Credence Goods, Experts and Risk Aversion

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Abstract

The existing literature in expert-customer relationship concludes that when: i) consumers are homogenous, ii) consumers are committed with an expert once this one makes a recommendation, and iii) the type of treatment provided is verifiable, an expert finds optimal to serve efficiently his customers. This work shows that the previous result may not occur when consumers are not risk-neutral. Our result, that holds in a monopoly setting and under Bertrand competition, suggests that risk averse consumers are more likely to be mistreated by experts.

Keywords: Credence goods, Expert services, Risk-aversion.

JEL classification: D40, D82, L15.

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1 Introduction

In many instances, the seller of a good or service knows more about this good or service than the consumer himself. Such expert services or goods have been called credence goods (Darby and Karni, 1973). Examples include the services provided by repair professionals, taxi drivers, agricultural consultants, medical doctors or lawyers. In all of these professions the seller not only provides the service but also acts as an expert diagnosing the consumer's requirements. A taxi driver will advise his customers as to the best route to take, medical doctors will recommend a specific treatment and auto mechanics will tell their clients whether they need new sparkplugs or en entire starter engine. This gives the expert to bias his recommendation towards the more profitable service for him. Nevertheless, the existing literature on expert-customer relationships shows that, under some conditions, the expert provides an efficient treatment (see e.g. Darby and Karni, 1973, or Emons, 1997, 2001).[1] In a recent model of credence goods that unifies previous analyses, Dulleck and Kerschbamer (2006) show that an expert has always interest to serve his customers efficiently when the three following assumptions hold: i) consumers are homogenous, ii) consumers are committed to an expert once this one makes a recommendation, and iii) the type of treatment provided is verifiable. The key to this result is that, in equilibrium, the expert charges the same markup for all possible treatments, removing any incentive to mislead his clientele. Any set of prices that does not respect this equal margin condition would lead to a fraudulent behavior of expert.

In the present paper, we extend the model than of Dulleck and Kerschbamer (2006) in two directions. First, we relax the assumption that the expert always conducts serious diagnostic tests. Such tests are costly in terms of time and material, so skimping on the initial investigation may indeed be rational for the expert. This issue has already been addressed in a few papers (see Pessendorf and Wolinsky, 2003, and Dulleck and Kerschbamer, 2009). However, theses papers focus on situations where the expert's diagnosis effort is unobservable. We make the opposite extreme assumption that the customer is aware of the effort expended on diagnosis. Assuming an expert's diagnosis effort unobservable or observable is extreme in both cases, but our assumption might be more appropriated in some cases (doctors, agricultural consultants,...) than in others (car mechanics, lawyers, ...). Here we consider observable diagnosis in order to focus on other behaviors than the incentives for expert to exploit the informational problems associated with the diagnosis effort. Second, and this is the main novelty of this work, we assume that consumers are

[1] Others works focus about situations where consumers cannot observe the type of service provided, so the expert may defraud the consummers by misrepresenting a low-cost service as a costly one (see e.g. Pitchik and Schotter, 1987 , Wolinsky 1993, Fong 2005 or Alger and Salanié, 2006).

risk-adverse. This assumption is particular relevant in several cases. The pesticide used by farmers is one first example. This type of product is generally supplied in combination with some advice on the precise product to use and the conditions for using it. An important body of the literature in agricultural economics shows that farmers are risk-averse. This aversion helps explain the intensive use of risk-reducing inputs such as pesticides (see e.g. Moschini and Hennessy, 2001, and Carpentier and Weaver, 1997). The supply of car repair to women is another example. Numerous studies in sociology, psychology, experimental economics, and econometrics, women are found to be more averse to risk than men (see e.g. Byrnes *et al.*, 1999, Croson and Gneezy, 2009, and Cohen and Einav, 2007). Hence, considering risk aversion might also help explain why women might be treated differently when taking their car to the auto mechanic. For instance, an Australian report of the Consumer Law Centre Victoria concludes that in automobile repairs industry women do not receive the same standard of service as men and pay an extra costs (Foster, 1997). The author also indicates that women place a high priority on services such as a recommended repair network when purchasing insurance, in order to avoid a discrimination in repair services.

We show that considering risk-averse consumers can modify the efficiency result of literature described in Dulleck and Kerschbamer (2006) quite dramatically. Indeed, the presence of risk-premia drives the expert not to conduct a proper diagnosis and to choose either overtreatment (to provide the more expensive treatment) or undertreatment (to provide the less expensive treatment) when conducting a diagnosis and providing the appropriate treatment would have been efficient. Our result occurs even when the three assumptions i), ii) and iii) hold. Hence our paper shows that the risk-neutral consumers assumption made in the literature is not without loss of generality.[2] Moreover we show that the introduction of competition between experts only alleviates the incentive to provide a false treatment if the risk premium decreases with the income. This means that customers may be still inefficiently served even with intense competition between expert providers.

