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Hospital competition when patients learn through experience[*]

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Abstract

We study competing hospitals' incentives for quality provision in a dynamic setting where healthcare is an *experience good*. In our model, the utility a patient derives from choosing a particular provider depends on a subjective component specific to the match between the patient and the provider, which can only be learned through experience. We find that the experience-good nature of healthcare can either reinforce or dampen the demand responsiveness to quality and the hospitals' incentives for quality provision, depending on two key factors: (i) the shape of the distribution of match-specific utilities, and (ii) the cost relationship between quality provision and treatment volume. Our analysis helps identify and understand the conditions required for the market-based provision of healthcare to deliver improved quality.

Keywords: Hospital competition; experience goods; forward-looking consumers; expectations; quality.

JEL Classification: I11, I18, L13, L51.

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1 Introduction

In recent years, many countries with a publicly funded healthcare system have introduced various types of market-based reforms, such as free patient choice, purchaser-provider separation, and activity-based funding, in the belief that competition for patients will stimulate quality of care and lead to a more efficient provision of healthcare. However, controversies about the relative merit of a market-based provision of healthcare remain, and there is a considerable heterogeneity of policy approaches across otherwise similar countries.[1]

A key premise for a market-based approach that seeks to stimulate healthcare quality through patient choice and provider competition is that patients respond sufficiently strongly to quality when making their choices of healthcare provider. The empirical literature suggests that demand responds positively to (some measures of) quality, but the results vary across different studies and the demand elasticities with respect to quality are generally quite small.[2] There is also empirical evidence of a considerable degree of demand inertia in healthcare markets, with prior utilisation being a key determinant of hospital choice (e.g., Irace, 2018; Raval and Rosenbaum, 2018). From a theoretical perspective, there are arguably still important knowledge gaps in our understanding of patient choice in healthcare markets.

In this paper, we provide a theoretical analysis of the determinants of patients' choice of hospital and, in turn, hospitals' incentives for quality provision. We do so by introducing an hitherto unexplored, and in our view highly relevant, dimension of healthcare in a context of patient choice and quality competition: *experience* and the learning that ensues. We argue that, while patients in general benefit from improvements in clinical quality and reduced mismatch between their conditions and the chosen hospital's fields of specialisation, the overall benefit from receiving hospital care exceeds these two dimensions. For example, the extent to which a patient identifies with a particular physician within a hospital, or the manner in which care is organised and delivered therein, is fully captured by neither aggregate indicators of clinical quality nor medical specialties. In other words, there is some *subjective* benefit from visiting a specific hospital, which often may only be learned through *experience*. In this regard, such subjective benefits differ a great deal from specialty mixes and clinical quality *sensu stricto*.

[1] For example, the organisation of healthcare provision in England and Scotland have diverged considerably over the last couple of decades. Whereas England has taken a more market-based approach that stimulates competition between healthcare providers, the Scottish approach is to a much larger extent based on integration and partnerships (Steel and Cylus, 2012).

[2] See Brekke et al. (2014) for an overview and Gutacker et al. (2016) for estimates of hospital demand elasticities for different measures of quality.

In order to study the implications of experience on patient choices and quality provision, we set up a dynamic model of hospital competition in a spatial (Hotelling) framework, where each patient demands hospital treatment from a chosen provider in each of two periods. As is commonly assumed in the literature, a patient's choice of hospital depends in part on the relative distance to the hospitals (or the relative mismatch between the patient's diagnosis and the hospitals' specialties) and in part on the (clinical) qualities offered by the hospitals. Since these two factors are commonly evaluated by all patients, they are in principle observable *ex ante* (if only through reputational effects). However, in contrast to the existing literature, we assume that a patient's choice of hospital depends additionally on a subjective utility component that is specific to the particular match between a patient and a hospital. Since this component is match-specific, it can only be observed *ex post*, through experience. *Ex ante*, when patients make their first-period choices, each patient only knows the distribution from which the match-specific utility component is drawn.

Our analysis reveals that the experience-good dimension of healthcare has several potentially important implications for patient choices and, in turn, quality provision. One key insight is that the shape of the distribution of match-specific utilities matters. For example, suppose that this distribution is such that the mean utility is below the median. In this case, a majority of patients will have an experience at the first hospital they choose that is better than what they expect to experience if they switch to a different provider. All else equal, this makes a majority of the patients inclined to stay with their current provider. In this way, the experience-good nature of healthcare creates something akin to a 'switching cost' that may help explain the demand inertia observed empirically in healthcare markets. Whether such an endogenously created demand inertia dampens or stimulates hospitals' incentives for quality provision is *a priori* unclear, though. On the one hand, this makes demand less responsive to quality, which reduces the hospitals' incentives for quality provision, all else equal. On the other hand, the lock-in effect of patient experience makes it more profitable to attract patients in the first place, which induces the hospitals to compete harder for patients and thus stimulates quality provision.

Another key insight is that the demand responsiveness to quality depends on the hospitals' treatment technology; more specifically, whether quality and treatment volume are cost substitutes or cost complements. In the case of cost substitutability, which implies that higher volume makes quality provision more costly on the margin, a majority of the patients who choose a hospital with relatively higher quality today will end up choosing a hospital with relatively lower quality in the future. If rational and forward-looking patients know that higher quality today likely comes at a cost of lower quality in the future, this makes them less inclined to base their hospital choices on relative qualities, thus reducing the demand responsiveness to quality. Conversely, in the case of cost complementarity, which means that higher volume makes quality provision *less* costly on the margin, higher quality today will imply even higher quality in the future for a majority of the patients, thus making demand *more* responsive to quality. These effects, which will be much more elaborately explained later, arise specifically as a result of the experience-good nature of healthcare. In the absence of an experience component, demand responsiveness to quality does not depend on hospital technology.

After defining a relevant benchmark, in which patient experience plays no role, we identify and characterise the specific conditions under which the experience-good nature of healthcare *dampens* or *reinforces* demand responsiveness to quality and hospitals' incentives for quality provision. As an example of the latter, suppose that there are strong cost complementarities between quality and treatment volume, which will make demand highly responsive to quality.[3] Suppose in addition that the mean patient experience is worse than the median, such that a majority of patients are more inclined to stay with the first provider they choose. In this case, hospitals have strong incentives to provide quality, partly because demand responds strongly to quality and partly because the lock-in effect of patient experience makes it highly profitable to attract patients. Conversely, very weak incentives for quality provision can arise in a scenario with strong cost substitutability between quality and treatment volume, and a distribution of match-specific utilities where the mean utility is considerably higher than the median. These results have indirect policy relevance, in that our analysis helps to pin down the conditions that need to be met for the market-based provision of healthcare to deliver the intended outcomes in terms of improvements in clinical quality.

We also reveal that the potential relevance and importance of the experience-good nature of healthcare depend to some extent on *patient expectations*. Our main analysis is conducted under the assumption that patients have rational expectations, but in an extension we explore the implications of a broad class of patient expectations. Here we show that the experience component affects the demand responsiveness to quality if patients are forward-looking and to some extent take into account, though not necessarily in a fully rational way, that their experiences might affect the hospitals' incentives for future quality provision.

