Physicians and Credence Goods: Why are Patients Over-treated?

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Abstract

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1. Introduction

A patient knows they are ill but has limited or no information about what illness they have, the severity of the illness, or the appropriate treatment. In this situation, a physician not only diagnoses the patient's illness and provides treatment, but also determines the severity of the illness and how much treatment is necessary. In some cases, even after the treatment has been delivered the patient does not know the extent of the treatment. Goods or services which have these characteristics are known as credence goods and arise in any market in which a consumer relies on the opinion of an expert to diagnose a problem and fix it.

There is a small but growing literature on credence goods. This literature has taken two directions. The first assumes that the type or the extent of the treatment is observable and verifiable but the outcome is not and is concerned with whether there is under- or over-treatment, Dulleck and Kerschbamer (2006) and Emons (1997 and 2001). To continue with the physician example. The patient observes the type of treatment and is charged accordingly (more for treating a severe illness) but does not know if the type of treatment was appropriate and in particular whether they received the treatment for a severe illness when in fact they had a non-severe illness. The second assumes that the extent of the treatment is not observable or verifiable but that the outcome is and it is concerned with overcharging, Dulleck and Kerschbamer (2006), Fong (2005), and Liu (2011). Once again continuing with the physician example. The patient observes the outcome of the treatment but does not know the type of treatment performed and in particular whether they needed and received treatment for a non-severe illness, but were charged for the treatment of a severe illness.

This paper is concerned with the under- and over-treatment of patients by physicians, though it equally applies to any situation in which an expert provider has more information than the consumer about the appropriate diagnosis and treatment of a problem. It is assumed throughout that treatment is observable and verifiable. The consistent finding of the literature is that the market solves the credence good problem in the sense that treatment is provided efficiently, that is, there is no under- or over-treatment. The intuition is clear, in equilibrium, the physician charges an equal price mark-up above cost for both the simple and extensive treatment and so does not have an incentive to under- or over-treat patients, Dulleck and Kerschbamer (2006). This result is also demonstrated under two-parts tariffs, Alger and Salanie (2006), where price is set equal to marginal cost and patient surplus is extracted via a diagnosis fee.

The efficient provision of physician treatment is not consistent with the health economics literature, where over-treatment (supplier induced demand) is thought to be pervasive, Dranove (1988) and McGuire (2000). In this paper, three assumptions made by Dulleck and Kerschbamer (2006) are relaxed and it is shown that in equilibrium under- and over-treatment are possible. The first assumption relaxed is that the patient is committed to treatment by the physician once the diagnosis is made and at prices set before the diagnosis. This is replaced by the assumption that the patient can refuse treatment if the price of the treatment is greater than the expected value of the treatment given prices and the diagnosis. Under this assumption, it is shown that if the patient thinks the probability is high that he has the severe illness, then equilibria exist in which treatment is provided efficiently or in which there is over-treatment of the patient with the non-severe illness. On the other hand, if this probability is low, then in equilibrium there is under-treatment of the patient with the severe illness.

The second assumption relaxed is the technical assumption that the gains from both treatments are equal. Given the cost of treating the severe illness is greater than the cost of treating the non-severe illness, the surplus created by treating the severe illness is less than that of treating the non-severe illness and under-treatment of the patient with the severe illness is possible in equilibrium. This technical assumption is replaced by the assumption that treating the sever illness has a greater surplus than treating the non-severe illness and in equilibrium results in either efficient treatment or over-treatment of the patient with the non-severe illness. This is consistent with the prevalence of supplier induced demand. It should be noted that efficient provision in equilibrium arises even with these two new assumptions if the physician uses a two-part tariffs.

The third assumption relaxed is that physician costs are observable by the patient. This assumption is necessary for the patient to infer physician incentives for diagnosis and treatment. Such an assumption seems unnatural. Therefore, it is assumed that patients know the value of treatment and its price, but not the costs of production. Under the above three new assumptions, it is shown that depending on the parameters of the model there is under-treatment of the patient with the severe illness or there is over-treatment of the patient with the non-severe illness.

