Collusion among Experts

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Abstract

This paper studies tacit collusion among experts with private information about customers’ problems. On the equilibrium path, through search for second opinions, all customers’ problems are fixed with probability one, and the total surplus from repairs is split evenly among experts. Even though a deviating expert can attract all customers by undercutting the equilibrium prices as in collusion among search-good sellers, some of the attracted customers will search for second opinions and have their problems fixed by non-deviating experts. The deviating firms’ inability to capture the entire industry profit before triggering a price war renders collusion among experts easier to sustain than collusion among search-good sellers.

Key Words: expert, tacit collusion, search cost
1 Introduction

Services provided by experts such as doctors, lawyers, car mechanics, and home improvement contractors are different from typical commodities or services because these experts not only provide repair services but also provide diagnoses of their customers' problems. The literature has extensively studied these experts' incentives to defraud their customers by misrepresenting the severity of their customers' problems, and highlights the market inefficiencies caused by the asymmetric information between experts and their customers. However, to the best of our knowledge, no research specifically studies collusion among experts which can further harm consumer welfare. This gap in the literature is significant because collusion among experts is empirically relevant and potentially different from collusion among typical sellers of goods or services.

There are many anecdotal evidence for collusion among experts. For a few examples, class-action lawyers are accused for colluding to raise the fees by as much as 10 times.\(^1\) Doctors in India are alleged to have colluded among themselves with diagnostic labs, hospitals, pharmaceutical companies, etc.\(^2\) In 2004, Pennsylvania’s Attorney General’s office investigated possible collusion among garages for emissions inspections even though the office did not find sufficient evidence to charge the garages.\(^3\)

Collusion among experts is different from collusion among sellers of typical products or services for the following reasons. First, experts post multiple prices for problems of different severities and they also decide which price to charge after diagnosing each customer’s problem. Second, the customer does not have to accept the expert’s recommended treatment after his diagnosis and can search for second opinions. In our model, infinitely-lived experts serve a sequence of short-lived customers, each with a serious or minor problem, through competition

\(^1\)Daniel Fisher, “Lawyers Won 10x Fee Payoff By Avoiding Competition, Objector Claims”, Forbes.com, May 7, 015.
\(^2\)“Collusion among Health Service Providers in India: Need for Effective Regulatory Enforcement” CUTS International Briefing Paper, undated.
\(^3\)Lyons, Kim, “Mechanics share trade secrets from the auto shop”, triblive.com, June 7, 2006.
Customers do not know the type of their problems and rely on the experts for diagnosis and treatment. Experts have different treatment for different types of problem, and it is efficient to use both treatment.

We show that collusion is more readily sustainable among experts than among sellers of typical products or services. One interesting discovery we made is that collusion among experts is facilitated by customers’ search for second opinions which ironically is the customers’ defense against the experts’ incentive to defraud them. We characterize a stationary symmetric equilibrium in which experts all lie with a small (yet positive) probability. Although customers reject the offer with positive probability on the first visit, they fix their problems with probability one by searching for second opinions on the equilibrium path. When an expert deviates in price to attract the customer on the first visit, the customer has to reject his recommendation with a positive probability to ensure that the expert will not always recommend the more expensive treatment for both problems. On the other hand, when the expert deviates by attracting the customer who search for second opinions, the customer has to accept treatment on the first visit with a positive probability, so that it is the customer’s best response not to visit the deviating expert first. Either way, the deviating expert is unable to capture the entire industry profit before triggering a price war, making collusion easier to sustain.

2 Literature Review

TBA

3 Model

Time is discrete, infinite, and indexed by $t = 1, 2, ..., \infty$. Each period, one risk-neutral customer arrives in the market and lives for only one period. It is common knowledge that each customer has a problem which is either serious ($s$), with probability $\alpha$, or minor ($m$), with probability $1 - \alpha$. If a customer’s problem $i \in \{m, s\}$ is left untreated, the customer (henceforth she) bears
a loss of $l_i$, with $l_m < l_s$. There are $n$ ($n \geq 4$) homogenous risk-neutral, long-lived experts (henceforth he)\textsuperscript{4}, providing costless diagnosis and costly treatment services at costs $r_m$ and $r_s$ for customers’ problems $m$ and $s$, respectively. It is efficient to have both problems repaired, i.e., $0 < r_m < l_m$ and $0 < r_s < l_s$, but treatments for different problems are not substitutable.