[3]For recent empirical evidence of these volume-outcome effects, see Avdic et al. (2019).

Our paper makes a contribution to two distinct literatures. Firstly, it adds to the literature on how the effect of competition (or the intensity thereof) on quality provision under regulated prices is mediated by the idiosyncrasies of the hospital industry. These include the departure from pure profit-maximisation (Brekke et al., 2011), gatekeeping by primary care providers (Brekke et al., 2007), sluggish demand adjustments to quality (Siciliani et al., 2013), and demand inertia and the sophistication of patient expectations (Sá and Straume, 2021).

Secondly, our paper is related to the literature on oligopolistic price competition in markets where consumers learn individual product-specific utilities (or valuations) through consumption. In two dynamic models with horizontally differentiated experience goods whose valuations are independently distributed, Villas-Boas (2004, 2006) seminally establishes two key effects. The shape of the distribution of valuations (i.e., whether the mean is below the median) determines whether current demand is valuable for firms in the future, as the majority of a firm's old consumers opt to switch or stay. It also affects consumers' price sensitivity; if, say, the mean valuation is less than the median, first-time consumers are less price sensitive because they foresee that they are likely to stick with the product they choose and, crucially, its price will increase. As one would expect, these two effects are present in our model, but we uncover novel insights. Namely, we show that the effect of hospital technology on consumer sensitivity (to quality) is independent of the mean valuation being less or greater than the mean.

De Nijs and Rhodes (2013) study behaviour-based price discrimination using a similar two-period model where the experience goods are not horizontally differentiated. As in our model and Villas-Boas (2004, 2006), a symmetric distribution of valuations yields the corresponding benchmark case: prices are the same with and without discrimination. If instead the mean valuation is less than the median, a pro-competition effect again arises in the first period, as over half of a firm's old consumers will believe in the second period that the alternative is inferior. With otherwise homogenous products, however, there is Bertrand competition in the first period, when both products are untried, implying that demand sensitivity to prices is unaffected by the experience dimension. A similar dynamic pro- or anti-competition effect resulting from the value of first-period demand is present in our model, but, as stated above, we explore in detail how experience shapes demand responsiveness to quality.

Z. C. Chen et al. (2021) show that the same results from De Nijs and Rhodes (2013) *may* arise when there are within-consumer informational spillovers; more specifically, when valuations are positively correlated, and experience is therefore partially informative about the untried product. The main assumptions in these two last-mentioned papers are of limited relevance to our analysis. Not only does horizontal differentiation play a major role in the hospital industry (e.g., distance) but also are independent valuations (that result from the match between a patient and a particular hospital) our focus. More generally, the insights from the above-mentioned analyses do not automatically carry over to ours. Owing to key modelling differences that reflect a different institutional setting, our framework is not a reparamaterisation of prices as 'negative quality'. The interplay between hospital technology and the asymmetry of the distribution of patient valuations, in particular, generates outcomes that simply are not present in the case of price competition.[4]

Finally, this paper is also related to the experimental results of Huck et al. (2016), who show that, under price regulation, quality becomes a much more salient determinant of consumer choice in oligopolistic experience goods markets. In our model, prices are regulated, and, in addition to distance, patients base their choices on observable quality and the experience dimension of healthcare.

The rest of the paper is organised as follows. In the next section, we present the model. In Section 3, we define and characterise a benchmark case in which patient experience plays no role. This benchmark will be used as a point of comparison for the remainder of the analysis. The main analysis is found in Section 4, where we explore how the experience-good nature of healthcare affects demand responsiveness to quality and hospitals' incentives for quality provision. The importance of patient expectations is analysed and discussed in Section 5, before the paper is closed with further discussion and concluding remarks in Section 6.

2 Model

Consider a healthcare market that opens for two periods, $t = 1, 2$, where there are two providers, indexed $i = A, B$, henceforth referred to as hospitals. In each of the two periods, hospitals invest in the quality of treatment, q_t^i, to attract demand. We assume that these qualities are *ex ante* observable to patients.

There is a continuum of patients with mass normalised to one, each of whom demanding a single unit of treatment from one of the hospitals in each period. Patients are characterised by

[4] There is another strand of the experience goods literature based on a different assumption. Instead of learning product-specific valuations through experience, consumers learn product quality, which results from a one-time investment made by the firms at the start of the game. A recent example of this strand is Y. Chen et al. (2022), where consumers learn idiosyncratic valuations through inspection but quality only through experience.

the time-invariant triple (v^A, v^B, x), whose elements are independent in the patient population. The element $v^i \in [\underline{v}, \overline{v}]$ measures the hospital-patient specific utility each patient derives from treatment at Hospital i. In contrast to the observable quality levels, q_t^i, a patient can only learn v^i after choosing Hospital i and receiving care therein.[5] The marginal prior cumulative distribution function for v^i is $F(v^i)$, and the density is $f(v^i)$. We assume that $F(v^i)$ and $f(v^i)$ are smooth and continuous in $(\underline{v}, \overline{v})$. The element x is uniformly distributed on $[0, 1]$, is known by patients beforehand, and reflects their horizontal preferences for some characteristics of the elective hospital treatments supplied in this market. In both periods, Hospital A is located at 0, and Hospital B at 1. The line segment may be thought of as a geographical space or a disease space. In the former case, a patient's location on the line, $x \in [0, 1]$, is simply her residence or workplace, while the location of a hospital is simply the place where its facilities were built. In the latter case, a patient's location on the line is a medical condition or a diagnosis, and the location of a hospital is the speciality mix (i.e., the treatments and services) it offers. Patients incur a travelling or mismatch cost τ per unit of distance between their location and that of the chosen hospital along the horizontal dimension, but bear no out-of-pocket expenses, either owing to public provision of healthcare or to (social or private) health insurance coverage.[6] Under these assumptions, the utility, in period t, of a patient located at x who demands treatment from Hospital i, located at z^i, is given by

$$u_t(v^i, x, z^i) = v^i + q_t^i - \tau|x - z^i|; \quad i = A, B, \quad t = 1, 2. \tag{1}$$

Patients are risk-neutral with respect to v^i, and both v^i and its expected value, $E(v^i)$, are assumed to be sufficiently high to ensure that all patients seek treatment in equilibrium.

The total costs of treatment are given by

$$C\left(q_t^i, D_t^i\right) = (cq_t^i + k)D_t^i + \frac{\gamma}{2}(q_t^i)^2; \quad i = A, B, \quad t = 1, 2, \tag{2}$$

where $c \lesseqgtr 0$ measures either the degree of cost substitutability (if $c > 0$) or complementarity (if $c < 0$) between quality and treatment volume, $k > \max\{0, -cq_t^i\}$ is the minimum unit cost of treatment, $\gamma > 0$ is a quality investment cost parameter, and D_t^i is the demand (i.e., the number

[5] We interchangeably use the expressions *valuation* (of treatment), *match-specific utility*, and *experience* at Hospital i when referring to v^i.

