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Regulating Physicians' Prices in the Presence of Health Platforms*

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Online platforms connecting physicians and patients are increasingly common and often operate in heavily regulated contexts. We consider a platform that provides cost-reducing services for physicians and quality-enhancing services for patients. The platform also improves the matching between patients and physicians, thereby increasing competition among the latter. When prices are unregulated, physicians charge different prices online and offline, yet not all join the platform, which is suboptimal in terms of social welfare. The platform may also under- or over-invest in the quality level offered to patients, making their participation suboptimal as well. We then analyze price regulation. Under a single regulated price for medical visits, regardless of the booking channel, all physicians join the platform. However, the first-best allocation cannot be implemented: patient participation remains inefficiently low because patients do not internalize the platform's cost-reducing effect. In contrast, allowing two regulated prices, one for offline visits and one for platform bookings, restores the first best. Overall, our findings suggest that an optimal pricing or reimbursement mechanism should differentiate across booking channels.

JEL Codes: I11, I18, L51, H75.
Keywords: Healthcare online platforms; Price regulation; Patient-physician matching.

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1 Introduction

In recent years, online platforms facilitating the intermediation between physicians and patients experienced enormous growth. These platforms gained momentum in response to the COVID-19 pandemic, which spurred innovation and incentivized the large-scale adoption of existing online booking platforms as well as new telemedicine services (Webster, 2020). In the US, patient adoption of virtual consultation skyrocketed, from 11 percent in 2019 to 46 percent in 2021.[1] Doctolib, a French-German start-up launched in 2013 to connect patients and physicians, experienced a major boost in 2020.[2] Similar patterns have occurred in other European countries (e.g., MioDottore.it in Italy, Doctena.be in Belgium and Luxembourg), in the US (e.g., Teladoc and Zocdoc, *inter alia*), and in many other regions worldwide (e.g., Practo in India and Halodoc in Indonesia). The digital transformation of the healthcare sector is therefore of increasing relevance for both scholars and practitioners in the field, as well as for governments and policymakers.

Healthcare platforms feature a high degree of heterogeneity. Some of them serve as matchmakers between groups (physicians and patients), while others provide complementary services (e.g., appointment-booking services, advanced marketing), or offer a centralized database with patients' referral information and appointments. These platforms typically provide users with the ability to search for healthcare providers based on specialty, location, availability, and other criteria, and then schedule appointments directly through the platform. This booking functionality enhances the convenience and accessibility of healthcare services for patients, allowing them to easily find and schedule appointments with providers that meet their needs.

It is also important to stress that these platforms often operate under particular circumstances. The healthcare sector is indeed distinctive in its regulatory framework, with significant oversight in many countries. Governmental agencies often set caps on tariffs, and negotiations with insurance companies also play a role. For instance, in France and several other European countries, drug prices, physicians' fees, and reimbursement rates for medical consultations are typically fixed.[3] Similar regulatory forces exist elsewhere.

[1] McKinsey Report "Telehealth: A quarter-trillion-dollar post-COVID-19 reality?", available at this link.
[2] "Doctolib: fighting Covid-19 with digital transformation", available at this link.
[3] There is, however, a certain degree of flexibility. For instance, in France, physicians can self-select into

In the US, for example, the One Big Beautiful Bill has modified public reimbursement by tightening Medicaid financing, limiting supplemental payments, and increasing eligibility and cost-sharing requirements.[4] These changes may crucially affect providers' revenues and incentives, as well as digital health platforms' responses.

Although there is a growing body of literature in the economics and management of digital markets on platform pricing strategies and their effects on market participants (Armstrong, 2006; Rochet and Tirole, 2006; Hagiu, 2006; Edelman and Wright, 2015; Bhargava et al., 2022; De Cornière et al., 2025), it remains unclear whether these insights also apply to heavily regulated sectors such as healthcare. This raises the need to examine how regulation affects platform pricing and its implications for access and quality of care.

This paper investigates the incentives for physicians and patients to join a healthcare platform, as well as the welfare effects resulting from this adoption. The platform enables heterogeneous patients to easily find the physician best suited to address their specific needs. Moreover, the platform provides additional benefits for both patients (e.g., by improving their experience through reminders and notifications) and physicians (e.g., by reducing their cost of handling patients), but may also imply entry costs. In addition, physicians adopting the platform become more visible to online patients, leading to increased competitive pressure. In the benchmark scenario (*laissez faire*), physicians are allowed to charge different prices for medical visits booked through the platform compared to visits booked outside the platform. We then explore the possibility for governments to regulate prices, either by imposing one single price, as it is commonly the case in countries with regulated prices, or by setting two distinct prices for online and offline patients.

We consider a setting in which physicians are heterogeneous, and the quality of physicians-patients matches may vary depending on whether interaction occurs through an online platform or not. We formally model this situation using a circular city model *à la* Vickrey (1964) and Salop (1979), and analyze the equilibrium behavior of physicians, patients, and a platform who can invest to attract patients. Notably, we consider the decision of *both* physicians and patients whether to remain *offline* or to join the platform and go *online*.

two groups, called "Sectors". Physicians choosing Sector 1 must adopt the price negotiated by the government and the medical associations, and patients are fully reimbursed. Conversely, physicians in Sector 2 are allowed to charge higher fees within reason, and patients obtain partial reimbursement.

[4] A summary of the health provisions of the One Big Beautiful Bill Act is available at this link.

We assume that all patients seek the same type of medical treatment (e.g., a visit in a given specialty) but may differ in preferences and needs, such as a physician's style of practice (e.g., likelihood of prescribing drugs), available services (e.g., on-site diagnostic tests), location, or appointment availability. These preferences may be patient-specific or related to the medical issue.[5]

In particular, we consider patients seeking treatment for a new condition or symptom, unsure of the particular specialization required within a field, and without prior experience with any physician in that area.[6] They face the option to either remain offline and visit a random physician without knowledge of location and price, or to go online and access the healthcare platform for more information on the physicians present on the platform. If patients seek for a physician offline, they do not have access to the physicians' locations in the product space or their prices at the point of booking the visit. Conversely, the location and price of the physicians that have joined the platform are observable to the patients who visit the platform. This assumption, while somehow extreme, captures the fact that the platform allows patients to better match doctors for their specific current issue.[7]

Patients are not required to pay a membership fee to join the platform.[8] However, they incur a idiosyncratic non-monetary costs of visiting the platform, which can be related to their difficulty in using an online platform, or to their sensitivity to privacy issues. Moreover, patients joining the platform can benefit from quality-enhancing investments provided by the platform. For instance, the platform can provide features in order to allow online patients to easily reschedule their appointments or receive notifications if an earlier time slot becomes available.[9]

[5] For instance, two patients seeking for a cardiologist may have different preferences for doctors belonging to large or small practices. They may also have different diagnostic needs. One of them may thus have a preference for a physician working closely with a hospital performing advanced tests, while the other may just need a simple visit.

[6] We do not focus on repeated interactions between patients and physicians, nor do we assume that offline patients have prior experience with physicians.

[7] This approach is reminiscent of Martens et al. (2021) that, in the context of e-commerce data sharing and potential recommendation bias, assume that only the platform knows the locations of the firms and can allow the consumers to access them.

[8] This is consistent with evidence from the health sector, for example from platforms such as Doctolib and Zocdoc. While there may be instances where patients are required to pay subscription fees for access to certain healthcare platforms (such as those providing virtual consultations, access to specialized content or resources, or priority booking options; an example is Carol Health), this is not typically the standard practice for most general-purpose healthcare platforms.