Each expert maximizes his expected discounted sum of profit given the common discount factor $\delta \in (0, 1)$. An expert’s profit from treating the minor problem at price $p$ is $p - r_m$, and that from treating the serious problem is $p - r_s$. Each customer maximizes her expected payoff in one period. A consumer’s payoff is $-l_i$ if she has problem $i \in \{m, s\}$ and the problem is left untreated. A consumer’s payoff is $-p$ if her problem is fixed at price $p$.

Experts can identify the customer’s problem through diagnosis. However, each customer does not know whether the problem is minor or serious, or which treatment has been provided even if the problem has been repaired. Hence, an expert can cheat by faking treatment $i$ when the problem is actually $j$, $j \neq i$, in which case the expert does not incur any additional cost besides $r_j$.

We describe the timeline of events in each period as follows. At the beginning of each period, experts simultaneously announce two prices $p_m$ and $p_s$ to charge for the minor and serious treatment respectively which become public information, where $p_m \leq p_s$ WLOG. A customer arrives in the market and Nature draws the loss of her problem according to the prior distribution. After observing the prices, the customer decides whether to visit any expert and which expert to visit. When a customer visits an expert who offers the price schedule $(p_m, p_s)$, the recommendation subgame indexed by $(p_m, p_s)$ begins. The expert first observes the customer’s problem, and recommends a (minor) treatment at the price $p_m$, a (serious) treatment at the price $p_s$, or refuses to provide any treatment. If the expert offers to fix the problem, the customer decides whether or not to accept the offer. If the customer accepts the

\textsuperscript{4}Assuming that $n \geq 4$ helps avoid some technical issues.
expert’s offer, the expert must repair her problem at the quoted price.\footnote{This is a commonly adopted assumption in the literature, termed Liability by Dulleck and Kerschbamer (2006).} If the expert refuses to provide any treatment or the customer rejects the expert’s offer, the customer decides whether to visit another expert and which expert to visit again. If the customer goes on visiting another expert who offers the price schedule \((p'_m, p'_s)\), a new recommendation subgame defined by \((p'_m, p'_s)\) begins. This process goes on within the same period until the customer’s problem is treated, the customer gives up treating the problem, or there is no more expert to visit.

Note that each expert does not commit to treating the customers’ problems at either of the announced prices. Following the literature (Pesendorfer and Wolinsky (2003), Wolinsky (1993)), we assume that an expert cannot identify whether a customer has visited another expert in the past. Also, we assume that, except for the first visit to an expert, a customer has to incur a sufficiently small visit cost \(k \geq 0\) for each additional expert she visits.\footnote{Assuming a positive search cost for the first visit will not affect the main result since it is sunk when customers decide whether to search for second opinions. Nevertheless, it will reduce customers’ maximum willingness to pay for the first expert’s treatment.} We also call \(k\) the unit cost of search for second opinions.

Each period, a pure strategy of the expert in the recommendation subgame specifies whether to refuse to provide a treatment, charge \(p_s\), or charge \(p_m\), conditional on the problem being \(i\), for \(i \in \{m, s\}\). A mixed strategy assigns probabilities to these actions, denoted respectively by \(\rho_i\), \(\beta_i\) and \(1 - \rho_i - \beta_i\). A pure strategy of the customer in the recommendation subgame specifies which experts she will visit, the sequence of visiting these experts, and whether she accepts or rejects a recommended treatment at the quoted price on her visit to some expert, for \(i \in \{m, s\}\). A mixed strategy assigns probabilities to these actions.

As in Fong (2005), we focus on the case in which

\[
\alpha l_s + (1 - \alpha)l_m < r_s.
\]

This restriction allows us to study how customers’ search for second opinions facilitates
expert collusion. Without this assumption, experts will set a single price equal to the customers’ ex ante expected loss (i.e. $p_m = p_s = \alpha l_s + (1 - \alpha)l_m$) in the collusive equilibrium, where each customer only visits one expert and repairs her problem with probability one on the first visit. Combined with the assumption that both treatments are efficient, this implies that $0 < r_m < l_m < r_s < l_s$.

