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Informational Intermediation and Competing Auctions

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Informational Intermediation and Competing Auctions

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Abstract

We examine the effects of provision of information about seller qualities by a third-party in a directed search model with heterogeneous sellers, asymmetric information, and where prices are determined ex post. The third party separates sellers into quality-differentiated groups and provides this information to some or all buyers. We show that this always raises total welfare, even if it causes the informed buyers not to trade with low quality sellers. However, buyers and some sellers may be made worse off in equilibrium. We also examine the provision of information by a profit maximizing monopoly, and show that it may have an incentive to overinvest in the creation of information relative to the social optimum.

1 Introduction

Many markets have the characteristic that prices are negotiated subsequent to search. This is the case in models of equilibrium unemployment such as those surveyed in Pissarides (2000), models of monetary exchange such as Trejos and Wright (1995) and Julien, Kennes and King (2006) and the basic competing auction models of Wolinsky (1988) and McAfee (1993). A fundamental problem in such markets if sellers are heterogeneous is that search could be better directed if buyers had some notion about the qualities of the competing sellers. Moreover, assuming that information gathering is subject to economies of scale, it can be argued that the provision of such information is best carried out by a monopoly third party. If a commercial enterprise undertakes this activity, questions are raised about its incentives to accumulate information, the methods by which this information is sold, the consequences for income redistribution, and the effects this information has on search behavior and prices. The basic goal of this paper is to provide some answers to these questions.

To date, the theoretical analysis of informed versus uniformed search invariably assumes that buyers receive price information (Salop & Stiglitz 1977, Anderson & Renault 2000 and Baye & Morgan 2001). In other words, these models assume that sellers are committed to a nominal price and that buyers are concerned with uncovering such commitments. Consequently, it is not obvious whether this literature offers clear insights about the incentives to gather information in markets where prices are determined ex post.

In this paper, we seek to understand the market for information about seller quality in an economy with search frictions and ex post pricing. To this end, we extend the competing auction model of McAfee (1993) and Wolinsky (1988) to include a third party information provider that does not itself transact in the market. We allow for sellers of two quality types – good and bad – and we consider how the third party information provider chooses to gather, price, and distribute its information about seller qualities.

The third party in our model operates by collecting information about sellers and distributing it to buyers. Potentially, the third party can earn revenues both from selling the information to buyers, and from charging good sellers to be distinguished from other sellers (to be 'accredited'). The third party therefore operates a 'two-sided' platform (Rochet & Tirole 2003, Caillaud & Jullien 2003, and Schiff 2003) and, if its objective is profit maximization, it must simultaneously consider the demands on both sides of the market when making its pricing decisions.

We are interested in three basic issues. First, how does the provision of information to buyers in the form of a partition of sellers into quality-differentiated groups affect the equilibrium search patterns of buyers, and what are the subsequent effects on equilibrium prices and welfare? We use the answer to this question to examine the incentives for a social planner to create and distribute information, and to derive the willingness to pay of buyers to be informed and the willingness to pay of good sellers to be accredited.

Second, if the third party is a profit-maximizing monopolist, what revenues can it earn from doing so, and what are its incentives to gather information in comparison with those of a social planner? And third, if a monopoly third party is restricted to pricing on only one side of the market (i.e. selling 'guidebooks' to buyers or selling 'accreditations' to good sellers), what influences its choice of which side to target?

We find that the provision of information to some or all buyers always raises equilibrium welfare, even if it causes informed buyers not to trade with lower quality sellers. Assuming for simplicity that the costs of creating and distributing information are fixed, the maximum welfare level is attained when the quality of every seller is identified and this information is given to all buyers. We also examine the distributional effects of providing such information. We show that if not all buyers are informed then those who are uninformed are made worse off in equilibrium relative to a situation in which all buyers are uninformed. In addition, the buyers who are informed may be worse off in equilibrium relative to when all buyers are uninformed. This occurs if the partition of sellers is not sufficiently 'informative' about seller qualities, in a sense that we will make clear in the paper. In addition, at the social optimum, most of the welfare gains accrue to good sellers, as buyers may be worse off and bad sellers are always worse off from being identified as such.

We then turn to monopoly provision of information and characterize the demands faced by the monopolist on the two sides of the market. We show that buyers' demand for information has normal characteristics – it is decreasing in the price of information, and increasing in the quality of the information provided. In contrast, we show that demand by good sellers for accreditations is potentially *increasing* in the price of accreditations, within some range of parameter values. That is, the willingness to pay of good sellers to be accredited may increase as the number of accredited good sellers increases. This is because an increase in the number of good sellers that are accredited increases the differential between the quality of an accredited seller (who we assumed can only be a good seller) and the expected quality of an unaccredited seller (who may be a good or bad seller).

Having characterized the demands, we consider the monopolist's choice of prices to maximize its profits, and the resulting profit that it makes. We find that the monopolist may have an incentive *overinvest* in information compared to the social planner. That is, it may create information at cost levels that the social planner would not. This is because the upward-sloping demand for accreditations enables the monopolist to extract relatively large revenues from the seller side of the market.

The organization of this paper is as follows. Section 2 sets up the basic model and defines the type of information that the third party creates about sellers. Section 3 examines the effects on the model's equilibrium of the provision of such information to some or all buyers, and characterizes a social planner's incentives to create and distribute information. We examine provision of information by a monopolist in section 4 and derive the demands that it faces on both sides of the market. We then report the results of a numerical simulation analysis in section 5, where we examine the incentives of a social planner and a monopolist to create information, quantify the equilibrium welfare effects in both cases, and examine the monopolist's choice of business model. Section 6 gives concluding remarks.

2 The model

A search market operates for one period with M buyers and N sellers. We assume the market is 'large' so that the sets of buyers and sellers can be treated as contiuums. We normalize $N = 1$ and denote the overall buyer-seller ratio ('market tightness') by $\Phi \equiv M/N$. Each seller has a single unit of a good for sale, and each buyer wishes to purchase one unit.

We assume there are two types of seller that sell goods of different quality levels. *Good type* sellers have goods of a quality level normalized to 1 for sale, and *bad type* sellers have goods of a quality level represented by $\theta \in (0, 1)$. We assume that half of the sellers are of each type, and denote the overall expected quality of a randomly chosen seller by $\widetilde{q} \equiv \frac{1}{2}(1+\theta)$. For simplicity we assume that all goods are worth zero to a seller.

Buyers are assumed to have identical preferences for quality. A good with quality $x \in \{\theta, 1\}$ gives gross utility x to any buyer. In the basic version of the model, buyers do not know the quality that any given seller has for sale but do know the distribution of qualities among sellers, that is, there is asymmetric information.

Sellers are assumed to sell their goods by advertising competing auctions. Buyers must simultaneously and independently choose to visit the auction of only one seller. Since each seller has only a single unit of the good for sale, there are coordination frictions among buyers. Once buyers have made their search investment and arrive at a seller's auction, we assume that the buyers at the auction become perfectly informed about the seller's quality. Effectively, we assume Bertrand competition among buyers at any given seller's auction. Thus a seller receives a strictly positive price if and only if more than one buyer turns up to his or her auction.

A third party that collects information (at some cost) about seller types may operate in the market. In the general case, the third-party's technology allows it to divide the sellers into two quality-differentiated groups, which we call *submarkets*. A submarket is a group of sellers that appear identical from a buyer's point of view when buyers are choosing which seller to visit. The third party is able to inform buyers of the proportion of sellers and the expected quality of a randomly chosen seller in each submarket. We call the two submarkets the *high quality submarket* and *low quality submarket* and let q_h and q_l respectively denote the expected quality levels, where $\theta \leq q_l < \widetilde{q} < q_h \leq 1$. We also let α denote the proportion of sellers in the low quality submarket. Note that $\alpha q_l + (1-\alpha) q_h \equiv \widetilde{q}$. We use ϕ_l and ϕ_h to denote the market tightnesses in the two submarkets.

Definition 1 *An* information partition *is a pair* (α, q_l) *where* $\alpha \in \left(0, \frac{1}{2}(1-\theta)/(1-q_l)\right)$ *is the proportion of sellers in the submarket with expected quality* $q_l \in [\theta, \widetilde{q})$.

