Information availability and ability choice in a market for physicians

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Abstract

In this paper we study the ability choices and pricing strategies of physicians in a duopolistic market where consumers base their decisions on anecdotal evidence. The consumers are aware of only some of the physicians in the market and estimate their abilities by taking a sample from the patients a physician has previously treated. Decisions based on anecdotal evidence entail two hindrances: an over-reliance on small samples and the limited availability of information. In this setting, situations arise where physicians have incentives to choose low levels of ability even when it is costless. In particular, more information availability leads to more ability differentiation and a lower average level. When information on the two physicians is readily available, the average ability in the equilibrium is not maximum. Conversely, an equilibrium where both physicians choose a maximum ability level is possible despite the anecdote-based decisions of consumers. This occurs when information on at least one of the physicians is not readily available to consumers. Fixing prices or restricting physicians to operate locally can induce a maximum average ability in the market irrespective of the availability of information level.

Keywords: Ability Choice, Information, Bounded Rationality, Healthcare, Anecdotal Reasoning

JEL classification: I11, D40, L13, D9

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1. Introduction

Healthcare markets involve many informational asymmetries. In particular, the physicians hold superior information concerning several aspects of their relation with the patients. At the core of the patient-physician interaction stands the essential informational asymmetry of these markets, pertaining the quality of the service being offered. The effort, ability, extent and nature of the treatment provided by a physician constitute a classic example of a credence good. Outcomes in the healthcare market are profoundly shaped by said asymmetry.

In this paper we focus on the physicians’ choice of abilities. This information, crucial to the patients’ decisions, is unknown to them at the moment they chose to visit a physician. With ability we refer to the probability of a physician changing a patient’s health state – in simpler words, to cure her. Consumers in the healthcare market value being healthy, hence favoring visiting the highest-ability physician they can afford. Therefore, before making their decision each consumer tries to estimate the physicians’ abilities by resorting to the limited and often hard to process information at her disposal. Deviating from rational behavior, consumers often over-rely on small samples to estimate the physicians’ abilities. In the specific scenario we study, when deciding which physician to visit a consumer usually asks family members and friends about their experiences, then forming her estimations based on these anecdotes. The information thusly gathered is further undermined by the fact that consumers have access only to anecdotal evidence concerning the physicians their close acquaintances have been treated by. That is, they can observe anecdotes just for the set of physicians who have treated someone they know. We explore the effect of such a decision procedure on the healthcare provision of physicians who compete in terms of prices and abilities.

Healthcare systems where patients can freely visit a physician without the referral of a gatekeeper or can choose between a physician in the public or private sectors are not rare. They can be observed in Germany, Switzerland, Belgium, Taiwan, and some US states where PPOs or FFS are predominant. Therefore, it could be argued that the use of simplifying heuristics like the one described above is pervasive in many healthcare markets. Indeed, according to the “National Survey on Americans as Health Care Consumers: An Update on The Role of Quality Information” (The Kaiser Family Foundation et al., 2000), around 80% of Americans are "very or somewhat" confident that they had enough information to make the right choices the last time they had to choose a doctor. However, the same survey reports that less than 37% of the subjects would go beyond their close network to find information on the quality of such a service. Along a similar line, it has been found that reliance on anecdotal evidence is common among consumers even when comprehensive statistics about medical treatments are available (Fagerlin et al., 2005). Moreover, many studies pursued from the perspective of economics, medicine, and the behavioral sciences, have shown the adoption of simplifying heuristics to be widespread.

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1Following Nelson (1970), those goods whose quality cannot be fully learned by the consumers even after purchase has taken place or the service been provided.

2For a concise but complete overview of the issue see Frank (2007).

3PPO stands for Preferred Provider Organization and FFS for Fee For Service insurance. In both of these health plan schemes consumers have a high degree of freedom to choose a particular specialist to visit.
when patients face healthcare choices.

Decisions based on anecdotal evidence entail two problems: an over-reliance on small samples to estimate the physicians’ abilities and the limited availability of information among the patients a consumer enquires. To be precise, a consumer will only ask a limited number of friends for anecdotes and all of these will have visited a small subset of the physicians active in the market. From the strategic perspective the first issue directly relates to each physician’s ability choice, which determines whether the anecdotal evidence found is positive or not and, thus, if the physician’s ability is over or underestimated. The second issue pertains to the probability of finding anecdotal evidence on a particular physician, which we denote by visibility and which affects the alternatives a consumer contemplates. Not all physicians in a market are equally visible. The probability of a patient finding an anecdote for a physician will be higher the more visible he is. Thus, a physician’s visibility can be thought of as how well-known he is across the market. In this study we believe there to be a strong exogenous component to visibility, as one can observe in the case of family sagas where the medical profession is carried over several generations and some fame along with it, or for physicians who have graduated from a more prestigious medical school. These hypothetical physicians will be more visible irrespective of their ability level.

The interaction of the physicians’ ability choices and the exogenous visibility poses interesting questions with policy-relevant implications. To untangle these effects we study the behavior of consumers who need to visit a physician and estimate his ability using anecdotal evidence. The limited nature of those estimations generates a demand whose characteristics affect the decisions of the physicians in terms of prices and abilities. Such demand depends on each physician’s ability and visibility level – in our model, a combination of strategic and exogenous factors. In this paper we try to understand the effect of information availability on the ability-choices of physicians in a market where consumers reason anecdotally. A secondary question involves analyzing the impact of information availability and the physicians’ ability choices on pricing strategies. Ultimately we try to understand the effect on the quality of healthcare provision, modelled through physicians’ abilities, in a market where boundedly-rational patients base their decisions on the past experiences of family and friends.

We develop a model where consumers have heterogeneous willingness to pay for health and try to learn the physicians’ abilities using anecdotal evidence. Each consumer draws a sample from the patients treated by a given physician and takes the outcome as that physician’s ability. That is, she observes an anecdote for the physician and estimates his ability based on whether the anecdote was positive or not. Each consumer samples from the subset of physicians she is aware of – her consideration set. The composition of such a set is determined by the physician’s visibility. There are two perfectly-informed and rational physicians in the market, with public fees and abilities not observable by the

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4 For a survey from a healthcare perspective, see Lipkus et al. (2001), Peters et al. (2006) and Reyna et al. (2009).

5 Furthermore, although we assume the ability to be a strategic variable and the visibility to be exogenous, the insights we derive to a large extent hold for the converse case. That is, when ability is deemed to be exogenous and visibility strategic – i.e. a scenario where the physician is born with a nature-determined ability level and chooses to invest in some form of advertisement. We briefly comment on the implications such a change would have on the interpretation of this paper’s equilibria in footnote 14.
consumers. Both the price and the ability are strategic variables which the physicians set before meeting the consumers. Ability choice is costless for the physicians and is taken by both of them simultaneously. We study the behavior of the agents through the equilibria in prices and abilities.

The fact that consumers follow an anecdotal-reasoning procedure induces a demand encompassing two parts for each of the physicians: a contested and a captive segments. The contested demand comprises those consumers who observe both physicians and find positive anecdotal evidence for the two of them. Thus, take them to be equivalent in ability. The captive demand includes the consumers who are either aware of only one physician and draw a positive anecdote, or being aware of both physicians gather a positive anecdote about him and a negative for the rival. Two main trade-offs emerge from this demand structure. First, the higher the price a physician sets, the larger the profits obtained from his captive segment and the smaller his contested demand. The second involves ability choice as a mean to surrender some of the demand in order to push the equilibrium prices up. By lowering his ability a physician increases his rival’s captive demand, inducing him to focus on it and thus relaxing competition over the contested segment. This second-order effect is one of the present paper’s main contributions.

In light of these trade-offs, the information availability level captured by the physicians’ visibilities is found to be a major determinant over the average ability level in equilibrium. We find that more information availability leads to more differentiation, with a lower average ability. When information about both physicians is easy to find, they have incentives to differentiate in abilities: one of them sets the maximum level and the rival chooses a lower value. The rationale behind this derives from the trade-offs discussed above. Higher visibility levels enhance the effect described, making it less costly for the physician who chooses to differentiate to surrender some of his contested demand in order to relax price competition. Furthermore, physicians with high visibility levels can set high fees even if their ability is low. Other situations arise where the physicians choose abilities such that the average equilibrium ability is maximum. Interestingly, this happens when consumers have less access to information.

Concerning the physicians’ pricing decisions, the market has a unique Nash Equilibrium in mixed strategies. In expected terms, the physician whose combined visibility and ability are superior –the dominant physician– sets a higher price. Such a physician has incentives to focus on his captive demand and is therefore more likely to set the monopoly price. The more visible the dominant physician becomes, the higher the price he can set. Yet, an increase in the rival’s visibility causes the expected price of the dominant physician to decrease. This happens because when information on the two physicians is easy to find, price competition becomes harsher. This analysis follows through only when we take abilities and visibilities as given, since the interaction between the physicians becomes a pricing game. Nevertheless, in the context of the whole game, the relation between prices and visibilities reinforces the incentives for the physicians to differentiate in abilities.

The demand generated by anecdotally-reasoning consumers creates incentives for the physicians to choose abilities such that the average equilibrium level is not maximum under given circumstances. A planner is interested in avoiding these situations to elevate the market’s average ability. We analyze two ability-enhancing measures: regulating the price and restricting physicians to operate locally. When setting a fixed price the planner
eliminates the competition-relaxing effect of choosing a low ability. Thus, the physicians compete exclusively in abilities, both setting the maximum level as the choice is costless. By restricting the physicians to operate locally, the planner splits the market in two portions, each aware only of the local physician. This effectively eliminates competition, giving incentives to the locally-operating physician to choose a maximum ability level. Situations of this type can be found in health systems where the physicians must practice within local jurisdictions.