The force that drives our result is the tension between the equal mark-up pricing that allows the expert to commit to provide the appropriate treatment and the risk borne by the consumers with this type of tariff. Because of risk aversion, the customer is in fact willing to pay a premium for overtreatment and undertreatment (risk free tariffs). This breaks the equality of margins across services and provides the expert with an incentive to save on diagnostic costs and provide the same treatment anyway. This tension still exists when there is competition between identical experts.

[2] In a physician-patient model, Sülzle and Wambach (2005) discuss their results when patients are risk averse. They conclude that assuming risk neutral or risk averse patients does not modify the equilibrium behavior. Their model is specific to markets where price are not flexible, for instance where prices are regulated by an authority. Conversely to models of credence goods with price setting (considered by Dulleck and Kerschbamer, 2006), in fixed-price models there exists at least one equilibrium with a positive level of fraud even when consumers are risk-neutral (see e.g. Wolinsky, 1993).

Nevertheless, if the lower price level reduces the risk premium, the incentive to always provide the same treatment is reduced by competition.

The paper is organized as follows: Sections 2 and 3 present the model assumptions and the equilibrium when consumers are risk-neutral. The market equilibrium when consumers are risk-averse is analyzed in Section 4. Section 5 introduces competition an Section 6 concludes.

2 The model

We use a model of credence goods similar to Dulleck and Kerschbamer (2006). Each consumer has a problem which can be of two possible types: major or minor. The cost of a major treatment is $\overline{c}$, and the cost of a minor treatment is $\underline{c}$, with $\overline{c} > \underline{c}$. A minor treatment can only solve a minor problem while a major treatment can solve either a major or a minor problem. The consumer knows that he has a problem but he does not know its type. Ex-ante each consumer knows that his problem is major with a probability h and minor with a probability $(1 - h)$. By conducting the proper diagnostic tests an expert can detect the true type of the problem. The expert can then supply an appropriate treatment or exploit his superior information to supply a minor or a major treatment regardless of the test results. We refer to these last two treatment strategies as *undertreatment* and *overtreatment* respectively. Without diagnosis, an expert cannot detect the true type of the problem. In this case, he can not supply an appropriate treatment and can only choose to always supply a minor or a major treatment.

Following the literature on valuation of credence goods we consider four assumptions. We use the terminology and definitions proposed by Dulleck and Kerschbamer (2006) to characterize these assumptions. *Homogeneity Assumption* (H): all consumers have the same probability h of having the major problem. The parameter v is the gross gain of a consumer when his problem is solved.[3] Otherwise he gets 0. *Commitment Assumption* (C): Once a recommendation is made, the customer is committed to undergo a treatment by the expert.[4] *Liability Assumption* (L): An expert cannot provide the minor treatment if the major is needed. And *Verifiability Assumption* (V): An expert cannot charge for the major treatment if he has provided the minor treatment. Assumption V rules out the overcharging problem.[5]

Conversely to the literature we consider a fifth assumption: the *Risk aversion Assumption* (R)

[3] We assume that it is always efficient that a consumer is treated when he has a problem $v - \overline{c} > 0$.

[4] The commitment assumption is justified in a monopoly setting, in markets with high economies of scope between diagnosis and treatment or in markets with symmetric information about the treatment supplied (see Emons, 2001, and Dulleck and Kerschbamer, 2006).

[5] When the consumer cannot evaluate the treatment received, he may require and receive a minor treatment but be charged for an major treatment. In the literature, this fraudulent expert behavior is referred as *overcharging.* Assumption V rules out this fraudulent behavior.

(consumers are risk-averse). The utility of a consumer is given by a *Von Neumann-Morgenstern* utility function $u(x)$ with x the consumer's gain and $u(0) = 0$.