[9] In addition, platforms such as WebMD, Mayo Clinic, and Healthline not only offer features for booking appointments with healthcare providers but also provide access to educational resources, self-care tools,

Physicians can decide to stay offline, or join the platform. We assume that physicians that join the platform still need to offer to their patients the possibility to book offline. In other words, physicians joining the platform always offer their services on both channels, online and offline. Joining the platform yields benefits to them, including better organization of their schedule and reduced administrative costs. For example, physicians using the health platform can benefit from improvements in appointment scheduling, reduction in 'no shows'[10], and the elimination of gaps between visits. They can also save on secretarial services by taking advantage of the platform for managing their agenda. However, as they become perfectly 'visible' when they appear online, physicians face heightened competitive pressure. Additionally, they are required to pay a membership fee to join the platform.[11]

We first consider the laissez-faire regime, in which prices are unregulated and freely set by physicians. Those physicians who join the platform find it optimal to set two prices, one for visits booked online and one for visits booked offline. We characterize the equilibrium prices, platform's quality investments, and patients' and physicians' participation to the platform. We find that the platform always extracts all the profits that physicians obtain online, and sets the fee in such a way that does not induce full participation by physicians on the platform. This is due to the fact that an increase in physicians' participation increases competition online, leading to lower online prices and lower profits for the platform. The platform strikes a balance between participation and prices, leading to some physicians choosing to remain offline.

We then derive the first-best allocation and examine the inefficiencies brought by the laissez-faire solution relative to the socially optimal level. We show that, for any given price, the allocation of physicians and patients on the platform is suboptimal. Physicians' participation is too low in the laissez faire with respect to the first best because the platform limits competition online, whereas in the first best all physicians participate. As per patients, their participation in the laissez faire can either be excessive or insufficient. This suboptimal participation is attributed to two main factors. First, in the laissez faire,

and information about preventive healthcare measures.

[10]The NHS, for example, has estimated that the cost of each no show to the health system is approximately £160. See, e.g., Hallsworth et al. (2015).

[11]Doctolib typically charges doctors a monthly subscription fee for using its platform. Zocdoc offers different subscription plans for healthcare providers, including monthly fees based on the number of practitioners and the features included in the plan.

patients compare online and offline prices, whose difference does not necessarily reflect the efficiency gain that physicians obtain on the platform. Second, patients take into account the quality investment of the platform, which is not necessarily optimal in the laissez faire. This in turn is justified by the fact that the platform in the laissez faire does not fully internalize neither the efficiency gains (leading to under-investment), nor the participation cost of the infra-marginal patients (leading to over-investment).

Finally, we consider regulated prices that mitigate the distortions arising in a laissez-faire regime. We first focus on the policy-relevant case where the regulated price is the same irrespective of whether the visit was booked online or offline. This is at the moment the case in most countries with regulated physician prices. We find that, with a single regulated price, all physicians join the platform, which is optimal, as there are no incentives for the platform to limit their participation and dampen competition. However, with a single instrument, it is not possible to correct for both the inefficient quality investment of the platform and the inefficient participation of patients. We find that the single price decentralizes the optimal quality investment. However, patients' participation remains too low. Patients, who face the same price irrespective of the booking channel, do not internalize the fact that the platform leads to cost reductions. In other words, the potential gains that could be realized thanks to the platform cannot be fully realized if the regulator does not condition the price to the booking channel.

If the regulator can use two prices, one for visits booked online, and one for visits booked offline, then appropriate prices can decentralize the first-best allocation. Interestingly, we find that the regulated online price is identical to the regulated price set under the single regulated price regime. The regulated offline price is instead set in such a way that the price difference between offline and online visits is exactly equal to the difference in marginal physicians' costs. This ensures the optimal participation of patients on the platform. All in all, our results suggest that, in presence of potentially welfare enhancing platforms, prices faced by patients should depend on the booking channel.

The remainder of the paper is as follows. In Section 2, we discuss the related literature. In Section 3, we present the model setup. In Section 4, we analyze the laissez-faire regime. In Section 5, we characterize the socially optimal participation of patients and physicians. In Section 6, we study optimal price regulation. Section 7 concludes.

2 Related Literature

The health economics literature has mainly focused on price regulation and its impact on entry, quality of health services, and innovation. These questions have been investigated in the context of the pharmaceutical sector (see, among others, Brekke et al., 2007, 2016; Bardey et al., 2016; Kyle, 2025), or in the context of hospital price regulation (see, for instance, Ma, 1994; Salkever, 2000; Chen and Miraldo, 2022). A detailed review of key issues in health care price regulation can be found in Newhouse (2002) and the more recent Barber et al. (2019), which examines the institutions established for health care price setting and regulation and determine how different countries have implemented pricing strategies.

In contrast, the literature on platforms within the health sector is rather sparse. Pezzino and Pignataro (2008) and Bardey and Siciliani (2021) model hospitals and nursing homes as a two-sided market with patients on the one hand and physicians and nurses on the other. Cross-side network externalities arise as patients prefer hospitals (nursing homes) with more physicians (nurses). Bardey and Rochet (2010) apply a two-sided market approach to health insurance companies, modeled as intermediaries between health care providers and patients. Insurance companies negotiate physicians' prices, so that the latter cannot freely set prices. Dutta et al. (2022) study a game where hospitals compete for physicians as well as patients in order to address the issue of dual practice in developing countries.

Close contributions to ours are Li et al. (2022) and Li et al. (2023), who study an online healthcare platform which provides both medical services to patients by connecting them with doctors and also sells medical products to patients. The platform obtains revenues from both sides of the market, through doctors' subscription and patients' demand for medicines. This dual revenue stream is rather peculiar, and characterizing the specific case study that they address, the Chinese platform 111.com. In particular, Li et al. (2022) focus on the interaction between platform services investment and pricing, whereas Li et al. (2023) study the optimal pricing for the platform. They emphasize the interconnections between participation and pricing affecting both sides. Insufficiently acknowledging these cross-sides synergies can result in suboptimal decision making by the platform.

To the best of our knowledge, however, there is no prior work studying the interplay between platform design, pricing, and price regulation in the healthcare sector. We set up our model to encompass the fundamental characteristics of the healthcare sector and, in particular, the situation of patients looking for a physician's consultation through an online booking platform. Notwithstanding this specificity, our model is related to any platform facing price regulation on (at least) one side of the market. Examples of price regulations related to platforms can be found with references to digital payments (Rochet and Tirole, 2011) and commission fees (Tirole and Bisceglia, 2023; Gomes and Mantovani, 2025; Wang and Wright, 2025).

In certain legislations prices are predetermined and identical online and offline, and this is a scenarios that we explicitly consider in our work. As a result, this research project relates to the recent theoretical and empirical literature on price parity clauses. These clauses are often adopted by dominant platforms and mandate that sellers can not post lower prices outside of the platform, which can potentially limit the attractiveness of other sales channels. The theoretical literature mainly emphasized the anticompetitive effect of these clauses (Edelman and Wright, 2015; Boik and Corts, 2016; Avilés-Lucero and Boik, 2018; Johnson, 2017; Wang and Wright, 2020; Calzada et al., 2022), with the partial exception of Johansen and Vergé (2017) and Liu et al. (2021). The empirical literature focused instead on the effect of the elimination of price parities (Hunold et al., 2018; Mantovani et al., 2021; Ennis et al., 2023; Ma et al., 2026), finding beneficial effects in terms of reduced prices. We contribute to this literature by studying price regulation in a second-best environment and how this affects the participation levels in the two-sides of the market, as well as how it potentially mitigates the distortions resulting from the availability of an online intermediary in a world in which all transactions traditionally occurred offline.