The rest of this paper is organized as follows: We first develop a brief survey of the literature, then introduce the model and study the duopoly market proposed, with an emphasis on consumer behavior. Next, we discuss the prices and abilities equilibria when finding a past-patient depends on the physicians’ visibility levels. Finally, we comment on the way these variables change with respect to some of the main modeling parameters, as well as the strategic interactions taking place between the physicians’ decisions. All the proofs are included in the technical appendices.

2. Related Literature

From the most general perspective, our paper is part of the literature studying markets where the quality of a good or service is hard for the consumers to ascertain. More specifically, we focus on a healthcare market in a setting where consumers follow an $S(1)$ boundedly rational rule to learn the quality of the service being offered. The $S(1)$ procedure is an extreme simplifying heuristics adopted by consumers who base their decisions on a single past experience, often gathered from a third party. We apply this rule as a departure from the Bayesian reasoning expected from perfectly rational agents. In the manner proposed by Osborne and Rubinstein (1998), consumers in our model estimate the abilities of the physicians using anecdotal evidence drawn from past consumers. Along this line we find the work of Gilboa and Schmeidler (2001), who concentrate on the similarity of the evidence being analyzed by the consumers and the analogies they can build before making a decision. However, since our model involves a single illness of unique severity, all cases are assumed to be perfectly similar vis-à-vis the consumers’ decisions.

The use of small samples to inform consumer decisions is widespread in healthcare markets and leads to non-standard outcomes. Among several others, Rabin (2002) studied the effects of consumer over-reliance on limited-size samples, finding that it induces suboptimal decisions in consumers, allowing low-skilled competitors to take part in the market. This is a significant issue for our study since it suggests a connection between market distortions and non-rational, sample-based decisions. On its part, the medical literature has long established the complexity of the decision making processes that patients face when engaging with the market. Health status, environmental factors, lack of medical literacy, communication barriers between the physician and the patients, are some of the factors driving such difficulties (Osborn et al. (2011), Say et al. (2006), Joseph-Williams et al. (2014)). Empirical evidence and relevant theoretical developments on such an issue

6For a survey on this issue from a healthcare perspective see Lipkus et al. (2001), Peters et al. (2006) and Reyna et al. (2009). A primer on small-sample effects on economic decisions is found in Tversky and Kahneman (1971).
can be found in The Kaiser Family Foundation et al. (2000), Tu and Lauer (2008), Freed et al. (2010), Mostaghimi et al. (2010), Azu et al. (2012), among others.

The estimation procedure followed by consumers in our model is further limited by the physicians’ visibilities, since each consumer can only sample from those physicians she is aware of. It is possible to understand this subset of alternatives as a consumer’s consideration set. In our model these sets are constructed reflecting how well-known a physician is and, therefore, how easy it is for a consumer to find anecdotal evidence on him. The literature on consideration sets contemplates cases where these emerge as a result of a firm’s promotional efforts (Eliaz and Spiegler (2011)) or due to cognitive biases on the side of the consumers (Manzini and Mariotti (2014)). We assume the physicians’ visibilities to be exogenous.

This paper crucially follows the work of Spiegler (2006), who introduced the $S(1)$ rule in a healthcare market analogue to ours. He studies the decisions of consumers who face a finite set of "quacks", who offer no improvement on a costless outside option. The anecdotal reasoning introduced through the $S(1)$ rule allows the market to be active, whereas under perfect information that would not be the case. A handful of additional market failures arise. In particular, the patients’ surplus decreases in the number of physicians and in the probability of being cured. However, this surplus-negative effect is non-monotonic. For a large number of "quacks" price competition becomes harsh, driving the prices down. Yet, the welfare loss is robust to high-value competitors ("non-quacks"), who do not manage to expel the "quacks" from the market. The anecdotal evidence-based procedure consumers follow, grants "quacks" a degree of market power, founded on blind luck (i.e., consumers finding a positive anecdote) instead of abilities.

There are important differences between Spiegler (2006) and our study. First, the physicians we consider are not "quacks", instead choosing their abilities strategically. Second, the consumers can only sample from a subset of physicians that they are aware of. Spiegler assumed that all the $n$ physicians in the market could be sampled at no cost. We think that it befits the limited nature of the anecdote-based procedure to restrict the set of past-patients available to the consumers so that it includes only a fraction of the physicians in the market. Hence, whether a consumer is able to find one of the physicians’ past-patients is determined by the visibility. Finally, where Spiegler consumers had a unique valuation for health, ours are endowed with a uniformly-distributed parameter representing their willingness to pay for healthcare services. This change brings the model closer to the standard way in which vertically-differentiated markets are analyzed, contrasting the robustness of Spiegler’s results in a more general setting.

Despite its proximity to Spiegler (2006), there are other papers our study is closely linked to. Although he does not analyze a healthcare market and works with the information a firm can disclose regarding its products instead of ability levels, Ireland (1993) finds results that resonate with ours. Namely, a small number of firms engage in a two-stage competition, choosing their information provision levels and prices. Ireland (1993) finds an equilibrium where there are incentives for differentiation in information provision. Moreover, non-full disclosure is profitable for the firms despite being costless for them to disclose information. In the case of our model, information disclosure could

\[ \text{McAfee (1994) finds very similar results studying an advertising game.} \]
be interpreted as physicians being able to strategically modify their visibilities. That said, the essential difference with our paper is that for Ireland (1993) the firms’ decisions only affect their promotional efforts, not the quality of the service being offered. On the contrary, we let physicians decide on their abilities, which directly affect the anecdotal evidence consumers find when sampling.

The closest precedent to our paper is found in Szech (2011), who extends Spiegler (2006) to include the strategic choice of abilities but keeps the unique valuation for health and the assumption of thorough sampling. She first constructs a unique equilibrium under full information and then uses it to characterize one where the consumers follow the $S(1)$ rule. The results in Szech (2011) are consistent with Spiegler (2006), in that they both find that the market is active when low-skilled physicians operate in it even under strong competition. Furthermore, incentives for the physicians to differentiate in abilities are found by Szech (2011). She finally conducts a welfare analysis which reveals that the number of physicians diminishes the negative effect of the anecdotal reasoning. This opens a door for the analysis of sampling over restricted sets, as we do in the present paper by including a consideration set.

The core difference between the existing literature and our work lays in that we study the interaction between information availability and the actual quality of the service being offered. In a setting with anecdotally-reasoning consumers, both play a crucial role in the physicians’ demand determination. However, they are rarely treated as two separate variables, the way we do in our model. As a matter of fact, we stress the essential distinction between them by letting physicians choose their ability, though they have no control over their visibility. Moreover, we find that the interplay between the variables is a major factor in the establishment of an equilibrium, driving the trade-off that allows ability differentiation. Actually, the results presented in Spiegler (2006), Szech (2011), and (to some extent) Ireland (1993) are but a subset of ours, with the equilibria they propose taking place when the physicians are universally known. Given the evidence justifying the limited nature of the information consumers have in healthcare markets, we consider that the case where physicians are not equivalently well-known due to a market variable outside their control, bears some consideration. More so when a policy-relevant outcome where every physician chooses a maximum ability in the equilibrium despite the consumers’ bounded-rational behavior, or the heterogeneous competitive conditions the physicians display, is attainable.

### 3. General Setting

We consider a market consisting of two physicians indexed by $i \in \{1, 2\}$, and a mass of consumers indexed by their willingness to pay for healthcare services $\theta$, uniformly distributed over $[0, 1]$. In our setting, health is defined as a binary variable $r$ such that $r = 1$ when the consumer is in full health and $r = 0$ when she suffers an illness unique in type and severity across consumers. Consumers are all initially ill and seek for a physician to treat them. Moreover, consumers do not recover their health unless they visit a physician. Hence, staying out of the market and not recovering from their ailment is the consumers’ outside option.
On the one hand, physicians are fully rational agents that are perfectly informed about the market setting. That is, they observe the ability chosen by all the other physicians in the market $\alpha_i \in [0, 1]$ for $i \in \{1, 2\}$ and set prices to maximize their individual profits. The physicians’ abilities represent the probability of a consumer visiting them to be cured, which results in her health state changing from 0 to 1. Thus, a consumer who visits Physician $i$ will be cured with probability $\alpha_i$. The marginal cost for the physicians to provide the service is zero. The physicians charge a fee $p_i \in (0, 1)$ for $i \in \{1, 2\}$ for their services, which is publicly known. Ability choice is costless for the physicians.

On the other hand, consumers are not perfectly informed and they use a sampling rule to obtain information. That is, a given physician’s ability is unknown to the consumers at the moment of taking the participation decision. Instead, they estimate it by gathering anecdotal evidence from their closest acquaintances. In order to do this, consumers follow an $S(1)$ procedure, which we explain in detail in the following section. Moreover, not all physicians in the market are known by the consumers. When sampling, the consumers have access to a limited subset of physicians’ past-patients. Thus, they only consider visiting those physicians who they are aware of and can be sampled. We assume $\gamma_i \in (0, 1]$ for $i \in \{1, 2\}$ to be Physician $i$’s visibility, the probability for him to be considered by any particular consumer, and to be exogenously set. Both visibilities are known by the physicians. Once the sampling process has taken place over all the physicians comprised in each consumer’s consideration set, she compares the physicians she is aware of based on the observed outcomes and the fees charged, deciding which one to visit if her willingness to pay so allows her. The aggregation of this individual behavior leads to the demand system physicians face when taking their ability and pricing decisions.

The timing of the game is the following:

1. The physicians choose their abilities independently and simultaneously.
2. The physicians, aware of each other’s abilities and visibilities, set a fee.
3. Each consumer takes a size-one sample from each physician in her consideration set.
4. Based on her sampled outcomes, the publicly known fees, and her willingness to pay for healthcare services, each consumer takes the participation decisions.