Our equilibrium concept is *Strong Perfect Bayesian Equilibrium*. The key requirement is that beliefs are determined by Bayes’ rule and the players’ equilibrium strategies where possible in every subgame both on and off the equilibrium path. Finally, there is a public randomization device so that when the industry can sustain a profit level $\pi$, the entire set of profits $[0, \pi]$ is sustainable by applying public randomization at the beginning of the first period.

## 4 Analysis

### 4.1 Bertrand Competition

We first characterize the equilibrium of the static game, which is the so called "specialization equilibrium". Since all experts get zero profit in this equilibrium, this serves as the most severe punishment when collusion breaks down.

**Lemma 1** When $k$ is sufficiently small, there exists a static equilibrium (Specialization Equilibrium) in which all experts get zero profit.

**Proof.** Consider the following candidate equilibrium. At least two experts serve as minor specialists posting a single price of $r_m$ (for a minor treatment) and at least two experts serve as serious specialists posting a single price of $r_s$ (for a serious treatment). A minor specialist recommends a repair at $r_m$ if the customer’s problem is minor and refuses to treat the customer if she has a serious problem. A serious specialist charges every customer who visits him at the price of $r_s$. Customers first visit a minor specialist and accept if and only if a minor treatment at $r_m$ is offered. Only customers who are refused treatment by a minor specialist go on to visit
a serious specialist, and accepts the offer with probability one. In this candidate equilibrium, customers’ surplus is \((1 - \alpha)(l_m - r_m) + \alpha (l_s - r_s - k)\).

Since at least two experts are minor specialists, and two experts are serious specialists, if any expert deviates, he can make positive profit only if the customer visits him first and accepts the serious treatment with positive probability. In this case, if the expert deviates by raising the price for a serious treatment above \(r_s\), she will not attract any customer if \(p_s \geq r_s + k\). Consider \(p_s \in (r_s, r_s + k)\). To rule out weakly dominated strategies, the expert must recommend the serious treatment for the serious problem with probability one. Denote \(\beta\) the probability that the expert recommends the serious treatment for the minor problem. To ensure that the expert will not recommend the serious treatment for both problems, the expert has to make positive profit by recommending the minor treatment, i.e., \(p_m \in (r_m, r_m + k)\). Also, the customer has to randomize between accepting and refusing the serious treatment, which implies

\[
(1 - \alpha)\beta(l_m - p_s) + \alpha(l_s - p_s) = (1 - \alpha)\beta(l_m - r_m - k) + \alpha(l_s - r_s - 2k)
\]

\[
p_s = k + \frac{(1 - \alpha)\beta}{(1 - \alpha)\beta + \alpha}r_m + \frac{\alpha}{(1 - \alpha)\beta + \alpha}(r_s + k)
\]

When the customer visits the deviating expert first, her surplus is

\[
(1 - \alpha)(1 - \beta)(l_m - p_m) + (1 - \alpha)\beta(l_m - p_s) + \alpha(l_s - p_s)
\]

\[
= (1 - \alpha)(1 - \beta)(l_m - p_m) + (1 - \alpha)\beta(l_m - r_m) + \alpha(l_s - r_s - [(1 - \alpha)\beta + \alpha + 1]k)
\]

\[
< (1 - \alpha)(l_m - r_m) + \alpha(l_s - r_s - k)
\]

Therefore, it is not the customer’s best response to visit the deviating expert, and the deviation profit is zero.