In this spirit, the presence of online platforms can affect the dynamics of the sector of physicians' consultations, which has been traditionally offline and with a relatively limited adoption of information technology solutions. Hence, our work relates to the recent and fast developing literature on the impact of digitization in health care. Digital tools have the potential to help and support the activity of physicians as, for example, through the adoption of electronic medical records (Bhargava and Mishra, 2014) or by using machine learning decision making tools in the choice of therapy and the use of antibiotics (Huang et al., 2022; Ribers and Ullrich, 2023). The COVID-19 pandemic has represented a turning point for the adoption of information technology in healthcare and, in particular, on the adoption of telemedicine solutions. Zeltzer et al. (2023b) study the adoption of a digital device that allows to carry on medical examinations at home. The use of the device, complemented with a telehealth consultation, resulted in a 12% higher utilization of primary care and increased use of antibiotics. At the same time, adoption lowers the use of urgent care, the emergency room, and hospitalization, with no significant increase in the overall costs. Relatedly, Zeltzer et al. (2023a) study primary care episodes before and after the lockdown between patients with high and low access to telemedicine. Telemedicine led to slightly more primary care visits but fewer prescriptions and no missed diagnoses or adverse outcomes.

Information technology and access to the internet more in general can benefit patients in their search for information in healthcare (Amaral-Garcia et al., 2022; Brown et al., 2023). In other sectors, it has been demonstrated that online platforms facilitating access to relevant information can enhance welfare, particularly in situations where there is uncertainty regarding the quality of received services (Aguiar and Waldfogel, 2018; Reimers and Waldfogel, 2021, among others).

In the healthcare sector, Kummer et al. (2022) use physician retirements as a shock that forces patients to find a new physician. They gather insurance claims data and combine them with web-scraped physician reviews from an online platform. The results show that reviews help patients find a new physician faster. By reducing interruptions in care, reviews can improve clinical outcomes and lower healthcare costs. Zhan et al. (2024) note that online healthcare platforms can enhance access and equity in the sector, but also exacerbate information asymmetry due to the vast number of doctors available online. They investigate the impact of platform endorsement to mitigate the effect information overload. The "Good Doctor of the Year" endorsement program by a leading Chinese platform boosted demand for endorsed doctors, who increased their prices while maintaining service quality. However, endorsed doctors also decreased "pro bono" services, to the detriment of underprivileged patients. While our work adopts a theoretical perspective and includes modeling the information impact of online healthcare platforms, our primary focus lies in examining their interplay with physician pricing and platform dynamics.

3 The Model

We consider a market in which an online intermediary platform allows patients seeking a treatment or consultation to reserve a visit from specialized physicians.[12] There is a unit mass of patients seeking medical treatment, and there are $N > 2$ physicians who offer their professional services in the market. Both patients and physicians decide whether or not to join the platform. Let $n \leq N$ denote the number of physicians joining the platform. In order to present the model's main characteristics, we consider in turn patients, physicians, and the platform.

Patients Patients all need one medical treatment, from which they obtain a benefit. Patients differ in their preferences or need for physicians' practices, medical specialization, or availability. For example, certain patients may prefer a physician who has graduated from a specific medical school or specializes in a particular discipline, such as sports medicine. Alternatively, within a field of specialization, say dermatology, the patient may need a doctor that has expertise in the evaluation of skin lesions, rather than aesthetics procedures. Outside the platform, patients are unaware of both the exact specialization and the price charged by the physician. On the contrary, when using the platform, patients receive full information about the physicians' characteristics and the price they charge.

We use a model à la Vickrey (1964) and Salop (1979) to capture patient heterogeneity, with the unit mass of the patient population uniformly distributed along a circle of unit length, whether they opt to remain offline or seek an appointment online.[13] We denote their location by x and assume they obtain a fixed benefit v from getting medical treatment. Patients are also heterogeneous in the cost of using the platform, denoted by $\xi \sim U \in [0, 1]$. This parameter captures various potential costs such as privacy concerns related to sharing data with the platform or learning how to use the platform.[14]

[12]Throughout the paper, we use the term physicians, but platforms may also cater to specialized health providers, diagnostic labs, and health care centers.

[13]From patients' perspective, both offline and online physicians are uniformly distributed around a circle with a unit circumference. In this context, location can be conceptualized as the physician's specialization (e.g., dermatology, gastroenterology, etc.) or medical practice, as previously introduced. This understanding allows us to consider the spatial distribution of doctors based on their respective areas of medical expertise. Alternatively, one may interpret the location as representing the availability of time slots over time, which may be perceived as more or less attractive by different patients.

[14]Here we assume that the cost is greater than or equal to zero. For some patients, it may actually be

A patient using the platform can select a physician from among the $n \leq N$ listed on the platform, based on match value and prices. In particular, a patient with cost ξ and location x who books a visit with physician i located at x_i along the "platform Salop circle" enjoys utility:

$$U^{on}(x_i, \xi) = v + \phi - t|x - x_i| - \xi - p_i,$$

with $|x - x_i|$ being the distance between the patient and a physician i on the platform, and ϕ being an extra quality or service offered by the platform. This parameter reflects the platform's ability to implement services aimed at enhancing reservation convenience, such as SMS appointment reminders or alerts for available slots with specific doctors. This constitutes an investment by the platform that enhances the perceived quality from the patients' perspective.

Conversely, a patient who decides not to use the platform will need to find a physician through offline means. In such case, we assume that the patient will be randomly matched with a doctor on the "offline Salop circle", obtaining utility:

$$U^{off}(x) = v - t\mathbb{E}[|x - x_i|] - E[p_i] = v - \frac{t}{4} - E[p_i].$$

With respect to online booking, offline booking does not allow patients to benefit from the platform quality ϕ, and from the potentially better matching due to the fact that patients can observe the location (specialization) of physicians. Nevertheless, offline booking does not involve the cost ξ, making the platform more appealing to patients with a low ξ. Clearly, once patients have incurred the cost ξ and have decided to use the platform, they do not consider the option of booking offline, where no information is available. Patients decide to use the platform if and only if $EU^{on} \geq EU^{off}$. This condition set to equality defines the cost of the indifferent patient joining the platform $\widehat{\xi}$. All the patients with a cost lower than this threshold join the platform.

Physicians There are $N > 2$ physicians who decide whether to join the platform or not. To enroll and use the platform, physicians pay a fixed membership fee F. Note that

more convenient to use the platform. Assuming that the cost of joining the platform is negative for some patients would not change our results, as long as some patients have a positive cost. For example, $\xi \in [\underline{\xi}, \overline{\xi}]$, with $\underline{\xi} \lesseqgtr 0$ and $\overline{\xi} > 0$.

this practice is consistent with recent evidence from several online health platforms (e.g., Doctolib). Additionally, the presence of a fixed membership fee also offers the advantage of preventing platform leakages and disintermediation. Consistent with the advocacy of their profession, the number of physicians $n \leq N$ who choose to join the platform also continue to serve the offline market.

