Credence Goods, Experts and Risk Aversion

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Abstract

The existing literature on credence goods and expert services has overlooked the importance of risk aversion. In this paper we extend a standard expert model of credence goods by considering risk-averse consumers. Our results show that the presence of risk aversion reduces the incentive of the expert to invest in diagnosis and thus may lead to consumers' mistreatment.

Keywords: Credence goods, Expert services, Risk aversion.

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1 Introduction

In number of activities, expertise reduces substantially the risk incurred by an agent. For instance, in agriculture, experts provide advice on the right use of pesticides that dramatically lower the output risk[1]. In health care, medical doctors diagnose illnesses and prescribe the appropriate treatment. For legal services, the lawyer suggests the best strategy to win the trial. As a result, the customer's risk aversion is likely to play a crucial role in the expert's incentives to acquire information on the most efficient treatment. At the same time, expertise has a credence good dimension (see Darby and Karni, 1973) since the information collected by the expert is usually not observed by the agent. Then, agent's risk-aversion could also induce the expert not to conduct thorough diagnosis and propose instead useless but risk-free costly treatment.

In this paper we examine the theoretical impact of risk aversion on the expert's incentives to collect information to avoid either overtreatment or undertreatment in a credence good context.

For that purpose, we develop a simple model of expert-customer relationship inspired by Dulleck and Kerschbamer (2006) and (2009) with risk-averse consumers. We show that in a credence good context, risk aversion reduces rather than increases the incentives of the expert to exert effort to provide the right treatment.

Our starting point is the well established result where the expert provides an efficient treatment if the three following assumptions hold (see Dulleck and Kerschbamer, 2006 and 2009): *i)* consumers are homogenous,[2] *ii)* consumers are committed to an expert once this one makes a recommendation, and *iii)* the type of treatment provided and the diagnostic effort are verifiable.[3] The key to this result is that, at the equilibrium, the expert charges the same markup for all possible treatments, removing any incentive to provide an inefficient treatment. The expert has then the right incentive to acquire information on the efficient treatment. In the present paper, we extend this framework by considering risk-averse consumers[4] and we show that the efficiency

[1] See for instance Moschini and Henessy (2001) on the importance of risk aversion and insurance devices on the demand for pesticides.

[2] See Dulleck and Kerschbamer, 2006 and Hyndmana and Ozerturk, 2011, for situations where this assumption does not hold. There are also recent papers (Liu, 2006 and Erharter, 2012) that study the role of experts' heterogenous preferences.

[3] Several works focus on situations where consumers cannot observe the type of treatment provided, so the expert may defraud the consumers by misrepresenting a low-cost service as a costly one (see e.g. Wolinsky 1993, Fong 2005 or Alger and Salanié, 2006).

[4] As far as we know, no model of expertise in a credence good context deals with risk averse consumers. Sülzle and Wambach (2005) study the role of insurance in a credence good context but without risk-averse consumers.

result may not hold. The force that drives our result is the tension between the equal mark-up pricing that allows the expert to commit to providing the appropriate treatment and the risk borne by the consumers under this type of tariff. Because of risk aversion, the customer is in fact willing to pay a premium for a risk free tariff that necessarily involves no equal markup and thus leads either to inefficient overtreatment or undertreatment. Even if it is known in principal-agent games that the optimal contract is second best when the agent is risk averse, we show that the mechanism by which risk aversion leads to inefficiency is rather different in a basic model of credence goods.

The model is presented in the next section. We then analyze the expert's equilibrium strategy (section 3) and its consequences for efficiency (section 4). Section 5 introduces competition and Section 6 concludes.

2 The model

We use a standard expert model of credence goods similar to the one developed in Dulleck and Kerschbamer (2006). We assume a continuum of identical consumers with total mass of 1. Each consumer has a problem which can be major or minor. Two treatments are available: a minor treatment can only solve a minor problem while a major treatment can solve both types of problem. The parameter v is the gross gain of a consumer when his problem is solved, otherwise he gets 0. The consumer knows that he has a problem but he does not know its type. Ex-ante, each consumer expects that his problem is major with a probability h and minor with a probability $(1-h)$. The consumers are supposed to be risk averse. Their utility follow a Von Neumann-Morgenstern form $u(x)$ with $u(0)=0$, x being the consumer's net gain.