The market environment is described as follows. There is a continuum of identical consumers with total mass of 1. Both treatments and the diagnosis are provided by one expert. The magnitude (i.e. type) of the consumer's problem can only be known by the expert if he invests in making a proper diagnosis. As in the bulk of the literature, we assume that the diagnostic fee charged to the consumer is exogenous and equals to the cost d borne by the expert (see e.g. Dulleck and Kerschbamer, 2006). However, contrary to the literature, we suppose that expert may decide not to make a thorough diagnostic, in which case, the diagnosis cost is zero and the consumer is exempted from paying the diagnostic fee.[6]

In the first period of the game, the expert posts prices $\overline{p}$ and $\underline{p}$ for a major treatment and a minor treatment respectively and commits to conduct or not a diagnosis. 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.[7] The action of making a diagnostic is observed by the client but the result of this diagnosis is not. When a diagnostic is not conduced, the expert can not observed the action of the nature. With the assumption (C) the game just described is a complete information game. We determine the subgame-perfect equilibrium of that game.

3 Equilibrium when consumers are risk-neutral

Our objective in that section is to determine whether the non observability of the diagnosis result is a source of inefficiency when consumers are risk neutral. We consider as the efficient benchmark the case where the diagnosis result is both observed and verifiable so that it can be contracted upon by the consumer and the expert. This definition of the efficient solution allows us to point out the impact of information asymmetry on the expertise outcome. Let us define precisely when a solution is considered as efficient under asymmetric information.

Definition 1 *A solution is efficient when the treatment exerted by the expert is the same as in a market without asymmetric information.*

[6] Assuming that the expert (respectively the consumers) bears a diagnosis cost (respectively pay a diagnosis fee) d_0, with $d > d_0 > 0$, when no diagnosis or only a "light" diagnosis is performed does not modify qualitatively our results.

[7] The commitment assumption (C) rules out the possibility to consumers to reject the expert's recommendation. Moreover the verifiability assumption (V) rules out the possibility to expert to charge an other treatment than the provided treatment.

With risk-neutral consumers, the existing literature concludes that when Assumptions H, C, and V hold, but L is violated, the expert finds it profitable to charge the same margin over all treatments and serve customers honestly. All consumers are thus efficiently served under equal markup (see Proposition 1 and Lemma 1 of Dulleck and Kerschbamer, 2006). This result is achieved when the expert bears a diagnosis cost whatever his strategy (appropriate treatment, overtreatment or undertreatment). When we assume that an expert may avoid to conduct a diagnosis, consumers are also always efficiently served but not necessarily under equal markup. More specifically, we show that for a high diagnosis cost d, it is more profitable for the expert to always supply the same treatment in order to save the diagnosis cost. The treatment provided depends on the cost difference between the two treatments. For a high cost difference, the expert always provides the minor treatment whereas if the cost difference is lower, the expert always provides the major treatment. Nevertheless, it is important to note that the consumers are efficiently served, i.e. as in an environment with symmetric information.

We specify in the following Lemma the tariff proposed by the expert at the equilibrium and figure 1 illustrates the partition of equilibrium – appropriate treatment (AT), overtreatment (O) or undertreatment (U) – according to values of d.

Lemma 1 *When Assumptions H (homogeneity), C (commitment) and V (verifiability) hold and when Assumptions R (risk aversion) and L (liability) are violated, the equilibrium prices* $(\overline{p}, \underline{p})$ *satisfy:*

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

The solution is efficient.

Proof. See Appendix 1 ■

Lemma 1 shows that assuming that undertreatment and overtreatment may be performed without diagnosis does not modify the literature's main results: customers are efficiently served by the expert. The intuition for this result is as follows. With an equal mark-up tariff, the expert is able to credibly commit to reveal the correct diagnosis result. Moreover, for a risk neutral consumer only the expected price matters. Thus, the consumer surplus for this particular tariff is the same as for any other tariff with the same expected price level when the diagnosis result is known to the consumer. Therefore, under asymmetric information the expert is able to capture the same consumer surplus as with symmetric information. Without diagnosis, the information is no longer relevant. As a result, the expert behavior is the same with and without information asymmetry. Hence the efficiency result.

This lemma is consistent with Lemma 1 of Dulleck and Kerschbamer (2009) which shows that in a competitive market for credence goods where the diagnosis effort is observable and verifiable the market is efficient in any equilibrium.[8]

We now turn to the risk-averse case.

4 Equilibrium when consumers are risk-averse

When consumers are risk-neutral, the efficiency result occurs. In the following we show that this is no longer the case when consumers are risk-averse (Assumption R holds). Let us determine the equilibrium first before discussing its efficiency.