We use the idea of an information partition as defined above to represent the information created by the third party. We assume that the third party creates an information partition and informs some or all of the buyers of the values of α and q_l. Figure 1 shows the set of feasible information partitions that can be created. Note that no information is created if either $\alpha = 0$ or $q_l = \frac{1}{2}(1+\theta)$. In some later sections we restrict attention to the upper frontier of this feasible set.

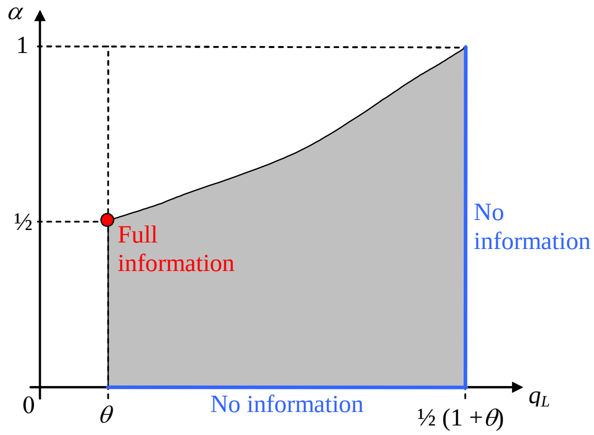

Figure 1: Feasible information partitions.

Given an information partition we can find q_h as

$$q_h(\alpha, q_l) = \frac{\widetilde{q} - \alpha q_l}{1 - \alpha} \tag{1}$$

and ϕ_h as

$$\phi_h(\alpha, \phi_l) = \frac{\Phi - \alpha \phi_l}{1 - \alpha}. \tag{2}$$

3 Equilibrium search patterns and welfare effects

In this section we examine how the equilibrium search patterns of buyers are affected by the provision of an information partition to some or all of the buyers, and the consequent welfare effects. For now we will work in the general case, without imposing further restrictions on the set of feasible information partitions, and without being specific about the precise way in which the information is created or distributed. In particular, we wish to examine the effects of providing a general information partition (α, q_l) to some fraction $0 < \beta \leq 1$ of buyers. In subsequent sections we will examine and compare some particular ways of creating information about seller qualities and of distributing this information to buyers.

3.1 Benchmark: All buyers are uninformed

As a benchmark, we first briefly review the equilibrium outcomes when all buyers have no information about seller qualities. For more details, see Kennes (2004).

We concentrate on a symmetric mixed strategy equilibrium where buyers randomize over the locations of sellers. In such an equilibrium, it is possible to show that the probability that any given seller receives at least one buyer is $1 - e^{-\Phi}$ and hence total welfare when all buyers are uninformed is

$$W_0 = \left(1 - e^{-\Phi}\right) \widetilde{q}. \tag{3}$$

The welfare losses due to search frictions are $e^{-\Phi}\widetilde{q}$.

It is also possible to show that the equilibrium probability that a buyer is alone at a seller is $e^{-\Phi}$. Under our assumption of Bertrand competition, buyers only receive a strictly positive payoff if alone at a seller, hence the total welfare of buyers is $B_0 = \Phi e^{-\Phi}\widetilde{q}$. In a market with tightness ϕ, the equilibrium probability that any given seller receives more than one buyer and hence receives a strictly positive payoff is $p(\phi) = 1 - (1 + \phi) e^{-\phi}$. Hence the aggregate welfares of bad and good sellers are $X_0 = \frac{1}{2}p(\Phi)\theta$ and $Y_0 = \frac{1}{2}p(\Phi)$ respectively. Note that $p'(\phi) > 0$.

3.2 Equilibrium search patterns with informed buyers

We now consider the case where a fraction β of buyers are informed of an information partition (α, q_l) and the remaining fraction $1 - \beta$ of buyers are uninformed about seller qualities. Our goal here is to examine how this affects the equilibrium search patterns of buyers. In the next subsection we will examine the welfare effects of the provision of information relative to the benchmark discussed above where all buyers are uninformed.

There are two possible equilibrium search patterns of the informed buyers:

1. Informed buyers only randomize over sellers in the high quality submarket.

2. Informed buyers randomize over sellers in both submarkets.

An equilibrium of the first type occurs if what we call the *exclusion constraint* (EC), to be defined below, is satisfied. In this case we have $\phi_l = (1 - \beta)\Phi$ and so the exclusion constraint is given by

$$e^{-\phi_h(\alpha,(1-\beta)\Phi)} q_h(\alpha, q_l) \geq e^{-(1-\beta)\Phi} q_l,$$

or,

$$\beta \leq \frac{1-\alpha}{\Phi} \ln\left(\frac{q_h(\alpha, q_l)}{q_l}\right). \tag{EC}$$

If an equilibrium of the second type occurs, informed buyers must have the same expected utility from visiting a seller in either submarket, that is, $e^{-\phi_h} q_h = e^{-\phi_l} q_l$. Using this and (2) we can solve for ϕ_l and ϕ_h. In summary, the equilibrium search patterns of buyers when β of them are informed of an information partition (α, q_l) give rise to the following equilibrium market tightnesses:

$$\phi_l = \begin{cases} (1-\beta)\,\Phi & \text{if EC} \\ \Phi - (1-\alpha)\ln\left(q_h(\alpha, q_l)/q_l\right) & \text{otherwise} \end{cases} \tag{4}$$

and

$$\phi_h = \begin{cases} \left(1 + \frac{\alpha\beta}{1-\alpha}\right)\Phi & \text{if EC} \\ \Phi + \alpha\ln\left(q_h(\alpha, q_l)/q_l\right) & \text{otherwise} \end{cases}. \tag{5}$$

It is straightforward to verify that ϕ_l and ϕ_h have the following properties for any feasible information partition:

1. If $\beta > 0$ then $\phi_h > \phi_l$.[1]
2. $\frac{\partial\phi_h}{\partial\beta} \geq 0$ and $\frac{\partial\phi_l}{\partial\beta} \leq 0$.
3. $\phi_l < \Phi < \phi_h$.
4. Both ϕ_l and ϕ_h are continuous in β.

Thus, market tightness is always greater in the high quality submarket than the low quality submarket if some buyers are informed, and this difference is weakly increasing when the fraction of informed buyers increases. As would be expected, in equilibrium the informed buyers respond to the creation of information by increasing the probability with which they visit sellers in the high quality submarket.

3.3 Welfare effects of the provision of information

We now consider the welfare effects of providing a generic feasible information partition (α, q_l) to a fraction β of buyers. For the moment we ignore any costs of creating the information partition, to emphasize the effects on equilibrium welfare of changes in buyer search patterns in response to the provision of information.

3.3.1 Effects on total welfare

Equilibrium total welfare when some buyers are informed is given by

$$W_1 = \alpha\left(1 - e^{-\phi_l}\right)q_l + (1-\alpha)\left(1 - e^{-\phi_h}\right)q_h(\alpha, q_l).$$

From (4) and (5) we have

$$W_1 = \begin{cases} \widetilde{q} - e^{-\Phi}\left[\alpha e^{\beta\Phi}q_l + (1-\alpha)\,e^{-\frac{\alpha}{1-\alpha}\beta\Phi}q_h(\alpha, q_l)\right] & \text{if EC} \\ \widetilde{q} - e^{-\Phi}q_l^{\alpha}q_h(\alpha, q_l)^{1-\alpha} & \text{otherwise} \end{cases}. \tag{6}$$

[1] If (EC) holds then $\phi_h - \phi_l = \beta\Phi/(1-\alpha) > 0$. If (EC) does not hold then $\phi_h - \phi_l = \ln\left(q_h(\alpha, q_l)/q_l\right) > 0$ since $q_h(\alpha, q_l) > q_l$ for a feasible information partition.

Thus, if (EC) does not hold, welfare losses due to search frictions are proportional to a Cobb-Douglas function of the information partition: $q_l^\alpha q_h(\alpha, q_l)^{1-\alpha}$. If (EC) holds there is a reduced volume of trade in the low quality submarket since such sellers are excluded by informed buyers, but increased volume of trade in the high quality submarket. The following proposition shows that in both cases equilibrium total welfare increases relative to when all buyers are uninformed.