In the absence of regulation, physicians operating both online on the platform and offline can potentially set different prices across the two booking modalities. We denote these prices as p^{on} for online bookings and p^{off} for offline bookings, respectively. For each visit, a physician incurs a marginal cost c^{on} if the patient has booked the visit on the platform. Conversely, if the visit was booked outside the platform, the marginal cost is c^{off}, with $c^{on} < c^{off}$. This distinction reflects the benefits for physicians provided by healthcare platforms in reducing 'no-shows', minimizing gaps between reserved visits, and facilitating the management of invoices and tax-related documents.[15]

The profit of physicians $i = 1...n$ who are both online and offline can be expressed as

$$\pi_i^{on} = (p_i^{on} - c^{on})D_i^{on} - F + (p_i^{off} - c^{off})D_i^{off},$$

where $D^{on} = \sum_i D_i^{on}$ represents the mass of patients booking online while $D^{off} = 1 - D^{on}$ is the mass of patients booking offline, of which firm i gets and amount D_i^{off}. Finally, F is the fee set by the platform.

The profit function of those physicians who exclusively operate offline is instead given by:

$$\pi_j^{off} = (p_j^{off} - c^{off})D_j^{off}.$$

Platform The platform operates as a monopolistic information service, charging physicians a fixed tariff F for access in exchange for its more efficient intermediation service,

[15] For example, in Italy, patients can obtain a partial refund of their consultation fees upon presentation of documents to the Tax Agency. Specifically, taxpayers can deduct medical fees incurred the previous year in occasion of the annual tax return and physicians are required to include the tax code of a patient in the invoice. In the US, reimbursement arrangements usually depend on insurance coverage. Under Medicare, physician fees are determined by an administratively set fee schedule based on relative value units. Privately insured patients may face negotiated rates between insurers and providers, often combined with deductibles and co-payments. Uninsured patients may be billed list prices, which can be substantially higher than negotiated reimbursement rates.

as evidenced by $c^{on} < c^{off}$. This model reflects the notion that physicians can optimize their schedules and maximize patient interactions when using the platform, all else being equal. Additionally, the platform offers its services to patients free of charge.

The platform also chooses the quality level ϕ, which entails a cost $k\phi^2/2$, where k is the marginal cost of investment. The profit of the platform is thus given by:

$$\Pi = nF - k\frac{\phi^2}{2}.$$

We assume that the marginal cost of investment is sufficiently high to ensure profit concavity, i.e., $k > 1$.

Timing The timing we consider is the following:

0. if the price is regulated, the regulator sets prices (either a single price or a price online and a price offline);
1. the platform sets its participation fee F and invests in ϕ;
2. physicians decide whether to join the platform or not;
3. patients decide whether to book a visit on or outside the platform;
4. if the price is not regulated, physicians set prices p^{on} and p^{off} for online and offline visits;
5. patients book their visit: if they are offline, they will be randomly assigned to a doctor; if they are online, they observe the location and price of each doctor.

We solve the model by backward induction and the equilibrium concept is subgame perfect with fulfilled expectations.

4 Laissez Faire

We assume that prices are not regulated, so that the game starts in stage 1, with physicians freely setting prices in stage 4. We solve the model by backward induction, beginning from the last stage of in which patients book their visit either offline or online. We assume that physicians are allowed to discriminate patients depending on the booking channel.

4.1 Patients' choice of physician

In stage 5, patients have already decided whether to join the platform or not. Let us define $D^{on} \in [0,1]$ the share of patients booking online, and by $D^{off} = 1 - D^{on}$ the share of patients booking offline.

Online, physicians on the platform are distributed uniformly along the Salop circle. Consider a patient whose location x lies between the locations of physician i and $i+1$. Since physicians are distributed uniformly, the distance between two of them is $1/n$. The patient's utility when booking on the platform a visit with physician i located at x_i is given by

$$U_x^i = v + \phi - t|x - x_i| - p_i,$$

whereas the utility from booking with physician $i+1$ located at x_{i+1} is

$$U_x^{i+1} = v + \phi - t|x_i + \frac{1}{n} - x| - p_{i+1}.$$

The patient is indifferent between the two physicians if and only if $x = 1/2n + (p_{i+1} - p_i)/2t$, which is equal to the demand for doctor i on one side. Applying the same reasoning for patients located between physicians i and $i-1$, we obtain that the demand online for physician i is equal to:[16]

$$D_i^{on} = D^{on}\left(\frac{1}{n} + \frac{p_{i+1} + p_{i-1} - 2p_i}{2t}\right).$$

For identical prices $p_i = p_{i+1} = p_{i-1}$, the online demand faced by a physician is the total demand online divided by the number of physicians that join the platform.

Offline, patients are randomly allocated to physicians, irrespective of their prices and their location. Then, physicians i faces an offline demand equal to:

$$D_i^{off} = \frac{D^{off}}{N}.$$

[16]We assume that the market is covered. See Assumption (2) below.

This demand is thus equal for all physicians irrespective of whether they are present online or not.

4.2 Physicians' prices

Offline, physicians receive patients randomly, which allows them to exploit their market power. We implicitly assume that patients need to call or visit each physician to learn their price, and this entails a search cost. In this context, the Diamond paradox applies, and the price is equal to the monopoly one. Then, physicians set a price equal to the value of the treatment v net of the average mismatch cost (physicians cannot charge contingent prices based on patients' locations). Thus, the offline price is[17]

$$p^{off} = v - t/4.$$

In order to ensure that physicians make positive profits we make the following assumption:

Assumption 1. ***Positive profits:*** $v - \frac{t}{4} > c^{off}$.

Online, each physician i maximizes the online profit

$$\pi_i^{on} = \left(p_i^{on} - c^{on}\right) D^{on} \left(\frac{1}{n} + \frac{p_{i+1} + p_{i-1} - 2p_i}{2t}\right) - F$$

with respect to p_i^{on}. Solving the first order condition of physicians and setting $p_i = p_{i+1} = p_{i-1}$ $\forall i = 1, ..., n$, it is trivial to show that the symmetric online price at equilibrium is

$$p^{on}(n) = c^{on} + \frac{t}{n}.$$

Then, the online equilibrium price increases in the marginal cost and in the mistmatch cost t, while it decreases as the number of physicians on the platform. The price is always greater than the marginal cost. Moreover, since all physicians on the platform deliver extra-utility ϕ, a convenience benefit perceived as higher quality, this is not ultimately passed onto prices.

[17]Note that this also means that some patients have a negative ex post utility.

For this to be the equilibrium price, it must be true that all patients prefer to be treated rather than go untreated. This is true if and only if

$$v + \phi - p^{on} - \frac{t}{2n} \geq 0 \iff v + \phi \geq c^{on} + \frac{3t}{2n}.$$

We make the following assumption, which ensures that the condition above holds and that the market is covered:

Assumption 2. ***Market coverage:*** $v - c^{on} + \phi \geq \frac{3t}{2n}$.

We have then established the following lemma:

Lemma 1. *Under assumptions (1) and (2), for a given number of physicians online n, the equilibrium prices are*

$$p^{on}(n) = c^{on} + \frac{t}{n}, \qquad p^{off} = v - \frac{t}{4}.$$

4.3 Patients' participation to the platform

In stage 3, patients decide whether to join and use the platform or not. Patients join the platform if the expected utility online is weakly larger than the expected utility offline. Namely, patients join the platform if $EU^{on} \geq EU^{off}$, that is if

$$v + \phi - \frac{t}{4n} - p^{on} - \xi \geq v - \frac{t}{4} - p^{off},$$

and book an appointment offline, otherwise. It is important to emphasize that, in a symmetric equilibrium, patients choose the closest physician when they book online. Since the distance between physicians is $1/n$, the maximal distance between a patient and the closest physician is $1/2n$. Since the patient expects their distance from the closest physician to be uniformly distributed between 0 and $1/2n$, the average transportation cost is equal to $t/4n$, which is decreasing in n. Conversely, if the patient stays offline, they are randomly allocated to a physician. The distance to the assigned physician is uniformly distributed between 0 and $1/2$, yielding an expected transportation cost of $t/4$.