4.2 Collusive Outcome

In this subsection, we study experts’ ability to tacitly collude and compare with the benchmark case in which firms sell the typical product or service. Specifically, we characterize the sets
of discount factors for which the monopoly industry profit is sustainable through collusion among experts. We restrict our attention to stationary symmetric equilibria not involving weakly dominated strategies. Also, we consider tacit collusion by experts in offering the price schedule, while they do not collude in the recommendation subgame.\footnote{In real life, experts’ recommendations and customers’ acceptance decisions are generally not publicly observable for privacy concerns, so that it is hard to monitor whether or not an expert has deviated in the recommendation subgame in the past.}

We first construct the collusive equilibrium which sustains the monopoly industry profit. On the equilibrium path, experts post the same prices \((p_m, p_s) = (p_m(k), p_s(k))\) each period. They offer \(p_s\) for the customers with the serious problem with probability one and for those with the minor problem with probability \(\beta(k) \in (0, 1)\). A customer randomly visits an expert when arriving at the market. If recommended the minor treatment on the first visit, the customer accepts it with probability one. If recommended the serious treatment on the first visit, the customer accepts it with probability \(\gamma(k) \in (0, 1)\) and searches for a second opinion with the complementary probability. If recommended any treatment on the second visit, the customer accepts it with probability one. Whenever a customer is recommended no treatment, she exits the market.

In this equilibrium, if a customer is recommended the serious treatment on the first visit, she can accept it and get a payoff of \(-p_s\). Alternatively, she can search for a second opinion and there is a positive probability that she is recommended the minor treatment on the second visit if she has the minor problem. The customer has a net benefit of \(p_s - p_m\) from search when the second opinion contradicts the first opinion. For customers who are recommended the serious treatment on their first visit to be indifferent between accepting the treatment and searching for a second opinion, we have the following search condition

\[
\Pr(p_m|p_s)(p_s(k) - p_m(k)) = k
\]

where \(\Pr(p_m|p_s) \equiv \frac{(1-\alpha)\beta(k)(1-\beta(k))}{(1-\alpha)\beta(k)\gamma + \alpha}\) is the probability that the second opinion recommends the minor treatment conditional on the first visit recommending the serious treatment. Since the
probability that the third opinion recommends the minor treatment conditional on two serious
treatment recommendations is smaller than $\Pr(p_m|p_s)$, the customer’s expected net benefit
from search for a third opinion is strictly less than the search cost, so that the customer strictly
prefers accepting the second treatment recommendation to searching for a third opinion.

The search condition have two solutions for $\beta(k)$. When $k$ converges to zero, the smaller
solution converges to zero while the larger one converges to one. If $\beta(k)$ converges to one, from
the participation constraint and $E(l) \equiv (1 - \alpha)l_m + \alpha l_s < r_s$ we can derive that

$$p_s(k) \leq \frac{\alpha}{(1 - \alpha)\beta(k) + \alpha} l_s + \frac{(1 - \alpha)\beta(k)}{(1 - \alpha)\beta(k) + \alpha} l_m < r_s$$

which cannot be an equilibrium since it is not a best response for experts to recommend
the serious treatment to customers with the serious problem. Therefore we take the smaller
solution to be the equilibrium value of $\beta(k)$, where

$$\beta(k) = \frac{(1 - \alpha)(p_s(k) - p_m(k) - k) - \sqrt{(1 - \alpha)^2(p_s(k) - p_m(k) - k)^2 - 4k\alpha(1 - \alpha)(p_s(k) - p_m(k))}}{2(1 - \alpha)(p_s(k) - p_m(k))}$$

The participation constraints for customers to accept both offers with a positive probability
on the first visit are

$$p_m(k) \leq l_m$$

and

$$p_s(k) \leq \frac{\alpha}{(1 - \alpha)\beta(k) + \alpha} l_s + \frac{(1 - \alpha)\beta(k)}{(1 - \alpha)\beta(k) + \alpha} l_m$$

To sustain the highest industry profit for experts, let the participation constraints bind, so
that

$$p_m(k) = l_m$$

and

$$p_s(k) = \frac{\alpha}{(1 - \alpha)\beta(k) + \alpha} l_s + \frac{(1 - \alpha)\beta(k)}{(1 - \alpha)\beta(k) + \alpha} l_m$$

where $p_s(k)$ converges to $l_s$ from below when $k$ converges to zero.
Next we consider experts’ incentive to recommend the treatment. For experts to be indifferent between offering the minor treatment and the serious treatment to customers with the minor problem, we must have

\[ [\text{Pr}(e|l_m) + (1 - \text{Pr}(e|l_m))\gamma](p_s(k) - r_m) = p_m(k) - r_m \geq 0 \]

where \( \text{Pr}(e|l_m) \equiv \frac{\beta(k)(1-\gamma(k))}{1+\beta(k)(1-\gamma(k))} \) is the probability that an customer is on her second visit conditional on her problem being minor.