An expert can detect the true type of the problem only by conducting a proper diagnosis. Without diagnosis, the expert can not supply an appropriate treatment and can only choose to always supply a minor treatment (*undertreatment*) or a major one (*overtreatment*). The cost of a major treatment is $\overline{c}$, and the cost of a minor treatment is $\underline{c}$, with $\overline{c} > \underline{c}$. If a diagnosis is performed, the expert bears a cost d that is charged to the consumers. In accordance with the literature on expert markets, we suppose that consumers are committed to stay with the expert once the recommendation is made, and also that the type of treatment provided by the expert is verifiable.

In the first period of the game, the expert posts prices $\overline{p}$ and $\underline{p}$ respectively for a major and a minor treatment, and commits to conducting a diagnosis or not. Consumers observe theses actions and decide whether to visit the expert or not (second period). In the third period, nature determines the type of the consumer's problem (major or minor). In the fourth period, the expert conducts a diagnosis or not, recommends a treatment, charges for it and provides it. The action of making a diagnosis is observed by the client[5] but the result of this diagnosis is not. As the customer is committed to undergo a treatment by the expert, the game just described is a complete information game.

3 The price setting strategy of the expert

First, consider prices $(\overline{p}, \underline{p})$ that ensure equal markup to the expert for both treatments $(\underline{p} - \underline{c} = \overline{p} - \overline{c})$. If the expert performs a diagnosis, he is induced to provide the right treatment, so that the gross gain of the consumer is always v. The net gain of the consumer is uncertain because the charged price depends on the diagnostic result. Hence, before the diagnosis and the expert's recommendation, the consumer's expected gain follows the lottery $(v - \overline{p} - d)$ with probability h and $(v - \underline{p} - d)$ with probability $1 - h$. The consumer's expected utility is equal to $hu(v - \overline{p} - d) + (1 - h)\, u(v - (\overline{p} - \overline{c} + \underline{c}) - d)$. The expert chooses prices that drive the consumer's expected utility down to 0. The consumer incurs a risk premium $\delta \in (0, (1 - h)\,(\overline{c} - \underline{c})]$ which is such that:

$$u(v - \overline{p} - d + (1 - h)\,(\overline{c} - \underline{c}) - \delta) = h\ u(v - \overline{p} - d) + (1 - h)\ \ u(v - (\overline{p} - \overline{c} + \underline{c}) - d) = 0 \quad (1)$$

Therefore, the expert posts prices satisfying:

$$\overline{p} = v - d + (1 - h)\,(\overline{c} - \underline{c}) - \delta \text{ and } \underline{p} = \overline{p} - \overline{c} + \underline{c} \quad (2)$$

The risk premium clearly reduces the profit of the expert with respect to the risk neutral case.

The expert could decide instead to post prices $(\overline{p}, \underline{p})$ that induce him to always provide the major treatment (i.e. $\overline{p} - \overline{c} > \underline{p} - \underline{c}$). No diagnosis is then required and thus no diagnostic cost is charged to the consumer. Moreover, the administration of the major treatment fully insures the consumer: his utility is $u(v - \overline{p})$. The prices posted are $\overline{p} = v$ and $\underline{p} < \overline{p} - \overline{c} + \underline{c}$. The risk aversion of consumers plays no role here.

Finally, the expert could also post prices $(\overline{p}, \underline{p})$ that always lead to a minor treatment (i.e. $\overline{p} - \overline{c} < \underline{p} - \underline{c}$). The consumer does not pay any diagnostic cost but bears the risk of an insufficient

[5] Unlike Dulleck and Kerschbamer (2009) and Pesendorfer and Wolinsky (2003), we do not consider here the case of unobservable diagnosic effort.

treatment. As a consequence there exists a risk premium $\gamma \in (0, (1-h)\,v]$ such that:

$$u((1-h)v - \underline{p} - \gamma) = h\ u(-\underline{p}) + (1-h)\ \ u(v - \underline{p}) = 0 \tag{3}$$

and the expert posts prices satisfying:

$$\underline{p} = (1-h)v - \gamma \text{ and } \overline{p} < \underline{p} - \underline{c} + \overline{c} \tag{4}$$

The subgame perfect Nash equilibrium is the result of the comparison of previous profits.

