Excessive Search

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Abstract

This paper shows that consumer search has a negative externality. It arises when sellers must incur costs to provide information sought by consumers. Under the assumption that the number of searches is private information, we find that there are multiple search equilibria. Between the two price dispersion equilibria, only the Pareto-dominated one is stable. Moreover, in the stable equilibrium, the expected equilibrium price decreases with search costs; consumers engage in excessive search that is detrimental to their own welfare; a decline in search costs leaves consumers worse off. The model suggests the use of intermediaries as a commitment/coordination mechanism. (JEL D40, L00)

Keywords: Bertrand competition, Cum-sales cost, Externality, Multiple equilibria, Price dispersion, Search cost.
Price dispersion is ubiquitous even for homogeneous goods. An important source of dispersion is insufficient consumer search (Stigler 1961). Two factors contribute to the lack of search: a direct effect from search costs and an indirect effect from a search externality. A search externality exists because consumers who do not search still benefit from sellers' competition for consumers who search. Since this is a positive externality, the resulting equilibrium has too little search. Following this line of reasoning, if every consumer searches diligently, then price dispersion will disappear and the "law of one price" will prevail.

In this paper, we show that search can also have a negative externality. It arises when sellers must incur costs to provide information sought by consumers. For concreteness, we call them "bidding costs", which include the cost of preparing price quotes and the cost of "cum-sales" services. Because of bidding costs, frequent searches increase the total costs of doing business. If sellers cannot distinguish non-searchers from searchers, the higher costs of doing business will be borne by all consumers, thus generating a negative externality. Consequently, the equilibrium number of searches may be excessive, yet price dispersion persists.

Our model builds on "the contractors' game" introduced by Lang and Rosenthal (1991). A striking result of their paper is that, the more sellers who compete in the market, the higher is the price. Intuitively, as the number of competitors increases, the chance of winning business gets smaller. As such, sellers will in equilibrium seek a higher expected profit in the event of winning, which translates into a higher price. Building on this insight, we develop a simple fixed-sample size search model that embeds "the contractors' game". Under the assumption that sellers cannot observe a consumer's number of searches, we find that, when search costs are small, there will be multiple price dispersion equilibria. In one equilibrium, sellers believe that the consumer will canvass a small number of sellers and accordingly they bid aggressively; in the other equilibrium, sellers believe that the consumer will canvass a large number of sellers and accordingly they less likely participate in bidding, and when they do they raise their prices to compensate for the bidding costs. The first equilibrium Pareto dominates the second, but only the second one is stable. Moreover, in the stable equilibrium, the expected equilibrium price, as well as the number of searches, decreases with the consumer's search costs. This means that a decline in search costs can leave consumers worse off, due to their lack of commitment. The model thus suggests the use of intermediaries as a commitment/coordination mechanism.

1The notion of "cum-sales" services was introduced by Bolton and Bonanno (1988). Unlike the services studied by Telser (1960), "cum-sales" services do not benefit a consumer unless she purchases the good from the same store.
Our paper is closely related to Burdett and Judd (1983) (henceforth BJ-83). In their model, consumers and sellers are ex ante identical. If everyone searches two sellers, then all prices will be set equal to marginal cost, but it is not an equilibrium because price uniformity eliminates the need to search (twice). In other words, search is a public good subject to a free-rider problem. As a result, there is insufficient search in the sense that only a fraction of consumers search two sellers and prices are above marginal cost, despite competition among homogeneous sellers. Although BJ-83 assume a continuum of consumers, their model equally applies to a representative consumer, who randomizes her number of searches. This means that even an individual consumer can suffer from the search externality between her own selves, if she does not have the ability to commit. Our model adopts the representative consumer framework of BJ-83, but assumes that sellers incur bidding costs when submitting their price quotes. The bidding costs play two roles. First, as shown by Lang and Rosenthal (1991), they generate price dispersion, which in turn gives a consumer the incentive to search more than two sellers. Second, since the bidding costs are paid indirectly by the consumer, they give rise to a negative externality that leads to excessive search. These two features distinguish our paper from BJ-83.