What is clear is that efficient treatment is not an equilibrium. It is well understood that efficient diagnosis and treatment can be recovered if diagnosis and treatment are provided by different agents as then the diagnosing agents does not have an incentive to recommend under-or over-treatment. In Section 4 it is assumed that the physician diagnoses the severity of the illness and treats the non-severe illness while other health providers (hospitals) treat the severe illness. As expected, if the physician is not able to extract any of the surplus created from the treating the severe illness, then diagnosis and treatment is efficient. On the other hand, if the physician is able to extract some of the surplus from the treating the severe illness, then under- or over-treatment is possible in equilibrium. This knife-edge result is tempered if the physician has some preference for diagnosing and treating honestly. Such altruism by physicians is viewed as a distinguishing characteristic of heath care markets, Chalkley and Malcolmson (1998), Ellis and Mcguire(1986), Liu (2011),. and McGuire (2000), In this case, it is shown that if the probability is low that the patient has the severe illness, then under-treatment of the severely ill patient occurs while if it is high, over-treatment of the non-severely ill patient occurs. For intermediate values of this probability efficient treatment occurs in equilibrium.

In section 5 physician altruism is further explored by assuming the patient knows the probability that a physician diagnoses and treats honestly. It is shown that the greater is this probability the larger is the range of parameters for which over-treatment of the non-severely ill patient occurs in an equilibrium. Essentially as the probability that the physician behaves honestly increases the greater is the expected benefit a dishonest physician receives from providing the treatment for the severely ill patient. The possibility of the physician being honest increases the benefit from acting dishonestly. For the case of observable physician costs, unverifiable treatment, and verifiable outcomes, this complements the results of Liu (2011) who found that the possibility of a physician being honest encourages a dishonest physician to behave opportunistically and overcharge for treating a patient with the non-severe illness.

2. A Basic Model of Credence Goods

In this section I reproduce the set-up of Dulleck and Kerschbamer (2006), outline their Lemma 1, and provide intuition for it. It is assumed that a patient has a non-severe or a severe illness. If the patient with the non-severe illness is treated at cost, $c_n = c$, then her benefit is $v_n = v$, if the patient with the severe illness is treated at cost, $c_s = c + c_o$, then her benefit is $v_s = v$, if the patient with the non-severe illness is treated at cost c_s, then her benefit is $v_n = v$, while if the patient with the severe illness is treated at cost c_n, then her benefit is 0. The more costly treatment cures both illnesses while the less costly treatment only cures the non-severe illness. It is assumed that $v - c_s > 0$ so it is always efficient for the patient to be treated. The patient knows she is ill but does not know whether her illness is non-severe or severe. However, the patient does know that with probability $\theta \in (0, 1)$ her illness is severe. A physician can diagnose the severity of the illness and treat it.

It is assumed that (i) the patient can observe and verify which treatment she has received, (ii) the physician can provide either treatment for either illness, and initially (iii) once a patient receives a diagnosis from a physician they are committed to that physician for treatment.

It is assumed that the physician posts take-it-or-leave prices for treating the non-severe or severe illness, p_n and p_s. The patient observes these prices and chooses whether to get a diagnosis and be committed to the physician for treatment. If the patient decides against a diagnosis her benefit is 0. If she decides on a diagnosis, the physician announces the severity of the illness and treats the patient accordingly. The physicain might announce the patient has the severe (non-severe) illness and treat then with cost c_s (c_n) even though the patient actually has the non-severe (severe) illness.

That is, there is over (under) treatment. In their Lemma 1, Dulleck and Kerschbamer (2006) demonstrate that under the assumptions made above, all patients are treated efficiently, that is, patients with the non-severe illness are treated at cost c_n and patients with the severe illness are treated at cost c_s. This is achieved by the physician optimally charging equal mark-ups of price above cost in equilibrium. In particular, $p_n - c_n = p_s - c_s$, where $p_n = v - \theta(c_s - c_n)$ and $p_s = v + (1-\theta)(c_s - c_n)$. Note that the expected payment of the patient is $\theta p_s + (1-\theta)p_n = \theta v + (1-\theta)v = v$ which is the expected benefit of the patient before diagnosis. Given equal mark-ups, the physician has no incentive to under-treat or over-treat and has an expected payoff of $v - \theta c_s - (1-\theta)c_n$.