Rearranging the condition above, it can be shown that there exists a marginal patient that is indifferent between reserving a consultation online or offline. This patient has a cost of joining the platform equal to

$$\widehat{\xi} \equiv \phi + \frac{t(n-1)}{4n} + (p^{off} - p^{on}).$$

All patients with $\xi \leq \widehat{\xi}$ join the platform, and the others stay offline. Using the equilibrium online and offline prices (see Lemma 1), it is then straightforward to obtain the online demand as a function of ϕ and n

$$D^{on}(\phi, n) = \widehat{\xi} = \min\left\{v + \phi - c^{on} - \frac{5t}{4n}, 1\right\}, \tag{1}$$

which is always positive under the market coverage assumption.

The participation of patients to the platform is increasing in the benefit of the treatment, the quality investment of the platform, and the number of physicians on the platform. It decreases as the marginal cost faced online by the physicians increases, as the degree of differentiation of physicians (captured by t) increases. This latter effect is counter intuitive, since one would expect that a higher transportation cost would make the platform, which allows for better matches, more attractive. However, a higher t also translates in a higher price online (while it has a negative impact on the price offline). Overall this latter effect dominates.

Throughout the analysis below we focus on the interesting cases where some patients join the platform even if few doctors do, and where not all patients join the platform in equilibrium, by making the following assumption:

Assumption 3. ***Interior Patients' Participation:*** $\frac{5t}{4n} < v - c^{on} + \phi < 1 + \frac{5t}{4n}$.

4.4 Physicians' participation to the platform

In stage 2, physicians choose whether to join the platform or not. In equilibrium, physicians prefer to join the platform as long as $\pi^{off} \leq \pi^{on}$. The profit obtained by physicians when staying offline is

$$\pi^{off} = \left(v - \frac{t}{4} - c^{off}\right)\frac{(1-\widehat{\xi})}{N}$$

which decreases in n since $\widehat{\xi}$ increases in n. The profit obtained by physicians when joining the platform is

$$\pi^{on} = \left(v - \frac{t}{4} - c^{off}\right)\frac{(1 - D^{on}(\phi, n))}{N} + \frac{tD^{on}(\phi, n)}{n^2} - F.$$

4.5 Platform's behavior

Since physicians are homogeneous, the platform can extract their online rents, making them indifferent between joining the platform or not. The instrument the platform can use to make them indifferent is the fixed membership fee F. Let us denote the laissez-faire equilibrium allocation with a superscript *. For given levels of ϕ and n the platform sets a fee

$$F^{\star}(\phi, n) = \left\{F|\pi^{off} = \pi^{on}\right\} = \frac{t\left(v + \phi - c^{on} - \frac{5t}{4n}\right)}{n^2},$$

The membership fee increases with the level of investment, as this generates greater patient participation on the platform. However, this increase is not directly internalized through prices set by the physicians.

For given levels of ϕ and n the profit of the platform is

$$\Pi(\phi, n) = F^{*}(\phi, n)n - k\phi^2/2.$$

The platform maximizes its profit with respect to n and ϕ. For a given quality ϕ, the optimal number of doctors on the platform is then given by the first order condition with respect to n. In an interior solution, we obtain.

$$n^{\star}(\phi) \equiv \frac{5t}{2(v + \phi - c^{on})}.$$

The optimal level of investment is given by

$$\phi^{\star} = \frac{2(v - c^{on})}{5k - 2},$$

which in turn implies that the equilibrium number of doctors on the platform is

$$n^\star = \frac{t(5k-2)}{2k(v-c^{on})}.$$

This solution is interior if $N^\star \in (2, N)$, which is the case if the following assumption is satisfied (which we assume throughout the rest of the paper):

Assumption 4. $\frac{t(5k-2)}{2kN} < v - c^{on} < \frac{t(5k-2)}{4k}$.

Substituting for ϕ^* and n^* in (1), we also have

$$D^\star = \widehat{\xi}^* = \frac{5k(v-c^{on})}{2(5k-2)}.$$

which is always smaller than or equal to 1 under Assumption (3).

The equilibrium platform's fee is

$$F^\star = \frac{10k^3(v-c^{on})^3}{t(5k-2)^3}.$$

Using these results, we can establish our first main result in the following proposition.

Proposition 1. *In the laissez-faire regime, under assumptions (1)-(4), not all doctors join the healthcare platform, i.e.,* $n^\star < N$. *Moreover, not all patients join the platform as well, i.e.,* $D^\star \leq 1$. *The equilibrium prices are discriminatory according to the reservation channel; i.e.,*

$$p^{off} = v - \frac{t}{4}$$

and

$$p^{on} = \frac{c^{on}(3k-2) + 2kv}{5k-2}$$

and the level of investment by the platform at equilibrium is

$$\phi^\star = \frac{2(v-c^{on})}{5k-2}.$$

Furthermore, the price online may be lower or greater than the price offline, with

$$p^{off} > p^{on} \iff v - c^{on} > \frac{t(5k-2)}{4(3k-2)}. \tag{2}$$

Proof. The equilibrium prices, quality effort, and participation to the platform have been derived above. The online price depends on the number of physicians that ultimately join the platform, and is obtained by substituting $n^\star$ in $p^{on} = c^{on} + t/n$.

□

The intuition between these results is linked to the fact that the platform determines the number of physicians online. As the platform's investment cost, k, decreases, the investment of the platform increases. Also, as the platform becomes more attractive to consumers (through a higher investment or a low c^{on}, the demand online increases, and this pushes the platform to reduce the number of physicians online in order to keep down the competitive pressure. Then, a decrease in the cost k also leads to fewer physicians being admitted to the platform.

This also explains our results on the price difference between online and offline visits is the following. As the platform's investment cost, k, increases, the investment of the platform decreases, and the number of physicians that the platform lets on the platform increases. As the number of physicians decreases, the price increases. Then, for high levels of k, condition (3) becomes less likely to be satisfied and the price online may be higher than the one offline. A similar intuition holds for an increase in c^{on}. As this cost drops, fewer doctors will be admitted online, leading to higher prices, potentially higher than the offline ones.

To further characterize equilibrium market power, we examine the relationship between prices and marginal costs

Lemma 2. *A comparison of price and cost differentials yields:*

$$p^{off} - p^{on} \geq c^{off} - c^{on} \iff v - c^{on} \geq \frac{(c^{off} - c^{on} + \frac{t}{4})(5k-2)}{(3k-2)}. \tag{3}$$

If the difference between offline and online price is larger than the difference in marginal costs, then offline physicians offline enjoy greater market power than online operating ones; the opposite holds otherwise. In other words, there is a higher market power offline if v is sufficiently large, that is whenever the treatment offered by the physicians creates, at equilibrium, a sufficiently large utility for the patients. Since the physicians operate offline as a monopolist, and as they receive patients randomly, then they can charge a high price, which increases with v. Then, the offline price does not depend on the marginal offline cost.