From the condition above we can solve

\[ \gamma(k) = \frac{p_m(k) - r_m - \beta(k)(p_s(k) - p_m(k))}{p_s(k) - r_m - \beta(k)(p_s(k) - p_m(k))} \]

Note that \( \gamma(k) \in [0, 1] \) when \( k \) is sufficiently low.

For experts to offer \( p_s(k) \) to customers with serious problems, we must have

\[ p_s(k) \geq r_s \]

which must hold when \( k \) is sufficiently low.

The collusive industry profit is

\[ \pi^C(k) = (1-\alpha)[(1-\beta(k))(1+\beta(k)(1-\gamma(k)))(p_m(k)-r_m)+\beta(k)(\gamma(k)+\beta(k)(1-\gamma(k)))(p_s(k)-r_m)]+\alpha(p_s(k)-r_s) \]

which is divided evenly among \( n \) experts.

As \( k \) converges to zero, we have

\[ \lim_{k \to 0} \beta(k) = 0 \]

\[ \lim_{k \to 0} \gamma(k) = \frac{l_m - r_m}{l_s - r_m} \]

and

\[ \lim_{k \to 0} \pi^C(k) = (1 - \alpha)(l_m - r_m) + \alpha(l_s - r_s) \]

which is highest feasible industry profit that can be attained. On the equilibrium path, even though a customer rejects the first expert’s serious treatment recommendation with a positive probability, her problem will be treated by the next expert she visits. In other words,
all customers’ problems are treated in each period. Note that customers with the serious problem are treated at a price lower than their reservation value, while customers with the minor problem may be treated at a price higher than their reservation value. This is because some cheating is necessary for customers to search for second opinions. The probability of lying goes to zero when the search cost is close to zero, because the benefit from search must also be reduced for the search condition to hold.

We show in the following proposition that collusion among experts is easier to sustain than among typical good or service sellers.

**Proposition 1** When $k$ is sufficiently small, there exists $\hat{\delta} < 1 - 1/n$ such that the equilibrium characterized above is sustainable if and only if $\delta \geq \hat{\delta}$.

**Proof.** Suppose an expert deviates by posting some price list $(p_{md}, p_{sd})$. It is WLOG to assume $p_{md} \in [r_m, l_m]$ and $p_{sd} \in [r_s, l_s]$. We focus on the equilibrium of the recommendation game which provides the highest deviation payoff for a given deviation price schedule.\(^8\)

The expert attract the customer to visit him first only if he provides the customer with a positive surplus. In the recommendation game, he must recommend the serious treatment for the serious problem with probability one since it is a weakly dominant strategy. Also, the customer will accept the minor treatment recommended by this deviating expert with probability one since it is a weakly dominant strategy. To ensure that the expert will not always recommend the serious treatment for both problems, the customer must accept the serious treatment with probability no higher than $(p_{md} - r_m) / (p_{sd} - r_m)$. This provides the deviant the highest deviation payoff of

$$\alpha (p_{sd} - r_s) \frac{p_{md} - r_m}{p_{sd} - r_m} + (1 - \alpha) (p_{md} - r_m)$$

\(^8\)If we can prove that collusion is facilitated when such equilibrium of the recommendation game is played off the equilibrium path, then we can also prove that collusion is facilitated for all equilibria of the recommendation game off the equilibrium path.
which is increasing in both $p_{md}$ and $p_{sd}$. Let $p_{md} = l_m - \varepsilon$ and $p_{sd} = l_s$, where $\varepsilon$ is arbitrarily close to zero.