In the Appendix it is shown that the equal mark-up equilibrium with honest diagnosis applies even if $v_s > v_n$.

3. Relaxing Assumptions

The basic model predicts that in equilibrium patients are diagnosed honestly and treated appropriately, that is, there is no under-treatment or over-treatment. At least for over-treatment, this seems inconsistent with the empirical literature on supplier induced demand, McGuire (2000). Therefore, in this section, some of the assumptions of the basic model are relaxed and the implications for efficient treatment are determined.

3.1. Relaxing Commitment

In the basic model it was assumed that once a patient receives a diagnosis from a physician they are committed to that physician for treatment. In the equal mark-ups equilibrium the price paid by the patient with the severe illness is greater than the benefit the patient receives from treatment, $p_s =$

$v + (1-\theta)(c_s - c_n) > v$, therefore, the patient has an expost incentive to not be treated and renege on the contract. Therefore, it seems natural to constrain the physician to prices which are accepted expost by the patient. These are prices such that $p_s \leq Ev$ and $p_n \leq Ev$, where Ev is the expected benefit of treatment given price mark-ups and the diagnosis.

Proposition 1: *Assume the basic model and in addition assume that $p_s \leq Ev$ and $p_n \leq Ev$. (1) If $\theta \geq \frac{c_s - c_n}{v}$, then the physician diagnoses honestly, charges prices so that $p_s - c_s = p_n - c_n$, and treats the patient efficiently or the physician diagnoses the severe illness, charges prices so that $p_s - c_s > p_n - c_n$, and over-treats the patient with the non-severe illness. (2) if $\theta < \frac{c_s - c_n}{v}$, then the physician diagnoses the non-severe illness, charges prices so that $p_s - c_s < p_n - c_n$, and under-treats the patient with the severe illness.*

Proof: (i) If $p_n - c_n = p_s - c_s$, then the physician diagnoses honestly and treats the patient accordingly. Therefore, the patient obtains benefit v if the illness is diagnosed as non-severe or severe. Now $p_s \leq Ev = v$ so the largest possible equal mark-up has $p_s = v$ and $v - c_s = p_n - c_n > 0$. Therefore, the expected payoff of the physician is $P_1 = v - c_s$ with $p_n = v - (c_s - c_n)$.

(ii) If $p_n - c_n > p_s - c_s$, then the physician has an incentive to diagnose the non-severe illness and treats the patient for it. The patient understands this, and so her expected benefit is $Ev = (1-\theta)v$. The physician extracts this benefit with $p_n = Ev$ and her expected payoff is $P_2 = (1-\theta)v - c_n$.

(iii) If $p_n - c_n < p_s - c_s$, then the physician has an incentive to diagnose the severe illness and treat the patient for it. The patient understands this, and so her expected benefit is $Ev = v$. The physician extracts this benefit and her expected payoff is $P_3 = v - c_s$.

Now $P_1 = P_3$ so the physician is indifferent between efficient treatment (equal mark-ups) and over-treatment of the patient with the non-severe illness ($p_n - c_n < p_s - c_s$). In addition, $P_1 = P_3 \geq P_2$ if $v - c_s \geq (1-\theta)v - c_n$, that is, if $\theta \geq \frac{c_s - c_n}{v}$. In this case, the physician prefers efficient treatment or over-treatment of the patient with the non-severe illness to under-treatment of the patient with the severe illness. □

The intuition is clear. If θ is large, then it is very likely the patient has the severe illness. In this case, the expected payoff to the physician of diagnosing the non-severe illness and under-treating the patient with the severe illness is small. Therefore, the physician either diagnoses honestly or over-treats the the patient with the non-severe illness. Similar arguments apply if v is large or $(c_s - c_n)$ is small.

3.2. Relaxing Commitment with $v_s - c_s > v_n - c_n$

There is a vast theoretical and empirical literature on supplier induced demand in health-care. Supplier induced demand is where health care providers over-treat patients. Therefore, the presumption is that in health-care the problem is over-treatment not under-treatment. The reason why under-treatment arises in the previous section is that treating the severe condition adds extra cost but results in the same patient benefit of v that would arise if a patient with the non-severe illness was treated appropriately. In the context of medical treatment, it seems natural to assume that the benefit a patient derives from being successfully treated for a severe illness (Melanoma) is greater than that for a non-severe illness (Basal cell carcinoma). This suggest it is appropriate to assume $v_s > v_n$, in fact, it is now assumed that $v_s - c_s > v_n - c_n$ so the surplus created by appropriately treating the severe illness is greater than that from the non-severe illness.