5 First best allocation

We assume that the regulator maximizes social welfare, defined as the sum of patients' surplus, physicians' surplus, and the platform's profits. Under a symmetric allocation, social welfare can be written as follows:

$$
\begin{aligned}
SW(\hat{\xi}, n, \phi, p^{on}, p^{off}) =& CS + n\pi^{on} + (N-n)\pi^{off} + \Pi \\
=& \int_0^{\widehat{\xi}} \left(v + \phi - \frac{t}{4n} - p^{on} - \xi\right) d\xi + \int_{\widehat{\xi}}^1 \left(v - \frac{t}{4} - p^{off}\right) d\xi \\
&+ (p^{on} - c^{on})\widehat{\xi} + (p^{off} - c^{off})(1-\widehat{\xi}) - Fn + Fn - k\frac{\phi^2}{2} \\
=& v + \left(\phi - \frac{t}{4n} - c^{on}\right)\widehat{\xi} - \frac{\widehat{\xi}^2}{2} - (1-\widehat{\xi})\left(\frac{t}{4} + c^{off}\right) - k\frac{\phi^2}{2}.
\end{aligned}
$$

Not surprisingly, because prices are just transfers, they cancel out from the social welfare function. In the first best, the regulator can control $\widehat{\xi}$, n, and ϕ. Then, the problem of the regulator is to maximize the equation above with respect to these variables.

The derivatives of the social welfare function with respect to n, $\widehat{\xi}$, and ϕ are, respectively

$$
\frac{\partial SW}{\partial n} = \frac{t\widehat{\xi}}{4n^2}, \tag{4}
$$

$$
\frac{\partial SW}{\partial \widehat{\xi}} = \phi + \frac{t(n-1)}{4n} + (c^{off} - c^{on}) - \widehat{\xi}, \tag{5}
$$

and

$$\frac{\partial SW}{\partial \phi} = \widehat{\xi} - k\phi. \tag{6}$$

Using them all together, we can establish the following proposition:

Proposition 2. *Let us denote with a superscript O the first-best allocation. In the first best, the participation of physicians and patients to the platform, and the platform investment level are, respectively*

$$n^O = N,$$

$$D^O = \widehat{\xi}^O = \frac{k}{k-1}\left[(c^{off} - c^{on}) + \frac{t(N-1)}{4N}\right],$$

and

$$\phi^O = \frac{(c^{off} - c^{on}) + \frac{t(N-1)}{4N}}{k-1}.$$

Proof. From (4), it follows that the social welfare function is always increasing in n so that, in the first best, all doctors should be online. Then, $n^O = N$. Simultaneously setting (5) and (6) equal to zero, evaluated at $n = N$, yields the optimal levels $\widehat{\xi}^O$ and ϕ^O. □

From the definition of ϕ^O and $\widehat{\xi}^O$, we can compute the comparative statics with respect to the model parameter. Both ϕ^O and $\widehat{\xi}^O$ increase in the cost efficiency of the platform $(c^{off} - c^{on})$. They also both increase in the matching efficiency of the platform, i.e., $t(N-1)/4N$, and they both decrease when the cost of the quality investment k increases.

5.1 Laissez faire vs first best

We can now compare the first-best outcome with the one that arises at the market equilibrium. In equilibrium, too few doctors join the platform ($n^* < N = n^O$). This is due to the fact that the platform anticipates the (negative) impact of entry on prices. Then, to limit competition, it sets the fee such that only a subset of doctors joins the platform.

Interestingly, when comparing the level of investment that the first best could generate with the one arising at the market equilibrium, we find that the platform may over-invest or under-invest in quality. Specifically, it over-invests if and only if

$$\phi^* \geq \phi^O \iff \frac{2(v - c^{on})}{5k - 2} \geq \frac{c^{off} - c^{on} + \frac{t(N-1)}{4N}}{k - 1}, \tag{7}$$

which in turn implies

$$v - c^{on} \geq \frac{(5k-2)\left(c^{off} - c^{on} + \frac{t(N-1)}{4N}\right)}{2(k-1)}. \tag{8}$$

This condition is more likely to be satisfied, and the platform is more likely to over-invest if k is high, v is high, or N is small. It is also more likely to occur when c^{on} is high and c^{off} is low.

The intuition is as follows. Two opposite effects are present. First, the platform only internalizes the cost ξ of the marginal patient, but not the cost of inframarginal patients. This effect leads towards over-investment, as the platform finds it optimal to attract more patients than optimal. Second, since the platform does not internalize the gain in efficiency $(c^{off} - c^{on} + t(N-1)/4N)$ of attracting more patients, it has incentives to under-invest. The net effect depends on the strength of these two opposite effects. When the former prevails over the latter, then the platform is more likely to over-invest. Conversely, it under-invests when the former effect is offset by the latter.

Let us now turn to the comparison between patient participation in the first best and in the laissez faire. Setting (5) equal to zero, yields

$$\widehat{\xi}^O = \phi^O + \frac{t(n-1)}{4n} + (c^{off} - c^{on}).$$

The optimal demand online $D^O = \widehat{\xi}^O$ is thus the result of a similar trade-off than in equilibrium, where the number of patients equals the difference between the expected utilities online and offline: $\phi^* + t(n-1)/4n + (p^{off} - p^{on})$. The comparison between first-best and laissez-faire participation depends on whether ϕ^O is greater or equal than ϕ^*, and on the comparison between $(c^{off} - c^{on})$ and $(p^{off} - p^{on})$. Intuitively, if the platform over-invests (under-invests) in the laissez faire, this pushes towards more (less) patients using the platform than it would be optimal. Similarly, if physicians set prices in such a way that the price difference is greater (smaller) than the efficiency gain from the platform, this pushes towards more (less) patients using the platform than it would be optimal.

If condition (8) holds, then $\phi^* \geq \phi^O$. Furthermore, condition (8) implies (3), so that $(p^{off} - p^{on}) \geq (c^{off} - c^{on})$. Then, patient participation to the platform is always higher than optimal in the laissez faire, i.e., $\widehat{\xi}^* > \widehat{\xi}^O$. Conversely, if condition (8) does not hold, then $\phi^* < \phi^O$, and $(p^{off} - p^{on}) \lesseqgtr (c^{off} - c^{on})$. It follows that there could be over- or under-participation of patients to the platform.

We summarize our results in the following proposition:

Proposition 3. *In the laissez-faire regime the platform leads to lower participation of physicians relative to the first best. Moreover, the platform over-invests in quality if and only if condition (8) holds. If the platform over-invests in quality, there is always over-participation of patients to the platform. Otherwise, patients' participation in the laissez faire may be greater than or equal to the first best.*

6 Regulation

In the previous section, we showed that the laissez-faire allocation does not achieve the first-best outcome. Therefore, there is scope for government intervention to correct such market inefficiencies.

In this section, we study the optimal physicians' price regulation. In the healthcare sector, price regulation can take various forms, including setting price ceilings, price floors, or price controls. In the US, for instance, reimbursement rates set by the Centers for Medicare and Medicaid Services act as price ceilings for healthcare services provided to Medicare and Medicaid beneficiaries. Similarly, in Canada, the federal government negotiates drug prices with pharmaceutical manufacturers, serving as price ceilings for prescription drugs. The French government, as previously mentioned, regulates healthcare prices through a fee schedule system known as the 'Tarif de Convention', which establishes the price of a medical visit and the percentage refunded by the state.