We proceed with our analysis by backwards induction. First we pay attention to the decisions the consumers make when facing a duopoly where the physicians have already established their abilities and fees. Next, we move to the physicians’ pricing decisions, which we describe for any pair of given abilities $(\alpha = (\alpha_1, \alpha_2))$. Finally, we consider the ability setting stage, where the physicians decide the ability level with which they will partake in the market. The structure of our model allows us to conduct a multi-layered analysis. Removing all but the last stage leads to a study of the consumers’ behavior. If we disregard the first stage, we are left with a pricing game where both the abilities and visibilities are exogenously given. We discuss each of these cases in the following sections.
3.1. The Sampling Process

The consumers do not know the abilities of the physicians in the market and estimate them following an S(1) boundedly rational procedure. Therefore, they independently sample a single past-patient from each of the physicians in their consideration sets. These consideration sets represent the fact that consumers might not have access to anecdotal evidence on one or more of the physicians, as their acquaintances may not be aware of each and every physician active in the market. The abilities and visibilities are all independent random variables.

In the duopoly we examine, there are four possible consideration sets: (1) being aware of both physicians, which happens with probability \( \gamma_1 \gamma_2 \), (2) being aware only of Physician 1, with probability \( \gamma_1 (1 - \gamma_2) \), (3) only being aware of Physician 2, with probability \( (1 - \gamma_1) \gamma_2 \), and (4) not being aware of any physician, which happens with probability \( (1 - \gamma_1)(1 - \gamma_2) \). It is reasonable to understand these probabilities as the expected proportion of consumers that have a particular consideration set which is hence determined by a combination of the physicians’ visibilities.

Formally, the sampling process is modeled as if the consumers observe a single realization of a Bernoulli distributed random variable with a parameter equal to Physician \( i \)'s ability \( \alpha_i \). Thus, a consumer observes 1 with probability \( \alpha_i \) when she samples Physician \( i \). That is, the patient she sampled recovered after visiting Physician \( i \). Therefore, this probability can be understood as the expected proportion of consumers who observe a positive anecdote from Physician \( i \).

As a result of following this sampling process, the consumers build their beliefs on physicians’ abilities based entirely on anecdotal evidence. If the anecdote is positive (Physician \( i \)'s past-patient was cured), the consumers think they will also be cured when visiting the same physician. Therefore, the consumers believe Physician \( i \)'s ability to be maximal: \( \alpha_i = 1 \). On the contrary, if the outcome is negative (the past-patient sampled was not cured despite visiting \( i \)), the consumers believe they will not be cured either. As a consequence, they assume Physician \( i \)'s ability to be null: \( \alpha_i = 0 \).

4. Consumer Behavior

We begin our analysis by studying the decisions of any consumer as a function of the anecdotal evidence they gather and the fees charged by the physicians. Under perfect information a consumer who visits Physician \( i \in \{1, 2\} \) gets an expected utility given by:

\[
\theta u(r = 1) \alpha_i + \theta u(r = 0)(1 - \alpha_i) - p_i.
\]

We further assume that \( u(r = 1) = 1 \) and \( u(r = 0) = 0 \). Then, the utility under perfect information would be:

\[
\theta \alpha_i - p_i.
\]

This is not the case in a setting where consumers take anecdote-based decisions. Once the anecdotal evidence is gathered, each consumer decides whether to visit one of the physicians she has sampled. A consumer would visit Physician \( i \) if he was included in the
consumer’s consideration set, a positive anecdote was found and \( \theta - p_i \geq 0 \) and \( p_i < p_j \), for each physician \( j \neq i \) she is aware of. That is, she decides to visit Physician \( i \) if he offers her the best price among all those physicians she is aware of and about who she has heard positive anecdotes. The expected utility for a consumer who found a positive anecdote for Physician \( i \) is: \( \theta - p_i \). On the contrary, if no positive anecdotal evidence is found, she discards the idea of visiting \( i \).

The anecdotal evidence observed by each consumer depends on the ability chosen by the physicians and on their respective visibilities. This implies that such decisions are, to some extent, determined by the composition of each consumer’s consideration set. Per our assumption on the physicians’ visibilities, both have a positive probability of being included in such a set. From the side of the abilities, \( \alpha_1 \) and \( \alpha_2 \) represent the probability that any one consumer would observe a positive anecdote subject to each physician being in her consideration set. Given the form of their utility function, among all the consumers who would in principle demand the services from a particular physician after observing the samples, only the ones with a high-enough willingness to pay end up visiting the physician. In particular, from all those who observe a positive anecdote for \( i \) and a negative one for the rival, only the consumers with a willingness to pay at least as big as Physician \( i \)’s fee, will visit him:\(^8\)

\[
\text{An analogue reasoning applies when two positive anecdotes are sampled. With this in mind, we build the demand Physician } i \text{ faces, for } \forall i, j \in \{1, 2\} : i \neq j:
\]

\[
D_i = \begin{cases} 
\gamma_i(1 - \gamma_j)\alpha_i(1 - p_i) + \gamma_i\gamma_j\alpha_i(1 - \alpha_j)(1 - p_i) + \gamma_i\gamma_j\alpha_i\alpha_j(1 - p_i) & \text{if } p_i < p_j \\
\gamma_i(1 - \gamma_j)\alpha_i(1 - p_i) + \gamma_i\gamma_j\alpha_i(1 - \alpha_j)(1 - p_i) + \gamma_i\gamma_j\frac{\alpha_i\alpha_j}{2}(1 - p_i) & \text{if } p_i = p_j \\
\gamma_i(1 - \gamma_j)\alpha_i(1 - p_i) + \gamma_i\gamma_j\alpha_i(1 - \alpha_j)(1 - p_i) & \text{if } p_i > p_j
\end{cases}
\]

The nature of the sampling process followed by the consumers to make their participation decisions, induces a demand for each physician comprising two parts: a captive and a contested demand segment. If a consumer observes positive anecdotal evidence about Physician \( i \) while being unaware of Physician \( j \), or observes a positive anecdote for \( i \) and a negative one for his competitor then in both cases \( i \) becomes her only alternative. Physician \( i \)’s captive demand segment comprises all such consumers. This portion of the demand is given by the first two terms in the function above, irrespective of the relationship between the prices. Physician \( i \) could act as a monopolist over this segment of the demand, for these consumers know no other physician or estimate him to be inferior. Naturally, by doing so the physician would lose demand in the remaining demand segment.

The contested demand segment includes all the consumers who, while being aware of the two physicians, simultaneously found positive anecdotal evidence about them. Then, the main deciding factor for each consumer becomes the fees charged by the physicians. Thus, direct price competition takes place between the physicians over this segment of the demand. In case the prices are tied, the contested demand is evenly split between the

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\(^8\)The expected utility for a consumer with willingness to pay \( \theta \), who observes a positive anecdote for \( i \) and a negative one for the rival, is given by \( \theta\alpha_i - p_i \). Since \( \alpha_i = 1 \) then the consumer will demand Physician \( i \)’s services if and only if \( \theta \geq p_i \). Hence, the demand for Physician \( i \) in such a scenario would be given by \( 1 - p_i \).
physicians. These cases are given by the third term in the first and second lines of the demand function above.

Since we restrict our analysis to uniform non-discriminatory prices, the main trade-offs regarding the decisions of the physicians emerge from these demand structures. First, keeping the competitor’s price and both physicians’ abilities and visibilities fixed, a higher price allows a physician to obtain bigger profits from his captive demand while diminishing his contested demand segment. The size of the captive and contested demand a physician serves depends not only on his ability, but also on that of the rival. Therefore, the trade-off just discussed becomes more interesting when the abilities are strategic variables. For instance, a physician may choose to set a low ability to increase the rival’s captive demand, inducing him to set a fee closer to the monopoly price. The interplay between the captive and the contested demand, through ability choices, could therefore be seen as a way for a physician to soften price competition.

Physician $i$’s demand can be rewritten as follows:

$$D_i = \begin{cases} 
\alpha_i \gamma_i (1 - p_i) & \text{if } p_i < p_j \\
\alpha_i \gamma_i (1 - \frac{\alpha_j \gamma_j}{2})(1 - p_i) & \text{if } p_i = p_j \\
\alpha_i \gamma_i (1 - \alpha_j \gamma_j)(1 - p_i) & \text{if } p_i > p_j.
\end{cases}$$

Evidently, the demands for the physicians negatively depend on their respective prices. This effect is reinforced by the fact that, when $i$’s own price increases, only consumers with higher willingness to pay parameters will demand Physician $i$’s services. This is captured in the demand expression above, by multiplying every portion of the expected demand by $(1 - p_i)$. In effect, only those consumers who have a willingness to pay that is high enough to afford visiting the physicians they have sampled, will do so. The participation cut-off, given the form of the consumers’ utility function and the fact that they estimate the ability of the physicians to be maximal upon finding positive anecdotal evidence, is simply given by Physician $i$’s fee.

It is possible to see that both the visibility and the ability level chosen are key to determining which demand a given physician faces. The demand for the physician whose ability is estimated to be superior expands as the ability difference between the physicians enlarges. The same applies to the visibility gap.

When writing the physicians’ demands in this way, one highlights the strategic interaction between visibility and ability, represented by the product $\alpha_i \gamma_i \forall i \in \{1, 2\}$. The demand expressions now exclusively depend on these products because: as being included in a consumer’s consideration set and the consumer observing a positive anecdote for a physician, are independent events, then $\gamma_i \alpha_i$ represents the probability of observing a positive anecdote from Physician $1$ conditional on his being in the consideration set. We are most interested in making this interaction as explicit as possible, for it stresses the relationship between information availability and the physician’s ability and its potential influence over the market outcomes, which we study here.