Proposition 2: *Assume the basic model and in addition assume that* $p_s \leq Ev$, $p_n \leq Ev$, *and* $v_s - c_s > v_n - c_n$. *(1) if* $\theta \leq \frac{c_s - c_n}{v_s - v_n}$, *then the physician* *diagnoses honestly, charges prices so that* $p_s - c_s = p_n - c_n$ *and treats the patient efficiently. (2) if* $\theta > \frac{c_s - c_n}{v_s - v_n}$*, then the physician diagnoses the severe illness, charges prices so that* $p_s - c_s > p_n - c_n$ *and over-treats the patient with the non-severe illness.*

Proof: In the Appendix, but the proof has the same structure as the proof of Proposition 1. □

Once again the intuition is clear. Under-treatment is never preferred by the physician because treating the severe illness appropriately generates more surplus than treating the non-severe illness appropriately. To get this extra surplus either the physician treats appropriately or diagnoses the severe illness. If θ is large, then it is very likely the patient has the severe illness. In this case, the expected payout to the physician of diagnosing the severe illness is large and close to $v_s - c_s$. This is greater than the payoff the physician receives from treating the patient with the non-severe illness appropriately, $v_n - c_n$. Similar arguments apply if $v_s - v_n$ is large or $c_s - c_n$ is small.

3.3. Two-Part Tariffs

If the physician is able to charge a two-part tariff consisting of a diagnosis fee, d, and prices for treatment, p'_s and p'_n, then there are a range of pricing schemes in which the physician diagnoses honestly and both the patient and the physician have an incentive to accept and deliver treatment. That is, $p'_s - c_s = p'_n - c_n$, $p'_s \leq v_s$, $p'_n \leq v_n$, $p'_s \geq c_s$, and $p'_n \geq c_n$.

Let the diagnosis fee take all the surplus from the patient given prices, that is $d = \theta v_s + (1-\theta)v_n - \theta p_s - (1-\theta)p_n$. Now the physician diagnoses honestly if $p_s = p_n + (c_s - c_n)$. Substituting this into d gives $d = Ev - \theta(c_s - c_n) - p_n$, where $Ev = \theta v_s + (1-\theta)v_n$. There are a range of prices and diagnosis fees that extract all the patient's surplus. The maximum diagnosis fee is $d = Ev - Ec$, where $Ec = \theta c_s + (1-\theta)c_n$ and $p_n = c_n$. The minimum diagnosis fee is $d = \theta\big((v_s - v_n) - (c_s - c_n)\big)$, where $p_n = v_n$. The use of two-part tariffs restores efficiency of treatment even if prices are constrained to ensure participation by the patient and the physician expost.

3.4. Relaxing Commitment and Observability of Costs with $v_s - c_s > v_n - c_n$

So far it has been assumed that the patient knows the the costs of appropriately treating non-severe and severe illnesses. This is a very strong assumption. Hilger (2011) relaxes this assumption to some extent by allowing two types of physicians with different costs of providing the non-severe and severe treatments. These different costs are known, but the physicians type is not. However, in reality, patients have little knowledge of the cost of treatment. In fact, it is usual to assume that the patient (consumer) only knows the type of treatment (good) delivered, the benefit the patient gets from treatment (consuming the good), and the price of treatment (price of the good). Therefore, in this section, only this is assumed. The patient has no information about physician costs at all.