Lemma 1 *The equilibrium prices* $\left(\overline{p}, \underline{p}\right)$ *satisfy:*

(1) $\overline{p} - \overline{c} \ = \ \underline{p} - \underline{c}$ *with* $\overline{p} = v - d + (1-h)\,(\overline{c} - \underline{c}) - \delta$, *for* $d \leq Min \left\{ \begin{array}{c} (1-h)\,(\overline{c} - \underline{c})\,, \\ h(v - (\overline{c} - \underline{c})) + \gamma \end{array} \right\} - \delta$

(2) $\overline{p} - \overline{c} \ > \ \underline{p} - \underline{c}$ *with* $\overline{p} = v$, *for* $d \geq (1-h)\,(\overline{c} - \underline{c}) - \delta$ *and* $v \geq \dfrac{\overline{c} - \underline{c} - \gamma}{h}$,

(3) $\overline{p} - \overline{c} \ < \ \underline{p} - \underline{c}$ *with* $\underline{p} = (1-h)v - \gamma$, *for* $d \geq h(v - (\overline{c} - \underline{c})) + \gamma - \delta$ *and* $v \leq \dfrac{\overline{c} - \underline{c} - \gamma}{h}$.

Proof. See Appendix 1. ■

In case 1, the expert conducts the diagnosis and proposes the appropriate treatment. In cases 2 and 3, the expert does not conduct a diagnosis and proposes either overtreatment (case 2) or undertreatment (case 3). Solid lines in figure 1 delineate these 3 different cases.

This lemma shows that the risk aversion of the consumers, captured by positive risk-premia δ and γ, clearly induces the expert to bias his pricing strategy towards the case where the consumer is fully insured i.e. the overtreatment. Indeed, to credibly commit to the revelation of the correct diagnostic result, the two mark-ups must be equal. This leads the consumer to bear risk whereas under overtreatment, the consumer is certain to always pay the same price. As a result, in the presence of risk aversion, the expert is more inclined than in the risk neutral case not to invest in diagnosis and then to propose the overtreatment to capture the risk premium. The bias between undertreatment against appropriate treatment depends on the case where the consumer bears the highest risk (the comparison between γ and δ).

4 Efficiency analysis

To what extent does the introduction of risk aversion lead the expert to bias his behavior with respect to the case where the diagnostic outcome is observed? To answer that question, we first determine the efficient solution, i.e. the equilibrium under symmetric information on the diagnostic outcome.

If the expert wants to follow an overtreatment strategy, his profit does not depend on the information available so he does not need to conduct a diagnosis. We denote by π^{O*} the profit of the expert under symmetric information with overtreatment (O) and by π^{O} the profit of the expert under asymmetric information with overtreatment. We have (see appendix 2 for a formal proof): $\pi^{O*} = \pi^{O} \equiv v - \overline{c}$. In the same way, undertreatment (U) does not require diagnosis so that using a similar notation we have $\pi^{U*} = \pi^{U} \equiv (1-h)v - \gamma - \underline{c}$.

Suppose now that the expert makes a diagnosis and provides the appropriate treatment (AT). His profit under symmetric information is thus given by $\pi^{AT*} \equiv h(\overline{p} - \overline{c}) + (1-h)(\underline{p} - \underline{c})$, which is maximized under the participation constraint of the consumer given by $hu(v - \overline{p} - d) + (1-h)\, u(v - \underline{p} - d) \geq 0$. Thus the expert charges $\overline{p} = \underline{p} = v - d$ and his profit is given by:

$$\pi^{AT*} \equiv v - d - \underline{c} - h(\overline{c} - \underline{c}) \tag{5}$$

So an expert who provides an appropriate treatment earns a higher profit than under asymmetric information since: $\pi^{AT*} > \pi^{AT} \equiv v - d - \delta - \underline{c} - h\left(\overline{c} - \underline{c}\right)$.

The following Lemma presents the equilibrium under symmetric information, and Proposition 1 concludes on the efficiency of the equilibrium stated by Lemma 1.