Proposition 1 *For any feasible information partition (α, q_l), $W_1 > W_0$ for all $\beta > 0$. In addition, $W_1 - W_0$ is non-decreasing in β.*

Proof. When $\beta = 0$, $W_1 = W_0$. At small enough values of β, (EC) holds and

$$\begin{aligned}\frac{\partial W_1}{\partial \beta} &= -e^{-\Phi}\left[\Phi\alpha e^{\beta\Phi} q_l - (1-\alpha)\frac{\alpha}{1-\alpha}\Phi e^{-\frac{\alpha\beta}{1-\alpha}\Phi} q_h(\alpha, q_l)\right] \\ &= \alpha\Phi e^{-\Phi}\left(e^{-\frac{\alpha\beta}{1-\alpha}\Phi} q_h(\alpha, q_l) - e^{\beta\Phi} q_l\right)\end{aligned}$$

where the term in brackets is positive exactly when (EC) holds. Thus when (EC) holds we have $W_1 > W_0$ and $W_1 - W_0$ strictly increasing in β. If (EC) does not hold then $\partial W_1/\partial\beta = 0$ and hence $W_1 - W_0$ is constant in β. However, since ϕ_l and ϕ_h are continuous in β, so is W_1, and thus we have $W_1 > W_0$ also when (EC) does not hold. ■

Proposition 1 has two consequences. First, provision of an information partition to at least some buyers always raises equilibrium total welfare. This is because buyer search is directed more accurately, and is true even in the case that informed buyers exclude low quality sellers, and even if this means that *all* buyers exclude low quality sellers (if all buyers are informed). Second, for any given information partition, total welfare will be maximized if it is available to all buyers. Note however that this is not necessarily the unique welfare maximizing solution, since if (EC) does not hold then equilibrium welfare is constant in β. Thus if (EC) does not hold when $\beta = 1$ then $\beta = 1 - \varepsilon$ will also give a maximum of total welfare for small ε.

The next proposition shows that the welfare gain created by the provision of an information partition to at least some buyers is increasing in the 'informativeness' of the partition.

Proposition 2 *When $\beta > 0$, $W_1 - W_0$ is decreasing in q_l and increasing in α for any feasible information partition.*

Proof. Since W_0 is constant and $W_1 > W_0$, we need to check the signs of $\partial W_1/\partial q_l$ and $\partial W_1/\partial\alpha$. From (6) we have

$$\frac{\partial W_1}{\partial q_l} = \begin{cases} \alpha e^{-\Phi}\left(e^{-\frac{\alpha}{1-\alpha}\beta\Phi} - e^{\beta\Phi}\right) & \text{if EC} \\ \alpha e^{-\Phi}\left(\frac{q_l - q_h(\alpha, q_l)}{q_l}\right)\left(\frac{q_l}{q_h(\alpha, q_l)}\right)^\alpha & \text{otherwise}\end{cases}$$

since $\partial q_h(\alpha, q_l)/\partial q_l = -\alpha/(1-\alpha)$. If (EC) holds this is negative if $e^{\beta\Phi} > e^{-\frac{\alpha}{1-\alpha}\beta\Phi}$ which is true since $\alpha < 1$. If (EC) does not hold it is also negative, since $q_l < q_h(\alpha, q_l)$.

To sign $\partial W_1/\partial\alpha$, define Z as such that $W_1 = \widetilde{q} - e^{-\Phi}Z$, that is,

$$Z = \begin{cases} \alpha e^{\beta\Phi} q_l + (1-\alpha) e^{-\frac{\alpha}{1-\alpha}\beta\Phi} q_h(\alpha, q_l) & \text{if EC} \\ q_l^{\alpha} q_h(\alpha, q_l)^{1-\alpha} & \text{otherwise} \end{cases}.$$

If (EC) holds then

$$\frac{\partial Z}{\partial\alpha} = e^{\beta\Phi} q_l - e^{-\frac{\alpha}{1-\alpha}\beta\Phi} q_h(\alpha, q_l) + \frac{e^{-\frac{\alpha}{1-\alpha}\beta\Phi}}{1-\alpha}\left(\widetilde{q} - q_l - \beta\Phi q_h(\alpha, q_l)\right)$$

since $\partial q_h(\alpha, q_l)/\partial\alpha = (\widetilde{q} - q_l)/(1-\alpha)^2$. Substituting for $\widetilde{q} = \alpha q_l + (1-\alpha) q_h$ and rearranging, we obtain:

$$\frac{\partial Z}{\partial\alpha} = \left(e^{\beta\Phi} - e^{-\frac{\alpha}{1-\alpha}\beta\Phi}\right) q_l - \frac{e^{-\frac{\alpha}{1-\alpha}\beta\Phi}}{1-\alpha}\beta\Phi q_h(\alpha, q_l).$$

This is negative, and hence $\partial W_1/\partial\alpha$ is positive, if

$$\frac{e^{-\frac{\alpha}{1-\alpha}\beta\Phi}}{1-\alpha}\beta\Phi q_h(\alpha, q_l) \geq \left(e^{\beta\Phi} - e^{-\frac{\alpha}{1-\alpha}\beta\Phi}\right) q_l$$

or,

$$\frac{q_h(\alpha, q_l)}{q_l} \geq \frac{1-\alpha}{\beta\Phi}\left(e^{\frac{\beta\Phi}{1-\alpha}} - 1\right). \tag{7}$$

Rearranging (EC) we obtain $q_h(\alpha, q_l)/q_l \geq e^{\frac{\beta\Phi}{1-\alpha}}$. Thus (7) is implied by (EC) if

$$e^{\frac{\beta\Phi}{1-\alpha}} \geq \frac{1-\alpha}{\beta\Phi}\left(e^{\frac{\beta\Phi}{1-\alpha}} - 1\right).$$

This is true since $e^x \geq (e^x - 1)/x$ for all $x > 0$.

If (EC) does not hold then $\ln(Z) = \alpha \ln q_l + (1-\alpha)\ln q_h(\alpha, q_l)$ and hence

$$\begin{aligned} \frac{\partial \ln(Z)}{\partial\alpha} &= \ln q_l - \ln q_h(\alpha, q_l) + (1-\alpha)\frac{\partial q_h(\alpha, q_l)/\partial\alpha}{q_h(\alpha, q_l)} \\ &= \ln\left(\frac{q_l}{q_h(\alpha, q_l)}\right) + 1 - \frac{q_l}{q_h(\alpha, q_l)} \end{aligned}$$

since $\partial q_h(\alpha, q_l)/\partial\alpha = (\widetilde{q} - q_l)/(1-\alpha)^2$. Thus $\partial \ln(Z)/\partial\alpha$ is negative because $\ln x + 1 \leq x$ for all x, and so we have $\partial W_1/\partial\alpha \geq 0$. ■

A straightforward consequence of propositions 1 and 2 is the following:

Proposition 3 *Welfare is maximized when a perfect information partition, $\left(\frac{1}{2}, \theta\right)$, is given to all buyers.*

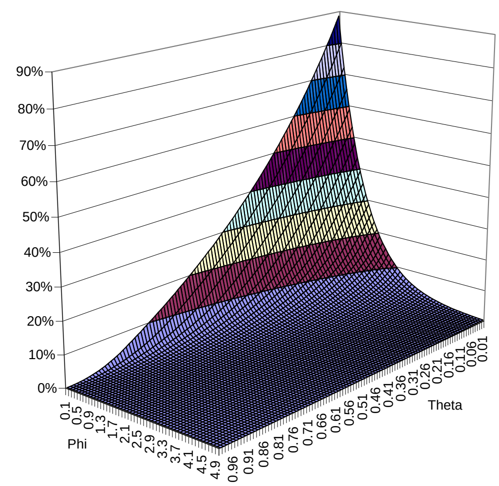

Figure 2: Maximum possible welfare gain from the provision of third-party quality information. Note the orientation of the axes.