If the patient is offered the non-severe treatment, then the expected benefit of this treatment is $Ev^n = (1-\theta)v_n$ while the expected benefit of being offered the severe treatment is $Ev^s = \theta v_s + (1-\theta)v_n$.[1]

Proposition 3: *Assume the basic model and in addition assume that* $p_s \leq Ev^s$, $p_n \leq Ev^n$, $v_s > v_n$, $v_s - c_s > v_n - c_n$, *and physician costs are not known by the patient. Assume it is profitable to offer treatment for the*

[1] Remember that if the patient has the severe illness and the patient is offered the non-severe treatment, then the patient's benefit is zero.

non-severe illness, $Ev^n - c_n \geq 0$. (1) if $\theta \geq \frac{c_s - c_n}{v_s}$, then the physician diagnoses the severe illness, charges $p_s = Ev^s$, and over-treat the patient with the non-severe illness. (2) if $\theta < \frac{c_s - c_n}{v_s}$, then the physician diagnoses the non-severe illness, charges $p_n = Ev^n$, and under-treats the patient with the severe illness. Assume it is not profitable to offer treatment for the non-severe illness, $Ev^n - c_n < 0$. (3) if $Ev^s - c_s \geq 0$, then the physician diagnoses the severe illness, charges $p_s = Ev^s$, and over-treats the patient with the non-severe illness. (4) if $Ev^s - c_s < 0$ then the physician offers no treatment to the patient.

Proof: Assume that it is profitable to offer treatment for the non-severe illness, that is, $Ev^n - c_n \geq 0$. For (1) and (2) simple algebra establishes that $Ev^s - c_s \geq Ev^n - c_n$, if $\theta \geq \frac{c_s - c_n}{v_s}$. In this case the physician offers the severe treatment and over-treats the patient with the non-severe illness. Note that $Ev^s - c_s > 0$. (3) and (4) follow from definitions. □

Once again, the intuition is clear. If θ is large, then it is very likely the patient has the severe illness. In this case, the expected payout to the physician of diagnosing the severe illness is large and close to $v_s - c_s$. This is the maximum surplus that can be generated and so the physician offers the severe treatment and over-treats the patient with the non-severe illness. Similar arguments apply if v_s is large or $c_s - c_n$ is small. For small θ, diagnosing and treating the non-severe illness is the most profitable diagnosis and treatment and so under-treatment of the patient with the severe illness arises even though $v_s > v_n$ and $v_s - c_s > v_n - c_n$.

In summary, with unobservable costs there are three outcomes. The first is where the physician over-treats the patient with the non-severe illness, (1) and (3) of Proposition 3. The second is where the physician under treats the patient with the severe illness, (2) of Proposition 3, and the third is where the physician does not treat the patient, (4) of Proposition 3.

The question explored in the next sections is whether efficiency can be restored by altering the structure of the basic model in realistic ways.

4. Other Health-care Providers

For many illnesses, physicians and other health-care providers (OHP) jointly treat patients.[2] It is now assumed that if a patient has the non-severe illness, then treatment solely by a physician at cost $c_n = c$ achieves patient benefit of v_n. On the other hand, if a patient has the severe illness, then joint treatment by the physician and the OHP at cost $c_s = c + c_o$, where c_o is the cost of the services provided by the OHP, achieves patient benefit of v_s. Apart from this change the assumptions of Section 3.4 are maintained.

The additional expected surplus created by the physician diagnosing the severe illness and jointly treating the patient with the OHP rather than diagnosing the non-severe illness and treating accordingly is $S = Ev^s - c - c_o - (Ev^n - c) = \theta v_s - c_o$ This surplus is assumed to be positive as is $Ev^n - c$, the payoff of the physician when diagnosing and treating the non-severe illness.

As treatment for the severe illness is jointly provided, it is assumed that Nash bargaining over the surplus takes place so that the physician receives an expected net payoff of $EP^s = \phi(\theta v_s - c_o) + Ev^n - c$, where $0 \leq \phi \leq 1$ is the share of the expected surplus that goes to the physician. That is, the physician receives a payoff equal to what she would get on diagnosing the non-severe illness plus a proportion ϕ of the additional expected surplus created by diagnosing the severe illness. The price the physician charges the patient is $p_s = EP^s + c$. The payoff of the OHP is $EP_o^s = (1 - \phi)(\theta v_s - c_o)$

[2] OHP include hospitals, testing services, and appliance makers.

and the price the OHP charges the patient is $p_{so} = EP_o^s + c_o$. Note that the patient pays a combined price of $p_s + p_{so} = Ev^s$ to the physician and the OHP.