Lemma 2 *The efficient solution is such that:*

(a) the expert sets a price $\overline{p}$ if the major treatment is diagnosed and a price $\underline{p}$ if the minor treatment is diagnosed with $\overline{p} = \underline{p} = v - d$, for $d \leq Min\left\{(1-h)\left(\overline{c} - \underline{c}\right), h(v - (\overline{c} - \underline{c})) + \gamma\right\}$,

(b) the expert does not undertake diagnosis and sets a price $\overline{p} = v$ for the major treatment only for $d \geq (1-h)\left(\overline{c} - \underline{c}\right)$ and for $v \geq \frac{\overline{c} - \underline{c} - \gamma}{h}$,

(c) the expert does not undertake diagnosis and sets a price $\underline{p} = (1-h)v - \gamma$ for the minor treatment only for $d \geq h(v - (\overline{c} - \underline{c})) + \gamma$ and $v \leq \frac{\overline{c} - \underline{c} - \gamma}{h}$.

Proof. See Appendix 2. ■

Based on Lemmata 1 and 2, we have the following implication.

Proposition 1 *With risk-averse consumers, the expert strategy leads to an inefficient equilibrium for intermediary level of the diagnostic cost:*

$$d \in \left[Min \left\{ \begin{array}{c} (1-h)\left(\overline{c} - \underline{c}\right), \\ h(v - (\overline{c} - \underline{c})) + \gamma \end{array} \right\} - \delta, Min \left\{ \begin{array}{c} (1-h)\left(\overline{c} - \underline{c}\right), \\ h(v - (\overline{c} - \underline{c})) + \gamma \end{array} \right\} \right]$$

Figure 1 illustrates proposition 1. In both identified areas on the graph, under asymmetric information, the expert inefficiently do not conduct a diagnosis. In area B, the expert overtreats the agent instead of proposing the appropriate treatment and in area A, the expert inefficiently undertreats the agent[6].

Our main conclusion concerns the inefficiency of the equilibrium under asymmetric information on the diagnostic outcome for an intermediate level of the diagnostic cost. Let us explain that result. With symmetric information on the diagnostic outcome, if the expert undertakes the diagnosis, he chooses the same price for both treatments ($\overline{p} = \underline{p} = v - d$) and then provides the appropriate treatment. The information symmetry on the diagnostic outcome allows the combination of a risk free tariff and the completion of the appropriate treatment. As long as the diagnostic cost is low enough, it is profitable for the expert to undertake the diagnosis and to propose the appropriate treatment. Otherwise, the experts either chooses an overtreatment or an undertreatment. With asymmetric information, in order to induce a truthful revelation of the diagnosis result, the expert is constrained to differentiate the price according to the treatment proposed. In other words, full insurance and information revelation are no longer compatible. Thus, under symmetric information, the full insurance allows the expert to capture the risk premium while under asymmetric information the expert is constrained to leave that risk premium to the consumer. This risk premium reduces the rent captured by the expert. If the expert provides instead an overtreatment, there is no risk since the consumer always pays the treatment and the diagnostic cost is saved. This choice is inefficient as long as the diagnostic cost is not too high but could be preferred by the expert that is no longer constrained to leave the risk premium to the consumer. Hence an inefficient choice of overtreatment for $(1-h)(\overline{c} - \underline{c}) - \delta < d < (1-h)(\overline{c} - \underline{c})$. The expert could also choose the undertreatment. The diagnostic cost is saved as under overtreatment. As before, information asymmetry increases the risk incurred under appropriate treatment and thus biases the expert choice between undertreatment and appropriate treatment towards undertreatment: whenever d is such that $h(v - (\overline{c} - \underline{c})) + \gamma - \delta < d < h(v - (\overline{c} - \underline{c})) + \gamma$, information asymmetry leads the expert to choose an undertreatment whereas the appropriate treatment is inefficient.