We begin by describing the new price setting strategy of the expert. Start with the expert that posts the prices $(\overline{p}, \underline{p})$ such that the markup is the same whatever the treatment provided $(\underline{p} = \overline{p} - \overline{c} + \underline{c})$. In that case, the expert is induced to provide the right treatment and thus his profit is given by $\overline{p} - \overline{c}$. Before the diagnosis and the expert's recommendation, the consumer's gain is uncertain: this one is $v - \overline{p} - d$ with a probability h and $v - \underline{p} - d$ with a probability $1 - h$. Hence the consumer's expected utility is given by $hu(v - \overline{p} - d) + (1 - h)\, u(v - (\overline{p} - \overline{c} + \underline{c}) - d)$.

At this stage we should note that the consumer bears risk because of the equal margin price. In other words, to commit to provide the right treatment, the expert cannot fully insure the consumer by proposing the same price for each treatment. As a consequence, the consumer incurs a risk premium $\delta \in (0, (1 - h)\,(\overline{c} - \underline{c})]$ with respect to a risk-free tariff. The equal mark-up tariff proposed by the expert is thus such that:

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

Therefore, the expert posts prices satisfying:

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

Now suppose that the expert decides instead to post prices $(\overline{p}, \underline{p})$ with $\overline{p} - \overline{c} > \underline{p} - \underline{c}$. Here, the

[8] Note that the conditions of the partition of efficient equilibrium are slightly different to ours. Conversely to our framework, if the treatment a consumer got is insufficient he loses v but he may buy a major treatment (at marginal cost) from the same or another provider in a following period. In our monopoly framework considering the same assumption might be interpreted as a warranty but would not modify qualitatively our results.

treatment provided is always the major treatment (overtreatment). In that case, no diagnosis is required and thus the consumer does not bear the diagnosis cost. Moreover, the administration of the major treatment fully insures the consumer. The consumer's utility is $u(v-\overline{p})$, and the prices posted are $\overline{p}=v$ and $\underline{p}<\overline{p}-\overline{c}+\underline{c}$.

Finally, suppose that the expert posts prices $\left(\overline{p},\underline{p}\right)$ such that $\overline{p}-\overline{c}<\underline{p}-\underline{c}$. Then, the treatment provided is always a minor treatment (undertreatment). As before the consumer does not bear any diagnosis cost but bears the risk of a possibly insufficient 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 expert has to determine the most profitable tariff between the three options presented above. The subgame perfect Nash equilibrium presented in the following Lemma is the result of this comparison.

Lemma 2 *When Assumptions H (homogeneity), C (commitment), V (verifiability) and R (risk aversion) hold and L (liability) is violated, the equilibrium prices $\left(\overline{p},\underline{p}\right)$ satisfy:*

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

Proof. See Appendix 2. ■

Basically, we show in that lemma that the strategy of the expert in the presence of risk-averse consumers also depends on the diagnosis cost as well as the cost difference between both treatments. The main difference with the previous lemma is in the relevant thresholds. Now the risk aversion of the consumers induces the expert to bias its pricing strategy towards the two cases where the consumer is fully or better insured: overtreatment and undertreatment.[9] Indeed, to credibly commit to the revelation of the correct diagnosis result, as before, the two mark-ups must

[9] For the consumer, an appropiated treatment is more risky than undertreament whenever $\delta>\gamma$.

be equal. This leads the consumer to bear risk whereas under overtreatment, the consumer is sure to always pay the same price. As a result, in the presence of risk-aversion, the expert is more inclined to propose the overtreatment to capture the risk premium than in the risk neutral case.

Now that the equilibrium with risk averse consumers is established, the key question concerns the efficiency of this equilibrium: to what extent does the introduction of risk aversion lead the expert to bias his behavior with respect to the observable diagnosis outcome case. To answer that question we have to determine the equilibrium under symmetric information with risk-averse consumers.

If the expert wants to follow an overtreatment strategy, he does not conduct a diagnosis, so his profit does not depend on the information available. If 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: $\pi^{O*} = \pi^{O} \equiv v - \overline{c}$. In the same way, undertreatment (U) does not require diagnosis so that using the same notation we have also $\pi^{U*} = \pi^{U} \equiv (1-h)v - \gamma - \underline{c}$.

On the other hand, if the expert wants to commit to provide the appropriate treatment (AT) , the expert profit under symmetric information is 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 that provides an appropriate treatment earns a higher profit than under asymmetric information since: $\pi^{AT*} > \pi^{AT} \equiv v - d - \delta - \underline{c} - h\,(\overline{c} - \underline{c})$.

The following Lemma presents the equilibrium under symmetric information (efficient solution), and the Proposition concludes on the efficiency of the equilibrium given in Lemma 2.