Proposition 4a: *Assume the assumptions of Proposition 3 and in addition that the severe illness is jointly treated by the physician and an OHP. Assume* $\phi = 0$. *(1) if* $\theta v_s - c_o \geq 0$, *then the physician treats the patient efficiently. (2) if* $\theta v_s - c_o < 0$, *then the physician offers no treatment to the patient. Assume* $0 < \phi \leq 1$. *Proposition 3 applies with appropriate reinterpretation.*

The proof of Proposition 4a is trivial and the intuition is clear. If the physician has no bargaining power and receives none of the surplus created by diagnosing the severe illness, then the physician is indifferent about which diagnosis to offer and so diagnoses honestly. Therefore, the outcome is efficient with the patient with the non-severe illness treated solely by the physician and the patient with the severe illness jointly treated by the physician and the OHP.

This stark result can be made less so if it is assumed that the physician has a preference for diagnosing honestly and treating accordingly. This assumption is made by McGuire (2000, Section 5) and a similar assumption, that physicians care about the utility of their patients, is common in the health economics literature, Ellis and McGuire (1986), and Chalkley and Malcolmson (1998), . Let the cost to a physician of diagnosing dishonestly be k and let $\phi > 0$.

Proposition 4b: *Assume the assumptions of Proposition 4a and in addition that the cost of the physician diagnosing dishonestly is* k. *(1)If* $\theta < \frac{c_o - \frac{k}{\phi}}{v_s}$, *then the physician diagnoses the non-severe illness and under-treats the patient with the severe illness. (2) If* $\frac{c_o - \frac{k}{\phi}}{v_s} \leq \theta \leq \frac{c_o + \frac{k}{\phi}}{v_s}$, *then the physician diagnoses honestly and treats the patient efficiently. (3) If* $\frac{c_o + \frac{k}{\phi}}{v_s} < \theta$, *then* *the physician diagnoses the severe illness and over-treats the patent with the non-severe illness.*

Proof: Given the patient has the non-severe illness, the physician diagnoses the non-severe illness if $Ev^n - c \geq EP^s - k$, that is, if $\theta \leq \frac{c_o + \frac{k}{\phi}}{v_s}$, and diagnoses the severe illness otherwise. Similarly, given the patient has the severe illness, the physician diagnoses the severe illness if $EP^s \geq Ev^n - c_n - k$, that is, if $\frac{c_o - \frac{k}{\phi}}{v_s} \leq \theta$, and diagnoses the non-severe illness otherwise. □

In Proposition 4a, where $0 < \phi \leq 1$, the physician either over-treats the the patient with the non-severe illness or under-treats the patient with the severe illness. In Proposition 4b, there is a range of θ over which the physician treats the patient efficiently. The size of this range depends on the ratio $\frac{k}{\phi}$. For a given ϕ, the greater is k the greater is the cost of diagnosing dishonestly and so the greater is the range of θ over which the physician diagnoses honestly. Similarly, for a given k, the smaller is ϕ, the smaller is the difference between the expected payouts of the physician from diagnosing the non-severe or severe illness and so the greater is the range of θ over which the physician diagnoses honestly.

Propositions 4a and 4b suggest that the further removed are the diagnosis decision and the treatment decision (the smaller is ϕ), the greater is the range of parameters over which the patient is treated efficiently. In a recent paper, Afendulis and Kesler (2007) found that interventional cardiologists, who diagnose and treat heart conditions, diagnosed and performed significantly more angioplasties (the treatment they provide) than were diagnosed by cardiologists who only diagnose.

It turns out that paying the physician a fixed payment (salary) independent of diagnosis also achieves the efficient outcome. Nevertheless, in practise, achieving efficiency is problematic as payments in cash or in-kind from the OHP to the physician are possible.

5. Physicians Care about Treatment

In Proposition 4b above it was assumed that the physician cares about whether the treatment she offers is appropriate. However, it was also assumed that the patient does not know ϕ or k. To further explore the role of assuming that the physician cares about the treatment she offers it is now assumed that the patient knows the probability, β, that the physician always diagnoses honestly and treats the patient appropriately. What implications does this assumption have for over-treatment or under-treatment of the patient?

