Credence goods

- **Credence goods**: products and services purchased from informed 'experts' such as auto mechanics, home improvement contractors, appliance service-persons, physicians, lawyers....
- The provider of the service also assumes the role of an expert and determines how much or what type of service the consumer needs.

Credence goods

- Even when the success of the service is observable to the consumer *ex post*, consumers typically
  - can never determine the type of the service they needed in the first place.
  - may not know what type of service was *actually* performed by the expert.
  - are unable to evaluate their true benefit from receiving a certain type of treatment (*e.g.*, how much changing a car part actually adds to the well-being of a car).

Credence goods

- This informational asymmetry between experts and consumers creates obvious incentive problems:
  - a mechanic may easily claim that a car needs a major and expensive repair, while only a minor and inexpensive repair is necessary.
  - experts may overcharge by claiming to provide an expensive treatment, although they actually solve the problem with a cheap treatment.

Credence goods

- Dulleck and Kerschbamer (2006) "....consumer's technical expertise, or expert's expectation of its existence on the consumer side, may affect market outcomes. The existing literature has ignored consumers' heterogeneity in expertise so far"

Credence goods

- Are uninformed consumers necessarily the most likely victims of expert cheating?
- How is the efficiency of the market outcome affected with more information on the consumer side?

Credence goods

- Focus on the implications of two potentially different pieces of consumer information.
- Information on the true benefit from an expensive treatment,
- Information on the seriousness of the problem.

Credence goods

- Fong (2005): an expert's recommendation strategy is typically selective and can be best understood to be conditional on observable and heterogenous consumer characteristics. Fong (2005) does not investigate the implications of heterogenous consumer information on the expert's cheating behaviour
- Wolinksy (1993) considers a competitive setting with many experts, and show that cheating can be eliminated when consumers search for second opinions.
- Pesendorfer and Wolinsky (2003) show that consumers' search for second opinions motivates experts to exert costly effort that improves the accuracy of their diagnosis.

Credence goods

- Alger and Salanie (2006) introduce a fraud cost by allowing the consumers to partially verify the actual inputs the expert uses during her treatment.
- Emons (1997, 2001) examine how the market price mechanism can eliminate fraudulent behaviour when experts have capacity constraints and the actual treatment received is verifiable by consumers.
- In the context of medical services, Dranove (1988) analyzes how demand inducement by physicians relates to the treatment price.

Consumers

- Continuum of consumers with measure one.
- Each consumer has a problem: serious ($\omega = s$) or minor ($\omega = m$).
- Consumers do not know the type of their problem.
- All consumers have an ex-ante probability $\alpha \in (0, 1)$ of having a serious problem.

The Model

Expert

- There is a *monopolist* expert who can perfectly diagnose and treat a consumer's problem.
- The expert can offer an expensive treatment at price p_s or a cheap one at a price p_m.
- Expensive treatment costs the expert $c_s > 0$, solves both serious and minor problems.
- Cheap treatment costs the expert $c_m < c_s$, solves only the minor problem.

The Model

No Verifiability

- Ex post consumers cannot verify the actual treatment expert provides. They can only tell if the problem is fixed or not.

Liability

- The expert has to fix the problem to receive payment (she cannot recommend and provide a cheap treatment when the problem is serious)

Minor Treatment Benefit

- When a minor problem is treated, all consumers benefit v_m where $v_m > c_m$.

Heterogeneity in Expensive Treatment Benefits

- **When the problem is serious**, depending on the consumer's type the expensive treatment provides a benefit of either v_s^h or v_s^l with $v_s^h > v_s^l > v_m$ and $v_s^l > c_s$.
  - A succesful expensive medical treatment may cause different side effects on different patients.
  - Changing an expensive car part may get the car running, but for how long may depend on the general state of the car.
  - General idea: Expensive solutions may succeed, but how well they succeed may differ across consumers.
- The *ex ante* probability of being type v_s^h is $\Pr\left(v_s^h\right) = \theta$. Consumers may or may not know if they benefit v_s^h or v_s^l.

Consumer Information

- We separately consider two different types of consumer information
  - some consumers may know whether their true benefit from an expensive treatment is v_s^h or v_s^l, while some do not know.
  - some consumers may receive a signal on whether their problem is serious or minor, while some remain uninformed.

The Model

Expert's Information

- The expert perfectly observes
  - the nature of the problem (serious or minor)
  - the true benefit if an expensive treatment is needed (v_s^h or v_s^l)
  - whether the consumer is informed or not (we also analyze the game when the expert cannot distinguish if consumer is informed).