[6] The assumption of no out-of-pocket expenses is analytically equivalent to having hospitals charge the same regulated price.

of patients treated) for Hospital i in period t. If $c > 0$, a certain level of quality is more costly to achieve when more patients are treated, implying that the marginal cost of quality is increasing in demand. In this case, hospital production exhibits *cost substitutability* between quality and treatment volume. On the other hand, if $c < 0$, the more patients a hospital treats, the less costly it is to provide each additional unit of quality, and the marginal cost of quality is decreasing in demand. In this case, quality and treatment volume are *cost complements*, reflecting the positive relationship between demand and quality observed when, all else equal, high-volume hospitals provide higher quality and generate better treatment outcomes than low-volume hospitals. In order to facilitate the analysis, we impose a lower bound $\underline{c} < 0$ on the parameter c, where this lower bound is defined such that $\gamma + c\left(\partial D_i/\partial q_i\right) \geq 0$ for $c \geq \underline{c}$. This parameter restriction, which ensures well-behaved and economically meaningful expressions throughout the analysis, implies that the degree of cost complementarity between quality and treatment volume is not too strong.[7]

We assume that hospitals are prospectively financed by a third-party payer (e.g., a regulator or insurer) that offers a price $\widetilde{p}$ for each unit of treatment supplied and a lump-sum transfer T, which ensures that a no-liability constraint is satisfied. We also assume that the hospitals are profit-maximisers, and the per-period profit of Hospital i is given by[8]

$$\Omega_t^i = T + \widetilde{p}D_t^i - C\left(q_t^i, D_t^i\right); \quad i = A, B, \quad t = 1, 2. \tag{3}$$

There is a lower bound on treatment quality that represents the minimum quality hospitals are allowed to offer, with quality below this threshold being interpreted as malpractice. For simplicity, we set this lower bound to zero. In the first period, patients discount second-period utility by a factor $\delta^P \in [0, 1]$, whereas hospitals discount second-period profits by a factor $\delta^H \in [0, 1]$. We also assume that hospitals and patients have rational expectation when making their first-period decisions.[9]

[7] See the proof of Lemma 2 in Appendix B for a more complete characterisation of the lower bound $\underline{c}$.

[8] With our specification of the cost function, we are implicitly modelling the case of semi-altruistic hospitals which maximise a weighted sum of profits and aggregate patient utility excluding mismatch costs. Cost substitutability (complementarity) captures the case where the marginal cost of quality dominates (is dominated by) the hospitals' concern for patient utility, implying that higher demand leads, all else equal, to lower (higher) quality provision. Therefore, the assumption of pure profit-maximisation is not excessively restrictive.

[9] In Section 5, we discuss the importance of this assumption and explore the implications of alternative assumptions regarding patient expectations.

3 Benchmark case

The main purpose of our analysis is to explore the possibility that patients can learn through experience and to investigate how this creates dynamic demand effects that in turn shape the hospitals' incentives for quality provision. In order to conduct this analysis, it is useful to start out by defining a relevant benchmark.

Our benchmark case is one in which learning through experience is irrelevant for patient choices and thus irrelevant for hospital behaviour. This would be the case if the utility parameter v is observable and equal for all patient-hospital matches, which is the standard assumption in the theoretical literature. But even without *ex ante* observability, learning through experience would not affect patient choices as long as $v^A = v^B$. Alternatively, we might assume that v^i is period-specific and thus re-drawn between the two periods, which would imply that the first-period experience has no learning value. In all of these cases, hospital choices are only determined by differences in qualities and travelling or mismatch costs, and there is no dynamic link between patient choices in the two periods. Demand for Hospital i in period t would then be given by

$$D_t^i = \frac{1}{2} + \frac{q_t^i - q_t^j}{2\tau}; \quad i = A, B, \quad i \neq j, \tag{4}$$

with demand for Hospital j given by $D_t^j = 1 - D_t^i$. In each period, each of the hospitals chooses quality to maximise (3), and the first-order condition for optimal quality provision by Hospital i in period t is given by

$$\left(p - cq_t^i\right) \frac{\partial D_t^i}{\partial q_t^i} - cD_t^i - \gamma q_t^i = 0, \tag{5}$$

where $p = \widetilde{p} - k > 0$, and

$$\frac{\partial D_t^i}{\partial q_t^i} = \frac{1}{2\tau} \tag{6}$$

is the demand responsiveness to quality, which depends only (and negatively) on travelling/mismatch costs. In the symmetric equilibrium, quality provision is equal in both periods and given by

$$\overline{q} = \frac{p - c\tau}{c + 2\tau\gamma}. \tag{7}$$

4 Quality provision when healthcare is an experience good

If patients learn through experience, two different effects arise that are not present in the benchmark case. First, current patient choices might affect future demand, thus creating a dynamic link on the demand side of the market, which in turn might affect hospitals incentives to attract patients in the first place. Second, current patient choices will be influenced by the patients' expectations about how their resulting experiences might affect their future choices. Because of these two effects, hospitals' first-period quality provision, which is the main focus of our analysis, will generally differ from the benchmark case. In the following, we characterise and explore each of these two effects separately, before analysing the hospitals' optimal first-period quality choices.

4.1 Dynamic demand effects of patient experience

Suppose that all patients with $x < (>) \widehat{x}$ chose Hospital A (B) in the first period. This implies that first-period demands were given by $D_1^A = \widehat{x}$ and $D_1^B = 1 - \widehat{x}$. Whether or not a patient chooses the same hospital again in the second period depends not only on the hospitals' quality provision, but also on the extent to which the patient's experience at the previously chosen hospital differs from the expected experience at the rival hospital. In Appendix A, we show that the second-period patient choices give rise to the following demand functions for hospitals A and B, respectively:

$$D_2^A = \int_0^{\widehat{x}} \left(1 - F\left[E(v) + q_2^B - q_2^A - \tau(1-2x)\right]\right) dx + \int_{\widehat{x}}^1 F\left[E(v) + q_2^A - q_2^B - \tau(2x-1)\right] dx, \tag{8}$$

$$D_2^B = \int_0^{\widehat{x}} F\left[E(v) + q_2^B - q_2^A - \tau(1-2x)\right] dx + \int_{\widehat{x}}^1 \left(1 - F\left[E(v) + q_2^A - q_2^B - \tau(2x-1)\right]\right) dx. \tag{9}$$

The dynamic demand effects of patient experience turn out to be determined by the shape of the distribution of valuations (patient experiences). Evaluated at the symmetric equilibrium, where $\widehat{x} = 1/2$, the effect of previous demand on current demand for Hospital i is given by

$$\frac{\partial D_2^i}{\partial D_1^i} = 1 - 2F[E(v)] > (<) \, 0 \quad if \quad F[E(v)] < (>) \, \frac{1}{2}. \tag{10}$$

Thus, whether the dynamic relationship between previous and current demand is positive or negative depends on whether the mean valuation is below or above the median. Since this turns out to be a key feature of the distribution, it is worth spending some time detailing its interpretation and implications.