Let $p(i|j)$ be the probability that the patient has illness $i = n, s$ given diagnosis of illness $j = n, s$. Therefore, given the physician diagnoses the non-severe illness and offers the non-severe treatment, the probability that the patient has the non-severe illness is $p(n|n) = \beta + (1 - \beta)(1 - \theta)$. The first term in this probability comes from the fact that with probability β the patient sees a physician who always diagnoses honestly. The second term comes from the fact that with probability $(1 - \beta)$ the patients seems a physician who reports what is in her economic interest to do so which might be either to diagnose the non-severe or severe illness. The patient learns nothing from this diagnosis and so the probability of having the non-severe illness is $(1 - \theta)$. This happens $(1 - \beta)$ of the time. Similar arguments establish that $p(s|n) = (1 - \beta)\theta$, $p(s|s) = \beta + (1 - \beta)\theta$ and $p(n|s) = (1 - \beta)(1 - \theta)$.

On being diagnosed with the non-severe illness and being offered appropriate treatment, the expected benefit of the patient is $Ev_n = 0 \cdot p(s|n) + p(n|n)v_n = \big(\beta + (1 - \beta)(1 - \theta)\big) \cdot v_n$. The expected benefit of the patient when diagnosed with the severe illness is $Ev_s = p(s|s)v_s + p(n|s)v_n = \big(\beta + (1-\beta)\theta\big)v_s + (1-\beta)(1-\theta)v_n$. The physician extracts all of the surplus from the patient and so charges prices of $p_n = Ev_n$ and $p_s = Ev_s$ for treating the patient diagnosed with the non-severe and severe illnesses, respectively.

Proposition 5: *Assume the assumptions of Proposition 3 and in addition that the probability the physician always diagnoses honestly is* $0 < \beta \leq 1$.
(1) There are more parameter values for which either diagnosis and treatment is profitable than in Proposition 3. (2) There are more parameters values for which a physician, who only cares about income, diagnoses the severe illness and over-treats the patient with the non-severe illness than in Proposition 3.

Proof: In the Appendix.

In the Appendix it is shown that the critical θ above which the physician, who only cares about income, diagnoses the severe illness and over-treats the patient with the non-severe illness is less than the critical point in Proposition 3. Therefore, there are now more parameter values for which the physician over-treats the patient with the non-severe illness. In fact, the greater is β the smaller is the critical θ. This has intuitive appeal because as the probability the physician diagnoses honestly increases, the probability $p(s|s)$ also increases, and given diagnosing the severe illness generates a greater surplus, a physician who only cares about income will diagnose the severe illness for more values of θ. Increasing β not only increases the probability that a patient is treated efficiently, but it also increases the range of θ over which over-treatment of the patient with the non-severe illness is preferred by the physician to under-treatment of the patient with the severe illness.

6. Conclusion

The credence goods literature on under- and over-treatment in the presence of observable and verifiable treatment demonstrates that the market mechanism solves the credence good problem. In the case of health care, this means that in equilibrium physicians treat patients efficiently. However, a number of assumptions under which this result is derived seem problematic. In this paper, it is assumed that (i) the patient is not committed to the physician, (ii) the extensive treatment creates more surplus than the simple treatment, and (iii) the physician's cost are not observable to the patient. Under these assumptions it is shown that under- or over-treatment arise in equilibrium depending on the relationship between the probability the patient has the severe illness, the additional cost of the severe treatment, and the value of the severe treatment to the patient.

The potential roles of the separation of diagnosis and treatment and physician altruism are also considered. It is found that efficiency is restored for some parameter values even when the physician extracts some of the additional surplus from the extensive treatment when the physician bears a cost of dishonesty. Finally it is shown that although introducing the possibility of altruistic behaviour into the framework trivially increases the probability of efficient treatment it also increases the range of parameters over which a dishonest physician diagnoses the severe illness and over-treats the patient with the non-severe illness. These results suggest that the market mechanism only provides a partial solution to the credence good problem in the health care market.

Future work will be aimed at adding patient insurance into the analysis.