The usual efficiency result resurfaces when undertreatment is prohibited by a liability clause. Indeed, with a liability clause, undertreatment is *de facto* prohibited. Hence, the expert provides

[6] Our results are consistent with Proposition 1 of Dulleck and Kerschbamer (2006) and Lemma 1 of (2009): for risk-neutral consumers ($\gamma = \delta = 0$), the market leads to the efficient outcome.

and appropriate treatment for any price such that $\underline{p} - \underline{c} \geq \overline{p} - \overline{c}$. As a result, the expert provides the appropriated treatment from the expert with a risk free tariff: $\underline{p} = \overline{p} = v - d$. Thus, consumers are always efficiently served. This crucial effect of liability on efficiency is consistent with the recent experimental study of Dulleck *et al.* (2011). These experiments show that, contrary to the predictions of the theoretical literature, verifiability of the treatment provided alone has no significant impact on the degree of efficiency, while the addition of liability has a highly significantly positive impact on the degree of efficiency.

5 Competition, inefficient experts and risk-averse consumers

We consider now an extended version of our model with two identical experts that compete in price. As before, an expert proposes a tariff for each treatment and a possible diagnosis at price d. Our purpose is to study whether our previous results is affected by the introduction of competition.

Not surprisingly, the competition between the two identical experts drives the prices down to the treatment costs.

In an equilibrium with appropriate treatment (AT), the two experts propose a diagnosis at price d with prices at their marginal cost: $\overline{p} = \overline{c}$ and $\underline{p} = \underline{c}$. Nevertheless, as before, such a tariff induces risk for the consumers. The expected utility of the consumer is $hu(v - \overline{c} - d) + (1 - h)\, u(v - \underline{c} - d) = u(v - h\overline{c} - (1 - h)\, \underline{c} - d - \widetilde{\delta})$ where $\widetilde{\delta}$ is the corresponding risk premium. We should observe here that since the prices are lower than under monopoly, the risk premium $\widetilde{\delta}$ is potentially different from δ. It is lower than δ if the consumer has a decreasing absolute risk aversion function u and higher than δ in case of an increasing absolute risk aversion function. The AT is an equilibrium as long as one expert is not induced to deviate by proposing, for instance, overtreatment at a price higher than $\overline{c}$ without diagnosis. The highest price a consumer accepts to pay for overtreatment is $h\overline{c} + (1 - h)\underline{c} + d + \widetilde{\delta}$. Therefore, the deviation is profitable as long as $h\overline{c} + (1 - h)\underline{c} + d + \widetilde{\delta} \geq \overline{c}$, i.e. $d \geq (1 - h)\,(\overline{c} - \underline{c}) - \widetilde{\delta}$.

In an equilibrium with overtreatment (O), the experts provide no diagnosis and competition also constrains both experts prices for the major treatment to $\overline{p} = \overline{c}$. The price $\underline{p}$ for the minor treatment is such that $\underline{p} < \underline{c}$. The corresponding utility of the consumer is thus equal to $u(v - \overline{c})$. If an expert deviates towards the undertreatment and sets a price $p > \underline{c}$ for the minor treatment, the expected utility of the consumer becomes $hu(-p) + (1 - h)u(v - p) = u((1 - h)v - p - \widetilde{\gamma})$ where $\widetilde{\gamma}$ is the risk premium. Therefore, the highest price p is equal to $\overline{c} - hv - \widetilde{\gamma}$ so that the deviation is profitable as long as $v \leq \frac{\overline{c}-\underline{c}-\widetilde{\gamma}}{h}$. Again, the position of the risk premium $\widetilde{\gamma}$ with respect to γ depends on the form of the utility function u.

Note that the homogeneity of consumers ensures that there is no equilibrium where each expert proposes a different tariff. Indeed, all the consumers would prefer only one of these two tariffs and would thus induce one expert to deviate.

We derive the following lemma and proposition from the previous discussion, which respectively specifies the tariff proposed by experts at equilibrium, and summarizes the impact of the competition on the provision of the efficient treatment.