Suppose first that $F[E(v)] < 1/2$, which implies that the mean valuation is below the median. This is the case if, for example, most patient experiences are likely to be reasonably good, but some experiences are potentially quite bad. In this case, for a majority of the patients who previously chose Hospital i and learned v^i, the experience at Hospital i turned out to be better than the *expected* experience at Hospital j (i.e., $v^i > E(v^j)$). In other words, it is more likely than not that the patient had an above-mean experience at Hospital i, which implies that the expected experience at Hospital j is more likely to be inferior. In this case, experience—or lack thereof—acts as a switching cost for the majority of patients, which in turn implies that, starting from equal demand in the first period, an increase in first-period demand faced by one hospital leads to higher second-period demand for the same hospital.

Suppose instead that $F[E(v)] > 1/2$, which implies that the mean valuation is above the median. This is the case if, for example, most patient experiences are likely to be quite ordinary, but some experiences are potentially very good. In this case, it is more likely than not that a patient who visited Hospital i in the first period had a below-mean experience at this hospital. Thus, for a majority of Hospital i's first-period patients, the expected valuation at Hospital j is higher than what they experienced at Hospital i (i.e., $v^i < E\left(v^j\right)$). This means that experience acts not as a switching cost, but as a 'staying cost' for a majority of patients, implying that higher first-period demand leads to lower second-period demand, all else equal.

The above described link between current and future demand creates in turn a strategic dynamic effect on the supply side of the market, in the sense that current demand affects each hospital's optimal future quality provision. This effect can be derived from the first-order condition of Hospital i's second-period problem, which is given by[10]

$$(p - cq_2^i)\frac{\partial D_2^i}{\partial q_2^i} - cD_2^i = \gamma q_2^i. \tag{11}$$

By totally differentiating (11) with respect to $\widehat{x}$ and evaluating the resulting expression at the symmetric equilibrium, at which $\widehat{x} = D_1^i = 1/2$ and $\partial q_2^{A*}/\partial\widehat{x} = -\partial q_2^{B*}/\partial\widehat{x}$, we arrive at (see Appendix A for details):

$$\frac{\partial q_2^{i*}}{\partial D_1^i} = -\frac{c\tau(1 - 2F[E(v)])}{3c(F[E(v)] - F[E(v) - \tau]) + \gamma\tau}. \tag{12}$$

The effect of current demand on future quality provision depends both on the distribution

[10]At $\widehat{x} = 1/2$, the second-order condition is

$$-\gamma - 2c\left(\frac{F[E(v)] - F[E(v) - \tau]}{\tau}\right) < 0,$$

which holds for all $c \geq \underline{c}$.

of valuations and on the hospitals' treatment technology.[11] If $F[E(v)] < 1/2$, having a poor experience in the first period is relatively rare, which induces most patients to stay at the familiar hospital (the 'switching cost' case). Whether higher first-period demand leads to higher or lower second-period quality depends on the sign of c. If $c > (<) 0$, the marginal cost of quality is increasing (decreasing) in demand, and because a first-period demand advantage carries over into the second period, higher first-period demand leads to lower (higher) second-period quality. If instead $F[E(v)] > 1/2$, having a poor experience in the first period is relatively common, and this encourages a majority of patients to switch to the untested provider (the 'staying cost' case). Interestingly, if $c > 0$, the hospital with more demand in the first period will then offer higher quality in the second; as it faces a patient outflow in the second period, its marginal cost of quality provision falls.

It follows from the above analysis that current demand affects future profits through two different channels. In addition to the direct demand effect, given by (10), future profits are also indirectly affected through changes in the incentives for future quality provision, as given by (12). By the Envelope Theorem, only changes in the *rival* hospital's quality provision affect future profits at the margin. The total effect (evaluated at the symmetric equilibrium) is given by

$$\frac{\partial \Omega_2^{i*}}{\partial D_1^i} = (p - cq_2^{i*})(1 - 2F[E(v)]) \left[1 - \frac{c(F[E(v)] - F[E(v) - \tau])}{3c(F[E(v)] - F[E(v) - \tau]) + \gamma\tau}\right]. \tag{13}$$

The first factor in (13) is the second-period profit margin, which is always positive in an equilibrium with strictly positive quality (cf. (11)). The second and third factors capture, respectively, the direct effect of first-period demand on second-period profits ($\partial D_2^i / \partial D_1^i$) and the indirect effect via changes in the rival hospital's quality provision. If $F[E(v)] < 1/2$, the direct effect is positive because of the switching cost nature of patient experiences (and the positive profit margin). In this case, higher current demand implies lower future demand for the rival hospital, which in turn affects quality provision in a direction that is determined by the sign of c. If $c < 0$, the rival hospital responds to lower demand by reducing its quality provision, which implies that the direct demand effect is *reinforced* by the rival's quality response. On the other hand, if $c > 0$, the direct effect of a current demand increase on future profits is *dampened* by the rival hospital's future quality increase. If instead $F[E(v)] < 1/2$, such that patient experience acts as a staying cost for a majority of patients, the direct effect is negative. This effect will once more be reinforced (dampened) if $c < (>)\, 0$, since the rival hospital now has an incentive

[11] Note that the denominator in (12) is always positive for $c \geq \underline{c}$.

to increase (reduce) its future quality provision. However, even if the direct effect is dampened by the indirect effect, the former effect always dominates, implying that the sign of the overall effect is given by the sign of $\partial D_2^i/\partial D_1^i$.

We summarise the above analysis as follows:

Lemma 1 *For each hospital, and starting from a symmetric situation of equal demand:*

(i) If $F[E(v)] < 1/2$, a marginal increase in current demand leads to an increase in future demand and profits, while future quality provision increases (decreases) if quality and treatment volume are cost complements (substitutes).

(ii) If $F[E(v)] > 1/2$, a marginal increase in current demand leads to a reduction in future demand and profits, while future quality provision decreases (increases) if quality and treatment volume are cost complements (substitutes).

4.2 Demand responsiveness to quality

Having established the characteristics of the dynamic demand effects created by the experience-good nature of healthcare, we now turn to the question of how the patients' first-period choices are affected by their expectations about what they will learn from their experiences. This question is answered by deriving the first-period demand responsiveness to quality. We show in Appendix A that this is given by

$$\frac{\partial D_1^i}{\partial q_1^i} = \frac{1 + \delta^P(1 - 2F[E(v)])\frac{\partial(q_2^i - q_2^j)}{\partial q_1^i}}{2\tau\left[1 + \delta^P(1 - 2F[E(v)])\right]}; \quad i, j = A, B, \quad i \neq j. \tag{14}$$

If the quality level at Hospital i increases, the subsequent increase in demand depends in part on how patients expect this quality increase to affect the future quality difference between the hospitals: $\partial(q_2^i - q_2^j)/\partial q_1^i$. Under the assumption that patients have rational expectations, the expected effect of a current unilateral quality increase on the future quality difference can be expressed as

$$\frac{\partial(q_2^i - q_2^j)}{\partial q_1^i} = \frac{\partial(q_2^i - q_2^j)}{\partial D_1^i}\frac{\partial D_1^i}{\partial q_1^i} = 2\frac{\partial q_2^i}{\partial D_1^i}\frac{\partial D_1^i}{\partial q_1^i}, \tag{15}$$

where we have used the fact that $\partial q_2^i/\partial D_1^i = -\partial q_2^j/\partial D_1^i$. By using the expression for $\partial q_2^i/\partial D_1^i$ from (12), substituting (15) into (14) and solving for $\partial D_1^i/\partial q_1^i$, we obtain

$$\left(\frac{\partial D_1^i}{\partial q_1^i}\right)^{-1} = 2\tau + 2\tau\delta^P(1 - 2F[E(v)]) + c\left[\frac{2\tau\delta^P(1 - 2F[E(v)])^2}{3c(F[E(v)] - F[E(v) - \tau]) + \gamma\tau}\right] > 0. \tag{16}$$