Sequence of Moves

- **Stage 1**: Nature decides if the problem is serious or minor and if a consumer benefits v_s^l or v_s^h from an expensive treatment.
  - The consumers do not know if the problem is minor or serious.
  - A fraction λ of consumers learn perfectly if they benefit v_s^l or v_s^h.
- **Stage 2**: The expert sets (p_m, p_s).
- **Stage 3**: The expert perfectly identifies if the problem is serious or minor, if the expensive treatment benefit is v_s^h or v_s^l, and if the consumer is informed or not. The expert either rejects to treat the consumer or recommends an expensive or a cheap treatment.
- **Stage 4**: The consumer can accept or reject the expert's recommendation. If the consumer rejects, the problem remains untreated.

Two Additional Assumptions

- **Assumption 1:** The treatment benefits and costs satisfy

$$\alpha v_s^t + (1-\alpha) v_m < c_s \text{ for } t \in \{h, l\}.$$

This restriction rules out a fixed price equilibrium in which the expert sets a single price for both expensive and minor treatments.

- **Assumption 2**: The expert cannot price discriminate across consumers, but can follow *selective recommendation strategies* contingent on observable consumer characteristics.

Expert's Strategies

- Conditioning on the problem being $i \in \{m, s\}$ and the consumer being of type v_s^t with $t \in \{h, l\}$, a pure strategy for the expert in the subgame (p_m, p_s) specifies whether she refuses to provide treatment, recommends a serious treatment or recommends a minor treatment.
- A mixed strategy assigns probabilities of taking these actions with $\rho_i^{t,k}$ denoting the probability of rejecting a type $(t, k) \in \{h, l\} \times \{I, N\}$ consumer with a problem $i \in \{m, s\}$, and $\beta_i^{t,k}$ denoting the probability of recommending a serious treatment to such a consumer.

Consumer Strategies

- A pure strategy for a consumer specifies whether he rejects or accepts the recommended treatment $i \in \{m, s\}$ at the posted prices (p_m, p_s).
- In terms of their information, there are three possible consumer profiles: those who know they are type $z = h$, those who know they are of type $z = l$, and uninformed consumers denoted by $z = n$.
- A mixed strategy for a consumer of type $z \in \{h, l, n\}$ assigns probabilities of accepting (γ_i^z) and rejecting $(1 - \gamma_i^z)$ a recommendation $i \in \{m, s\}$.

Benchmark: all consumers are uninformed

- All consumers have an *ex ante* valuation v_s from an expensive treatment where $v_s = \theta v_s^h + (1-\theta) v_s^l$.
- The expert's equilibrium price vector is $(p_m^* = v_m,\ p_s^* = v_s)$. The expert does not cheat any consumers.
- All consumers accept an expensive treatment recommendation with probability

$$\gamma_s^n = \frac{v_m - c_m}{v_s - c_m}$$

and a cheap treatment recommendation with probability 1.

All Consumers Uninformed

- For $(p_m, p_s) \in [c_m, v_m] \times [c_s, v_s]$, an uninformed consumer mixes between accepting and rejecting an expensive treatment only when the expert cheats with a probability

$$\beta_m^{h,N} = \beta_m^{l,N} = \frac{\alpha(v_s - p_s)}{(1-\alpha)(p_s - v_m)}.$$

All Consumers Uninformed

- For $(p_m, p_s) \in [c_m, v_m] \times [c_s, v_s]$, for the expert to mix between recommending the expensive and cheap treatments when the problem is minor, the uninformed consumers must be accepting expensive treatments with probability:

$$\gamma_s^n = \frac{p_m - c_m}{p_s - c_m}.$$

All Consumers Uninformed

- For $(p_m, p_s) \in [c_m, v_m] \times [c_s, v_s]$ the expert's expected profit function is

$$\Pi(p_m, p_s) = \alpha\,(p_s - c_s)\,(\frac{p_m - c_m}{p_s - c_m}) + (1-\alpha)(p_m - c_m).$$

which yields $p_m^* = v_m,\ p_s^* = v_s$ and hence

$$\beta_m^{h,N} = \beta_m^{l,N} = 0 \quad \beta_s^{h,N} = \beta_s^{l,N} = 1$$

$$\gamma_s^n = \frac{v_m - c_m}{v_s - c_m} \quad \gamma_m^n = 1$$

All Consumers Uninformed

- Despite the truthful revelation of expert's information, a feature of the above equilibrium is the efficiency loss in the form of foregone but required expensive treatments.
- The consumers must reject an expensive treatment recommendation with some probability to induce truthfulness. This leads to an **under-provision** of required expensive treatments. The size of this equilibrium efficiency loss is

$$EL_{\lambda=0} = \alpha \left(\frac{v_s - v_m}{v_s - c_m} \right) (v_s - c_s).$$

Intuition for truthful equilibrium

- The expert's cheating probability that makes the consumer indifferent is given by

$$\beta_m^N = \frac{\alpha(v_s - p_s)}{(1-\alpha)(p_s - v_m)}.$$

- The higher the price p_s, the less tolerant consumers are for expert cheating. At $p_s = v_s$, the expert can get an expensive treatment accepted only by always being truthful.
- For the expert, charging $p_s = v_s$ is optimal, because while increasing p_s reduces the acceptance rate, it increases the profit margin even more.