In addition to BJ-83, Salop and Stiglitz (1977), Varian (1980), Baye and Morgan (2001), Armstrong (2015) and Salz (2017) have also noted the existence of a positive search externality between consumers. By comparison, the literature on negative externalities or excessive search is more sparse, but there are two exceptions. Anderson and Renault (2000), in a model of horizontally differentiated duopoly, show that information on product characteristics can have a negative externality. In their model, consumers informed of their match values with sellers have less elastic demand. Prices are higher the greater the proportion of informed consumers. As a result of this externality, consumers overinvest in information gathering. Wolinsky (2005) considers consumer search in the markets for procurement contracts by assuming that sellers can provide better matching via costly investment. Consumers, however, fail to fully internalize the costs incurred by the sellers, and therefore search excessively. While these two papers generate an excessive search result similar to ours, there are several important differences: first, their models are concerned with search for prior information about product characteristics (so there is no price dispersion), whereas our model is concerned with prior information about prices; second, in their models, while search intensity is excessive from a social planner’s point of view, it is optimal for the consumer, but in our model excessive search is detrimental to the consumer herself as well as social welfare; third, equilibrium welfare decreases with search costs in their models, but not in ours. The last two differences are due to their focus on cross-group externalities, as opposed to ours on within-group externalities.
The remainder of this paper is organized as follows. Section 1 introduces the model and discusses assumptions. Section 2 solves the model and examines equilibrium properties. Section 3 concludes by discussing the implications of our results. Any formal proofs omitted from the main text are contained in the appendix.

1 The Model

A consumer is in the market for 1 unit of a good, which can be provided by any one of the \(N\) sellers. Also available to the consumer is an outside option, which costs \(v\).\(^2\) In order to find the best deal, the consumer visits sellers to request price quotes. Each visit costs the consumer \(s\), i.e., the search cost. Sellers have the same production cost of \(c\). Submitting a price quote, whether successful or not, costs a seller \(b\), i.e., the bidding cost.\(^3\) The values of all above variables are assumed to be common knowledge. Without loss of generality, \(v\) is normalized to 1 and \(c\) is normalized to 0. Hence, \(s\) and \(b\) should be understood as the magnitude relative to \(v - c\).

The game is played in the following order:

1. The consumer requests prices quotes from \(n\) sellers;
2. Upon request, but without observing \(n\), each seller decides whether to incur \(b\) to submit a price quote from the distribution of \(F(p)\);
3. After receiving all price quotes, the consumer buys from the seller that offers the lowest price. If no seller submits a price quote, then the consumer takes the outside option.

We focus on symmetric equilibria, in which sellers choose the same bidding strategy. We also restrict our attention to equilibria in which the consumer uses a pure strategy, i.e., the consumer does not randomize over her number of searches. Thus, an equilibrium will be characterized by a triplet \(\{n, \alpha, F(p)\}\), where \(n\) is the number of searches, \(\alpha\) is the probability of a seller choosing to bid, and \(F(p)\) is the cumulative distribution function of price quotes. Sellers use pure strategies in pricing if and only if price distributions are degenerate. The solution concept is a Bayesian Nash equilibrium. The consumer and sellers

\(^2\)For example, in the auto insurance market studied by Honka (2014), a buyer can always default to the current provider if she cannot find a better rate elsewhere. The availability of an outside option, however, is not essential to our results. Alternatively, we can assume that the consumer does not make a purchase if no seller submits a price quote or if prices are greater than \(v\) (i.e., reservation price). Results will remain the same.

\(^3\)In the working paper version (Miao 2017; available upon request), we allow uncertainty in the production cost and explicitly model the entry cost as the cost to acquire information to resolve that uncertainty.
form beliefs about each other’s strategies. In the equilibrium, their beliefs are correct. For ease of exposition, we ignore the integer constraint on the number of searches and assume that the pool of sellers is so large that the consumer’s number of searches is never constrained by the number of sellers, i.e., \( N \to \infty \).

By assumption, the consumer engages in a fixed-sample size search, as opposed to sequential search where consumers visit sellers one-by-one and do not stop searching until their reservation price is met. There are several reasons why we make this assumption. First, it facilitates comparison with BJ-83. Second, existing empirical evidence suggests that fixed-sample size search provides a more accurate description of observed consumer search behavior (De los Santos, Hortacsu, and Wildenbeest 2012, Honka and Chintagunta 2017). Third but particularly relevant to this model, costly bidding can lead to delay and delay is a more significant problem for sequential search than for fixed-sample size search.\(^4\)