Compared with the benchmark case, given by (6), the demand responsiveness to quality is determined by two additional effects, given by the second and third terms in (16), when patients rationally anticipate that they will learn through experience. The first effect, captured by the second term in (16), is directly related to the dynamic demand effect of patient experience analysed in Section 4.1, which depends on the shape of the distribution of valuations. If $F[E(v)] < 1/2$, experience induces a majority of patients to continue using the hospital they chose in the first period because their expected valuation of the untested hospital is more likely to be below their learned valuation of the chosen hospital. When patients rationally foresee this, they realise that they will more likely than not travel twice from the same location, which increases the importance of mismatch costs relative to quality and thus leads to lower demand responsiveness to quality. On the other hand, if $F[E(v)] > 1/2$, patients know that their first-period experience is more likely than not to be below-mean, which makes it more likely that they choose different hospitals in the two periods. This reduces the relative importance of mismatch costs and thus makes demand more responsive to quality.

The second effect, which is captured by the third term in (16), is related to the relationship between present and future quality provision. Although this effect arises from the ability of patients to learn from experience, the direction of the effect turns out to be *independent* of the shape of the distribution of valuations. Instead, it is uniquely determined by hospital technology; namely, the sign of c. To grasp why, suppose first that $c > 0$. If $F[E(v)] < 1/2$, patients know that, starting from equal demand in the first period, a marginal increase in quality offered by one of the hospitals will lead to a demand increase that will persist in the future. This happens because the majority of patients have a good (i.e., above-mean) experience at the first hospital they try. However, if $c > 0$, the persistent demand advantage resulting from a current quality increase implies that the hospital in question will reduce its quality provision relative to the other hospital in the future. And since patients know that experience will most likely make them continue using the same hospital that they chose in the first period, they anticipate that higher quality today is likely to come at the cost of lower quality in the future. All else equal, this makes patients less attracted to this quality increase and thus reduces the demand responsiveness to quality.

If $c > 0$ but instead $F[E(v)] > 1/2$, patients know that a current demand increase for a hospital that offers higher quality will turn into a future demand increase for the competing hospital. Again, this happens because a majority of patients will have a poor (i.e., below-mean) experience at the first hospital they try. If $c > 0$, the hospital that enjoys a future demand increase will also offer relatively lower quality in the future, and since a majority of the patients are inclined to switch hospitals in the future, it is once more the case that higher quality today is likely to come at the cost of lower quality tomorrow. If patients rationally anticipate this, it makes current demand less responsive to quality also in this case.

The reverse logic applies if $c < 0$. A current quality increase by one of the hospitals will generate a future demand advantage for either the same hospital (if $F[E(v)] < 1/2$) or for the competing hospital (if $F[E(v)] > 1/2$). In either case, if $c < 0$, the hospital with the future demand advantage will have relatively stronger incentives for quality provision in the future. Since patients rationally expect that they are more likely to end up choosing the hospital with the demand advantage (and thus relatively higher quality) in the future, they realise that higher quality today will most likely translate into higher quality also in the future. All else equal, this *increases* the demand responsiveness to quality.

Since both of the two additional effects introduced by patient learning have an *a priori* ambiguous sign, it is clearly the case that the demand responsiveness to quality can be either higher or lower than in the benchmark case (in which there is no scope for patients to learn through experience). The following Lemma provides a precise characterisation of this comparison:

Lemma 2 *(i) If* $F[E(v)] < \min\{1/2, 3F[E(v) - \tau] - (1/2)\}$*, the first-period demand responsiveness to quality is always lower than in the benchmark case.*

(ii) If $3F[E(v) - \tau] - (1/2) < F[E(v)] < 1/2$*, the first-period demand responsiveness to quality is higher than in the benchmark case if hospital quality and treatment volume are sufficiently strong cost complements.*

(iii) If $1/2 < F[E(v)] < 3F[E(v) - \tau] - 1$*, the first-period demand responsiveness to quality is higher than in the benchmark case if hospital quality and treatment volume are either cost complements or sufficiently weak cost substitutes.*

(iv) If $F[E(v)] > \max\{1/2, 3F[E(v) - \tau] - 1\}$*, the first-period demand responsiveness to quality is always higher than in the benchmark case.*

The demand responsiveness to quality is higher than in the benchmark case under certain conditions on either hospital technology (c) or the distribution of valuations ($F(v)$). Even if $F[E(v)] < 1/2$, demand responsiveness might be higher than in the benchmark case if quality and treatment volume are sufficiently strong cost complements. In this case, which also requires

$F[E(v)] > 3F[E(v) - \tau] - (1/2)$, the dominating effect is that, even with experience working as a switching cost, a patient who chooses the hospital with higher quality today is more likely, because of strong cost complementarities, to end up choosing the hospital with higher quality also in the future, which makes rational and forward-looking patients more responsive to increases in quality provision.

On the other hand, regardless of the value of c, demand responsiveness is also higher than in the benchmark case if (i) $F[E(v)] > 1/2$ and (ii) $F[E(v)] > 3F[E(v) - \tau] - 1$. The first condition ensures that patient experience works as a staying cost, while the second condition implies that the effect of current demand on future quality provision is relatively small (cf. (12)). Given that the first condition holds, the second condition always holds if $F[E(v) - \tau] < 1/2$, which is true if τ is sufficiently large or if the mean of the distribution is sufficiently close to the median. In this case, the dominating effect is that the experience at the hospital chosen in the first period will more likely than not give patients an incentive to switch hospitals in the second period, thus making quality a relatively more important factor for the first-period choice.

In contrast to the above discussed examples, it might also be that patients' ability to learn through experience makes demand very *unresponsive* to quality. Suppose that the mean of the distribution of valuations is far below the median, while there is a strong cost substitutability between quality and treatment volume. In this case, a substantial share of the patients will have an experience at their initially chosen hospital that makes them very reluctant to switch to a different hospital in the future. Furthermore, if the initially chosen hospital has higher quality than the competing hospital today, this is likely to be reversed in the future. Because of these two effects, patients with rational expectations will make their first-period choice of hospital mainly based on travelling/mismatch costs and demand will therefore be relatively unresponsive to quality.

4.3 Equilibrium quality provision

In the first-period, each hospital chooses its quality provision by maximising expected profits over the two periods, anticipating how patients' experiences in the first period might affect their second-period choice of hospital. In the symmetric equilibrium, the first-period quality chosen by Hospital i, q_1^{i*}, is implicitly given by

$$\left(p - cq_1^{i*} + \delta^H \frac{\partial \Omega_2^{i*}}{\partial D_1^i}\right) \frac{\partial D_1^i}{\partial q_1^i} - \frac{c}{2} - \gamma q_1^{i*} = 0, \tag{17}$$

where $\partial\Omega_2^{i*}/\partial D_1^i$ and $\partial D_1^i/\partial q_1^i$ are given by (13) and (16), respectively.

