractive the more firms there are. As the number of firms becomes large, the possibility of return vanishes. This is precisely what Larson (2011), Bar-Isaac et al. (2011), and others who model the supply side as a continuum of firms, use to derive their results: either a consumer buys upon the first visit at a firm or does not buy there at all since she never runs out of options to visit new firms. In such a setting, the probability of a complex firm of selling to consumers becomes binary, either it sells to all consumers that visit it or to none at all. Those authors get rid of this by assuming that there is always some residual differentiation of firms' products to smooth demand. However, empirical evidence by Hortacsu et al. (2012) suggests that consumers return to previously visited before exhausting all search options. The importance of returning customers is substantial.

I abstract from the possibility of advertising, i.e. I do not allow firms to convey information to consumers before they start to search. This seems to be restrictive. However, for the motivating examples of this paper mentioned in the introduction, it need not be. It is hard to imagine that it is feasible to provide consumers with all the necessary information about all different cost components of, for instance, a bank account by means of simple advertisement. Contracts entailing a large amount of fine print are hard to understand and clearly cannot be fully understood and evaluated without active support. Moreover, there would be a commitment problem if firms could communicate to consumers that they are more transparent than their rival. As we have seen before, once a consumer is visiting a firm, the firm would like to hide all information that would be given in excess of what she would get at the rival. Telling consumers that it is more transparent than the other firm thus is not credible. Investigating the possibility of altering the search behavior of consumers via advertising will be done in future work.

The assumption of inelastic demand seems to be particularly suitable for these instances. Insurance contracts, bank accounts, or mobile phones are must-haves, either because they are required by law or are necessary in everyday's life. This in turn implies that the fixed utility attached to these goods is high, making obfuscation in my model more likely. In this context, search can be interpreted as consumers' attempts to avoid bad matches rather than looking for better deals.

Consumers are modeled as homogenous in their ability to understand products in this paper. Naturally, one would think that complexity could be set such that some consumers understand the product while others do not. Consider a variant of the model where consumers differ in their cognitive ability. Firms have the possibility to obfuscate their products such that all consumers with ability below the level of complexity of the product do not understand it while the others understand it. Essentially, the problem of making a product complex in such a setting boils down to the one investigated in this paper if we just think of the decision analyzed in this paper being for every individual consumer rather than for all consumers: does a firm want this type of consumers to learn her match value or not? This alters the results quantitatively without changing them qualitatively.

7 Conclusion

This paper provides an explanation why so many products and contracts consumer face in real life are almost impossible to understand. It interprets complexity as withholding information about horizontal characteristics of products. Under this notion of complexity, consumers rationally prefer products they do not understand over products of which they know that they are not a good match for them. By providing information, firms only give consumers the chance to find out that their product is bad for them. Hence, even in a competitive setting, firms do not gain from making their offers more transparent than their rivals'. Moreover, if consumers correctly anticipate that all goods in the market are complex, they have no incentives to search as this would not enable them to find out which product is best for them.

Importantly, the level of search costs plays (almost) no role in this model. Consumers do not search in equilibrium because they do not understand products independent of the level of search costs. This illustrates why even more efficient search technologies like the internet do not push firms to abandon obfuscatory practices.

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