Lemma 3 *The efficient solution with risk averse consumers:*

(i) 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* $d \leq Min\left\{(1-h)\left(\overline{c} - \underline{c}\right), h(v - (\overline{c} - \underline{c})) + \gamma\right\}$*,*

(ii) 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* $v \geq \frac{\overline{c} - \underline{c} - \gamma}{h}$*,*

(iii) 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 3. ■

Based on Lemma 2 and Lemma 3, we have the following implication.

Proposition 1 *When Assumptions H (homogeneity), C (commitment), V (verifiability) and R (risk aversion) hold and L (liability) is violated the subgame-perfect equilibrium is inefficient for* $d \in \left[Min \left\{ \begin{array}{c} (1-h)\left(\overline{c}-\underline{c}\right), \\ h(v-(\overline{c}-\underline{c}))+\gamma \end{array} \right\} - \delta, Min \left\{ \begin{array}{c} (1-h)\left(\overline{c}-\underline{c}\right), \\ h(v-(\overline{c}-\underline{c}))+\gamma \end{array} \right\} \right]$

Our main conclusion concerns the inefficiency of the equilibrium for an intermediate level of the diagnosis cost. Let us explain that result. If the diagnosis cost d is low enough, under symmetric information, the expert undertakes the diagnosis. Moreover, the risk aversion of the consumer induces the expert to fully ensure the consumer by setting the same price for both treatments. Hence the information symmetry about the diagnosis outcome allows the combination of this type of "full insurance" tariff and the completion of the right treatment. In case of 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 not 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 that bears a risk. For a higher level of diagnosis cost, the expert does not undertake the diagnosis but can propose a major or a minor treatment. As we noted above, the information plays no role here since no diagnosis is undertaken. As a result, the trade-off between overtreatment and undertreatment is not affected by the asymmetric information. Let us focus on the incentive to provide an appropriate treatment. In the trade-off between appropriate treatment and overtreatment, the combination of risk aversion and asymmetric information clearly distorts the comparison in favor of the overtreatment. This explains why the equilibrium with overtreatment is inefficient whenever $(1-h)\left(\overline{c}-\underline{c}\right)-\delta < d < (1-h)\left(\overline{c}-\underline{c}\right)$. The efficient equilibrium is a appropriate treatment. The trade-off between the appropriate treatment and the undertreatment is apparently less clear since in both cases the consumer is not fully insured. Nevertheless the risk incurred under undertreatment is still present under the symmetric information while the risk in case of appropriate treatment is only due to the asymmetric information. Hence as before, there is a bias against appropriate treatment: for $h(v-(\overline{c}-\underline{c}))+\gamma-\delta < d < h(v-(\overline{c}-\underline{c}))+\gamma$, the equilibrium with undertreatment is inefficient. The efficient equilibrium is an appropriate treatment. Figure 2 illustrates theses inefficient zones (hatched) with a quadratic utility function.

This Lemma shows that assuming risk-neutral consumers is not without loss of generality. When consumers are risk-neutral (δ and γ null) we find the equilibrium price described in Lemma

1. The customers are thus efficiently served by the expert. When consumers are risk-averse, the provision of the appropriate treatment induces a risk-premium. This risk premium does not exist in markets where the diagnosis result is observed since the expert can separate the price from the treatment provided and can propose a risk free tariff ($\overline{p} = \underline{p} = v - d$). So, in markets where there is asymmetric information on the diagnosis, the presence of a risk-premium drives the expert to choose overtreatment or undertreatment while an appropriate treatment would be efficient.

We would like to add two remarks about our result. First, our assumption about the diagnostic plays an important role. Indeed, if the expert must conduct a proper diagnosis (i.e. the case where $d = 0$), all consumers are efficiently supplied with an appropriate treatment. The expert has never interest to deviate even if the equal mark-up tariff generates a risk premium. Second, the usual efficiency result resurfaces when the liability assumption (L) holds. Let us explain that result. With the liability assumption, undertreatment is *de facto* prohibited and AT equilibrium prices satisfy: $\underline{p} - \underline{c} \geq \overline{p} - \overline{c}$ and $\underline{p} + h(\overline{p} - \underline{p}) = v - d - \delta$. As a result, the expert may provide the appropriated treatment 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.* (2010). These experiments show that, contrary to the predictions of the theoretical literature (see e.g. Dulleck and Kerschbamer, 2006), 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 (see Main Result 1 and Table 3).

5 Competition and market equilibrium

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 to what extent our previous result 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 $\overline{p} = \overline{c}$ 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 an expert is not induced to deviate by proposing, for instance, overtreatment at a price higher than $\overline{c}$ without diagnosis. The highest price the 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. $d\geq(1-h)\left(\overline{c}-\underline{c}\right)-\widetilde{\delta}$.