Lemma 3 *Competition between two identical experts leads to the following equilibrium:*

(1) $\overline{p}-\overline{c}=\underline{p}-\underline{c}=0$ *for* $d \leq Min\left\{(1-h)\left(\overline{c}-\underline{c}\right), h(v-(\overline{c}-\underline{c}))+\widetilde{\gamma}\right\}-\widetilde{\delta}$

(2) $\overline{p}=\overline{c}$ *and* $\underline{p}<\underline{c}$ *for* $d \geq (1-h)\left(\overline{c}-\underline{c}\right)-\widetilde{\delta}$ *and* $v \geq \frac{\overline{c}-\underline{c}-\widetilde{\gamma}}{h}$

(3) $\overline{p}<\overline{c}$ *and* $\underline{p}=\underline{c}$ *for* $d \geq h(v-(\overline{c}-\underline{c}))+\widetilde{\gamma}-\widetilde{\delta}$ *and* $v \leq \frac{\overline{c}-\underline{c}-\widetilde{\gamma}}{h}$

The subgame-perfect equilibrium with competition is inefficient for:

$$d \in \left[Min\left\{\begin{array}{c}(1-h)\left(\overline{c}-\underline{c}\right), \\ h(v-(\overline{c}-\underline{c}))+\widetilde{\gamma}\end{array}\right\}-\widetilde{\delta}, Min\left\{\begin{array}{c}(1-h)\left(\overline{c}-\underline{c}\right), \\ h(v-(\overline{c}-\underline{c}))+\widetilde{\gamma}\end{array}\right\}\right]$$

Based on Lemma 3 and Proposition 1, we have the following implication.

Proposition 2 *Competition between experts reduces the inefficiency if the consumers have a decreasing absolute risk aversion VNM function and magnifies the inefficiency if the consumers have an increasing absolute risk aversion VNM function.*

Hence, provided that the consumer is characterized by a decreasing absolute risk aversion (DARA) utility function, competition between experts reduces inefficiency in the sense that the range of parameters where the experts provide overtreatment and undertreatment is narrower than under monopoly (i.e. $\widetilde{\delta}<\delta$). However inefficiency remains a possible outcome despite the competition between experts. Moreover, competition actually increases the range of parameters over which inefficient outcomes arise if the consumer is characterized by a increasing absolute risk aversion (IARA) utility function. The intuition is basically the same as the one with a monopoly. The appropriate treatment requires equal mark-up but the introduction of competition drives the mark-up down to zero. To fully ensure the consumers, an expert could be induced to deviate from that equilibrium by providing overtreatment at a higher price because of the risk premium.

Nevertheless, since the prices in the AT equilibrium with competition are lower than under monopoly, the risk premium changes. If the risk premium is lower, the deviation is less likely to be profitable. In that case, competition reduces the likelihood of an inefficient equilibrium. Nevertheless, we cannot exclude a higher risk premium that would increase the incentive to provide an overtreatment. In that case, the introduction of competition worsens the provision of inefficient treatments.

Finally, as in the monopoly case, the efficiency result obtains when the liability assumption holds too. Consider the case where both experts set $\underline{p} = \overline{p} = h\overline{c} + (1-h)\underline{c}$. Because $\overline{p} - \overline{c} < \underline{p} - \underline{c}$, there is no overtreatment and the undertreatment is prohibited by the liability. As a result, for these prices consumers are served efficiently. Moreover, this tariff is risk free and because both prices are equal to the expected cost, the utility of consumers is maximized. Thus, there is no profitable deviation for an expert.

6 Conclusion

In this paper we show that risk-averse consumers may lead to an inefficient behavior of experts in a credence good market. Information revelation requires that all treatments are sold at the same profit margin. However, with risk-averse consumers such equal margin tariffs generate a risk premium. This may drive the expert to abstain from diagnosis and supply an inefficient treatment. Such a behavior may be cured with a liability clause. By prohibiting undertreatment, a liability clause allows the expert to provide the appropriated treatment with a risk free tariff. Our results hold in a monopoly setting and under Bertrand competition.

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Appendix

Appendix 1: Proof Lemma 1

If the expert sets equal markup prices (i.e. $\overline{p} - \overline{c} = \underline{p} - \underline{c}$) and makes a diagnosis, he then proposes the appropriate treatment. The corresponding expected utility is $hu(v - \overline{p} - d) + (1-h)\,u(v - \underline{p} - d)$. The most profitable price $\overline{p}$ is such that $hu(v - \overline{p} - d) + (1-h)\,u(v - \underline{p} - d) = 0$. We define the risk premium δ by the following equality: $hu(v - \overline{p} - d) + (1-h)\,u(v - \underline{p} - d) = u(v - \overline{p} + (1-h)(\overline{p} - \underline{p}) - d - \delta)$, with $\delta \in \left(0, (1-h)\left(\overline{p} - \underline{p}\right)\right]$.