Our main aim is to compare the equilibrium quality provision with the benchmark case, in which patient experience plays no role. By combining the two first-order conditions which define the first-period optimal quality, q_1^{i*}, and benchmark quality, $\overline{q}$, we obtain, after some manipulation,

$$\left(\gamma + c\frac{\partial D_1^i}{\partial q_1^i}\right)(q_1^{i*} - \overline{q}) = \left(\frac{\partial D_1^i}{\partial q_1^i} - \frac{1}{2\tau}\right)(p - c\overline{q}) + \delta^H \frac{\partial \Omega_2^{i*}}{\partial D_1^i}\frac{\partial D_1^i}{\partial q_1^i}. \quad (18)$$

Notice that the left-hand side of (18) is monotonically increasing in $(q_1^{i*} - \overline{q})$ for $c > \underline{c}$. Consequently, $q_1^{i*} > \overline{q}$ if the right-hand side of (18) is positive, which requires that

$$\frac{\delta^H \frac{\partial \Omega_2^{i*}}{\partial D_1^i}}{p - c\overline{q}} > \frac{\frac{1}{2\tau}}{\frac{\partial D_1^i}{\partial q_1^i}} - 1. \quad (19)$$

Compared with the benchmark, the experience-good nature of healthcare generates two additional determinants of hospitals' incentives for quality provision. The first one, which we dub the *market share effect*, is the present value of the future profit yielded by treating an additional patient today, and is captured by the left-hand side of (19). This effect is analysed in Section 4.1, and its sign follows from Lemma 1. The second one, which we dub the *demand responsiveness effect*, is the difference in how strongly demand responds to quality relative to the benchmark, and is captured by the right-hand side of (19). This effect is analysed in Section 4.2, and its sign follows from Lemma 2.

Whereas the sign of the demand responsiveness effect depends both on the distribution of valuations and on treatment cost technology, the sign of the market share effect is uniquely determined by whether the mean of the distribution of valuations is above or below the median. In the benchmark case, with no intertemporal link between current demand and future profits, the future profit gain of treating an additional patient today is zero. In contrast, when patient experience matters, the future profit gain of higher current demand can be either positive or negative, depending on whether experience works as a switching cost or as a staying cost.

If $F[E(v)] < 1/2$, we know from Lemma 1 that $\partial\Omega_2^{i*}/\partial D_1^i > 0$, which implies that the market share effect stimulates quality provision, since a first-period demand advantage carries over to the second period and patients are profitable for the hospitals. In this case, quality provision is unambiguously *higher* than in the benchmark if the demand responsiveness effect is also positive, which from Lemma 2 requires that output and quality are sufficiently strong cost complements (in addition to some conditions on the shape of $F(v)$). On the other hand, if $F[E(v)] > 1/2$, which implies that $\partial\Omega_2^{i*}/\partial D_1^i < 0$, the market share effect dampens quality provision, since a first-period demand advantage is reversed in the second period. In this case, equilibrium quality provision is unambiguously *lower* than in the benchmark if the demand responsiveness effect is also negative, which from Lemma 2 requires that output and quality are sufficiently strong cost substitutes (in addition to some conditions on the shape of $F(v)$).

The next proposition provides a characterisation of three different cases for which it is possible to determine whether quality provision is higher or lower than in the benchmark, even if the market share and demand responsiveness effects go in opposite directions:

Proposition 1 *Suppose that hospitals are more forward-looking than patients; i.e., $\delta^H > \delta^P$.*

(i) If the degree of cost substitutability or cost complementarity between quality and treatment volume is sufficiently weak, first-period quality provision is higher (lower) than in the benchmark case if $F[E(v)] < (>) \, 1/2$.

(ii) If $3F[E(v) - \tau] < F[E(v)] < 1/2$, first-period quality provision is higher than in the benchmark case unless quality and treatment volume are sufficiently strong cost substitutes.

(iii) If $\max\{1/2, 1 - F[E(v) - \tau]\} < F[E(v)] < F[E(v) - \tau] + (1/2)$, first-period quality provision is lower than the benchmark case unless quality and treatment volume are sufficiently strong cost complements.

The first case identified in Proposition 1 shows that, if quality and treatment volume are sufficiently close to being cost-independent, whether quality is above or below the benchmark is uniquely determined by whether the mean of the distribution of valuations is above or below the mean. In the case of cost independence ($c = 0$), the sign of the demand responsiveness effect depends only on whether patient experience acts as a switching or a staying cost. This means in turn that the demand responsiveness effect and the market share effect always work in opposite directions. If $F[E(v)] < 1/2$, patient experience acts as a switching cost. On the one hand, this reduces hospitals' incentives for quality provision because patients respond less to quality increases (i.e., the demand responsiveness effect is negative). But on the other hand, incentives for quality provision are strengthened because current demand increases yield future profit gains, all else equal (i.e., the market share effect is positive). The latter effect dominates if hospitals are more forward-looking than patients, implying that equilibrium quality provision is higher than in the benchmark case. If instead $F[E(v)] > 1/2$, such that patient experience acts as a staying cost, the exact reverse logic applies. By continuity, these results hold also in the neighbourhood of $c = 0$ (i.e., for sufficiently low degrees of cost substitutability or cost complementarity).

The second and third parts of the proposition identify cases in which equilibrium quality provision is, respectively, higher and lower than the benchmark for a wide range of treatment cost characteristics. If $F[E(v)] < 1/2$, such that patient experience acts as a switching cost and the market share effect is positive, quality provision is *higher* than the benchmark for any degree of cost complementarity if the distribution of valuations is such that the density close to the mean valuation is sufficiently high (i.e., $F[E(v)]$ is sufficiently large relative to $F[E(v) - \tau]$). The reason is that cost complementarity makes demand more quality-responsive, and this effect increases in the distance between $F[E(v)]$ and $F[E(v) - \tau]$, as can be seen from (16).

On the other hand, if $F[E(v)] > 1/2$, such that patient experience acts as a staying cost and the market share effect is negative, quality provision is *lower* than the benchmark for any degree of cost substitutability if the distribution of valuations is such that the density close to the mean valuation is sufficiently low (i.e., $F[E(v)]$ is sufficiently small relative to $F[E(v) - \tau]$). Once more, this is explained by the magnitude of the demand responsiveness to quality, as given by (16). Cost substitutability makes demand less quality-responsive, and this effect is larger if $F(v)$ has relatively low density close to the mean. By continuity, the results in the second and third parts of Proposition 1 also apply for sufficiently low degrees of cost substitutability and cost complementarity, respectively.

Finally, notice that the condition on $F(v)$ in the third part of Proposition 1 is always satisfied if $F[E(v) - \tau] > 1/2$, which has the following immediate implication:

Corollary 1 *If $F[E(v) - \tau] > 1/2$ and hospitals are more forward-looking than patients, first-period equilibrium quality is always lower than in the benchmark unless quality and treatment volume are sufficiently strong cost complements.*

5 The importance of patient expectations

We have conducted our analysis under the assumption that patients have rational expectations. In this section, we discuss the importance of this assumption and explore how our results might change under alternative assumptions about patient expectations.