The physicians are fully rational and perfectly informed, thus aware of their potential demands. They maximize their profits, contingent to such demands, when solving the pricing game. We discuss these decisions in the upcoming sections.
5. Price Competition with Exogenous Abilities

For the analysis of the physicians’ competitive behavior, we assume without loss of generality that $\alpha_2 \geq \frac{\gamma_2}{\gamma_2} \alpha_1$. This assumption simply underlines the fact that there may be interacting effects between how easy it is to find a given physician’s past-patients, and the intensity of the competition in abilities. The analysis of the interdependence between visibility and ability is undertaken in the ability competition section of the paper. Nevertheless, we can already grasp some of the effects this interaction has on the price competition stage.

First, unlike what is observed in standard models of price competition with vertical differentiation, there is no Nash Equilibrium in pure strategies for the game. This happens because, regardless of the rival’s pricing strategy, a physician will always serve a positive portion of the demand, even if being undercut by the competitor. A physician who faces a low-pricing rival still serves the consumers that found a positive anecdote concerning him, and a negative one from the competitor. Thus, undercutting cannot be carried out to the point where both prices reach the marginal cost – which is zero in our case. Setting a price equal to a null marginal cost would yield zero profits for both physicians, and they would thus rather set any positive price. A positive price, no matter its size relative to the competitor’s, would give the physician positive profits from serving his captive market segment. Hence, setting a price equal to marginal cost does not constitute a Nash Equilibrium in pure strategies. Neither does both physicians setting a unique positive price, since there are incentives to undercut the rival.

Therefore, it is possible to see that anecdotal reasoning, via the captive market it generates for each of the physicians, provokes the impossibility of a pure strategies Nash Equilibrium in the pricing stage. This result aligns with Spiegler (2006), who similarly found the non-existence of a pricing Nash Equilibrium in pure strategies when consumers followed an analogous belief-formation process. Proposition 1, presented below, formally describes this result.

**Proposition 1.** In the price competition stage of the game, with two physicians active in the market, given their abilities $\alpha_1, \alpha_2$, and visibilities $\gamma_1, \gamma_2 \in (0, 1]$, such that $\alpha_2 \geq \frac{\gamma_2}{\gamma_2} \alpha_1$, there is a unique Nash Equilibrium in mixed strategies characterized by the following c.d.f.s:

$$ F_1(p_1) = \frac{1}{\alpha_1} \left[ 1 - \frac{1 - \alpha_1 \gamma_1}{4p_1(1 - p_1)} \right] \quad \forall p_1 \in \left( \frac{1 - \sqrt{\alpha_1 \gamma_1}}{2}, \frac{1}{2} \right), $$

$$ F_2(p_2) = \frac{1}{\alpha_2} \left[ 1 - \frac{1 - \alpha_1 \gamma_1}{4p_2(1 - p_2)} \right] \quad \forall p_2 \in \left( \frac{1 - \sqrt{\alpha_1 \gamma_1}}{2}, \frac{1}{2} \right), $$

and $F(2)$ has a mass point at $p_2 = \frac{1}{2}$, occurring with probability $M_2 = \frac{\gamma_2 \alpha_2 - \gamma_1 \alpha_1}{\alpha_2 \gamma_2}$.

In the equilibrium, the asymmetry created by the visibility/ability relationship we hypothesized generates a strategic interaction in the physicians’ mixed pricing strategies reported in Proposition 1. These rely on distribution functions with support over a range of
fees comprised between what the physicians would charge if they were alone in the market, and the lowest price that allows them to keep obtaining the profits level they would get if focusing on their captive market segment. The lowest pricing boundary for these distributions is a function of the physician with the smallest ability/visibility combination \((\alpha_1\gamma_1)\). Naturally, this neglects any room for undercutting.

Due to the assumption over Physician 2’s ability and visibility, the cumulative distribution function characterizing his pricing behavior does not comprise the upper bound. Furthermore, the function includes a mass point for such a price level, meaning Physician 2 is more likely to set a fee equal to the upper pricing bound. The relative dominance implied by the assumption allows Physician 2 to attract consumers even when setting higher prices, given that his captive market segment is relatively bigger than Physician 1’s. \(^{10}\) The size of the mass point reflects the extent of Physician 2’s relative superiority. Thus, the probability for him to price in the upper bound decreases as the gap between abilities and visibilities disappears.

In the equilibrium, the prices the physicians are expected to set are given by the following expressions:

\[
E_{p_1} = \frac{1 - \gamma_1\alpha_1}{4\gamma_1\alpha_1} \left[ \ln \left( \frac{1 + \sqrt{\gamma_1\alpha_1}}{1 - \sqrt{\gamma_1\alpha_1}} \right) - \left( \frac{2\sqrt{\gamma_1\alpha_1}}{1 + \sqrt{\gamma_1\alpha_1}} \right) \right].
\]

\[
E_{p_2} = \frac{\gamma_2\alpha_2 - \gamma_1\alpha_1}{2\gamma_2\alpha_2} + \frac{1 - \gamma_1\alpha_1}{4\gamma_2\alpha_2} \left[ \ln \left( \frac{1 + \sqrt{\gamma_1\alpha_1}}{1 - \sqrt{\gamma_1\alpha_1}} \right) - \left( \frac{2\sqrt{\gamma_1\alpha_1}}{1 + \sqrt{\gamma_1\alpha_1}} \right) \right].
\]

We can see that Physician 2’s expected price is above the competitor’s. The expected price Physicians 1 sets depends exclusively on his own ability and visibility. Unsurprisingly, Physician 2 can charge a higher price the bigger his ability is. On the contrary, Physician 2’s expected price decreases as either \(\alpha_1\) or \(\gamma_1\) grow. Moreover, both expected prices negatively depend on these variables. In effect, though it is true that Physician 2 charges a higher fee in expected terms, both \(p_2\) and \(p_1\) converge when \(\alpha_1\gamma_1\) tends to \(\alpha_2\gamma_2\) – i.e., the gap in visibilities and abilities diminishes. When positive anecdotes conditional on the physicians being known by the consumers are similarly easy to come by for both physicians, the price competition becomes more fierce, taking place over a larger segment of the market. Furthermore, when \(\alpha_1\gamma_1 = \alpha_2\gamma_2 = 1\), the physicians’ captive markets disappear altogether, and with them the incentives to set a positive price irrespective of the threat of being undercut. Indeed, a Bertrand equilibrium where both physicians set a fee equal to the marginal cost, takes place under such a scenario.

Both physicians’ expected prices decrease in \(\alpha_1\). Naturally, Physician 2 feels the competitive pressure generated by the rival’s ability improvement, and thus pushes his price down. But Physician 1 endures this effect as well, since a higher \(\alpha_1\) implies that price competition will be established over a wider market segment. In the opposite case, when \(\gamma_1\alpha_1\) tends to zero, Physician 2 is able to operate uncontested over a larger portion

\(^{10}\) We talk about a relative dominance because our assumption does not imply that the physician has either a superior ability or visibility. Instead, it claims that the combination of both parameters is bigger. Hence, it could be the case that a lower-ability physician who is better known than his higher-ability-though-lesser-known competitor, satisfies our assumption.
of the market. That is, while neither Physician 2’s ability or visibility change, the segment of consumers who find positive anecdotal evidence for both physicians is smaller. Thus, Physician 2’s expected price tends to $\frac{1}{2}$, while the competitor’s approaches zero. Then again, the fact that Physician 1’s price decreases in his own ability hints at the incentives to differentiate from Physician 2. Namely, Physician 2 will always want to choose a maximum ability level, whereas Physician 1 could benefit from setting a lower ability. Hence, it is possible to say that Physician 1, by choosing an ability below Physician 2’s, indirectly softens the competition. By doing this Physician 1 induces 2 to focus on his captive market, therefore allowing himself to set a higher expected price in the portion of the market where both compete.

Finally, we look at the profits the physicians expect to obtain from playing the strategies described in Proposition 1. Taking the abilities and visibilities as given, the profits the physicians expect to obtain are:

$$\Pi_1 = \frac{\alpha_1 \gamma_1 (1 - \alpha_1 \gamma_1)}{4},$$
$$\Pi_2 = \frac{\alpha_2 \gamma_2 (1 - \alpha_1 \gamma_1)}{4}.$$

The physicians’ expected profits depend on their abilities and visibilities. Physician 2 always gets bigger profits than his rival. As expected, Physician 2’s profits depend negatively on the competitor’s ability, and positively on his own. Interestingly, despite being smaller in magnitude, Physician 1’s profits do not depend on the rival’s ability. This further amplifies the incentives for Physician 1 to differentiate in the ability-setting stage.

We have so far discussed at length the pricing stage of the competitive game taking place between two physicians in a market where consumers reason anecdotally. What we obtain, aside from expressions concerning the pricing equilibrium in mixed strategies, is a first glance at the incentives for ability differentiation between the physicians. As we are solving the game by backwards induction, we move next to the preceding stage, where the physicians choose their ability level. We analyze these decisions in the following section.

6. Ability Choice

In the ability choice stage of the game, the physicians strategically set a value for their respective $\alpha_i$. More simply put, they decide the probability with which a patient who visits them will be cured. Since we have assumed that the consumers reason anecdotically, such a decision resonates in the demand the physicians face. Among the physicians included in the consideration set, the ability determines the probability of a consumer finding positive anecdotal evidence when asking past-patients about a certain physician. We can thus expect the ability decision to involve the interactions described in the price-setting stage.

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11When it is $\gamma_2 \alpha_2$ that tends to zero, by our assumption $\gamma_2 \alpha_2 \geq \gamma_1 \alpha_1$, it must be that $\alpha_1 \gamma_1$ approaches zero even faster. Hence, the analysis of the reverse scenario still holds.