In our model, we assume that patients pay the full price of physician's visits. However, our results carry over to the introduction of health insurance with patients paying only a fraction of their health expenditures.

Without loss of generality, we abstract from specific examples and consider the case in which the price of the medical visit is set by the regulator. We first assume that the regulator sets a single price, irrespective of whether patients book the visit online or offline. Then, we consider the case where the regulator sets two prices: one for medical appointments booked online and one for those booked offline.

6.1 One-price regulation

We first consider the case where the regulator sets a single price. This is often the case in physicians markets.[18] Let us denote p the regulated price, and by a superscript R the single-price regulation scenario.

Since the price is the same irrespective of whether the visit was booked online or offline, its level does not affect patients' decisions to join the platform. Patients join the platform if and only if

$$EU^{on}(\phi, n, p) \equiv v + \phi - \frac{t}{4n} - p - \xi \geq EU^{off}(p) \equiv v - \frac{t}{4} - p.$$

Defining by $\widehat{\xi}^R$ the marginal patient indifferent between joining the platform or not, we find that the participation of patients to the platform is

$$D^{on,R}(\phi, n, p) = \widehat{\xi}^R = \min\left\{\frac{(n-1)t}{4n} + \phi, 1\right\}.$$

We focus on the interior case where $\phi + t(n-1)/4n < 1$.

Since all physicians have the same price, patients are randomly allocated to physicians offline, and just choose the closest doctor offline. Then, the profit of physicians online and offline are, respectively

$$\pi^{on,R}(\phi, n, p) = \frac{p - c^{on}}{n}\left(\frac{(n-1)t}{4n} + \phi\right) - F^R + \frac{p - c^{off}}{N},$$

[18] It is for instance the case in France, where there is no distinction between booking channels when it comes to the regulated price.

whereas the profit offline is given by the following

$$\pi^{off,R}(p) = \frac{p - c^{off}}{N}.$$

Since physicians are homogeneous, the platform can extract all online rents by setting

$$F^R(\phi, n, p) = F|_{\pi^{off,R}=\pi^{on,R}} = \frac{(p - c^{on})(n(t + 4\phi) - t)}{4n^2}.$$

The profit of the platform can then be written as

$$\Pi^R(\phi, n, p) = F^R n - k\frac{\phi^2}{2} = \frac{(p - c^{on})(n(t + 4\phi) - t)}{4n} - k\frac{\phi^2}{2}.$$

The platform maximizes profits with respect to n and ϕ. The profit is monotonically increasing in the number of doctors on the platform, since,

$$\frac{\partial \Pi^R(\phi, n, p)}{\partial n} = \frac{t(p - c^{on})}{4n^2} > 0.$$

Then, the platform finds it profit-maximizing to set the fee in such a way that all doctors join the platform so that $n^R = N$. This result is intuitive: since the price is regulated, increasing n does not have any impact on the online price. As a result, the platform has no incentive to limit entry in order to dampen online competition and sustain higher prices. Increasing the number of doctors online has only the effect to increase the revenues of the platform through the collection of membership fees.

The quality investment of the platform is given by the first-order condition of the profit with respect to ϕ. Re-arranging it, one can obtain the following level of quality investment:

$$\phi^R(p) = \frac{p - c^{on}}{k}, \tag{9}$$

which increases in the margin per patient, i.e., $p - c^{on}$. This is due to fact that the platform extract this margin via the participation fee charged to physicians. Not surprisingly, the quality investment also decreases in the cost parameter k.

Given $\phi^R(p)$ and $n^R = N$, the number of patients on the platform is

$$D^{on,R}(p) = \widehat{\xi}^R = \phi^R + \frac{t(N-1)}{4N} = \frac{p - c^{on}}{k} + \frac{t(N-1)}{4N}.$$

In stage 0, the regulator maximizes the social welfare with respect to p, taking into account that all doctors will join the platform, irrespective of the price level. After some intermediate manipulations, one can write the social welfare as follows:

$$\begin{aligned} SW^R(p) &= CS + N\pi^{on,\mathrm{R}} + \Pi^R \\ &= v - \frac{t}{4} + \left(\phi^R(p) + \frac{t(N-1)}{4N} + c^{off} - c^{on}\right) D^{on,R}(p) - \frac{\left(D^{on,R}(p)\right)^2}{2} - k\frac{(\phi^R(p))^2}{2}. \end{aligned}$$

The regulated price, obtained by the first-order condition of the regulator's problem is given by

$$p = \frac{kc^{off} - c^{on} + k\frac{(N-1)t}{4N}}{(k-1)}, \tag{10}$$

which increases as c^{off} and t increase, while it decreases as c^{on} and k increase. In words, the price increases (decreases) as the platform becomes more efficient relative to the offline alternative. This is due to the fact that a higher p translates into a higher $\phi^R(p)$, which in turns attracts more patients to the platform. For similar reasons, if the cost of the platform's quality investment k increases, the optimal price decrease. Conversely, the optimal regulated price increases in the gain in matching quality allowed by the platform, captured by t. All in all, as the platform becomes more efficient, the optimal regulated price increases.

Substituting this regulated price in (9), it is easy to show that $\phi^R = \phi^O$. Then, the regulated price decentralizes the first-best platform quality investment. However, it does not decentralize the optimal demand. Under a single regulated price, the online participation of patients is too low with respect to the first best, as

$$\widehat{\xi}^R = \phi^R + \frac{t(N-1)}{4N} = \phi^0 + \frac{t(N-1)}{4N} < \phi^0 + \frac{t(N-1)}{4N} + (c^{off} - c^{on}) = \widehat{\xi}^O.$$

Patients do not internalize the efficiency difference between online and offline booking. Then, for the same level of quality ϕ, there will be under-participation of patients to the platform. Our results can be summarized in the following proposition:

Proposition 4. *If the regulator can set a single regulated price for medical treatments, the optimal price is given by equation (10). The resulting platform quality investment and participation of doctors to the platform are equal to the first-best ones. However, too few patients participate to the platform with respect to the first best.*

To conclude, a single regulated price is common practice in many countries. If online platform enter the market,however, such a single price may lead to under-utilization of the platform with respect to the first best. In other words, the potential gains related to the platform cannot be fully realized by a single price. In the following section, we analyze policies conditioning the price paid by consumers to the booking channel.

It should be noted that our results would be unchanged if an actuarially fair health insurance contract was available, implying a premium equal to $(1-\alpha)p$ and a copayment equal to αp, with $\alpha \in (0,1)$ (here the visit occurs with probability 1).

6.2 Two-prices regulation

Since a single regulated price does not allow to decentralize the first-best allocation, we now consider the case where the regulator has two instruments: a price for visits booked online and a price for visits booked offline. We denote $\overline{p}^{on}$ and $\overline{p}^{off}$ the online and offline regulated prices, respectively. Then, the model is solved as in the baseline model for given prices. Specifically, in stage 3, patients decide to join the platform if and only if

$$EU^{on}(\phi, n, \overline{p}^{on}) \equiv v + \phi - \frac{t}{4n} - \overline{p}^{on} - \xi \geq v - \frac{t}{4} - \overline{p}^{off} \equiv EU^{off}(\overline{p}^{off}),$$

which generates

$$D^{on,2R}(\phi, n, \overline{p}^{on}, \overline{p}^{off}) = \widehat{\xi}^{2R} = \min\{\overline{p}^{off} - \overline{p}^{on} + \frac{(n-1)t}{4n} + \phi, 1\}$$

Consistently with the baseline unregulated model, we only focus on the interesting case where the patients demand is interior.