In an O type equilibrium, 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, as before, the position of the risk premium $\widetilde{\gamma}$ with respect to γ depends on the form of the utility function u.

Moreover, assumption (H) 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 from the previous discussion the following lemma and proposition that respectively specifies the tariff proposed by experts at equilibrium, and summarizes the impact of the competition on the provision of the efficient treatment.

Lemma 4 *When Assumptions H (homogeneity), C (commitment), V (verifiability) and R (risk aversion) hold and L (liability) is violated, the competition between two identical experts leads to the following equilibrium:*

$$\begin{cases}\overline{p}-\overline{c}=\underline{p}-\underline{c}=0 \text{ for } d\leq Min\left\{(1-h)\left(\overline{c}-\underline{c}\right),h(v-(\overline{c}-\underline{c}))+\widetilde{\gamma}\right\}-\widetilde{\delta},\\ \overline{p}=\overline{c} \text{ and } \underline{p}<\underline{c} \text{ for } d\geq(1-h)\left(\overline{c}-\underline{c}\right)-\widetilde{\delta} \text{ and } v\geq\frac{\overline{c}-\underline{c}-\widetilde{\gamma}}{h},\\ \overline{p}<\overline{c} \text{ and } \underline{p}=\underline{c} \text{ for } d\geq h(v-(\overline{c}-\underline{c}))+\widetilde{\gamma}-\widetilde{\delta} \text{ and } v\leq\frac{\overline{c}-\underline{c}-\widetilde{\gamma}}{h}.\end{cases}$$

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 4 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. 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. AT equilibrium prices satisfy: $\underline{p} - \underline{c} \geq \overline{p} - \overline{c}$ and $\underline{p} + h(\overline{p} - \underline{p}) = h\overline{c} + (1-h)\underline{c}$. As a result, experts may provide the appropriated treatment with a risk free tariff $\underline{p} = \overline{p} = h\overline{c} + (1-h)\underline{c}$. Consumers are efficiently served.

6 Conclusion

In this paper we show that the risk-neutral consumers assumption considered in the literature on expert services is not without loss of generality. 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. This result holds in a monopoly setting and under Bertrand competition.

Our model sheds new light on the relationship between the consumers' risk attitudes and the market's capacity to solve the fraudulent expert problem. For instance, a high degree of risk aversion means that the mechanism market does not a good job and induces inefficient overtreatment or undertreatment. Our findings suggest that risk averse consumers like farmers and women are more likely to be "mistreated" by experts. This may be a serious problem given the current need for farmers to switch to environmentally friendly practices[10] and the increasing proportion of women in the customers of auto repair shops or other experts.[11]

Our model might be considered restrictive in several respects: homogeneous consumers, only two types of problems and treatments. However, we have chosen this simple framework in order to asses the robustness of the efficiency result of the Dulleck and Kerschbamer (2006)'s benchmark with risk averse consumers. Finally, in this paper we focus on the incentives for experts to exploit the informational problems associated with the diagnosis result. Future research can address the informational problems associated with the treatment supplied or the diagnosis effort.

[10] Such practices require that the farmer should fit its pesticide use to the level of the pest pressure.

[11] The US National Institute for Automobile Service Excellence (ASE) reports that in 2001 in United States 65% of customers who take their vehicles to a repair shop for service and repair are women.

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Appendix

Appendix 1: Proof Lemma 1

Under equal markup prices (i.e. $\overline{p}-\overline{c}=\underline{p}-\underline{c}$) and diagnosis committed, the consumer is provided honestly and its expected utility is $hu(v-\overline{p}-d)+(1-h)\,u(v-\underline{p}-d)$. Under equal markup prices (i.e. $\overline{p}-\overline{c}=\underline{p}-\underline{c}$) without diagnosis committed, the expert is fraudulent[12]. In that case, overtreatment or undertreatment is more profitable.

Under markup prices more important for the major problem (resp. the minor problem), the expert is fraudulent and has not interest to conduce a diagnosis, the consumer's utility is $u(v-\overline{p})$ (resp. $hu(-\underline{p})+(1-h)\,u(v-\underline{p})$).