The polar extreme of rational expectations is that patients are completely myopic. This case is captured by setting $\delta^P = 0$, which from (14) implies that the demand responsiveness to quality in the first period is given by $1/(2\tau)$. Thus, the first-period hospital choices made by myopic patients coincide with the choices they would make in the benchmark case where learning through experience is not relevant. This is quite obvious, since myopic patients do not take into account that their experience might affect their future choice of hospital and thus the future quality provision in the market. Under myopic patient behaviour, the demand responsiveness effect is therefore zero, and whether equilibrium first-period quality is higher or lower than the benchmark is uniquely determined by the market share effect, implying that $q_1^* > (<) \overline{q}$ if $F[E(v)] < (>) 1/2$.

Perhaps a more realistic alternative is that patients are forward-looking but fail to accurately predict the hospitals' future incentives for quality provision. An example of such expectations has been explored by Sá and Straume (2021) under the terminology of *forward-looking but naïve* expectations. Suppose that patients are forward-looking in the sense that they correctly anticipate how their first-period experience with their chosen hospital might affect their propensity to choose a different provider in the future. However, they fail to understand how this might affect the hospitals' incentives for future quality provision. Instead, they naïvely expect that the current qualities offered by the two hospitals will remain constant in the future.

If patients are forward-looking but naïve, they will expect that a quality difference created by a unilateral current quality increase will persist in the future, which means that $\partial(q_2^i - q_2^j)/\partial q_1^i = 1$. From (14), however, this means that the first-period demand responsiveness to quality also in this case is equal to $1/(2\tau)$; i.e., similar to the benchmark case. This might appear surprising, but can be explained as follows. Suppose that $F[E(v)] < 1/2$, which implies that patient experience acts as a switching cost. In this case, a majority of the patients expect that they will be 'locked-in' to the same hospital in the future, thus having to suffer the same mismatch costs twice. All else equal, this makes them less inclined to incur higher mismatch costs in order to enjoy higher quality in the first period, thus making demand less quality-responsive. However, if they have naïve expectations about future quality provision, they also believe that, by choosing the higher-quality hospital in the first period, they will enjoy this higher quality over two periods. The effect of enjoying higher quality twice cancels out the effect of suffering higher mismatch costs twice, thus leaving the demand responsiveness to quality at the benchmark level.

Suppose instead that $F[E(v)] > 1/2$, which implies that patient experience acts as a staying cost. This makes a majority of the patients more inclined to accept higher mismatch costs in order to obtain higher quality in the first-period, because they are likely to choose a different hospital in the future. However, this also means that they are likely to enjoy the higher quality only in one period, if they believe that a first-period quality difference will persist in the second period. Once more, the two counteracting effects cancel out each other, such that demand responsiveness to quality is similar to the benchmark case.

The above discussion illustrates that, for patient experience to have an effect on the demand responsiveness to quality, it is not enough that the patients foresee how their first-period experiences might affect their second-period choices. The patients also need to realise that these dynamic demand effects might influence the hospitals' incentives for future quality provision, which they do if they have rational expectations. However, even if their expectations are not fully rational, the patients' ability to learn through their experiences might affect the hospitals' incentives for quality provision, depending on the nature of the patients' expectations. This can be seen from (14), which shows that the demand responsiveness to quality crucially depends on patient expectations about how a unilateral quality increase today is going to affect quality differences in the future; i.e., the sign and magnitude of $\partial \left(q_2^i - q_2^j \right) / \partial q_1^i$. This is precisely characterised by the next Lemma:

Lemma 3 *(i) If $F[E(v)] < 1/2$, demand responsiveness to quality is higher (lower) than in the benchmark case if patients expect that $\partial \left(q_2^i - q_2^j \right) / \partial q_1^i > (<) \, 1$.*

(ii) If $F[E(v)] > 1/2$, demand responsiveness to quality is higher (lower) than in the benchmark case if patients expect that $\partial \left(q_2^i - q_2^j \right) / \partial q_1^i < (>) \, 1$.

Consider a unilateral first-period quality increase by Hospital i from a symmetric starting point, making Hospital i the current high-quality hospital. If patient experience acts as a switching cost ($F[E(v)] < 1/2$), demand responsiveness to quality is higher than in the benchmark case if patients expect Hospital i's quality advantage to be *reinforced* in the future. In this case, for a majority of patients, the prospect of incurring the same mismatch cost twice is more than outweighed by the prospect of a current quality gain that will be even higher in the future. Consequently, demand will respond stronger to first-period quality changes. In contrast, if patient experience acts as a staying cost ($F[E(v)] > 1/2$), demand responsiveness to quality is higher than in the benchmark case if patients expect Hospital i's quality advantage to be *reduced* in the future. In this case, for a majority of patients, the utility gain of choosing the high-quality hospital today is larger than the utility loss of switching away from this hospital in the future, thus making demand more responsive to first-period quality changes.

6 Discussion and concluding remarks

This paper considers the implications of treating healthcare as an experience good. We argue that there is some individual and subjective dimension of patient utility—possibility due to the match between a patient and a provider that is not captured by medical specialities or observable clinical quality—which may only be learned through experience. In other words, we argue that, once a patient visits a hospital, it is henceforth viewed differently from the untried hospitals in the patient's choice set. This informational difference, granted, needs not be beneficial to the hospital. Whether it is depends on the shape of the distribution of match-specific utilities.

We establish sufficient conditions for quality provision by two competing hospitals to be higher or lower than in the benchmark where experience plays no role (i.e., is uninformative). If the distribution of match-specific utilities in the population induces the majority of patients to stay (switch) with the first provider they choose, competition is intensified (softened) owing to the future value of current demand. Under the arguably realistic assumption that hospitals are more forward-looking than patients, this supply-side effect will lead to quality provision above (below) the benchmark unless the responsiveness of demand to quality is low (high) enough. This, in turn, requires that the marginal cost of quality is sufficiently increasing (decreasing) in treatment volume.

While our less computationally demanding two-period model offers a clearer account of the implications of treating hospital care as an experience good, it is worth asking which aspects of our analysis carry over to a setting where hospitals compete for first-time and experienced patients simultaneously. In this regard, it is instructive to consider an infinite-horizon overlapping-generations model with patients living for two periods and behaving, when new and old, as in each of the two periods analysed here. Relative to the first period of our model, the coexistence of old and new patients generates two additional effects. First, because it is *a priori* ambiguous whether old patients are more sensitive to quality than new ones, there is an indeterminate change in demand responsiveness due to the compositional change in the total demand faced by a hospital. Second, as in our second period, there is a demand advantage or disadvantage from old consumers, which affects the marginal cost of quality. Note, however, that this second effect vanishes in a symmetric steady-state with a 50-50 demand split and a fully covered market. The pro- or anti-competition incentive resulting from the future value of current demand obviously remains.