As in the baseline model, the platform can entirely extract the physicians' online rents through the fee F. Denoting F^{2R} the fee set by the platform in this scenario, we focus on the interior case.

$$F^{2R}(\phi, n, \overline{p}^{on}, \overline{p}^{off}) = \left\{F | \pi^{off} = \pi^{on}\right\} = \frac{(\overline{p}^{on} - c^{on})(n(t + 4\phi + 4(\overline{p}^{off} - \overline{p}^{on})) - t)}{4n^2}.$$

Anticipating this fee, the platform maximizes its profit

$$\Pi^{2R}(\phi, n, \overline{p}^{on}, \overline{p}^{off}) = \overline{F}n - k\phi^2/2$$

with respect to n and ϕ. We observe that the profit function is monotonically increasing in the number of doctors on the platform, since

$$\frac{\partial \Pi^{2R}(\phi, n, \overline{p}^{on}, \overline{p}^{off})}{\partial n} = \frac{t(\overline{p}^{on} - c^{on})}{4n^2} > 0.$$

Then, the platform lets all the physicians enter the platform, and $n^{2R} = N$ denotes the number of physicians online. Intuitively, since prices are regulated, the presence of more physicians on the platform does not negatively affect online prices, as it does in the laissez faire. As a result, the platform has an incentive to induce all physicians to join the platform and maximize the sum of membership fees.

The level of the quality investment, derived from the first-order condition, is:

$$\phi^{2R}(\overline{p}^{on}) = \frac{\overline{p}^{on} - c^{on}}{k}.$$

Again, the level of quality investment increases with the per-patient margin $p^{on} - c^{on}$ and decreases in the investment cost.

We can now turn to the problem of the regulator in stage 0. The regulator maximizes social welfare taking into account that all doctors will be online, irrespective of the price, and that $\phi = \phi^{2R}(\overline{p}^{on})$. The social welfare function can then be written as

$$
\begin{aligned}
SW^{2R}(\overline{p}^{on}, \overline{p}^{off}) &= CS + N\pi^{on,2\mathrm{R}} + \Pi^{2R} \\
&= v - \frac{t}{4} + \left(\phi^{2R}(\overline{p}^{on}) + \frac{t(N-1)}{4N} + c^{off} - c^{on} \right) D^{on,2R}(\overline{p}^{on}, \overline{p}^{off}) \\
&- \frac{\left(D^{on,R}(\overline{p}^{on}, \overline{p}^{off}) \right)^2}{2} - k\frac{(\phi^{on,R}(\overline{p}^{on}))^2}{2}.
\end{aligned}
$$

The regulated prices, obtained from the first order conditions are:

$$
\overline{p}^{on} = \frac{kc^{off} - c^{on} + k\frac{(N-1)t}{4N}}{k-1} \tag{11}
$$

$$
\overline{p}^{off} = c^{off} + \frac{k}{k-1}\left[c^{off} - c^{on} + \frac{t(N-1)}{4N} \right] \tag{12}
$$

It is easy to show that the online price is equal to the regulated single price p defined in equation (10) in the previous section. As it was shown above, this price decentralizes the optimal quality investment, so that $\phi^{2R} = \phi^{O}$.

Furthermore, from a direct comparison of the two prices, one can observe that $\overline{p}^{off} - \overline{p}^{on} = c^{off} - c^{on} > 0$. Then, using this equation and substituting for the optimal prices, we get

$$
\widehat{\xi}^{2R} = \frac{\overline{p}^{on} - c^{on}}{k} + \frac{t(N-1)}{4N} + (\overline{p}^{off} - \overline{p}^{on}) = \phi^{O} + \frac{t(N-1)}{4N} + (c^{off} - c^{on}) = \widehat{\xi}^{O}.
$$

In words, the regulator is now able to decentralize the optimal participation of patients to the platform. This is due to the fact that, with two prices, the regulator is now able to align the incentives of patients (who compare prices when choosing to book online or offline) with social efficiency (which depends on the difference in costs online and offline). Then, patients' participation to the platform is always greater with two regulated prices rather than one ($\widehat{\xi}^{R} < \widehat{\xi}^{O} = \widehat{\xi}^{2R}$).

All in all, we can summarize our findings in the following proposition:

Proposition 5. *When the regulator sets two prices, one online and offline, the regulator can decentralize the first-best allocation by setting the prices defined in (11) and (12).*

Our results suggest that, with the entry of platforms in the healthcare markets, it may become optimal to regulate in a different way services obtained through the online channel and services obtained offline. In other words, the current regulatory regimes that tend not to differentiate between online and offline booking lead to a suboptimal allocation.

Our results generalize to the introduction of fair health insurance with a coinsurance rate α. In this case, the first-best solution could also be decentralized by a single price and two different copayment rates, one for visits booked online, and one for visits booked offline.

7 Conclusion

Online platforms that allow patients to book medical visits are becoming increasingly pervasive in healthcare markets and are reshaping how healthcare services are accessed and delivered. In this paper, we have considered a monopolistic platform that improves patient-physician matching, reduces physicians' marginal costs, and enhances patients' perceived quality of care. Physicians pay a fixed fee to join the platform, while patients face heterogeneous participation costs.

We first analyzed a laissez-faire regime in which physicians freely set prices. We demonstrated that this equilibrium is suboptimal from a welfare perspective. The platform strategically limits physician participation in order to soften competition online, resulting in too few physicians joining relative to the social optimum. In addition, the platform may under- or over-invest in quality-enhancing activities because it does not fully internalize cost reductions or patients' participation costs. As a consequence, patient adoption may be either inefficiently high or inefficiently low.

We then examined price regulation, a central feature of healthcare systems worldwide. Under price regulation, all physicians join the platform, which is socially optimal. The result is due to the fact that the platform has no incentive to limit entry to dampen competition. Patient participation, however, is not necessarily efficient, as it crucially depends on whether the regulator can differentiate prices across booking channels. When the regulator sets a uniform price for online and offline appointments, the optimal price decentralizes the platform's quality investment but fails to achieve efficient patient adoption, since patients do not internalize the cost savings generated by platform-mediated visits.

By contrast, allowing differentiated prices across booking channels restores the first-best allocation, aligning patient incentives with supply-side efficiencies.

Our analysis suggests that, with the emergence of platforms on the health sector, policy makers should consider regulation where the price is conditional on the booking channel. In particular, allowing differentiated regulated prices for online and offline visits, or a reimbursement scheme that conditions payments on the booking channel, allows to align patient incentives with supply-side cost efficiencies while preserving competitive discipline among physicians.

Our results rely on a number of assumptions. First, we have adopted a static model where there are no reputational effects and the only way to learn about physicians' characteristics is to pass through the platform. Allowing patients to gather some information online would make the platform less attractive, but our results would remain quantitatively unchanged as long as more information is available online than offline. Second, we have assumed that all doctors are homogeneous and have no cost of joining the platform. This simplifies our analysis, but inflates the social value of the platform. Finally, we have assumed that the platform has monopoly power, which allows it to extract all the online surplus. In practice, in most countries multiple platforms are present on the market. While relaxing these assumptions would affect our outcomes quantitatively, the central insight would however remain: when digital platforms alter cost structures and matching efficiency, uniform price or reimbursement rules may distort participation decisions on both sides of the market.

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