Since consumers are risk-neutral, the maximal profit per customer for a monopolist is: $\pi^{AT}\equiv v-d-\underline{c}-h\,(\overline{c}-\underline{c})$ under equal markup, $\pi^{O}\equiv v-\overline{c}$ under overtreatment, and $\pi^{U}\equiv(1-h)\,v-\underline{c}$ under undertreatment. 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 $d\leq h(v-(\overline{c}-\underline{c}))$, and iii) $\pi^{O}\geq\pi^{U}$ iff $v\geq\frac{\overline{c}-\underline{c}}{h}$.[13]

The consumers are efficiently served when they are served as in an environment without asymmetric information. The expert that provides an overtreatment (resp. an undertreatment) does not conduce a diagnosis, so he charges the same prices and has the same profit what the diagnosis result is common knowledge or not ($\pi^{O*}\equiv v-\overline{c}$ and $\pi^{U*}\equiv(1-h)\,v-\underline{c}$).[14]

Without asymmetric information, the expert that provides an appropriate treatment maximizes his profit given by $\pi^{AT*}\equiv h(\overline{p}-\overline{c})+(1-h)(\underline{p}-\underline{c})$ under the consumer participation constraint $hu(v-\overline{p}-d)+(1-h)\,u(v-\underline{p}-d)\geq 0$. The expert charges $\overline{p}=\underline{p}=v-d$ and has the same

[12] The expert is fraudulent as so far as he may provide an unappropriated treatment.

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

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

profit as in the environment with asymmetric information ($\pi^{AT} = \pi^{AT*} = v - d - \underline{c} - h(\overline{c} - \underline{c})$). So the treatment provided with asymmetric information is efficient whatever the value of parameters considered.

Appendix 2: Proof Lemma 2

Under equal markup prices (i.e. $\overline{p} - \overline{c} = \underline{p} - \underline{c}$) and diagnosis committed, the consumer is provided honestly and its 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 $\delta \in \left(0, (1 - h)\,(\overline{p} - \underline{p})\right]$. Under equal markup prices (i.e. $\overline{p} - \overline{c} = \underline{p} - \underline{c}$) without diagnosis committed, the expert is fraudulent. In that case, overtreatment or undertreatment is more profitable.

Under markup prices more important for the major problem (resp. the minor problem), the expert is fraudulent and has not interest to conduce a diagnosis, the consumer's utility is $u(v - \overline{p})$ (resp. $hu(-\underline{p}) + (1 - h)\,u(v - \underline{p})$).

Since consumers are risk-averse, the maximal profit per customer for a monopolist is: $\pi^{AT} \equiv v - d - \delta - \underline{c} - h\,(\overline{c} - \underline{c})$ under equal markup, $\pi^{O} \equiv v - \overline{c}$ under overtreatment, and $\pi^{U} \equiv (1 - h)\,v - \gamma - \underline{c}$ under undertreatment. 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 3: Proof Lemma 3

The consumers are efficiently served when they are served as in an environment without asymmetric information. The expert that provides an overtreatment (resp. an undertreatment) does not conduce a diagnosis, so he charges the same prices and has the same profit what the diagnosis result is common knowledge or not ($\pi^{O*} = \pi^{O} \equiv v - \overline{c}$ and $\pi^{U*} = \pi^{U} \equiv (1 - h)\,v - \gamma - \underline{c}$).

Without asymmetric information, the expert that provides an appropriate treatment maximizes his profit given by $\pi^{AT*} \equiv h(\overline{p} - \overline{c}) + (1 - h)(\underline{p} - \underline{c})$ under the consumer participation constraint $hu(v - \overline{p} - d) + (1 - h)\,u(v - \underline{p} - d) \geq 0$. The expert charges $\overline{p} = \underline{p} = v - d$, his profit is superior than in the environment with 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 $\left(\overline{p}, \underline{p}\right)$

satisfies:

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

Figures

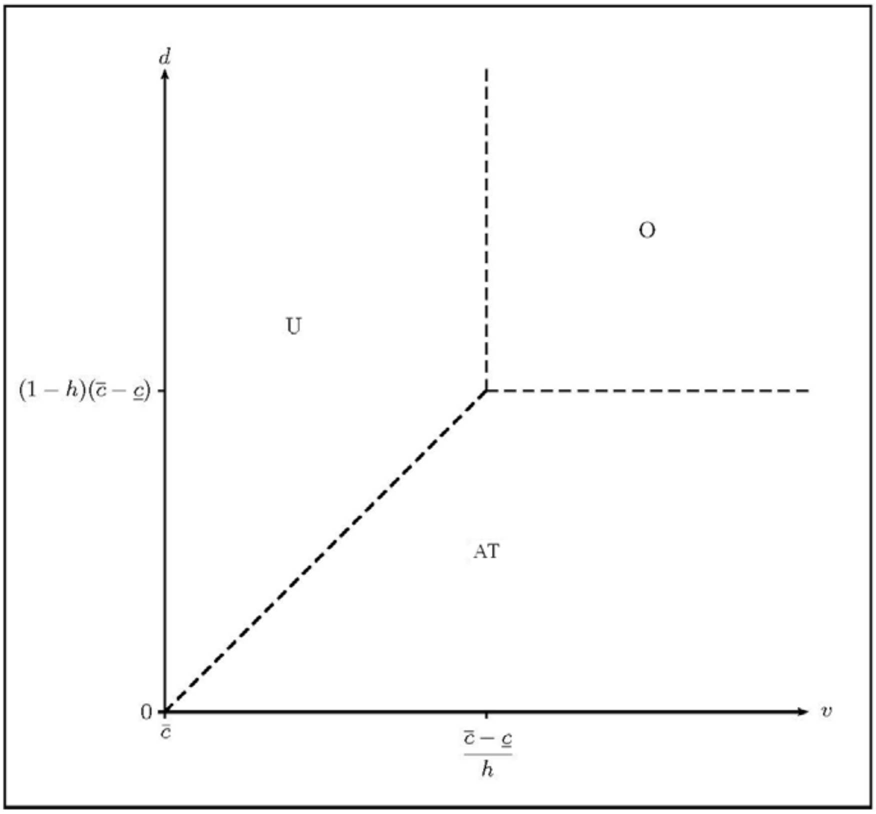

Figure 1: Expert's choice according to d and v with risk-neutral consumers.

(with $\underline{c} = 0$, $\overline{c} = 1/2$ and $h = 1/2$)

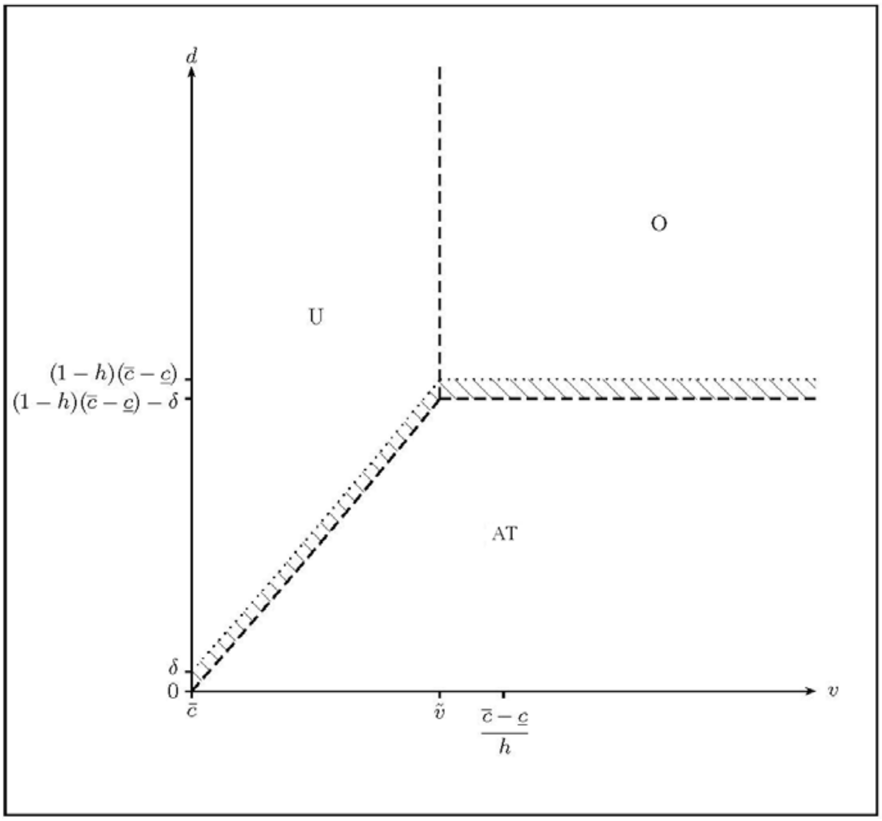

Figure 2: Expert's choice according to d and v with risk-averse consumers.
(with $u(x) = x - \frac{\alpha}{2}x^2$, $\underline{c} = 0$, $\overline{c} = 1/2$, $h = 1/2$
and $\widetilde{v} = \frac{\overline{c}-\underline{c}-\gamma}{h}$ with $\gamma = \frac{1-\sqrt{1+(h-1)hv^2\alpha^2}}{\alpha}$)