Therefore, letting W_1^* denote the welfare level associated with a perfect information partition, from (3), (6) and (EC), the maximum amount of additional welfare that the provision of third-party quality information can generate is given by

$$W_1^* - W_0 = \begin{cases} e^{-\Phi}\left[\widetilde{q} - \frac{1}{2}\left(e^{\Phi}\theta + e^{-\Phi}\right)\right] & \text{if } \Phi \leq \frac{1}{2}\ln\left(\frac{1}{\theta}\right) \\ e^{-\Phi}\left[\widetilde{q} - \sqrt{\theta}\right] & \text{otherwise} \end{cases}.$$

This is shown graphically in Figure 2. From this we can conclude that the provision of third-party quality information is more useful in markets where there is a bigger relative difference between bad and good quality, and/or the market is relatively 'thin' (relatively few buyers to sellers).

3.3.2 Welfare effects on buyers

Let us now consider the effects on the equilibrium welfare of buyers from the provision of third party quality information. Suppose that a fraction β of buyers are informed. The expected payoff of an uninformed buyer is

$$b_U = \alpha e^{-\phi_l} q_l + (1-\alpha)\, e^{-\phi_h} q_h(\alpha, q_l)\,.$$

Thus from (4) and (5) we have

$$b_U = \begin{cases} e^{-\Phi}\left[\alpha e^{\beta\Phi} q_l + (1-\alpha)\, e^{-\frac{\alpha}{1-\alpha}\beta\Phi} q_h(\alpha, q_l)\right] & \text{if EC} \\ e^{-\Phi} q_l^{\alpha} q_h(\alpha, q_l)^{1-\alpha} & \text{otherwise} \end{cases}. \tag{8}$$

Proposition 4 *Uninformed buyers are always worse off when some buyers are informed compared to when no buyers are informed.*

Proof. It is straightforward to verify that b_U is continuous in β. It is also simple to check that given an information partition (α, q_l), if $\beta = 0$ then $b_U = b_0$ where $b_0 = B_0/\Phi$ is the payoff of an individual buyer when no buyers are informed. For small values of β, (EC) holds, and

$$\frac{\partial b_U}{\partial \beta} = \Phi\alpha e^{-\Phi}\left[e^{\beta\Phi}q_l - e^{-\frac{\alpha}{1-\alpha}\beta\Phi}q_h(\alpha, q_l)\right].$$

The term in square brackets is negative exactly when (EC) holds. For large values of β, (EC) does not hold and $b_U - b_0$ is constant in β. From the continuity of b_U we thus have $b_U < b_0$ for all $\beta > 0$. ■

In equilibrium, informed buyers either only visit sellers in the high quality submarket, or randomize over all sellers such that their expected payoff from visiting a seller in either submarket is the same. Therefore, the expected payoff of an informed buyer is

$$b_I = e^{-\phi_h}q_h(\alpha, q_l).$$

Thus from (5) we have

$$b_I = \begin{cases} e^{-\Phi}e^{-\frac{\alpha}{1-\alpha}\beta\Phi}q_h(\alpha, q_l) & \text{if EC} \\ e^{-\Phi}q_l^{\alpha}q_h(\alpha, q_l)^{1-\alpha} & \text{otherwise} \end{cases}. \tag{9}$$

Proposition 5 *If (EC) does not hold, informed buyers are worse off relative to when all buyers are uninformed.*

Proof. If (EC), $b_I = b_U$, and from proposition 4 we have $b_U < b_0$. ■

If (EC) holds, informed buyers may be better or worse off relative to when all buyers are uninformed. In this case, the change in an informed buyer's payoff is

$$b_I - b_0 = e^{-\Phi}\left[e^{-\frac{\alpha}{1-\alpha}\beta\Phi}q_h(\alpha, q_l) - \tilde{q}\right].$$

Comparing with (EC), we can see that informed buyers may be better or worse off.

From the above results we can conclude that buyers in aggregate will be worse off from the provision of an information partition to some or all buyers if it is not sufficiently informative as to allow the informed buyers to exclude bad sellers. Given this, it is important to show that informed buyers will actually use information provided to them when making their search decisions. The following proposition shows that if an information partition is given to some buyers, it will be an equilibrium for all of them to actually use it.

Proposition 6 *If an information partition* (α, q_l) *is provided to a fraction* β *of buyers then none of them can gain by unilaterally not using this information.*

Proof. If (EC) does not hold, from (8) and (9) we have $b_I = b_U$ buyers are indifferent about using the information. If (EC) holds, we have

$$b_I - b_U = \alpha e^{-\Phi} \left[e^{-\frac{\alpha}{1-\alpha}\beta\Phi} q_h(\alpha, q_l) - e^{\beta\Phi} q_l \right]$$

and the term in square brackets is positive exactly when (EC) holds. Thus we have $b_I \geq b_U$ always. ■

The proof of proposition 6 also gives the condition under which informed buyers will be better off in equilibrium than uninformed buyers, and hence will be willing to pay for information.

Corollary 1 *Buyers are only willing to pay for an information partition if it enables them to exclude sellers in the low quality submarket in equilibrium, that is, if (EC) holds.*

We can also confirm that if an information partition is available to some or all buyers, there will not be an equilibrium in which all buyers choose to ignore the available information.

Proposition 7 *If an information partition* (α, q_l) *exists and is available to a fraction* β *of buyers but is not used by any buyers then every individual buyer has an incentive to use it.*

Proof. Examining (EC) reveals that it always holds when $\beta = 0$, since the right-hand side of the constraint is always strictly greater than zero when the information partition is informative (i.e. when $q_h > q_l$). From the proof of proposition 6, this means that $b_I > b_U$ when $\beta = 0$, and all buyers to whom the information is available could gain by using the information, given that the other buyers do not. ■

3.3.3 Welfare effects on sellers

The welfare effects on sellers of the provision of an information partition to some or all buyers are straightforward. Recall that a seller's expected payoff in a (sub)market with tightness ϕ is $p(\phi)\,q$ where $p(\phi)$ is increasing in ϕ and q is the seller's quality. Clearly, bad sellers are made worse off and good sellers are made better off from the provision of information to buyers, since in equilibrium we have $\phi_l < \Phi < \phi_h$.

3.3.4 Conclusions from the welfare analysis

Let us briefly summarize our findings from the welfare analysis. First, providing an information partition to some or all buyers always raises welfare, even if it induces the informed buyers not to trade with sellers in the low quality submarket. The welfare gain from providing information increases when there is greater separation between the groups of sellers, that is, when q_l decreases or α increases. In addition, the welfare gain may increase, and does not decrease, when the partition is provided to more buyers. The socially optimal solution is therefore to create a perfect information partition, $\left(\frac{1}{2}, \theta\right)$ and give it to all buyers. This maximizes total welfare even if it causes all buyers to exclude bad sellers.

Second, uninformed buyers are always made worse off from the provision of information to some other buyers, while the informed buyers may be worse off if the information partition is not sufficiently informative so as to allow them to excluded sellers in the low quality submarket. Buyers are only willing to pay for an information partition if it allows them to exclude sellers in the low quality submarket.

Third, bad sellers are made worse off and good sellers are made better off. Combining the above results, it appears that, in aggregate, most of the welfare gains are likely to accrue to good sellers. We will examine the distribution of welfare numerically in section 5 below.

4 Monopoly information provision

The preceding analysis examined the provision of information to buyers without saying how it was generated or how it was distributed to buyers. In this section we consider information provision by a monopolist, who has access to some technology for generating information and a way of distributing it to buyers.

Rather than considering a general information partition as above, in this section we simplify and assume that the monopolist creates information by 'accrediting' a fraction σ of good sellers. The information partition created is thus:

$$(\alpha(\sigma), q_l(\sigma)) = \left(1 - \frac{1}{2}\sigma, \frac{1-\sigma+\theta}{2-\sigma}\right). \tag{10}$$

In terms of the set of feasible information partitions as shown in Figure 1, we are restricting attention to the upper frontier of this set, with σ determining the position along the frontier between full information ($\sigma = 1$) and no information ($\sigma = 0$). Note also that this implies $q_h = 1$, since only good sellers can be accredited by assumption. Under these restrictions, the exclusion constraint becomes $e^{-\phi_h} \geq e^{-\phi_l} q_l(\sigma)$, or

$$\beta \leq \frac{-\sigma}{2\Phi} \ln q_l(\sigma). \tag{EC*}$$

We assume that the monopolist has two potential sources of revenue: it can sell the information partition that it creates to buyers, and it can charge good sellers to be accredited. We let p_G denote the price that a buyer must pay to obtain the information partition, and p_A denote the price that a good seller must pay to be accredited.