12This is particularly true for the case we are currently analyzing, given that we take the probability of finding a past patient ($\gamma_i, \forall i \in \{1, 2\}$) to be exogenous and positive. Hence, a bigger alpha ceteris paribus increases the probability that a consumer will find a positive anecdote on a specific physician.
In particular, there might be incentives for the physicians to differentiate in abilities, owing to the manner in which consumers form their beliefs, as seen in Ireland [1993] and Szech [2011]. Yet, unlike what those two studies postulate, the availability of information on the physicians must also be taken into account in our equilibrium, represented as it is by the physicians’ visibilities.

This is the first stage of the game which, according to the timeline described, means that the physicians choose their ability knowing that in the next stage they will compete in prices. Generally speaking, a high-ability physician whose past-patients are hard to find, will in all likelihood have a smaller captive market than a well-known competitor with a lower ability level. Therefore, the trade-off between ability and visibility becomes crucial for the physicians’ decisions. Ability choice is costless for the physicians and is taken simultaneously.

Two equilibria in abilities are possible in the market setting we analyze, depending on the physicians’ visibilities. How high or low these are will determine whether ability differentiation is observed or not. In particular, the physician in a relatively weaker competitive position, given his being lesser-known, will have to decide whether to pool with the better-known rival by choosing a high ability level or set a lower ability level that forgoes competition over patients outside his captive market. The better-known physician, regardless of the size of his visibility \( \gamma_i \), always chooses the maximum ability level. We formally present the first of these results in the following proposition.

**Proposition 2.** If at least one of the physicians’ visibility is below one half, that is \( \gamma_1 < \frac{1}{2} \), \( \gamma_2 < \frac{1}{2} \) or both, then the physicians do not differentiate in abilities, choosing \( \alpha_1 = \alpha_2 = 1 \) in equilibrium.

If a physician’s visibility is low, then only a small portion of the population is aware of his presence in the market. Naturally, by choosing a high ability the physician increases the size of the patients’ mass that could potentially demand his services. Out of those who have the physician in their consideration sets, however few they may be, the higher the ability is, the more likely it is that such consumers come by positive anecdotal evidence. Thus, if a physician is endowed with a low \( \gamma_i \), i.e., he has unfavorable initial conditions (e.g., not being part of a family saga in the medical profession) the best he can do is choose as high an ability as possible. In doing this the physician maximizes the probability that when one of his past-patients is actually found, she will report a positive experience.

In this equilibrium the better-known physician is in a relatively advantageous position given his superior visibility, \( \gamma_2 \geq \gamma_1 \). Thus, Physician 2 sets a higher price and obtains bigger profits by also choosing the highest possible ability, \( \alpha_2 = 1 \). Therefore, both physicians set the maximum ability level to maximize their profits. According to Proposition 2, the equilibrium profits are given by:

\[
\Pi_1 = \frac{\gamma_1(1 - \gamma_1)}{4} \quad \text{and} \quad \Pi_2 = \frac{\gamma_2(1 - \gamma_1)}{4}.
\]

The profits for both Physician 1 and 2 positively depend on their respective visibilities for visibility values of one half. Being known by a bigger portion of the population entails a potentially larger demand for the physicians, both in their captive market as well as in the segment they compete over. The profits Physician 2 obtains decrease as the rival’s visibility grows. Nonetheless, this effect is proportional to the physician’s own visibility.
The second type of equilibrium we need to consider takes place when both physicians’ visibilities are above one half. In such a case, ability differentiation occurs: one of the physicians chooses a lower ability than the rival, who continues to set the highest ability level possible, and vice-versa. We formally present this result in the following proposition.

**Proposition 3.** If both physicians’ visibilities are above one half, \( \gamma_1 \geq \frac{1}{2} \) and \( \gamma_2 \geq \frac{1}{2} \), two equilibria where ability differentiation is observed are possible:

\[
\alpha_1 = \frac{1}{2\gamma_1}, \quad \alpha_2 = 1;
\]

and

\[
\alpha_1 = 1, \quad \alpha_2 = \frac{1}{2\gamma_2}.
\]

We can see that the physicians differentiate in abilities if the visibility of both is above one half. In each of the possible equilibria one of them chooses to be a low-ability physician, while the rival chooses to be high-ability. The equilibrium level chosen by the low-ability physician is proportional to his own visibility. The rationale driving these choices has to do with the form of each physician’s demand, comprising captive and contested segments. A low ability entails a small captive demand for the physician who chooses it, and a larger one for the rival. In this type of equilibrium it pays off for the low-ability physician to differentiate despite this trade-off. By choosing a non-maximum level the low-ability physician surrenders some of his demand in order to induce the rival to focus on his own captive demand. This pushes the high-ability physician to play a pricing strategy skewing toward the monopoly price. Hence, the equilibrium prices over the whole market rise in expected terms, effectively softening the competition.

To analyze the profits levels obtained by each physician and the interactions between them in the equilibrium, we take the case of a market where Physician 2 is the better-known of the pair: \( \gamma_2 \geq \gamma_1 > \frac{1}{2} \). The equilibrium abilities are: \( \alpha_2 = 1 \) and \( \alpha_1 = \frac{1}{2\gamma_1} \). The profits each of the physicians obtain are given by:

\[
\Pi_1 = \frac{1}{16} \quad \text{and} \quad \Pi_2 = \frac{\gamma_2}{8}.
\]

The better-known physician prices higher, serves a bigger demand, and obtains superior profits to those of his rival. Actually, Physician 1’s profits do not depend on any variable, given that they come from the maximization of the physician’s captive segment. On the other hand, Physician 2’s profits increase with his visibility.

A summary of the equilibria presented in propositions 2 and 3, as a function of the two physicians’ visibilities, is presented in the following graph:
Figure 1: Ability equilibria as a function of visibilities ($\gamma_1, \gamma_2$)

Figure 1 illustrates the trade-off established in the ability-competition stage, between ability differentiation and information availability. Considering the physicians’ visibilities as a measure of how plentiful information about the physicians is, we can see that ability differentiation does not take place when both values of $\gamma_i$ are smaller than $\frac{1}{2}$. For what we call low visibilities, both physicians set a maximum ability level. This decision comes from the fact that both the physicians’ captive market and the segment of consumers over which they compete, are small. Their past-patients are hard to find, and the physicians are included in a reduced number of consideration sets—few consumers are aware of them. By choosing a maximum ability level, the physicians make sure that whenever a rare past-patient of theirs is sampled, her experience with the treatment was positive. Also, the proportion of consumers who have both physicians in their consideration set at the same time, is quite small. Thus, the price-diminishing effect of setting a high ability that we described in the previous section, is relatively small. The two physicians will very rarely compete in prices, hence the incentives to reduce the intensity of price competition by setting a below-maximal ability level, are insignificant.

We can also note that the result remains for as long as the lesser-known physician’s visibility is below one half. Thus, ability differentiation is not observed in the equilibrium either when the two physicians are little-known or just when the lesser-known of the two’s visibility is below one half. In the latter case, the limited competitive presence of the lesser-known physician exerts little pressure on the superior-visibility rival, who by all intents and purposes acts as a monopolist over a large portion of the market, setting a maximum ability level since it is costless for him to do so. Thus, the price-diminishing effect of setting a high ability that we described in the previous section, is relatively small. The two physicians will very rarely compete in prices, hence the incentives to reduce the intensity of price competition by setting a below-maximal ability level, are insignificant.
For higher visibility values, i.e., when the lesser-known physician’s visibility is above one half, ability differentiation is observed in the equilibrium. Furthermore, it is always the relatively lesser-known physician who differentiates by setting an ability level that is proportionally smaller than that of his rival. How much smaller the chosen ability is depends on the lesser-known physician’s visibility. The differentiated ability will move away from the maximum level as the physician’s visibility grows. As a matter of fact, when both visibilities are equal to one, we get the Spiegler (2006) and Szech (2011) results, in what could be called maximal ability differentiation, with one of the physicians setting an ability level of one and the other choosing one half.

We have discussed the reasons behind the differentiation decision throughout this section, and how it is motivated by the lesser-known physician’s desire to give-up some of his demand in order to downplay price competition over the whole market so that he can set a higher fee for his captive segment. Another way of seeing this mechanism would be to focus on the effect the low-visibility physician’s ability has on the mass point the better-known rival assigns to the upper pricing bound: the higher such an ability, the more likely the superior-visibility competitor is to price close to one half. Lastly, it is interesting to see that the non-generality-impairing nature of our assumption on the sizes of the abilities and visibilities is confirmed, since all the equilibria in abilities are symmetric, with no result hinging on the identity of any of the physicians. Moreover, the pricing stage equilibrium is also symmetric, granted one considers that the change in the direction of the assumption will imply a change in the relation of the equilibrium-prices set. That is, the relatively dominant physician will continue to price above his rival.

7. Extensions

We have so far analyzed a setting where boundedly-rational patients base their decision to visit a physician on anecdotes gathered from their close acquaintances. Indeed, they follow the $S(1)$ procedure and sample a single anecdote for each physician they are aware of. On the side of the suppliers we studied a duopoly of perfectly informed physicians who compete in prices and abilities, the latter a choice bearing no cost for them. In this section we will explore three extensions to that model: first to consider a set of $n \geq 2$

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$^{13}$Let us briefly comment the case where the visibility is strategic and ability exogenous, as outlined in footnote 5. Interpreting the equilibria presented in Figure 1 under such set-up, a high level of visibility could not be considered completely informative, for there exist equilibria where either both of the physicians or at least one of them would have a low ability. The specific ability level of a physician cannot be inferred from his choosing a high visibility in the equilibrium. Nevertheless, a high investment in visibility from both physicians in all cases indicates a low average ability in the duopoly. This result is not entirely surprising, since one would expect low-ability physicians to try to expand their markets through their visibility; particularly since this is a one-shot interaction and visibility choice bears no cost. Interestingly, when both physicians have a high (exogenous) ability, one of them differentiates by choosing a low visibility, thus focusing on his captive demand. Here the same second-order mechanism we identified kicks in: the high-ability physician who decides to stick to his captive demand declines to compete in the wider market in order to set a higher price. This is why we can affirm that the present paper’s main conclusions hold when the strategic and exogenous variables are switched, and the former’s choice kept costless. A planner might be interested in curtailing competition in visibility in a market of this sort, since low skill competitors would be in a position to expand their demand through visibility investment. However, further analytic nuance would be needed to provide robust policy insights.
competing physicians, next to analyze the case where ability choice has a positive cost, and finally studying a set-up where patients are allowed to take larger samples \((K \geq 1)\) when facing a duopoly of physicians, both in the case of a costly and costless ability choice.