It should also be noted that there is a subtle difference between the commitment problem behind the common criticism against the fixed-sample size approach of modeling consumer search and the commitment problem highlighted in this paper. The former is about a consumer’s inability to commit to the fixed-sample size strategy itself, but the latter is the consumer’s inability to commit to the optimal number of searches. In economic environments where fixed-sample size search is more advantageous than sequential search, the issue of commitment to strategy does not bite, but the issue of commitment to the number of searches remains.

\[ \text{Equilibrium Properties} \]

The Subgame Equilibrium at the "Bidding" Stage The (stage 2) subgame is simply "the contractors’ game" studied by Lang and Rosenthal (1991), where the number of projects is one. Lemma 1 summarizes their result:

**Lemma 1** In a symmetric equilibrium, each seller chooses to submit a bid with a probability of \( \alpha = 1 - b^{1/(n-1)} \). If a seller submits a bid, he quotes a price from the distribution of \( F(p) = \frac{1-(b/p)^{1/(n-1)}}{1-b^{1/(n-1)}} \), with \( p = b \) and \( \bar{p} = 1 \). Sellers earn zero expected profits.

Throughout the analysis, we will make use of the expected lowest price. However, according to Lemma 1, sellers do not always bid. This means that the consumer can sometimes fail to obtain a single bid so a price quote does not always exist. This is not an essential difficulty. From the consumer’s point of view, a no-bidding outcome is equivalent to paying

\[ \text{In the same vein, Morgan and Manning (1985) and Janssen and Moraga-Gonzalez (2004) argue that fixed-sample size search is more appealing when a consumer needs to gather price information quickly.} \]
v for the outside option, both resulting in the same net utility. Therefore, when computing the expected price, we assume that the lowest price is v if no seller bids. Thus, we obtain the following result:

**Lemma 2** If the number of sellers is 0 or 1, then the expected price is 1. If the number of sellers is \( n \geq 2 \), then the expected price is \( E(p_{\text{min}}) = b[n - (n - 1) b^{1/(n-1)}} \), increasing in \( n \).

As shown by Lang and Rosenthal (1991), *ceteris paribus*, an increase in the number of sellers, \( n \), causes the winning bid to increase in the sense of first-order stochastic dominance. This seemingly paradoxical result arises because the consumer indirectly pays for sellers’ bidding costs in the form of a higher price.\(^5\) As the consumer searches more sellers, the total bidding costs as well as the expected number of bidders increase. Consequently, the price paid by the consumer increases with \( n \), as shown in Lemma 2.

It is also worth noting that the (stage 2) subgame is similar to the game studied by Baye and Morgan (2001). In their model, sellers have to pay an information gatekeeper a listing fee in order to advertise prices on its Internet site. Because of this fee, there is price dispersion even for a homogenous good. Basically, the listing fee in their model has the same effect as the bidding cost in ours. The only difference exists in consumers’ options when no seller bids/lists. In our model consumers either do not buy or choose an outside option, whereas in theirs consumers randomly buy from one of the sellers because sellers are local monopolies in the absence of Internet listing. This difference has two consequences. First, it follows that sellers are less willing to cut prices in their model, particularly when \( n \) is small. Hence, the monotonicity result given by Lemma 2 is not a feature of their model. Second, unlike the present model, sellers’ profits are not competed away in Baye and Morgan (2001) so the listing fee is only partially passed through to consumers.

### 2.1 Multiple Equilibria

Without observing the consumer’s search behavior, sellers must form their beliefs and bid accordingly. Let \( T(n, m) \) denote the expected total cost, where \( n \) represents the actual number of searches and \( m \) represents sellers’ belief about the number of searches. Also denote the corresponding expected lowest price by \( E(p_{\text{min}}|n, m) \). The equilibrium condition is

\[
m = \arg \min_n T(n, m), \text{ where } T(n, m) = E(p_{\text{min}}|n, m) + ns.
\]

\(^5\)French and McKormick (1984) were the first to make this point by showing that the winner’s expected profit equals the sum of his competitors’ sunk costs of bid preparation under a free-entry condition.
The equilibrium number of price quotes, \( n^e \), must satisfy

(1) \[ \frac{\partial}{\partial n} E(p_{\text{min}}|n, m) \big|_{m=n=n^e} = -s, \]

and

(2) \[ \frac{\partial^2}{\partial n^2} E(p_{\text{min}}|n, m) \big|_{m=n=n^e} > 0. \]