We can define the buyer-seller ratios $\phi_l(\beta,\sigma)$ and $\phi_h(\beta,\sigma)$ by substituting (10) into (4) and (5) respectively to give

$$\phi_l(\beta,\sigma) = \begin{cases} (1-\beta)\,\Phi & \text{if EC*} \\ \Phi + \frac{1}{2}\sigma \ln q_l(\sigma) & \text{otherwise} \end{cases} \tag{11}$$

and

$$\phi_h(\beta,\sigma) = \begin{cases} \left(1+\frac{2-\sigma}{\sigma}\beta\right)\Phi & \text{if EC*} \\ \Phi - \left(1-\frac{1}{2}\sigma\right)\ln q_l(\sigma) & \text{otherwise} \end{cases}. \tag{12}$$

4.1 Demand for information

The first step in analyzing the monopolist's behavior is to derive the demands on the two sides of the market. We let $p_G(\beta,\sigma)$ denote the willingness of buyers to pay for information and $p_A(\beta,\sigma)$ denote the willingness of good sellers to pay to be accredited.

4.1.1 Demand by buyers

A buyer gets $b_I - p_G$ from buying the information and b_U from being informed, where b_U and b_I are given by (8) and (9) above. Since all buyers are identical we look for a mixed strategy equilibrium in which buyers randomize over being informed, that is, where $b_I - p_G = b_U$. From corollary 1 we know that buyers will only be willing to pay a positive price if the informed buyers are able to exclude unaccredited sellers. We therefore have buyers' willingness to pay for an information partition given by

$$p_G(\beta,\sigma) = \begin{cases} \alpha(\sigma)\left[e^{-\phi_h(\beta,\sigma)} - e^{-\phi_l(\beta,\sigma)}q_l(\sigma)\right] & \text{if EC*} \\ 0 & \text{otherwise} \end{cases}. \tag{13}$$

Proposition 8 *Buyers' demand for information has the following properties:*

1. *Continuous in β for all $\beta \in [0,1]$.*

2. *There is always some demand: $p_G(0,\sigma) > 0$ for $\sigma > 0$.*

3. *Willingness to pay is non-decreasing in the fraction of accredited good sellers: $\frac{\partial p_G}{\partial \sigma} \geq 0$.*

4. *Demand slopes down: $\frac{\partial p_G}{\partial \beta} \leq 0$.*

Proof.

1. Follows from the continuity of ϕ_h and ϕ_l in β.

2. Follows from the proof of proposition 7.

3. Changes in σ affect both the *number* of sellers in the two submarkets and the *relative quality* between them. If (EC*) holds, using the fact that $\frac{\partial \phi_l(\beta,\sigma)}{\partial \sigma} = 0$, we have

$$\begin{aligned}\frac{\partial p_G(\beta,\sigma)}{\partial \sigma} &= e^{-\phi_h(\beta,\sigma)}\left[\alpha'(\sigma) - \alpha(\sigma)\frac{\partial \phi_h(\beta,\sigma)}{\partial \sigma}\right] \\ &\quad - e^{-\phi_l(\beta,\sigma)}\left[\alpha'(\sigma)\, q_l(\sigma) + \alpha(\sigma)\, q_l'(\sigma)\right]\end{aligned}$$

   Substituting and rearranging gives

$$\frac{\partial p_G(\beta,\sigma)}{\partial \sigma} = \frac{1}{2}\left(e^{-\phi_l} - e^{-\phi_h}\right) + \frac{\beta(2-\sigma)\Phi}{\sigma} e^{-\phi_h}$$

   which is positive since $\phi_h > \phi_l$ implies $e^{-\phi_l} > e^{-\phi_h}$.

4. If (EC*) holds,

$$\begin{aligned}\frac{\partial p_G(\beta,\sigma)}{\partial \beta} &= \alpha(\sigma)\left[\frac{\partial \phi_l(\beta,\sigma)}{\partial \beta} e^{-\phi_l(\beta,\sigma)} q_l(\sigma) - \frac{\partial \phi_h(\beta,\sigma)}{\partial \beta} e^{-\phi_h(\beta,\sigma)}\right] \\ &= -\alpha(\sigma)\,\Phi\left[e^{-\phi_l(\beta,\sigma)} q_l(\sigma) + \frac{2-\sigma}{\sigma} e^{-\phi_h(\beta,\sigma)}\right] < 0 \qquad (14)\end{aligned}$$

■

The willingness to pay of buyers thus exhibits standard properties that we would expect from a demand curve. Willingness to pay is positive at $\beta = 0$ and declines as β increases. At some point, (EC*) ceases to hold, and buyers' willingness to pay is zero. Willingness to pay is also increasing in the 'quality' of the information that the buyer purchases, as represented by σ.

4.1.2 Demand by good sellers

A good seller gets $p(\phi_h) - p_A$ from being accredited and $p(\phi_l)$ from being unaccredited. Since $\phi_h > \phi_l$, good sellers are always willing to pay something to be accredited, provided that at least some buyers are informed ($\beta > 0$). Since all good sellers are identical we look for a mixed strategy equilibrium where good sellers randomize over being accredited or not. The demand for accreditations is therefore given by

$$p_A(\beta,\sigma) = p(\phi_h(\beta,\sigma)) - p(\phi_l(\beta,\sigma)). \qquad (15)$$

Proposition 9 *Good sellers' demand for accreditations has the following properties:*

1. *Continuous in σ for all $\sigma \in [0,1]$.*
2. *There is always some demand: $p_A(\beta, 0) > 0$ for $\beta > 0$.*
3. *Willingness to pay is non-decreasing in the number of informed buyers: $\frac{\partial p_A}{\partial \beta} \geq 0$.*
4. *Demand slopes down ($\frac{\partial p_A}{\partial \sigma} < 0$) when (EC*) holds and slopes up ($\frac{\partial p_A}{\partial \sigma} > 0$) when (EC*) does not hold.*

Proof.

1. Follows from the continuity of ϕ_h and ϕ_l and $p(\cdot)$.
2. Follows from the fact that $\phi_h > \phi_l$ when $\beta > 0$, and the fact that $p(\cdot)$ is a strictly increasing function.
3. Follows from the fact that $\frac{\partial \phi_h}{\partial \beta} \geq 0$ and $\frac{\partial \phi_l}{\partial \beta} \leq 0$, and that $p(\cdot)$ is a strictly increasing function.
4. If (EC*) holds then $\phi_l(\beta, \sigma)$ is constant in σ and $\frac{\partial \phi_h(\beta,\sigma)}{\partial \sigma} = -2\Phi\beta/\sigma^2 < 0$. Since $p(\cdot)$ is a strictly increasing function, $p(\phi_h) - p(\phi_l)$ declines when σ increases. If (EC*) does not hold then

   $$\frac{\partial \phi_l(\beta, \sigma)}{\partial \sigma} = \frac{1}{2}\left(\ln q_l(\sigma) + \frac{\sigma(\theta - 1)}{(2-\sigma)(1+\theta-\sigma)}\right)$$

   and

   $$\frac{\partial \phi_h(\beta, \sigma)}{\partial \sigma} = \frac{1}{2}\ln q_l(\sigma) + \frac{1-\theta}{2(1+\theta-\sigma)}.$$

   The former is unambiguously negative. The latter may be positive or negative. However, note that (EC*) holds for relatively high values of σ and does not hold for $\sigma = 0$. Furthermore,

   $$\frac{\partial \phi_h(\beta, 0)}{\partial \sigma} = \frac{1}{2}\ln\frac{1+\theta}{2} + \frac{1-\theta}{2(1+\theta)} > 0$$

   and

   $$\frac{\partial^2 \phi_h(\beta, \sigma)}{\partial \sigma^2} = \frac{(1-\theta)^2}{2(2-\sigma)(1+\theta-\sigma)^2} > 0.$$

   Thus $\phi_h(\beta, \sigma)$ is strictly increasing in σ when (EC*) does not hold. Therefore, when (EC*) does not hold $\phi_l(\beta, \sigma)$ is strictly decreasing in σ and $\phi_h(\beta, \sigma)$ is strictly increasing in σ. Since $p(\cdot)$ is a strictly increasing function, $p_A(\beta, \sigma)$ is strictly increasing in σ.