Some consumers informed about expensive treatment benefits

- Suppose a fraction $\lambda > 0$ of consumers are informed about their true benefit from an expensive treatment and the expert can identify consumers as informed and uninformed.
- Will the expert specifically target and cheat uninformed consumers?

Some consumers informed about treatment benefits

- Unique equilibrium in which, depending on the parameter values, there are 3 possible outcomes.
- **Type I Outcome**: $p_m^* = v_m$, $p_s^* = v_s^l$, the expert cheats informed high types and uninformed consumers, but is truthful to informed low types. All consumers accept expensive treatment with a common positive probability.
- **Type II Outcome**: $p_m^* = v_m$, $p_s^* = v_s$, the expert cheats informed high types, but is truthful to uninformed and informed low types. Only uninformed consumers and informed high types accept expensive treatment with a common positive probability.
- **Type III Outcome**: $p_m^* = v_m$, $p_s^* = v_s^h$, the expert is truthful to all consumers. Only informed high types accept expensive treatment with a positive probability.

Some consumers informed about treatment benefits

- In Type I outcome, expert sets $p_s^* = v_s^l$ and cheats informed high types and uninformed, while being always truthful to informed low types. This outcome arises when λ is relatively large (most consumers are informed) and θ is relatively small (most consumers are of low value type)

Some consumers informed about treatment benefits

- In Type II outcome, expert sets $p_s^* = v_s$ and cheats only informed high types, while being always truthful to informed low types (who always reject) and uninformed. This outcome arises when fraction λ of informed is not too high and θ is not too low (sufficiently high fraction of high value types)

Some consumers informed about treatment benefits

- In Type III outcome, expert sets $p_s^* = v_s^h$ and she is always truthful to all types of consumers. Informed low types and uninformed consumers always reject. Expensive treatment is provided only to informed high types. This outcome arises when both λ and θ are sufficiently high (majority of the market is informed high types).

Some consumers informed about treatment benefits

Some observations

- Unlike the case when all consumers are uninformed, cheating may now emerge when some consumers are informed about their true benefit from an expensive treatment.
- There is **no equilibrium outcome in which the expert only cheats the uninformed** consumers. In fact, the most frequent victims of expert cheating are informed high types.

Some consumers informed about treatment benefits

Another question

- How does introducing heterogenous and identifiable consumer information on treatment benefits affect the efficiency loss in the form of foregone but required treatments?

Perhaps surprisingly

- All types of equilibrium outcomes that may arise when some consumers are informed about their true benefit from an expensive treatment **involve more efficiency loss** than the one in which all consumers are uninformed.

Some consumers informed

Intuition for more efficiency loss

- In Type I outcome, uninformed consumers and informed high types are cheated. Cheating creates an additional source of inefficiency: now some minor problems are left untreated as well.
- In Type II outcome, all informed low types always reject expensive treatments: the loss due to foregone but required expensive treatments increases.
- In Type III outcome, expert is always truthful but only informed high types can afford expensive treatments. All uninformed and informed low types are excluded.

Consumer information on the type of their problem

- Before visiting the expert, a fraction λ of consumers observe an informative signal on whether their problem is serious or minor.
- The information signal $\tilde{z}$ can take two values: A good signal $(z = g)$ indicates that the problem is more likely to be minor, whereas a bad signal $(z = b)$ indicates that the problem is more likely to be serious.
- The precision of the signal, denoted by ϕ is defined as

$$\phi \equiv \Pr(z = b|\omega = s) = \Pr(z = g|\omega = m) \in (\frac{1}{2}, 1).$$

Consumer information on the type of their problem

- The posterior beliefs are given by

$$\alpha_g \equiv \Pr(s|g) = \frac{\alpha(1-\phi)}{(1-\alpha)\,\phi + \alpha(1-\phi)}$$

$$\alpha_b \equiv \Pr(s|b) = \frac{\alpha\phi}{\alpha\phi + (1-\alpha)(1-\phi)}$$

- A customer with no signal still believes that his problem is serious with probability α. For notational convenience, let us define $\alpha_n \equiv \alpha$.