Using the results from Lemma 1, we obtain that

\[
E(p_{\text{min}}|n, m) = (1 - \alpha)^n + n\alpha \int_0^1 \left( \sum_{k=1}^n \frac{(n-1)!}{(k-1)!(n-k)!} (1 - \alpha)^{n-k} [\alpha (1 - F)^{k-1} F_m^{-1}(F)] \right) dF
\]

(3) \[
= (1 - \alpha)^n + nb \frac{1 - (1 - \alpha)^{n-m+1}}{n - m + 1},
\]

where \( \alpha = 1 - b^{1/(m-1)} \) and \( F_m(p) = \frac{1 - (b/p)^{1/(m-1)}}{1 - b^{1/(m-1)}} \). Hence,

\[
\frac{\partial}{\partial n} E(p_{\text{min}}|n, m) = (1 - \alpha)^n \ln (1 - \alpha) + b \frac{1 - (1 - \alpha)^{n-m+1}}{n - m + 1}
\]

\[
- \frac{nb}{(n - m + 1)^2} \left( (1 - m) (\ln (1 - \alpha)) (1 - \alpha)^{n-m+1} + (n \ln (1 - \alpha) - 1) (1 - \alpha)^{n-m+1} + 1 \right).
\]

Let \( g(n, m) = -\frac{\partial}{\partial n} E(p_{\text{min}}|n, m) \) and \( h(n) = g(n, n) = b (n - 1) \left[ 1 + \left( \frac{\ln b}{n-1} - 1 \right) b^{1/(n-1)} \right] \), the equilibrium conditions (1) and (2) can be rewritten as \( h(n) = s \) and \( g_1(n, n) < 0 \).

**Lemma 3** There are two roots of \( n \) for \( h(n) = s \) if and only if \( s < \bar{s} \), where \( \bar{s} = \left( \frac{1}{\ln x} + x \right) b \ln b \) and \( x \) is the root of \( 1 - \ln x + \ln^2 x = 1/x \). Denote them by \( n_1 \) and \( n_2 \), where \( n_1 < n_2 \).

(i) \( h'(n_1) > 0 \) and \( h'(n_2) < 0 \);

(ii) \( g_1(n, n) < 0 \) for both \( n_1 \) and \( n_2 \).

Lemma 3 implies that there are two price dispersion equilibria when \( s \) is sufficiently small. If sellers expect the consumer to choose a small \( n \), then they will more actively participate in bidding and bid more aggressively, causing prices to be concentrated just above the marginal cost. Their expectation is self-fulfilled because the consumer gains little from searching a large number of sellers. Conversely, if sellers expect the consumer to choose a large \( n \), then
they will either choose not to bid or bid less aggressively, leading to a greater degree of price dispersion. Again their expectation is self-fulfilled because in this case the consumer gains more from expanding her search effort.

The above two equilibria can be Pareto-ranked. Since sellers earn zero profits in both equilibria, but the consumer pays a lower price when \( n \) is small, the equilibrium with the smaller number of searches Pareto dominates the other. Unfortunately, however, the Pareto-dominant equilibrium is not a stable equilibrium.

In order to check the stability of the equilibrium where \( n^e = n_1 \), consider a small perturbation \( \Delta n_1 \) at \( m = n = n_1 \). Let \( n'_1 \) denote the consumer’s best response that satisfies \( g(n'_1, n_1 + \Delta n_1) = s \). Since \( h'(n_1) > 0 \), we must have \( g(n_1 + \Delta n_1, n_1 + \Delta n_1) > g(n_1, n_1) = s = g(n'_1, n_1 + \Delta n_1) \). At the same time, since \( g_1(n, m) < 0 \), we must have \( n'_1 > n_1 + \Delta n_1 \). This means that the change in the consumer’s best response will be greater than the initial perturbation, and therefore the equilibrium at \( n_1 \) is not stable. Conversely, since \( h'(n_2) < 0 \), the change in the consumer’s best response will be smaller than the initial perturbation at \( n_2 \). Hence, the equilibrium at \( n_2 \) is stable.

Intuitively, \( h(n) \) can be seen as the marginal benefit of search when \( m = n \). Figure 1 plots \( h(n) \) for \( b = 0.01 \). Since \( h(n) \) is unimodal, there are two price dispersion equilibria for a sufficiently small \( s \), represented by the two intersections of \( h(n) = s \). Between the two intersections, in Region II, the marginal benefit of search is greater than \( s \), so there is an upward pressure for more searches; whereas in Region I and III, there is a downward pressure for fewer searches. Therefore, only the intersection on the right represents a stable equilibrium.