Consider the following equilibrium of the recommendation game. The customer visits the deviating expert first, who makes honest recommendations by offering $l_m - \varepsilon$ for the minor problem and offering $l_s$ for the serious problem. If recommended the minor treatment, the customer accepts with probability one. If recommended the serious treatment, the customer accepts with probability $\frac{l_m - \varepsilon - r_m}{l_s - r_m}$ and exits the market with the complementary probability. We assume the customer believe that all the non-deviating experts will recommend the serious treatment for both problems, so that it is optimal for the customer to visit the deviating expert first. In this case, the highest deviating profit is arbitrarily close to

$$\alpha (l_s - r_s) \frac{l_m - r_m}{l_s - r_m} + (1 - \alpha) (l_m - r_m)$$

Alternatively, the deviating expert can let the customer visit some non-deviating expert first. By doing so, he can free ride on other experts’ diagnosis to signal the customer’s type of problem, especially when the first expert makes honest recommendations. If the customer believes that she has the serious problem with probability one after the first visit, she is willing to pay any price no higher than $l_s$ for the treatment when she visits the second expert. However, the deviating expert cannot get any profit if the customer has the minor problem. To see this point, suppose the first expert makes honest recommendations and the customer accepts the treatment with positive probability on her second visit regardless of the type of her problem, which implies $p_{md} \leq l_m - k$ and $p_{sd} \leq p_s(k) - k$. Then it is the customer’s best response to visit the deviating expert first.

Let $p_{md} = l_m$ and $p_{sd} = p_s(k) - k - \varepsilon$, where $\varepsilon$ is arbitrarily close to zero. Consider the following equilibrium of the recommendation game. The customer randomly visits some non-deviating expert first, who makes honest recommendations by offering $l_m$ for the minor problem and offering $p_s(k)$ for the serious problem. If recommended the minor treatment, the customer accepts with probability one. If recommended the serious treatment, the customer goes on to
visit the deviating expert who offers \( p_s(k) - k - \varepsilon \) for both problems. Such sequence of visiting is optimal for the customer to choose, since the customer will not accept any treatment if she visits the deviating expert first. In this case, the highest deviating profit is arbitrarily close to
\[
\alpha (p_s(k) - k - r_s)
\]
which converges to \( \alpha (l_s - r_s) \) when \( k \) converges to zero.

Therefore, when \( k \) converges to zero, the monopoly industry profit is sustainable if and only if
\[
\frac{(1 - \alpha)(l_m - r_m) + \alpha(l_s - r_s)}{n(1 - \hat{\delta})} \geq \max \{ \alpha (l_s - r_s) \frac{l_m - r_m}{l_s - r_m} + (1 - \alpha) (l_m - r_m), \alpha (l_s - r_s) \}
\]
\[
\hat{\delta} \geq 1 - \frac{(1 - \alpha)(l_m - r_m) + \alpha(l_s - r_s)}{n \max \{ \alpha (l_s - r_s) \frac{l_m - r_m}{l_s - r_m} + (1 - \alpha) (l_m - r_m), \alpha (l_s - r_s) \}}
\]

It is easy to verify that
\[
\hat{\delta} < 1 - \frac{1}{n}
\]

It is well known that tacit collusion is sustainable among \( n \) firms if and only if \( \delta \geq 1 - 1/n \) when firms sell the typical product or service. It is also easy to show that if customers have perfect information about their problems, i.e., the service provider is no longer an expert, tacit collusion is also sustainable if and only if \( \delta \geq 1 - 1/n \). So Proposition 1 implies that collusion among experts is more readily sustainable than among typical good or service sellers or non-experts.

The main intuition of our finding is that on the equilibrium path, a customer’s decision to visit another expert to get treatment after rejecting the first expert’s recommendation for serious treatment ensures that her problem is fixed with probability one by some expert in the industry. However, when an expert deviates, even if he can attract the customer to visit him first, the customer will reject his recommendation with a positive probability to ensure that the expert will not always recommend the serious treatment for both problems. On the other hand, when the expert deviates by attracting the customer who search for second opinions,
the customer has to accept treatment on the first visit with a positive probability, so that it is the customer's best response not to visit the deviating expert first. Either way, the deviating expert is unable to capture the entire industry profit before triggering a price war, making collusion easier to sustain.

5 Discussion

5.1 Verifiability and Non-liability

TBA

6 Conclusion

References