7.1. Analysis of a market with \(n\) physicians\(^{14}\)

We look at a scenario where competition is heightened by the presence of a large number of physicians. This is particularly relevant to the present paper’s conclusions, considering that we found the limited sampling and information asymmetries to allow physicians to offer subpar services and charge high fees due to their control over a captive demand. To be precise, those patients who only had access to one physician and based their decision on a single positive anecdote were, for all effects, part of a monopolistic market operating on the side of the competitive one.

The literature would suggest that more competitive pressure on a specific physician might give him incentives to increase the quality of the service he offers or push his fee closer to the marginal cost. Indeed, the mechanism that allowed low-ability Physicians to focus on their captive markets is essentially altered in the presence of strong competition. A market with a large number of physicians implies smaller captive segments for each provider, thus affecting their incentives to focus on them. It is interesting to consider whether a more competitive market could correct the distortions found in this paper’s main model, leading to potential regulatory insights for a social planner to examine.

In terms of the market set-up, the side of the consumers and the way they process the anecdotes sampled remains unchanged. We introduce \(n\) physicians in the market, indexed by \(i \in N = \{1, 2, \cdots, n\}\). These compete in prices and abilities, the latter a costless choice. The physicians are fully rational and perfectly informed. That is, they observe the ability chosen by all the other physicians in the market once it has been chosen. Next, they simultaneously set prices to maximize their individual profits. The physicians’ fees are publicly known, whereas their abilities are unknown to the consumers. The consumers estimate these abilities through small samples of anecdotal-evidence gathered from past consumers. We denote \(\gamma_i \in (0, 1]\) for all \(i \in N = \{1, 2, \cdots, n\}\) to be Physician \(i\)’s visibility, the exogenously given probability for him to be considered by any particular consumer. All visibilities are known by the physicians. The timing of the game is not changed from the duopolistic model.

We find that low-ability physicians still can participate in the market despite the large number of competitors. Indeed, increasing the number of providers has a minimal impact over the participation decisions of patients. The anecdote-based reasoning the patients follow makes the existence of superior but unknown suppliers irrelevant. That is, if a patient decides to visit a physician upon finding a positive anecdote, it may not matter that she is unaware of a large number of high-ability rivals.

When extending the duopolistic market analyzed in this paper to a competitive one, we identify three types of physicians per their equilibrium ability choices: a very visible

\(^{14}\)A more comprehensive version of this extension can be found here. Full proofs for this appendix are available upon request.
physician who charges a high fee but offers a high-quality service, a few physicians who are quite visible but not as much as the relatively-dominant player and charge a smaller fee for a service of relatively lesser quality, and a mass of smaller and hardly visible physicians who compete for patients in prices and offer a service of quality comparable to that of the relatively dominant provider.

A planner might affect the composition of such market by controlling the physicians visibilities. Higher visibility values lead to lower average equilibrium abilities. Moreover, if all visibilities were equal to one – all physicians being universally visible –, we get an analogue of Spiegler (2006) and Szech (2011) results, in what could be called maximal ability differentiation, with one of the physicians setting an ability level of one and the other choosing one half. This is also in line with the results presented in the duopolistic scenario. That is, more ability differentiation is observed when information on the physicians is more readily available.

Regarding their equilibrium pricing strategies, the availability of more physicians entails a decrease in the information consumers have across the market, allowing for high equilibrium fees. This is a counter-intuitive result, since more competition would not be be expected to lead to prices different to the marginal cost. However, bearing the demand structure our model entails we know that, no matter how small, the captive market segment causes physicians to price as monopolists. Thus, many suppliers serving their small captive segments for a positive fee viably exist in the competitive equilibrium.

This result, outlining a peculiar relation between the number of physicians in the market and the fees they charge, has previously been described in the literature. Several pioneering econometric analyses of healthcare markets found a partial positive correlation between the physicians stock and prices (Feldstein (1970); Fuchs and Kramer (1972)). Those studies contradict the predictions of standard competitive model, opening the door for alternative explanations, one of which might be the informational route this paper proposes.

7.2. Analysis of the case where ability choice has a cost

We are interested in discussing to what extent the results presented are driven by the assumption of a costless ability. Particularly the equilibrium where the two physicians choose the maximum ability level despite the heterogeneity in their visibilities and the limited information available to the consumers. We introduce a convex cost for the abilities in order to capture the investment physicians make when setting a high ability level. Aside from expanding our main model, this separates us from preceding works which either did not consider the abilities as a strategic variable or took it as a costless choice.

The main setting and timing remain the same except for the addition of a costly ability, described by the following function: \( C(\alpha_i) = \frac{1}{2}c\alpha_i^2 \), where \( c > 0 \).

We find that the two physicians differentiate in abilities for any combination of visibilities in the support. That is, while in the costless case they both set the same ability level as long as at least one of their visibilities was small enough, when it has a cost the

\[ \text{A more comprehensive version of this extension can be found here. Full proofs for this appendix are available upon request.} \]
relatively-dominant physician will always choose a higher equilibrium ability, no matter the specific size of the visibilities.

The relatively-dominant physician is defined as the one who has a superior visibility. Hence, the relative size of the physicians’ visibilities will determine their abilities in the equilibrium. They differentiate when the difference in visibilities is large, with the relatively-dominant player setting a higher ability level than his rival. Moreover, in many cases the relatively-dominant physician is also the one who has a higher visibility. On the other hand, if the visibility levels are not too far apart, two robust equilibria in abilities are found. In each of them, one of the physicians sets a higher ability than the competitor, though the relationship between the visibility level and the equilibrium ability of each one is not as clear.

The total healthcare profits are bigger when the relatively-dominant physician is the one who sets the highest ability in the equilibrium. The dominant player serves the largest demand and charges the higher fee for his services, obtaining the most profits as well. These results align with the ones discussed in the costless case, although there are many other important differences that deserve to be mentioned. First, when the ability is costly there is no equilibrium where the two physicians set the maximum ability. Neither is there one where the competitors choose the same ability level. The two physicians differentiate in abilities for all visibilities as long as the choice carries a cost. Furthermore, the costlier the ability decision is, the lower the equilibrium average ability in the market.

Both physicians’ equilibrium abilities decrease in the cost. Thus, the costlier it is for a physician to offer a high-quality service, the further down the overall market standard is pushed. This feature might potentially interest a planner. The difference between the equilibrium abilities diminishes as the non-dominant physician’s visibility increases, thus reducing the dominant player’s advantage. Again, a relevant feature policy-wise, for it would entail that more information could lead to a higher average ability in the market. That said, since abilities are exogenous in our model, the implications for a planner are not immediate.

The two physicians’ abilities increase in their visibilities, with the dominant player’s position becoming stronger as his visibility increases. The easier it is for a consumer to find an anecdote for a given physician, the more incentives he has to set a high ability. This result somewhat contradicts our findings in the costless ability case, since here the equilibrium where both visibilities are equal to one does not lead to the maximum differentiation in abilities. That is, when both physicians are equally visible, their costly ability choice facing boundedly-rational patients is not trivial. This suggests several questions regarding which we hope to explore in the near future.

7.3. Analysis of the case where patients sample $K > 1$ anecdotes

Here we examine the effects of expanding the sample size upon which the consumers base their decision, considering a set of $K$ anecdotes before visiting a given physician. The consumers estimate the ability of the physicians who compete in the duopolistic market through that sample.

\footnote{A more comprehensive version of this extension can be found here. Full proofs for this appendix are available upon request.}
To an extent, the market distortions we found hinge on consumers sampling one and only one patient. We are thus interested in understanding how the market behaves when consumers are allowed wider samples. Hence, we let each consumer draw $K > 1$ anecdotes from past patients who visited each physician she is aware of. That is, if three different physicians have treated some members of her family, she will gather $K$ anecdotes for each of them, estimate their respective abilities, and then decide which one to visit.

The sample-processing procedure is slightly altered with respect to the one introduced in this paper’s main model. Here we assume that finding a negative anecdote from a physician drives the consumer to discard such physician, no matter if she had previously found some positive anecdotes. A negative anecdote out of the $K$ sampled is equivalent to assigning the physician a zero ability. Hence, in order to consider visiting a given physician the consumer must get exactly $K$ positive anecdotes. A physician from whom she only heard positive anecdotes is attributed an ability of one.

This type of reasoning finds its rationale in the behavioral bias known as *negativity bias*, defined as the tendency for humans to pay more attention or give more weight to negative experiences over neutral or positive counterparts.  Aside from this change in the sampling procedure, the competitive set-up remains unaltered.

We find that higher visibilities lead to more differentiation in abilities, with lower average ability values appearing in the equilibrium. That is, one of the physicians in the duopoly sets the maximum ability level while the other chooses a proportionally lower value. On the other hand, low visibilities across the market lead to an equilibrium where all the physicians set a maximum ability level, granted the choice is costless to them. However, this does not happen when we include a costly choice of ability. Indeed, the differentiation takes place even when information availability is low.

To summarize, we have seen that the ability differentiation found in the duopoly is also observed for a competitive market with $n$ physicians. In such scenario, the "best-known" physician will set the maximum ability level while the remaining competitors choose ability levels below that one. This is also the case when the ability is costly and two physicians compete in the market, with ability differentiation appearing for high visibility levels. Furthermore, ability differentiation continues to appear in the duopoly when patients estimate the abilities through larger samples.