![Figure 1. Marginal Benefit of Search when \( m = n \).](image-url)
Last, it is easy to see that the Diamond (1971) outcome of monopoly pricing is also an equilibrium. Summarizing, we obtain the following result:

**Proposition 1** There exists a $\bar{s} > 0$ such that for $s < \bar{s}$ there are three equilibria: (1) $n = 0$ and $p = v$; (2) $n = n_1$; (3) $n = n_2$, where $n_1$ and $n_2$ are the two roots of 
\[(n-1)\left[1 + \left(\frac{\ln b}{n-1} - 1\right) b^{1/(n-1)} \right] = s/b.\]
In (2) and (3), each seller quotes a price according to the distribution of $F(p) = \frac{1-(b/p)^{1/(n-1)}}{1-b^{1/(n-1)}}$. Furthermore,

(i) equilibrium (2) Pareto dominates equilibrium (3);

(ii) equilibrium (2) is unstable and equilibrium (3) is stable.

The existence of multiple equilibria is a common feature in fixed-sample size search models. In BJ-83, in addition to the monopoly equilibrium, there are two dispersed price equilibria - one with low search intensity and high prices, the other with high search intensity and low prices. Fershtman and Fishman (1992) argue that only the second one is stable. In an oligopolistic version of BJ-83 where some consumers search costlessly, Janssen and Moraga-Gonzalez (2004) show that there are three distinct price dispersion equilibria characterized by low, moderate and high search intensity. Our finding of multiple equilibria is similar to the existing ones. However, despite the similarity, our model differs from the others in its prediction of excessive search, as shown below.

### 2.2 Excessive Search

In this section, we compare the equilibrium number of searches to the optimal number of searches. The optimal number of searches minimizes the consumer’s expected total cost, including the price paid and the search costs. Since firms earn zero profits, the optimal number of searches not only maximizes consumer surplus, but also maximizes social surplus. Let it be denoted by $n^*$. By definition,

\[(4) \quad n^* = \arg\min_n E(p_{\min|n,n}) + ns.\]

It will be chosen if the consumer has the ability to commit to $n^*$ when searching. In our model, if sellers can observe the consumer’s choice of $n$ before submitting price quotes, then commitment is possible; but if $n$ is not publicly observable, then there will be no commitment (Bagwell 1995).

**Proposition 2** In the stable equilibrium, the equilibrium number of searches $n^e$ is strictly greater than $n^*$ if $s < b[(1-b) + b\ln b]$.
The intuition behind Proposition 2 is as follows. In the noncommitment case, when a consumer decides whether to search another seller, it is driven by the expected price decrease \( \frac{\partial}{\partial n} E(p_{\min}|n, m) \), holding sellers’ belief and strategy constant. Prices are lower the more searches by the consumer. Whereas in the commitment case, a consumer’s decision to search another seller causes all sellers to revise their strategies and raise their prices, so the expected price decrease, i.e., the negative of \( \frac{\partial}{\partial n} E(p_{\min}|n, n) \), is smaller (by Lemma 2, it is in fact negative). Therefore, given the same search cost, the consumer has a stronger incentive to search more sellers if she is unable to commit, but it is too strong to maximize consumer surplus.

Another way to understand the result is to recognize that search has a negative externality. To see this, we examine \( \frac{\partial}{\partial (m-1)} E(p_{\min}|n, m) \). It is equal to \( \frac{nb}{(n-m+1)^2} (1 + x \ln x - x) \), where \( x = \frac{b}{n} (m-1) \). Since \( 1 + x \ln x - x > 0 \) for all \( x \in (0, 1) \), \( \frac{\partial}{\partial (m-1)} E(p_{\min}|n, m) \) must be positive. Note that \( m \), the expected number of searches, represents the number of searches by an average consumer. The positive sign of \( \frac{\partial}{\partial (m-1)} E(p_{\min}|n, m) \) means that more searches by an average consumer lead to higher expected prices, paid by all consumers, whether they search or not. As a result, there will be excessive search in the equilibrium.