7. References

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8. Appendix

1. Dulleck and Kerschbamer with $v_s > v_n$.

(i) If $p_n - c_n = p_s - c_s$, then the physician diagnoses honestly. Therefore, the expected benefit that a patient receives is $\theta v_s + (1-\theta)v_n$. This benefit can be extracted by the physician through a take-it-or-leave-it offer where $\theta v_s + (1-\theta)v_n = \theta p_s + (1-\theta)p_n$. The physician's expected payout is $P_1 = \theta v_s + (1-\theta)v_n - \theta c_s - (1-\theta)c_n$

(ii) If $p_n - c_n > p_s - c_s$, then the physician has an incentive to diagnose the non-severe illness and treat the patient for it. The patient understands this, and so her expected benefit is $(1-\theta)v_n$. The physician extracts this benefit and her expected payout is $P_2 = (1-\theta)v_n - c_n$.

(iii) If $p_n - c_n < p_s - c_s$, then the physician has an incentive to diagnose the severe illness and treat the patient for it. The patient understands this, and so her expected benefit is $\theta v_s + (1-\theta)v_n$. The physician extracts this benefit and her expected payout is $P_3 = \theta v_s + (1-\theta)v_n - c_s$.

Now $P_1 > P_2$ because $v_s - c_s > 0$ and $P_1 > P_3$ because $\theta < 1$. Therefore, the physician maximises her expected payout by offering equal mark-ups, the patient consults the physician, and the patient is diagnosed honestly.

2. Proof of Proposition 2:

(i) If $p_n - c_n = p_s - c_s$, then the physician diagnoses honestly and treats the patient accordingly. Therefore, the patient obtains benefit v_s if the illness is severe and v_n if the illness is non-severe. Now $p_n \leq v_n$ so the largest possible equal mark-up has $p_n = v_n$ and $p_s - c_s = v_n - c_n > 0$. Therefore, the expected payout of the physician is $P_1 = v_n - c_n$ with $p_s = v_n + (c_s - c_n)$.

(ii) If $p_n - c_n > p_s - c_s$, then the physician has an incentive to diagnose the non-severe illness and treat the patient for it. The patient understands this, and so her expected benefit is $Ev = (1-\theta)v_n$. The physician extracts this benefit with $p_n = Ev$ and her expected payout is $P_2 = (1-\theta)v_n - c_n$.

(iii) If $p_n - c_n < p_s - c_s$, then the physician has an incentive to diagnose the severe illness and treat the patient for it. The patient understands this, and so her expected benefit is $Ev = \theta v_s + (1-\theta)v_n$. The physician extracts this benefit with $p_s = Ev$ and her expected payout is $P_3 = \theta v_s + (1-\theta)v_n - c_s$.

Now $P_1 > P_2$, so the physician prefers equal mark-ups, honest diagnosis, and efficient treatment to always diagnosing the non-severe illness and under-treatment of the patient with the severe illness. In addition, $P_1 \geq P_3$ if $\theta \leq \frac{c_s - c_n}{v_s - v_n}$. In this case the physician prefers equal mark-ups, honest diagnosis, and efficient treatment to diagnosing the severe illness and over-treatment of the patient with the non-severe illness. □

3. Proof of Proposition 5

(1) $Ev_n - c_n > Ev^n - c_n$ and $Ev_s - c_s > Ev^s - c_s$

$Ev_n - c_n > Ev^n - c_n$ if and only if $\beta + (1-\beta)(1-\theta) > (1-\theta)$, that is, if and only if $\beta\theta > 0$. The last inequality is true by definition. The same method of proof established that $Ev_s - c_s > Ev^s - c_s$. □

(2) The severe illness is diagnosed and treated by the physicians who only care about income if $Ev_s - c_s \geq Ev_n - c_n$. That is, if $\big(\beta + (1-\beta)\theta\big)v_s + (1-\beta)(1-\theta)v_n - c_s \geq \big(\beta + (1-\beta)(1-\theta)\big)v_n - c_n$. Rearranging this condition yields, $\theta \geq \frac{c_s - c_n}{(1-\beta)v_s} - \frac{\beta(v_s - v_n)}{(1-\beta)v_s}$ and further rearranging yields $\theta \geq \frac{c_s - c_n}{v_s} - \frac{\beta}{1-\beta}\left(\frac{v_s - c_s}{v_s} - \frac{v_n - c_n}{v_s}\right)$. The right hand side of this last inequality is less than $\frac{c_s - c_n}{v_s}$ and so is less than the critical point in Proposition 3. □