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17 We assume the sample size $K$ to be small enough not to contradict the informational limitations inherent to the market. In simpler words, $K$ will be small enough for each consumer to be able to find such number of anecdotes for all the physicians who have treated someone she knows.

18 According to Sunstein (2003), in the face of negative events people tend to focus on the "badness" of the outcome rather than on its probability. This bias results in what Sunstein calls *probability neglect*. Even when negative experiences are inconsequential or highly improbable, individuals tend to focus on their negative effects rather than their actual probability. It is not far-fetched to imagine a boundedly-rational consumer, suffering an ailment severe enough for her to decide to gather more evidence on a provider, to be prone to a *negativity bias*. 

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8. Concluding Remarks

In this paper we study the role of asymmetric information in a market for physicians where consumers base their decisions on anecdotal evidence. We closely follow Spiegler(2006) and Szech(2011). However, we introduce a crucial distinction: separating the exogenous and strategic components underlying the physicians’ strategies in this market settings. In order to do this, we restrict consumers’ samples to consideration sets whose composition is determined by an exogenous factor we call visibility. A physician’s visibility reflects how well-known he is, thus influencing his competitive decisions.

The novelty of our approach resides in analyzing the interactions between the strategic choice of physician’s abilities and the exogenous factor captured by their visibility. The non-existence of a pricing equilibrium in pure strategies and the incentives to differentiate in the abilities we find, heavily depend on the complementarity of these two features. A clear interdependence between ability choices and visibilities is established, to the point that whether ability differentiation is observed in the equilibrium or not, depends on the physicians’ visibilities. To be precise, more ability differentiation is observed when information on the physicians is more readily available.

In the equilibria we characterize, ability differentiation does not always take place when anecdotal-reasoning consumers are involved. We find an equilibrium where one of the physicians chooses a lower ability level, as established in the literature, only when both physicians have high visibilities. Our set-up allows for an equilibrium where all physicians in the market set the maximum ability level, in contrast to what the existing literature shows. Namely, when at least one of the physicians visibilities is low the two physicians set an ability equal to one. This is a result that carries valuable policy insights for a planner.

From a normative perspective, the interesting question to ask is how to achieve an equilibrium where ability attains its maximum level despite the consumers’ bounded rationality and the heterogeneity in the physicians’ visibilities. Interestingly, introducing a maximum ability physician in the way of a high-value competitor does not induce such an equilibrium. Similarly, forcing information on the physicians to be freely available would only work to the extent that it included an actual record of the physicians’ abilities. Otherwise, it would just amplify the distorting effects of anecdotal-reasoning, potentially leading to the maximum ability-differentiation equilibrium one observes when all physicians in the market are equally visible but their ability remains private.

Achieving a high average ability in equilibrium seems to require information to be "less plentiful" for at least one of the physicians involved in the market. There are some ways for a planner to implement this. A regulator may intervene by restricting physicians to act in local parcels, which effectively eliminates competition by creating local monopolies where each physician is interested in choosing the highest ability possible. An alternative intervention would be to set a fixed fee for the physicians’ services, which would induce them to focus on ability competition and lead them to the highest ability level since the decision is costless for the physicians.

Though our results are novel to the literature and potentially interesting for a regulator, a healthcare market is one of the type requiring further research before finer policy
recommendations are made. In particular, it would be worthwhile analyzing the interaction between visibility and ability choice in greater depth. In this paper we have focused on a static game in which visibilities are completely exogenous. Yet, it is natural to think that the analysis could be pushed to a dynamic setting in which the present visibility of a physician depends on the number of patients he has treated in the past (his market share) or his success rate (itself a function of the ability). This could lead to a deeper comprehension of the rise and development of family sagas, as observed in the medical profession, and the effect these have on market abilities and prices. Nevertheless, we believe that our paper offers some early insights concerning the impact of information availability on the decisions of physicians in a healthcare market. Thus, we hope it can set a path for future research, ultimately leading to policy considerations regarding a market where the access to information and its reliability play an increasingly critical role.

References


Appendix A. Proofs

Proof of Proposition 1. We first compute the equilibrium prices taking the abilities as given \((\alpha_1, \alpha_2)\). We start by showing that there is no pure strategies equilibrium, and then find the actual Nash Equilibrium in mixed strategies for the price competition stage of the game.

Step 1: There is no equilibrium in pure strategies

Physician 2’s demand, given his ability \(\alpha_2\), is the following:

\[
D_2 = \begin{cases} 
\alpha_2 \gamma_2 (1 - p_2) & \text{if } p_2 < p_1 \\
\alpha_2 \gamma_2 (1 - \frac{\alpha_1 \gamma_1}{2})(1 - p_2) & \text{if } p_2 = p_1 \\
\alpha_2 \gamma_2 (1 - \alpha_1 \gamma_1)(1 - p_2) & \text{if } p_2 > p_1
\end{cases}
\]

The demand for Physician 1 is symmetric. Thus, physician \(k\)’s profits will be given by:

\[
\Pi_k = p_k D_k \quad \forall k = \{1, 2\}.
\]

First, in a pure strategies equilibrium, none of the physicians would ever set a price above \(\frac{1}{2}\). If the rival has a price bigger than one half, the optimal price for the physician is to set a price equal to one half. If the rival undercuts the physician in prices, then the best strategy is to set a price strictly smaller than one half. Therefore, we can discard any price larger than \(\frac{1}{2}\) as being part of an equilibrium in pure strategies.

Second, \(p_1 = p_2 = \frac{1}{2}\) cannot be an equilibrium either. Assume, by contradiction that these pricing strategies constitute a Nash Equilibrium in pure strategies. The profits for Physician 2 in such a case are given by:

\[
\pi_2 = \frac{1}{4} \alpha_2 \gamma_2 \left(1 - \frac{\alpha_1 \gamma_1}{2}\right).
\]

If Physician 2 undercuts Physician 1 by setting \(p_2^d < \frac{1}{2}\), his profits are given by:

\[
\pi_2^d = p_2^d (1 - p_2^d) \alpha_2 \gamma_2.
\]

Equating these two expressions to find the minimum price that yields the same profits for Physician 2, we get:

\[
p_2^d = \frac{1}{2} \pm \frac{1}{4} \sqrt{2 \alpha_1 \gamma_1}.
\]

Therefore, any price \(p_2^d \in \left(\frac{1}{2} - \frac{1}{4} \sqrt{2 \alpha_1 \gamma_1}, \frac{1}{2}\right)\) constitutes a profitable deviation for Physician 2. Moreover, a similar argument follows through for any pricing situation such that: \(p_1 = p_2 \forall p_1, p_2 \in (0, \frac{1}{2})\). That is, no positive price in the interval, simultaneously set by both physicians, is a Nash Equilibrium in pure strategies.

Finally, \(p_1 = p_2 = 0\) is not an equilibrium either. Assume, by contradiction that it is an equilibrium. Clearly, both physician have incentives to deviate. Since these prices yield them zero profits, any positive price would constitute a profitable deviation, considering that it would yield positive profits for the physician, no matter how small the price, from serving his captive market segment.

Therefore, there is no equilibrium in pure strategies for the pricing game. Let us consequently assume there exists a Nash Equilibrium in mixed strategies for the game, which induces a c.d.f. \(F_i\) with support over \([p_i^L, p_i^H]\) for all \(i \in \{1, 2\}\), where \(p_i^H = \frac{1}{2}\) (obtained from the maximization of \(i\)’s captive market segment), and \(p_i^L\) is the lowest price that lets Physician \(i\) obtain the same profits level that \(p_i^H\).
Step 2: Show that the mixed strategies Nash equilibrium does not include mass points in any price $p^* < p^H_i$

It is necessary to comment on the possibility that there may exist one (or several) mass points at any price $p^*$ below the upper bound of Physician $i$’s c.d.f., support. This is useful for our proof because, if there are no spikes in the mixed strategies, then the measure of the set of prices for which there might be pricing ties is negligible, and we can rule out all such cases.

First, we need to show that the physicians never assign a mass point to the same price in their action domain. This is true because, if physician 1 has an atom on $p$, then physician 2 would never set an atom on the same $p$ in equilibrium. Because, by moving the atom to a price just below $p$ physician 2 would obtain higher profits, constituting a profitable deviation.

Now we show that none of the physicians would individually assign a mass point to a price lower than the upper bound of their action domain. Which we show next.

Assume, by contradiction, that Physician 1 plays in the equilibrium a mixed strategy that assigns a measurable probability to some price $p^* < p^H_1$, i.e. $F_1$ has a discontinuity at $p^*$. Then, it would not be optimal for Physician 2 to play $p^*$ with a measurable probability, since by playing any price below $p^*$ he would undercut his rival, obtaining higher profits. Furthermore, it would be profitable for Physician 2 to reduce any positive density above $p^*$, and place a mass point at a price just below $p^*$. In fact, Physician 2 would never play any price above $p^*$. Thus, Physician 1 would like to redistribute its own mass point over the whole pricing interval, to increase the expected price and enhance the expected demand. Therefore, we conclude that a mass point cannot occur in equilibrium at any price below $p^H_1$ and, more importantly, both physicians will never select the same mass point. Hence, the only possibility is that only one of the physicians assigns a mass point to the upper boundary of the c.d.f.’s support. In the next step we show that this is indeed the case for the high physician whose ability satisfies $\alpha_1 \geq \frac{2\gamma}{\gamma_1}\alpha_j$ where $i, j \in \{1, 2\} : i \neq j$.