■

The properties of the willingness of good sellers to pay for being accredited are all as would be expected, except for the fact that demand is upward sloping when (EC*) does not hold. To see why this is the case, note that when σ increases, two things happen. One, q_l decreases, i.e. the expected quality of unaccredited sellers relative to that of accredited sellers decreases (quality effect). This causes buyers to search more intensively in the good submarket and raises the probability of trade for sellers in that submarket. Two, the number of sellers decreases in the bad submarket and increases in the good submarket (quantity effect). The first effect increases the gains from being accredited, but the second effect decreases them. Which effect dominates depends on whether or not (EC*) holds.

When (EC*) does not hold (at low values of σ), an increase in σ decreases q_l relative to q_h and the equilibrium search pattern of buyers changes so that ϕ_l decreases and ϕ_h increases. Thus $p(\phi_h) - p(\phi_l)$ increases, and good sellers are willing to pay more to be accredited. In other words, the gain to a good seller from being accredited increases with the number of good sellers who are accredited, provided that unaccredited sellers are not excluded.

When (EC*) holds, unaccredited sellers are excluded and $\phi_l = 0$. In this case an increase in σ only serves to increase the number of sellers in the good submarket, and ϕ_h falls. Thus demand for accreditations is decreasing in σ when (EC*) holds.

4.2 Monopoly profit

Assuming for now no costs of creating information, since the total number of buyers is Φ and the total number of good sellers is $\frac{1}{2}$, the monopolist's profit is:

$$\pi(\beta, \sigma) = \Phi p_G(\beta, \sigma) \beta + \tfrac{1}{2} p_A(\beta, \sigma) \sigma.$$

The monopolist chooses β and σ simultaneously to maximize its profit.

Proposition 10 *Monopoly profit is maximized by accrediting all good sellers and making this information available to all buyers, that is, where $\sigma = \beta = 1$.*

Proof. The first-order conditions are:

$$\frac{\partial \pi(\beta, \sigma)}{\partial \beta} = \Phi p_G(\beta, \sigma) + \Phi \frac{\partial p_G(\beta, \sigma)}{\partial \beta} + \frac{1}{2} \sigma \frac{\partial p_A(\beta, \sigma)}{\partial \beta} = 0 \qquad (16)$$

$$\frac{\partial \pi(\beta, \sigma)}{\partial \sigma} = \Phi \beta \frac{\partial p_G(\beta, \sigma)}{\partial \sigma} + \frac{1}{2} p_A(\beta, \sigma) + \frac{1}{2} \sigma \frac{\partial p_A(\beta, \sigma)}{\partial \sigma} = 0 \qquad (17)$$

Examining (17), we see that if (EC*) does not hold then $\frac{\partial \pi(\beta,\sigma)}{\partial \sigma} > 0$ since from proposition 8 we have $\frac{\partial p_G(\beta,\sigma)}{\partial \sigma} = 0$ and from proposition 9 we have

$\frac{\partial p_A(\beta,\sigma)}{\partial \sigma} > 0$. If (EC*) does hold then using (11), (12), (13) and (15) after some manipulation we obtain

$$\frac{\partial \pi(\beta,\sigma)}{\partial \sigma} = \frac{(1+\Phi)\left(\sigma e^{-\phi_l(\beta,\sigma)} + (2\beta\Phi - \sigma)\, e^{-\phi_h(\beta,\sigma)}\right)}{2\sigma}.$$

This is positive if

$$\beta > \frac{\sigma\left(e^{-\phi_h(\beta,\sigma)} - e^{-\phi_l(\beta,\sigma)}\right)}{2\Phi e^{-\phi_h}}$$

which is always true since the right-hand side is negative due to the fact that $\phi_h(\beta,\sigma) > \phi_l(\beta,\sigma)$ and e^{-x} is a strictly decreasing function. Thus the monopolist will always set $\sigma = 1$.

It remains to show that $\beta = 1$ is profit maximizing given that $\sigma = 1$. First suppose that β is small so that (EC*) holds. Then from (11), (12), (13), (14) and (15) we have

$$\begin{aligned}\frac{\partial \pi(\beta,1)}{\partial \beta} &= \frac{1}{2}\Phi\left[e^{-\phi_h(\beta,1)} - e^{-\phi_l(\beta,1)}\theta\right] \\ &\quad -\frac{1}{2}\Phi^2\left[e^{-\phi_l(\beta,1)}\theta + e^{-\phi_h(\beta,1)}\right] \\ &\quad +\frac{1}{2}\Phi^2\left[(1+\beta)\, e^{-\phi_h(\beta,1)} + (1-\beta)\, e^{-\phi_l(\beta,1)}\right]\end{aligned}$$

which simplifies to

$$\frac{\partial \pi(\beta,1)}{\partial \beta} = \frac{1}{2}\Phi e^{-\phi_h(\beta,1)}(1+\beta\Phi) - \frac{1}{2}\Phi e^{-\phi_l(\beta,1)}(\theta + \Phi\theta - \Phi(1-\beta))$$

This is positive if

$$\frac{e^{-\phi_h(\beta,1)}}{e^{-\phi_l(\beta,1)}} \geq \frac{\theta + \Phi\theta - \Phi(1-\beta)}{1+\beta\Phi}. \tag{18}$$

If (EC*) holds and $\sigma = 1$ then we know that $e^{-\phi_h(\beta,1)}/e^{-\phi_l(\beta,1)} \geq \theta$. Subtracting the right-hand side of (18) from θ we obtain

$$\theta - \frac{\theta + \Phi\theta - \Phi(1-\beta)}{1+\beta\Phi} = \frac{(1-\beta)(1-\theta)\Phi}{1+\beta\Phi} > 0$$

thus if (EC*) holds then (18) also holds. Therefore, $\frac{\partial \pi(\beta,1)}{\partial \beta} \geq 0$ when (EC*) holds. If (EC*) does not hold then

$$\frac{\partial \pi(\beta,1)}{\partial \beta} = \frac{1}{2}\frac{\partial p_A(\beta,1)}{\partial \beta} \geq 0$$

from proposition 9. Thus the monopolist's profit is maximized where $\beta = \sigma = 1$. ■

5 Numerical simulation results

In this section we present the results obtained from a numerical simulation of our model. The parameters of the model are the buyer-seller ratio, $\Phi > 0$, and the bad quality level relative to good quality, $\theta \in (0, 1)$. This numerical analysis addresses three issues. First, we quantify the welfare gains and distributional effects under provision of information by a social planner and a monopolist. Second, we examine the incentives of a social planner and a monopolist to create information when doing so requires incurring a fixed cost $F \geq 0$. Third, if we further restrict the monopolist to only serving one 'side' of the market, that is, to only sell guidebooks or only sell accreditations, we examine the factors that influence the monopolist's choice of which side to serve.

5.1 Welfare effects

Figure 2 showed the maximum possible welfare gain, which occurs when a perfect information partition, $\left(\frac{1}{2}, \theta\right)$ is given to all buyers, as a function of the parameters Φ and θ. In this section we present numerical results that quantify how this welfare gain is distributed among the economic agents in the model under the planner and monopoly solutions.[2]

First, figure 3 shows the welfare effects on buyers (in aggregate) under the planner and the monopolist. The upper two graphs show the percentage change in aggregate welfare of buyers relative to their equilibrium welfare level when search is 'unguided', that is, relative to the benchmark characterized in section 3.1 where no buyers are informed. The lower two graphs show the change in aggregate welfare of buyers divided by the change in the level of total welfare due to the provision of information.

From figure 3 we can see that buyers are always worse off under monopoly and worse off in many cases under the social planner. Buyers are only better off under the planner if the bad quality level is relatively low, or if the buyer-seller ratio is relatively low. For some parameter cases shown, the effects on buyers are identical under the social planner and monopoly. This occurs if the parameters are such that in equilibrium buyers do not exclude bad sellers. In that case, as shown in corollary 1, buyers do not benefit from being informed and the monopolist is unable to extract any revenue from them, and proposition 5 tells us that buyers are made worse off by the provision of information.