Once excessive search is understood as the result of a negative externality, it becomes clear that our model is driven by two key assumptions: first, a seller’s costs must increase with consumers’ search intensity; second, the seller cannot price discriminate between searchers and non-searchers. Besides price search, many consumer activities exhibit these features. For example, they include account inquiries, requests for customer services and warranty repairs, etc. Our analysis suggests that there may also be excesses in these consumer activities due to negative externalities.

Our result of excessive search contrasts with the result of insufficient search in BJ-83. The differences are two-fold. First, as explained earlier, negative externality of consumer search arises in our model because of bidding costs, but in BJ-83 bidding costs are absent. Second, our equilibrium condition is based on the assumption that the consumer uses pure strategies, i.e., she does not randomize on the number of searches, whereas in BJ-83 a consumer uses mixed strategies. In our model, if we allow the consumer to use mixed strategies, then there will be additional equilibria. However, it is unclear whether doing so will contribute to any new insights.\(^6\) Therefore, we leave this question open for future research.

Last, it is worth noting that the present model assumes that the consumer cannot engage in multiple rounds of searches. Assuming otherwise will only serve to exacerbate the consumer’s commitment problem and further lower sellers’ incentive to bid (aggressively).

\(^6\)Tractability is another concern. In BJ-83, \( b = 0 \), so a consumer never searches more than two sellers. It is no longer true if \( b > 0 \), in which case the consumer’s randomizing strategy is considerably harder to solve.
2.3 Comparative Statics

In this section, we examine the impact of search costs on the equilibrium outcome. We continue to focus our attention on the stable equilibrium.

2.3.1 Equilibrium Number of Searches

Proposition 3 summarizes the impact of search costs on the equilibrium number of searches.

Proposition 3 In the stable equilibrium where $n = n_2$, the equilibrium number of price quotes $n_2$ decreases with $s$.

The basic intuition behind the above result can be readily seen from Figure 1. The hump-shaped curve is essentially the demand curve for search. An unstable equilibrium exists on the upward-sloping segment of the demand curve, whereas a stable equilibrium exists on the downward-sloping segment. Accordingly, the equilibrium number of searches may increase or decrease with the cost of search, depending upon the slope of the demand curve.

2.3.2 Expected Price

Next we consider the price impact of search costs. It is well-known that if prices are unobservable before search, then market prices tend to rise with search costs. Intuitively, an increase in search costs dampens consumers’ incentive to search and strengthens each seller’s market power, resulting in higher prices. The following result shows that the introduction of bidding costs can, however, generate an opposite result:

Proposition 4 In the stable equilibrium, the expected equilibrium price decreases with $s$.

According to Proposition 4, not only can a decrease in the search cost lead to excessive search, as shown in Proposition 2, but it can also result in higher prices.\footnote{Several recent papers generate the same surprising result, but they rely on very different mechanisms. See Armstrong and Zhou (2011), Zhou (2014), Shen (2015), Garcia, Honda and Janssen (2017), Haan, Moraga-Gonzalez, and Petrikaite (2017), Moraga-Gonzalez, Sandor and Wildenbeest (2017), and Choi, Dai and Kim (2018).} While a consumer with commitment must take into account the impact of additional searches on the price distribution, a consumer without commitment takes the price distribution as given. Consequently, a lower search cost is more likely to tempt a consumer without commitment to engage in additional searches, but this causes sellers to quote higher prices in order to compensate for their smaller chances of winning the bidding war. This compensation effect dominates the usual competitive effect as $n$ increases, causing prices to decrease with search costs.
2.3.3 Expected Consumer Surplus

Although lower search costs may result in higher prices, the consumer is not necessarily worse off because the savings on search costs can potentially offset the price increase. However, Proposition 5 shows that, the indirect price effect is so strong that it dominates the direct cost savings effect, with the result that a decline in search costs can perversely leave consumers worse off.

**Proposition 5** *In the stable equilibrium, consumers are always worse off when $s$ decreases.*

With the advance of the Internet, a lot of research has been devoted to understanding the impact of search cost on consumer welfare. It is generally accepted that consumers benefit from lower search costs (Bakos 1997, Brown and Goolsbee 2002, Lin and Wildenbeest 2015). Even in Wolinsky (2005), which otherwise finds that consumer search can be excessive, the effect of a lower search cost on welfare remains positive. Proposition 5, however, shows that a lower search cost, contrary to consensus, can sometimes leave consumers worse off. This finding has two important implications: first, when there are multiple sources of transaction costs, policy makers should be careful in prescribing cost reduction as the panacea for market imperfections; second, it suggests the use of intermediaries as a coordination/commitment mechanism. One such example is the online mortgage referral agent LendingTree.com, which matches potential borrowers with various loan programs. A consumer who applies to LendingTree receives four different offers and each lender quotes a price including interest rates and up-front fees. In our model, the mere stipulation of four searches can provide a focal point for consumers and sellers to coordinate, steering them away from the Pareto-dominated equilibrium involving excessive search.