Step 3: Find the upper and lower bounds for the mixed strategies c.d.f.’s support

Recall that, without loss of generality we assume that $\alpha_2 \geq \frac{2\gamma}{\gamma_2}\alpha_1$. Since we have ruled out the probability of ties, then we know that for every possible price $p_2$, the expected demand of Physician 2, given the mixed strategy of his rival, is:

$$D_2 = \gamma_1\gamma_2\alpha_2(1 - \alpha_1 F_1(p_2))(1 - p_2) + \gamma_2(1 - \gamma_1)\alpha_2(1 - p_2)$$

Where $F_1(p_2)$ is the probability that $p_1$ is smaller or equal than the price $p_2$. Using the expression above we can write Physician 2’s expected profits function as follows:

$$E\Pi_2 = E_{p_2}[\gamma_1\gamma_2\alpha_2(1 - \alpha_1 F_1(p_2))(1 - p_2)p_2 + \gamma_2(1 - \gamma_1)\alpha_2(1 - p_2)p_2]$$

The expressions for the expected profits and demand of Physician 1 are symmetric. We use them to find the upper and lower bounds for the mixed strategies of the physicians.

Let $p^L_i$ and $p^H_i$ represent $F_1$’s lower and upper bounds. First, the upper bound will be the maximum price to which any physician would assign a positive probability, so that $F_i(p^H_i) = 1$ and $F_i(p) < 1 \forall p < p^H_i$. This price is the one that maximizes Physician 1’s profits when the rival is undercutting his price. Thus, this is the price that yields the maxmin profits. Notice that when physician $i$ is being undercut he will only serve the portion of patients that sampled both physicians and got a positive from $i$ and a negative from its rival, plus the portion of patients that sampled only physician $i$ but not his rival, and found a positive anecdote from him – i.e. Physician $i$’s captive market segment. Notice that this upper bound price coincides for both physicians, $p^H_i = \frac{1}{2} \forall i \in \{1, 2\}$.

Second, the lower bound is the minimum price to which any physician $i$ would assign a positive probability, so that $F_i(p^L_i) = 0$ and $F_i(p) = 0 \forall p < p^L_i$. Due to the fact that the expected
profits are strictly increasing for any price in the \([0, \frac{1}{2}]\) interval, the lower bound corresponds to price \(p_i'\), which –even if undercutting the rival’s– would yield the same expected profits level than setting the price that yields the maxmin profits.

\[
p_i' \alpha_i \gamma_i \left( 1 - \alpha_j \gamma_j F_1(p_i') \right) (1 - p_i') = \frac{1}{4} \alpha_i \gamma_i (1 - \alpha_j \gamma_j) \iff p_i' = \frac{1 \pm \sqrt{\alpha_j \gamma_j}}{2}.
\]

Where \(j\) indexes the variables corresponding to physician \(i\)'s rival. Thus, Physician \(i\) will never set a price below \(\frac{1 - \sqrt{\alpha_j \gamma_j}}{2}\), guaranteeing a profits level at least equal to what he would get by following his maxmin strategy. Carrying out these computations for both physicians we get: \(p_1' = \frac{1 - \sqrt{\alpha_2 \gamma_2}}{2}\) and \(p_2' = \frac{1 - \sqrt{\alpha_1 \gamma_1}}{2}\).

Since every result up to now is symmetric for both physicians, we can assume without loss of generality that \(\gamma_2 \alpha_2 > \gamma_1 \alpha_1\). This implies that \(p_1' < p_2'\). Let us assume that these prices represent the lower bound of the corresponding pricing strategies, in the equilibrium. Then, Physician 1 would be assigning a positive probability to the range \([p_1', p_2']\). However this is not an equilibrium because Physician 1 would be better off by redistributing this positive probability over the remaining interval of the pricing region: \([p_2', \frac{1}{2}]\). Thus, the lower bound of the domain of the \(c.d.f\) of both physicians are equal, \(p_1' = p_2' = \frac{1 - \sqrt{\alpha_j \gamma_j}}{2}\).

**Step 4:** We find the expressions of the \(c.d.f\).s induced by the Nash Equilibrium strategies.

We know that for all prices in the \([\frac{1 - \sqrt{\alpha_2 \gamma_2}}{2}, \frac{1}{2}]\) interval, function \(F_1(p_2)\) must be such that Physician 2 is indifferent when playing any price in its action space. Therefore,

\[
v_2 = p_2 \alpha_2 \gamma_2 (1 - \alpha_1 F_1(p_2)) (1 - p_2) + \gamma_2 (1 - \gamma_1) \alpha_2 p_2 (1 - p_2),
\]

must be the same for every \(p_2\) in the interval. In particular, this must be the case for \(p_1'\) and \(F_2(p_1') = 0\). Thus, we can plug this in the preceding profits equation, in order to compute the value of \(v_2\):

\[
v_2 = \frac{\alpha_2 \gamma_2 (1 - \alpha_1 \gamma_1)}{4}.
\]

Substituting \(v_2\) back in the equation, and isolating the \(c.d.f\)., we get:

\[
F_2(p_2) = \frac{1}{\alpha_2 \gamma_2} \left( 1 - \frac{1 - \alpha_1 \gamma_1}{4p_2 (1 - p_2)} \right).
\]

Following the same procedure for the other physician, we get the corresponding \(c.d.f\): 

\[
F_1(p_1) = \frac{1}{\alpha_1 \gamma_1} \left( 1 - \frac{1 - \alpha_1 \gamma_1}{4p_1 (1 - p_1)} \right).
\]

**Step 5:** We compute the size of the mass point Physician 2 assigns to \(p_2 = \frac{1}{2}\).

It is easy to see that \(F_2(\frac{1}{2})\) is lower than one. Moreover, substituting \(p_2 = \frac{1}{2}\) in the Nash Equilibrium \(c.d.f\). just computed, we get:

\[
F_2 \left( \frac{1}{2} \right) = \frac{\gamma_1 \alpha_1}{\gamma_2 \alpha_2}.
\]

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and thus, the mass point ability Physician 2 assigns to the upper pricing bound is:

\[ M_2 = 1 - F_2 \left( \frac{1}{2} \right) = 1 - \frac{\gamma_1 \alpha_1}{\gamma_2 \alpha_2} = \frac{\gamma_2 \alpha_2 - \gamma_1 \alpha_1}{\gamma_2 \alpha_2}. \]

\[ \square \]

**Proof of Propositions 2 and 3.** Once the equilibrium prices are found, we go back one stage in the game, when physician’s abilities are chosen. As found in the proof of Proposition 1, the physicians profits given the abilities are:

\[ \pi_1 = \begin{cases} \frac{\alpha_1 \gamma_1 (1 - \alpha_2 \gamma_2)}{4} & \text{if } \alpha_1 \geq \alpha_2 \\ \frac{\alpha_1 \gamma_1 (1 - \alpha_1 \gamma_1)}{4} & \text{if } \alpha_1 \leq \alpha_2 \end{cases} \]

and

\[ \pi_2 = \begin{cases} \frac{\alpha_2 \gamma_2 (1 - \alpha_1 \gamma_1)}{4} & \text{if } \alpha_2 \geq \alpha_1 \\ \frac{\alpha_2 \gamma_2 (1 - \alpha_2 \gamma_2)}{4} & \text{if } \alpha_2 \leq \alpha_1 \end{cases} \]

Thus, the equilibrium abilities would be given by:

\[ \alpha_1^* = \begin{cases} 1 & \text{if } \alpha_1 \geq \alpha_2 \\ \frac{1}{2\gamma_1} & \text{if } \alpha_1 \leq \alpha_2 \end{cases} \]

and

\[ \alpha_2^* = \begin{cases} 1 & \text{if } \alpha_2 \geq \alpha_1 \\ \frac{1}{2\gamma_2} & \text{if } \alpha_2 \leq \alpha_1 \end{cases} \]

However, we need to check which of these strategies are Nash equilibria. The profits level each physician would obtain when setting a given ability level are:

\[ \pi_1^* = \begin{cases} \frac{\gamma_1}{8} & \text{if } \alpha_1 \geq \alpha_2 \\ \frac{1}{16} & \text{if } \alpha_1 \leq \alpha_2 \end{cases} \]

and

\[ \pi_2^* = \begin{cases} \frac{\gamma_2}{8} & \text{if } \alpha_2 \geq \alpha_1 \\ \frac{1}{16} & \text{if } \alpha_2 \leq \alpha_1 \end{cases} \]

We can see that:

\[ \frac{\gamma_1}{8} > \frac{1}{16} \iff \gamma_1 \in \left( \frac{1}{2}, 1 \right]. \]

Therefore, we face the following combinations:

If \( \gamma_1 \in \left( 0, \frac{1}{2} \right] \) then \( \alpha_1 = \frac{1}{2\gamma_1}, \alpha_2 = 1 \) and,

if \( \gamma_1 \in \left( \frac{1}{2}, 1 \right) \) then \( \alpha_1 = 1, \alpha_2 = \frac{1}{2\gamma_1} \).

These are all possible equilibria, with their symmetric equivalents. Nevertheless, there is only one profitable deviation for each physician: if Physician 1 sets an ability level \( \alpha_1 = 1 \) when \( \gamma_1 \in \left( 0, \frac{1}{2} \right] \), the profits he obtains are \( \frac{\gamma_1 (1 - \gamma_2)}{4} \). Moreover: \( \frac{\gamma_1 (1 - \gamma_2)}{4} \geq \frac{\gamma_1}{8} \iff \frac{1}{2} \geq \gamma_2 \).

Thus, if one or both of the visibilities are smaller than \( \frac{1}{2} \), the two physicians set a maximum ability level: \( \alpha_1 = \alpha_2 = 1 \). On the other hand, if both visibilities are above \( \frac{1}{2} \), two equilibria are feasible: \((\alpha_1 = 1, \alpha_2 = \frac{1}{2\gamma_2})\) and \((\alpha_1 = \frac{1}{2\gamma_1}, \alpha_2 = 1)\).

\[ \square \]