Figure 4 shows the welfare effects on the bad sellers of the provision of information by both the planner and monopolist. Since the monopolist does not generate any revenue directly from the bad sellers, the effects on bad sellers are identical in both cases. We can also see that the welfare

[2] Recall from propositions 3 and 10, both of these solutions involve creating a perfect information partition and making it available to all buyers.

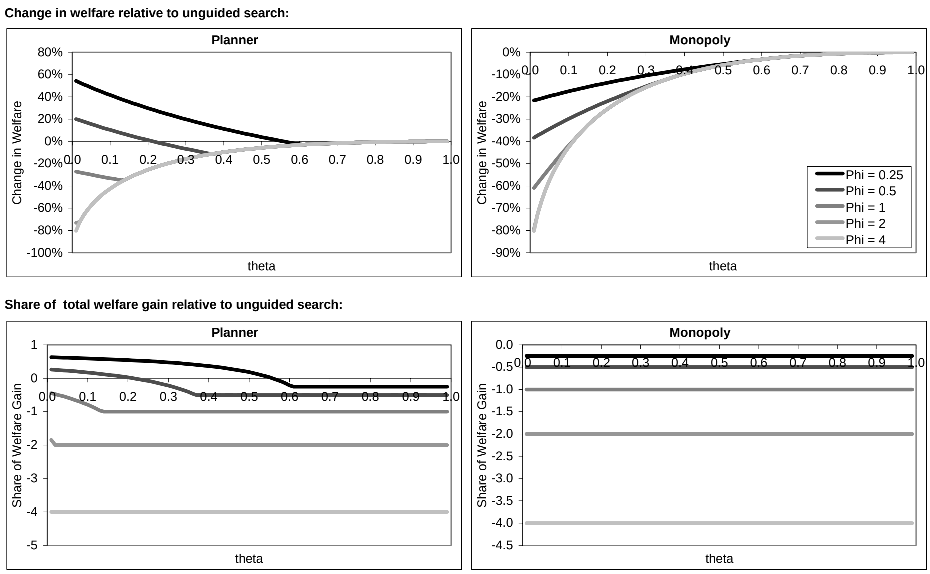

Figure 3: Welfare effects on buyers.

loss suffered by bad sellers can be as high as 100% of their welfare under unguided search if bad sellers are excluded by buyers in equilibrium, since both the planner and monopolist provide a perfect information partition to all buyers.

Figure 5 shows the aggregate welfare effects on the good sellers. Under the planner, good sellers are always better off from the provision of information because identifying the good sellers results in an increase in their probability of trade. The numerical results also show that under the planner the gains to good sellers can be many times the total welfare gain. Thus the good sellers benefit from the welfare losses suffered by bad sellers and by buyers.

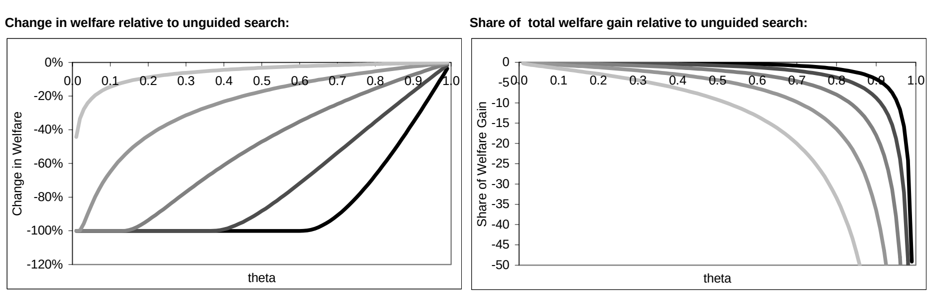

Figure 4: Welfare effects on bad sellers.

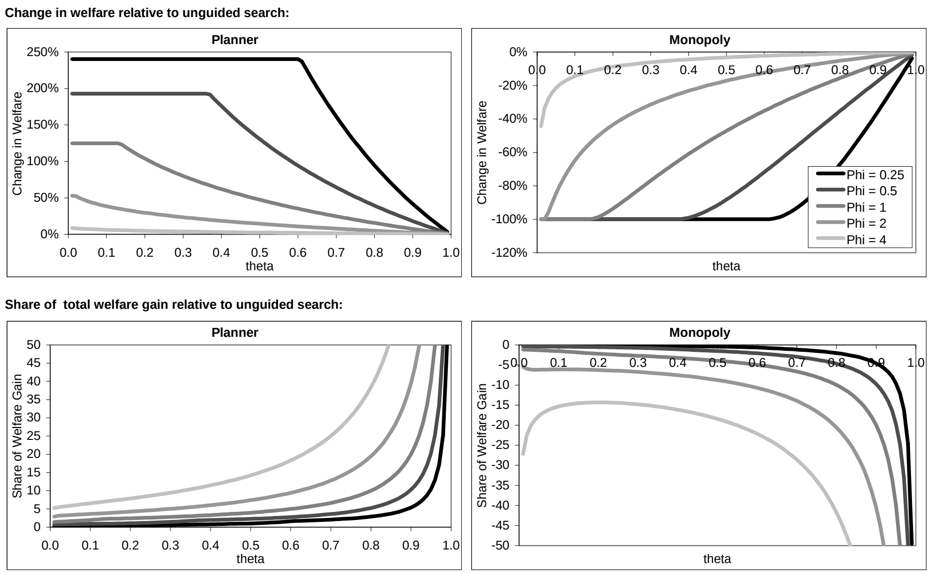

Figure 5: Welfare effects on good sellers.

Under monopoly, good sellers are always worse off relative to when buyers are uninformed. In our model, the monopolist is able to extract from good sellers all of the benefits of being distinguished from bad sellers. If the parameters are such that bad sellers are excluded by buyers in equilibrium, the monopolist is able to extract all of the surplus from a good seller. This is because in that case a good seller's alternative of not being accredited means being unable to trade in equilibrium.

Finally, figure 6 shows the monopolist's profit as a fraction of the total welfare gain in equilibrium relative to unguided search. The numerical results indicate that in equilibrium the monopolist in many cases appropriates more welfare than the additional welfare that it creates by the provision of information. This occurs partly because of the upward-sloping nature of demand for accreditations by good sellers when bad sellers are not excluded. In this case, the demand for accreditations exhibits a 'network effect' in the sense that as more good sellers become accredited, the gain from being accredited also increases.

5.2 Incentives to create information

The numerical version of the model can also be used to examine the incentives of the social planner or monopolist to gather and distribute information when doing so is costly. For simplicity, we assume that generating a perfect information partition $\left(\frac{1}{2}, \theta\right)$ and distributing it to all buyers requires either the planner or the monopolist to incur a fixed cost of $F \geq 0$. For a given

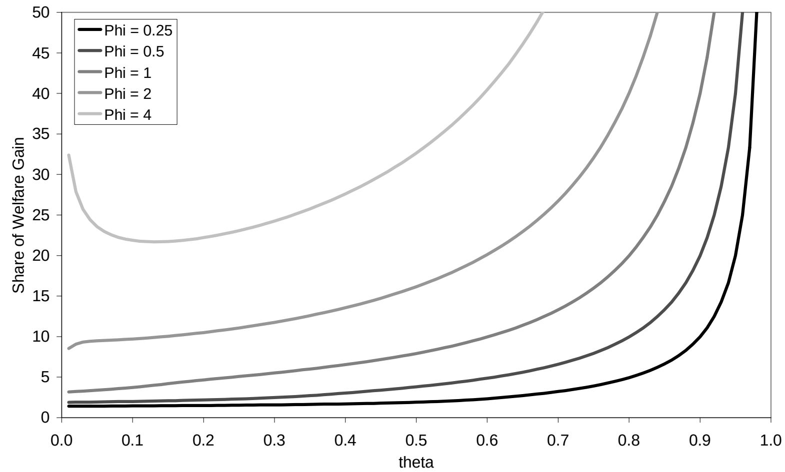

Figure 6: Monopolist's profit as a fraction of the total welfare gain from providing information.

value of F, the planner will choose to create the information if the additional welfare generated, $W_1 - W_0$, exceeds the fixed cost, while the monopolist will choose to create the information if its total revenues from buyers and good sellers exceed the fixed costs.