Consumer information on the type of their problem

- For simplicity, assume that all consumers benefit v_s when a serious problem is treated where $v_s > v_m > 0$.
- Again, to rule out a trivial fixed price solution, we again assume that

$$\alpha_b v_s + (1 - \alpha_b) v_m < c_s.$$

Consumer information on the type of their problem

- The signals are noisy. A consumer with a minor problem might arrive in the expert's office believing that his problem is serious if he had observed a signal $z = b$.
- Such a pessimistic consumer seems more willing to accept an expensive treatment recommendation than a consumer who has received a good signal.
- This construction helps to address whether the expert will exploit and cheat those consumers who already believe that their problem is serious.

Consumer information on the type of their problem

When Expert Can Identify Informed Consumers

- The expert can condition her recommendation strategy also on whether the consumer has a good or a bad signal, or he is uninformed.
- A mixed strategy profile for the expert in a recommendation sub-game (p_m, p_s) is now given by the probabilities $\{\rho_i^t, \beta_i^t, 1 - \beta_i^t - \rho_i^t\}$ for $i \in \{m, s\}$ and $t \in \{g, b, n\}$.
- A mixed strategy profile for a consumer of type $t \in \{g, b, n\}$ is given by the probability γ_i^t of accepting a recommendation $i \in \{m, s\}$.

Consumer information on the type of their problem

- The expected payoff for a consumer of type $z \in \{g, b, n\}$ from accepting an expensive treatment

$$V_z^s = \frac{\alpha_z \beta_s^z v_s + (1-\alpha_z)\beta_m^z v_m}{\alpha_z \beta_s^z + (1-\alpha_z)\beta_m^z} - p_s.$$

which yields the cheating probability of the expert

$$\beta_m^z = \frac{\alpha_z (v_s - p_s)}{(1-\alpha_z)(p_s - v_m)} \text{ for } z \in \{g, b, n\}.$$

- For any given $p_s < v_s$, we have $\beta_m^b > \beta_m^n > \beta_m^g$. However, at $p_s = v_s$ regardless of their information, all consumers accept with positive probability only if $\beta_m^z = 0$.

Consumer information on the type of their problem

- For the expert to mix between recommending the expensive and cheap treatments for a minor problem, a consumer of type $t \in \{g, b, n\}$ must be accepting with a probability

$$\gamma_s^t = \frac{p_m - c_m}{p_s - c_m} \text{ for } t \in \{g, b, n\}.$$

- The expert's expected profit function is given by

$$\Pi(p_m, p_s) = \alpha \left(\frac{p_m - c_m}{p_s - c_m} \right) (p_s - c_s) + (1 - \alpha)(p_m - c_m)$$

- Therefore, the expert will set $p_s^* = v_s$ and be **truthful to everyone regardless of their information status.**

When Expert Can NOT Identify Informed Consumers

- In this case, the expert can only condition her recommendation strategy on the type of the problem.
- A mixed strategy profile for the expert in a recommendation subgame (p_m, p_s) is now given by the probabilities $\{\rho_i, \beta_i, 1 - \beta_i - \rho_i\}$ for $i \in \{m, s\}$.
- A mixed strategy profile for a consumer of type $z \in \{g, b, n\}$ is described by the probability γ_i^z of accepting a recommendation $i \in \{m, s\}$.

Consumer information on the type of their problem

- For a given $p_m \in [c_m, v_m]$ and $p_s \in [c_s, v_s]$, a consumer of type $z \in \{g, b, n\}$ sets

$$\begin{aligned} \gamma_s^z &> 0 \text{ if } \beta_m < A_z \equiv \frac{\alpha_z}{1-\alpha_z} \frac{v_s - p_s}{p_s - v_m}, \\ \text{and } \gamma_s^z &= 0 \textit{ if } \beta_m \geq A_z \end{aligned}$$

- It can be shown that in any equilibrium, the expert will always follow a recommendation strategy with $\beta_m \in [A_g, A_b]$.

Consumer information on the type of their problem

- In any equilibrium the expert must be indifferent between recommending the expensive and cheap treatments when the problem is minor, which implies

$$\gamma_s^T \equiv \lambda[\phi\gamma_s^g + (1-\phi)\gamma_s^b] + (1-\lambda)\gamma_s^n = \frac{p_m - c_m}{p_s - c_m}$$

- The ex ante profit function for the expert is identical to the one before. Hence, the unique equilibrium price is again given by $p_s^* = v_s$ and the expert will always be truthful to all consumers.

Consumer information on the type of their problem

Unique Equilibrium is Truthful

- Suppose a fraction $\lambda > 0$ of consumers observe an informative signal on whether their problem is serious or minor.
- The equilibrium outcome **is unique and is the same when the expert can or cannot identify informed and uniformed consumers**.
- In the unique equilibrium outcome, the expert sets $p_m^* = v_m$ and $p_s^* = v_s$ and is always truthful to all types of consumers. All consumers accept a cheap treatment with probability one. All consumers accept an expensive treatment recommendation with a positive probability strictly less than one.