2.4 The $s - b$ Indifference Map and Estimation Fee

In our comparative statics exercise, we have focused on search costs. It is straightforward to extend the analysis to bidding costs, but it is omitted here for brevity. Nonetheless, it is perhaps useful to draw a diagram, in the spirit of indifference curves, to illustrate how consumer utility is affected by search costs and bidding costs. In Figure 2, the solid hulk represents the maximum values of $s$ for a price dispersion equilibrium to exist, the dashed curves are different combinations of $s$ and $b$ that generate the same consumer utility in the stable equilibrium, and the solid straight line represents combinations of $s$ and $b$ whose sum is a constant. The arrow indicates the preference direction: consumer utility increases towards the upper left corner.
From the graph, we can see that consumers may potentially benefit if sellers shift their bidding costs to the consumer side. This can be done by requiring consumers to pay a fee for price quotes, e.g., estimation fee. Given a fee of $f$, a consumer’s search cost becomes $s + f$, while sellers’ effective bidding costs becomes $b - f$. The sum of the two costs remains $s + b$. Charging a fee thus corresponds to a move towards the upper left corner in Figure 2. Consumer utility will increase because the fee reduces the consumer’s incentive to search excessively. This observation naturally raises the question why some sellers charge estimation fees, but some do not. For example, most auto mechanics do not charge an estimation fee and many lawyers offer the initial consultation for free, whereas doctors all charge fees for medical examinations. While we speculate that the choice of the latter could be due to insurance companies’ playing the role of coordinators, other factors including the nature of the bidding cost and the verifiability of "estimation" may also play a role.\footnote{For example, in Wolinsky (2005), a seller can avoid the cost of diagnosis by investing zero efforts, so the "no compensation" equilibrium becomes the unique equilibrium.} Extending the model to explore how sellers’ design of the compensation for the bidding cost depends on these factors can provide additional insights. Last, it should be noted that, as long as the bidding cost is not fully compensated by the fee, our results will remain relevant.

3 Conclusion

Firms almost never sell a product without providing ancillary services, but they rarely receive direct compensation for those services. Using bidding cost as an example and building
on a search model, this paper shows that indirectly compensated services generate a negative externality that leads to excessive usage. It sheds light on a commitment problem in consumer search that has been previously overlooked and delivers a number of surprising results. In particular, it finds that a decline in search costs does not necessarily lower prices or benefit consumers.

These results pose a challenge to empirical studies that attempt to recover consumer search costs from the observed price distributions. The standard estimation strategy relies on a monotonicity assumption, i.e., prices are monotonically increasing functions of the search costs (Hortacsu and Syverson 2004, Hong and Shum 2006), but the breakdown of monotonicity cautions against the extension of this approach to markets where bidding costs are important.

For policy makers, this paper offers a cautionary message: regulations that aim to eliminate market frictions but focus only on search costs may end up worsening consumers’ commitment problem. A standard exercise, when making policy recommendations, is the use of counterfactual analyses, but one must be careful in interpreting the results obtained from those analyses that presume consumers would gain from reductions of search costs.
References