As was shown in figure 6, the monopolist is in many cases able to appropriate more welfare than the additional welfare that it creates due partly to the nature of demand for accreditations. Thus for any given cost of creating information, the monopolist has a stronger incentive to do so than the social planner. Even though the monopolist's profit maximizing behavior is to create a perfect information partition and distribute this to all buyers, the nature of the demands for its services mean that it will generally choose to *overinvest* in the production of information relative to the social planner.

To illustrate, figure 7 shows the parameter regions in which the planner and/or monopolist would choose to create information for $F = 0.0001$, for $\theta \in (0, 1)$ and $\Phi \in (0, 10)$. In general, the gains from creating information decrease as the bad quality level increases or the buyer-seller ratio increases. However, the monopolist creates information for a large region of parameters in which it is socially undesirable to do so.

5.3 Monopolist's choice of business model

In the previous analysis of monopoly provision of information we have assumed that the monopolist serves both sides of the market, that is, earns revenues both from accrediting good sellers and from selling information to buyers. In this section we restrict the monopolist to only serving one side of

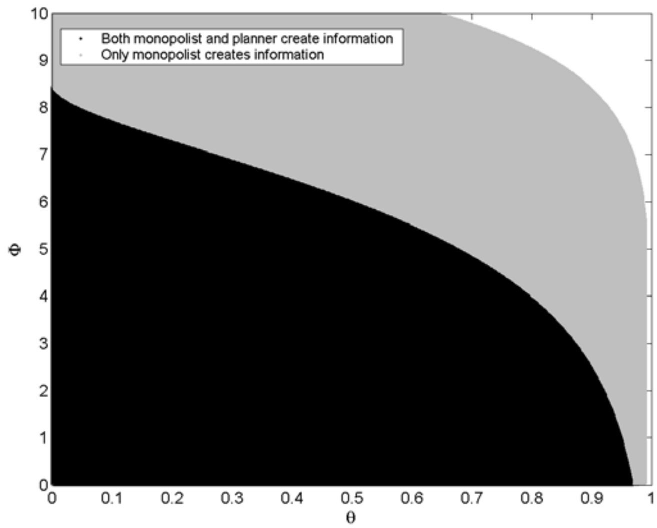

Figure 7: Parameter regions in which the social planner and/or monopolist choose to create information, for $F = 0.0001$. In the black region, both the planner and the monopolist choose to create information. In the grey region, only the monopolist chooses to create information.

the market. We consider a monopolist who either operates an accreditations service by selling accreditations to good sellers and giving this information to all buyers, or who operates a 'guidebook' service by accrediting all good sellers and selling this information to buyers.

In particular, under a guidebook service we assume that $\sigma = 1$ and the monopolist does not charge sellers to be accredited. Thus the monopolist's profit in this case is

$$\pi_G(\beta) = \Phi\beta p_G(\beta, 1).$$

Under an accreditations service we assume $\beta = 1$ and the monopolist does not charge buyers for guidebooks. Thus the monopolist's profit in this case is

$$\pi_A(\sigma) = \tfrac{1}{2}\sigma p_A(1, \sigma).$$

Clearly, unlike the case where the monopolist serves both sides of the market, it cannot always be optimal to give guidebooks to all buyers, for example. If the monopolist did that, in many cases it would earn no revenue, as $\beta = 1$ often does not satisfy the exclusion constraint. A similar argument applies for the sale of accreditations, since at some level of σ the demand for accreditations becomes downward sloping. Therefore, in general the monopoly solutions in these two more restricted cases will involve $\beta, \sigma < 1$.

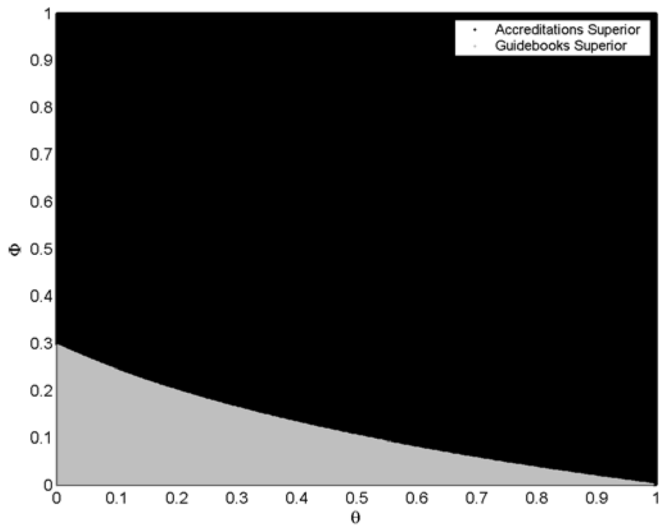

Figure 8: Parameter regions in which a monopolist chooses to sell guidebooks to buyers (the grey region) or sell accredications to good sellers (the black region).

It is not possible to obtain explicit solutions for the profit-maximizing choice of β or σ in either case due to the nature of the functional forms involved. Instead, we have used a numerical algorithm to find the profit-maximizing quantity given the parameters Φ and θ. We can then evaluate the monopolist's profit at the optimum and compare between the two business models.

Our objective here is not to examine why a monopoly provider of third-party information would choose to serve only one side of the market rather than both sides. In our framework, the monopolist always makes (weakly) more profit from serving both sides of the market. Instead, our objective is to assess the conditions under which the monopolist would choose to sell guidebooks over selling accreditations, and vice versa.

Figure 8 shows the parameter regions that cause the monopolist to choose one or the other of these business models, for values of θ and Φ between 0 and 1.[3] These results indicate that selling guidebooks generates more revenue than selling accreditations if the buyer-seller ratio is relatively low, or if the bad quality level is relatively low compared to good quality.

[3] For $\Phi > 1$ the numerical results indicate that the monopolist always chooses to sell accreditations.

6 Conclusion

This paper has analyzed a market with heterogenous sellers in which the buyers wish to find high quality sellers but also wish to economize on search costs. We showed that a third party can facilitate these goals by accrediting high quality sellers and then providing this information to buyers. All this was done using a competing auction model. The model gives four main results: First, the value of information is influenced by a network effect - the incentive to gain accreditation increases with the number of accredited sellers; Second, the network effect can dominate other factors and thus a third party may have an incentive to market guidebooks for free and extract all revenues from seller accreditation; Third, the third party may have an incentive to overinvest in information compared to the social planner; And fourth, selling guidebooks generates more revenue than selling accreditations if the buyer-seller ratio is relatively low, or if the bad quality level is relatively low compared to good quality.

There is no obvious market-based solution to the problem of excessive informational investment by a monopoly third party in our model. In particular, the information gathering technology is treated as a lumpy investment. Therefore, if two intermediaries invest in these technologies, redundant investments are undertaken and hence an inefficiency. Alternatively, we might allow competition prior to the investment in the information gathering technology. For example, the intermediary might attempt to contract with the sellers prior to its investment. Here, an intermediary might promise a low price of accreditation prior to its investment. However, given that the resulting information partition is private information to the intermediary, this contract would be subject to renegotiation. In particular, a court could not verify the threat to have any particular accreditation withheld. Therefore, the intermediary could ask for a price of accreditation that is higher than the contracted price and the contracted seller would be willing to accept it. For these reasons, if we take the assumptions of our model seriously, we are not surprised that accreditation activities are highly regulated.

In terms of the two-sided markets literature, in our model we have shown that it can be profit-maximizing for a two-sided platform to charge a zero price on one side of the market, even though there is potentially value on both sides of the market. Thus a zero price on one side of a two-sided market does not make it a one-sided market.

The framework developed in this paper may be useful for several avenues of future research. First, it would be interesting to examine competition among third-party information services. General issues related to pricing in two-sided markets are examined by Rochet and Tirole (2003) and Caillaud and Jullien (2003), among others, but these models assume an exogenous matching technology for the two sides of the market. In our model, the demands arise from the equilibrium search behavior of buyers. It would also be interesting to examine investment in different qualities of assessment technology by competing firms.

Some additional insights may also be gained by making the trading environment of our model richer. For example, by introducing entry and exit by sellers, and/or sale of long-lived assets.

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