If the expert sets prices such that the major treatment markup is higher ($\overline{p} - \overline{c} > \underline{p} - \underline{c}$), the expert overtreats the agent. In that case no diagnosis is needed and thus the utility is $u(v - \overline{p})$. The corresponding optimal price is then $\overline{p} = v$.

If the expert sets prices such that the minor treatment markup is higher ($\underline{p} - \underline{c} > \overline{p} - \overline{c}$) the expert undertreats the agent. In that case no diagnosis is needed and thus the utility is $hu(-\underline{p}) + (1-h)\,u(v - \underline{p})$. We define the risk premium γ by the following equality: $hu(-\underline{p}) + (1-h)\,u(v - \underline{p}) = u((1-h)v - \underline{p} - \gamma)$, with $\gamma \in (0, (1-h)\,v]$. The corresponding optimal prices are then: $\underline{p} = (1-h)v - \gamma$ and $\overline{p} < \underline{p} - \underline{c} + \overline{c}$.

In brief, the different possible profits for the expert are: $\pi^{AT} \equiv v - d - \delta - \underline{c} - h(\overline{c} - \underline{c})$ under appropriate treatment, $\pi^{O} \equiv v - \overline{c}$ under overtreatment, and $\pi^{U} \equiv (1-h)\,v - \gamma - \underline{c}$ under undertreatment.[7] It is easy to see that i) $\pi^{AT} \geq \pi^{O}$ iff $d \leq (1-h)(\overline{c} - \underline{c}) - \delta$, ii) $\pi^{AT} \geq \pi^{U}$ iff $d \leq h(v - (\overline{c} - \underline{c}) + \gamma - \delta$, and iii) $\pi^{O} \geq \pi^{U}$ iff $v \geq \frac{\overline{c} - \underline{c} - \gamma}{h}$.

Appendix 2: Proof Lemma 2

We say that the consumers are efficiently served if the diagnostic outcome is observed (symmetric information on the diagnostic outcome). Let us determine the optimal prices in that case.

[7] The superscript AT, O, and U indicates the treatment supplied: appropriate treatment, overtreatment and undertreatment.

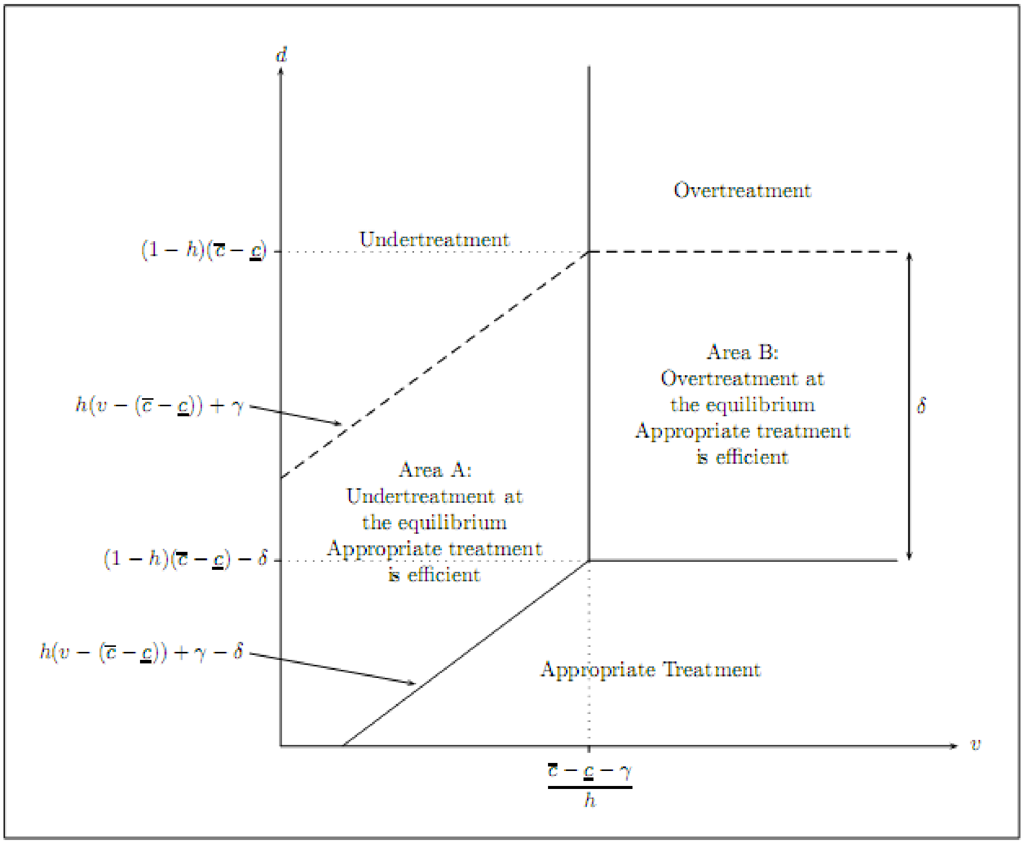
If the expert provides an overtreatment (resp. an undertreatment), he does not make a diagnosis and then he charges the same prices as under asymmetric information. The resulting profits are unchanged and equal to: $\pi^{O*} = \pi^{O} \equiv v - \overline{c}$ and $\pi^{U*} = \pi^{U} \equiv (1-h)\,v - \gamma - \underline{c}$).[8]