Appendix

A Proof

Proof of Lemma 3. (i) By definition, \( h(n) = b\left(\frac{1-b^z}{z} + b^z \ln b\right) \), where \( z = \frac{1}{n-1} \). Let \( f(z) = b\left(\frac{1-b^z}{z} + b^z \ln b\right) \). It is easy to verify that \( \lim_{z \to 0} f(z) = \lim_{z \to \infty} f(z) = 0 \) since \( b < 1 \). In addition, \( f'(z) = \frac{b}{z^2} (x + x \ln^2 x - x \ln x - 1) \), where \( x = b^z \in (0, 1) \). Note that \( x \) is decreasing in \( z \) and that \( x + x \ln^2 x - x \ln x - 1 \leq 0 \) when \( x \leq 0.166 \). This means that \( f(z) \) is unimodal, increasing when \( z < \log_b 0.166 \) and decreasing when \( z > \log_b 0.166 \). Thus, \( h(n) \) as well as \( f(z) \) is maximized when \( z = \log_b 0.166 \). The maximum is \(-0.298b \ln b\). Hence, there are two roots of \( z \) for \( f(z) = s \) if and only if \( s < -0.298b \ln b \). Denote them by \( z_1 \) and \( z_2 \), where \( z_1 > z_2 \), \( f'(z_1) < 0 \) and \( f'(z_2) > 0 \). Equivalently, there are two roots for \( h(n) = s \), where \( n_1 = 1 + 1/z_1 \) and \( n_2 = 1 + 1/z_2 \), with \( h'(n_1) > 0 \) and \( h'(n_2) < 0 \).

(ii) \( g_1(n, n) = -\frac{\partial^2}{\partial s^2} E(p_{\text{min}}|n, m)|_{m=n} = (x \ln^2 x - 2x \ln x + 2x - 2) (n-1) b \), where \( x = b^{n-1} \). Since \( x \ln^2 x - 2x \ln x + 2x - 2 < 0 \) for all \( x \in (0, 1) \), we must have \( g_1(n, n) < 0 \) for all \( n > 1 \).

Proof of Proposition 2. First, as long as \( s \) is not too large, it is obvious that \( n^* = 2 \) by Lemma 2. Second, in the stable equilibrium where \( n^e = n_2 \), \( h(n_2) = s \) and \( h'(n_2) < 0 \). Hence, \( n^e > n^* \) if and only if \( h(2) > h(n_2) = s \), but \( h(2) = b(1-b+b \ln b) \). Last, we note that \( h(2) \leq \max_n h(n) = -0.298b \ln b \), so a stable price dispersion equilibrium exists if \( s < b(1-b+b \ln b) \).

Proof of Proposition 3. Since \( h(n_2) = s \) and \( h'(n_2) < 0 \) by Lemma 3(i), \( n_2 \) must decrease when \( s \) increases. It can also be shown that \( \frac{\partial^2}{\partial s^2} E(p_{\text{min}}|n, m)|_{m=n} = (x \ln^3 x - x \ln x - 1) b^2 > 0 \) as long as \( x > 0.166 \). Hence, \( n_2 \) must decrease with \( b \). Conversely, since \( h'(n_1) > 0 \), \( n_1 \) must increase with \( s \).

Proof of Proposition 4. By Lemma 2, \( E(p_{\text{min}}) = b \left[n - (n - 1) b^{(n-1)}\right] \). Let \( z = \frac{1}{n-1} \), \( E(p_{\text{min}}) \) can be written as \( b \left(1 - \frac{b^z}{z} + 1\right) \). Using L'Hopital's rule (Estrada and Pavlovic 2017), we can verify that \( 1 - \frac{b^z}{z} \) decreases with \( z \). Therefore, \( E(p_{\text{min}}) \) increases with \( n \). By Proposition 3, \( n_2 \) decreases with \( s \). We thus conclude that \( E(p_{\text{min}}) \) decreases with \( s \).

Proof of Proposition 5. Let \( k = n - 1 \), the total expected cost can be written as \( T = (-kb^{1/k} + k + 1) b + (k + 1) s \), where \( k \left((1 - b^{1/k}) + b^{1/k} \ln b^{1/k}\right) = s/b \). Thus, \( \frac{\partial T}{\partial s} = k + 1 + \frac{dk}{ds} \left(s + \frac{b}{k} (k - kb^{1/k} + b^{1/k} \ln b)\right) = (k + 1) (1 + \frac{b}{k} \frac{dk}{ds}) \). This means that \( \frac{\partial T}{\partial s} < 0 \) if and only if \( \frac{dk}{ds} < 0 \). Since \( \frac{dk}{ds} = bk \left(2 - 2x + 2x \ln x - x \ln^2 x\right) > 0 \), where \( x = b^{1/k} \), whether \( \frac{\partial T}{\partial s} < 0 \) only depends on the sign of \( \frac{dk}{ds} \). In the unstable equilibrium, \( \frac{dk}{ds} > 0 \), hence \( \frac{\partial T}{\partial s} > 0 \); but in the stable equilibrium, \( \frac{dk}{ds} < 0 \), hence \( \frac{\partial T}{\partial s} < 0 \).