If the expert makes a diagnosis and provides the appropriate treatment, his profit is given by $\pi^{AT*} \equiv h(\overline{p} - \overline{c}) + (1-h)(\underline{p} - \underline{c})$. This profit is maximized under under the consumer participation constraint $hu(v - \overline{p} - d) + (1-h)\,u(v - \underline{p} - d) \geq 0$. The expert charges $\overline{p} = \underline{p} = v - d$. We note that his profit is higher than under asymmetric information: $\pi^{AT*} \equiv v - d - \underline{c} - h(\overline{c} - \underline{c}) > \pi^{AT} \equiv v - d - \delta - \underline{c} - h\,(\overline{c} - \underline{c})$.

It is easy to see that i) $\pi^{AT*} \geq \pi^{O*}$ iff $d \leq (1-h)\,(\overline{c} - \underline{c})$, ii) $\pi^{AT*} \geq \pi^{U*}$ iff $d \leq h(v - (\overline{c} - \underline{c}) + \gamma$, and iii) $\pi^{O*} \geq \pi^{U*}$ iff $v \geq \frac{\overline{c} - \underline{c} - \gamma}{h}$. Then the equilibrium prices $\left(\overline{p}, \underline{p}\right)$ satisfy:

$$\begin{cases} \overline{p} = \underline{p} = v - d, \text{ for } d \leq Min \left\{ \begin{array}{c} (1-h)\,(\overline{c} - \underline{c})\,, \\ h(v - (\overline{c} - \underline{c})) + \gamma \end{array} \right\}, \\ \overline{p} - \overline{c} > \underline{p} - \underline{c} \text{ with } \overline{p} = v, \text{ for } d \geq (1-h)\,(\overline{c} - \underline{c}) \text{ and } v \geq \frac{\overline{c} - \underline{c} - \gamma}{h}, \\ \overline{p} - \overline{c} < \underline{p} - \underline{c} \text{ with } \underline{p} = (1-h)v - \gamma, \text{ for } d \geq h(v - (\overline{c} - \underline{c})) + \gamma \text{ and } v \leq \frac{\overline{c} - \underline{c} - \gamma}{h}. \end{cases}$$

[8] The superscript $*$ indicates an efficient environment, i.e. without asymmetric information.



d
Overtreatment
$(1-h)(\overline{c}-\underline{c})$
Undertreatment
$h(v-(\overline{c}-\underline{c}))+\gamma$
Area B:
Overtreatment at
the equilibrium
Appropriate treatment
is efficient
δ
Area A:
Undertreatment at
the equilibrium
Appropriate treatment
is efficient
$(1-h)(\overline{c}-\underline{c})-\delta$
$h(v-(\overline{c}-\underline{c}))+\gamma-\delta$
Appropriate Treatment
v
$\frac{\overline{c}-\underline{c}-\gamma}{h}$

Figure 1