Although the relative strength of these effects generally depends on parameter values, we may nonetheless sketch—albeit with differing precision—how simultaneous competition for first-time and experienced patients affects two polar cases. Namely, when quality provision is unambiguously higher or lower than the benchmark. Suppose first that part *(ii)* of Proposition 1 holds with a degree of cost complementarity such that demand responsiveness is higher than the benchmark. In this instance of the 'switching cost' case, quality provision is unambiguously higher than the benchmark in the first period of our model, but experienced patients are less sensitive to it than new ones (see (A8) in the Appendix). The coexistence of the two generations of patients then leads to overall lower demand responsiveness and dampens the intensity of competition for current demand, since now only a fraction of all patients will remain in the market in the future. Alternatively, suppose that part *(iii)* of Proposition 1 holds with a degree of cost substitutability such that demand responsiveness is lower than the benchmark. In this instance of the 'staying cost' case, quality provision is unambiguously lower than the benchmark in the first period of our model, but it is now unclear whether experienced patients are more or less sensitive to quality than new ones. Given the shape of the distribution of match-specific utilities under *(iii)*, and for the same reason as above, the coexistence of the two generations of patients fosters the intensity of competition for current demand. This is reinforced if cost substitutability is sufficiently strong—so that new patients are less sensitive to quality than old ones—or hospitals are sufficiently more forward-looking than patients—so that the increased intensity of competition for current demand dominates any change in demand responsiveness. Thus, relative to the first period of our model, there is less scope for *steady-state* quality (in the infinite-horizon model) to be higher than the benchmark in the most favourable scenario and lower than the benchmark in the most unfavourable one.

References

[1] Avdic, D., Lundborg, P., and Vikström, J. (2019). Estimating returns to hospital volume: Evidence from advanced cancer surgery. *Journal of Health Economics*, 63, 81-99. https://doi.org/ 10.1016/j.jhealeco.2018.10.005

[2] Brekke, K. R., Gravelle, H., Siciliani, L., and Straume, O. R. (2014). Patient choice, mobility and competition among health care providers. In R. Levaggi and M. Montefiori (Eds.), *Health care provision and patient mobility. Developments in health economics and public policy* (Vol. 12). Milano: Springer. https://doi.org/10.1007/978-88-470-5480-6 1

[3] Brekke, K. R., Nuscheler, R., and Straume, O. R. (2007). Gatekeeping in health care. *Journal of Health Economics*, 26(1), 149-170. https://doi.org/10.1016/j.jhealeco.2006.04.004

[4] Brekke, K. R., Siciliani, L., and Straume, O. R. (2011). Hospital competition and quality with regulated prices. *The Scandinavian Journal of Economics*, 113(2), 444-469. https://doi.org/ 10.1111/j.1467-9442.2011.01647.x

[5] Chen, Y., Li, Z., and Zhang, T. (2022). Experience goods and consumer search. *American Economic Journal: Microeconomics*, 14(3), 591-621. https://doi.org/10.1257/mic.20200070

[6] Chen, Z. C., Stanton, C. T., and Thomas, C. (2021). Information spillovers in experience goods competition (Working Paper No. 28584). National Bureau of Economic Research. https:// doi.org/10.3386/w28584

[7] De Nijs, R., and Rhodes, A. (2013). Behavior-based pricing with experience goods. *Economics Letters*, 118(1), 155-158. https://doi.org/10.1016/j.econlet.2012.10.014

[8] Gutacker, N., Siciliani, L., Moscelli, G., and Gravelle, H. (2016). Choice of hospital: Which type of quality matters? *Journal of Health Economics*, 50, 230-246. https://doi.org/10.1016/ j.jhealeco.2016.08.001

[9] Huck, S., Lünser, G. K., and Tyran, J.-R. (2016). Price competition and reputation in markets for experience goods: An experimental study. *The RAND Journal of Economics*, 47(1), 99-117. https://doi.org/10.1111/1756-2171.12120

[10] Irace, M. (2018). Patient loyalty in hospital choice: Evidence from New York (Working Paper No. 2018-52). University of Chicago, Becker Friedman Institute for Economics. http:// dx.doi.org/10.2139/ssrn.3223702

[11] Raval, D., and Rosenbaum, T. (2018). Why do previous choices matter for hospital demand? Decom- posing switching costs from unobserved preferences. *The Review of Economics and Statistics*, 100(5), 906-915. https://doi.org/10.1162/rest a 00741

[12] Siciliani, L., Straume, O. R., and Cellini, R. (2013). Quality competition with motivated providers and sluggish demand. *Journal of Economic Dynamics and Control*, 37(10), 2041-2061. https:// doi.org/10.1016/j.jedc.2013.05.002

[13] Steel, D., and Cylus, J. (2012). United Kingdom (Scotland): Health system review. *Health Systems in Transition*, 14(9), 1-150. https://apps.who.int/iris/handle/10665/330314

[14] Sá, L., and Straume, O. R. (2021). Quality provision in hospital markets with demand inertia: The role of patient expectations. *Journal of Health Economics*, 80, 102529. https://doi.org/ 10.1016/j.jhealeco.2021.102529

[15] Villas-Boas, J. M. (2004). Consumer learning, brand loyalty, and competition. *Marketing Science*, 23(1), 134-145. https://doi.org/10.1287/mksc.1030.0044

[16] Villas-Boas, J. M. (2006). Dynamic competition with experience goods. *Journal of Economics & Management Strategy*, 15(1), 37-66. https://doi.org/10.1111/j.1530-9134.2006.00091 .x

Appendix A: Supplementary calculations

In this Appendix we provide supplementary calculations to help understand the derivation of several of the expressions displayed in the main analysis.

Second-period demand

In the second period, the history of the game is captured by the first-period demand faced by each hospital, with all patients with $x < (>)\widehat{x}$ choosing Hospital A (B) in $t = 1$, such that $D_1^A = \widehat{x}$ and $D_1^B = 1 - \widehat{x}$. Having chosen Hospital A in the first period, a patient chooses this hospital again if

$$v^A + q_2^A - \tau x > E(v^B) + q_2^B - \tau(1 - x), \tag{A1}$$

or

$$v^A > E(v^B) + q_2^B - q_2^A - \tau(1 - 2x). \tag{A2}$$

Similarly, having chosen Hospital B in the first period, a patient now switches to Hospital A if

$$E(v^A) + q_2^A - \tau x > v^B + q_2^B - \tau(1 - x), \tag{A3}$$

or

$$v^B < E(v^A) + q_2^A - q_2^B - \tau(2x-1). \tag{A4}$$

Thus, total demand facing Hospital A in the second period is given by

$$D_2^A = \int_0^{\widehat{x}} \int_{E(v^B)+q_2^B-q_2^A-\tau(1-2x)}^{\overline{v}} f(v^A)dv^A dx + \int_{\widehat{x}}^1 \int_{\underline{v}}^{E(v^A)+q_2^A-q_2^B-\tau(2x-1)} f(v^B)dv^B dx. \tag{A5}$$

Similarly, the total demand facing Hospital B in the second period is given by

$$D_2^B = \int_0^{\widehat{x}} \int_{\underline{v}}^{E(v^B)+q_2^B-q_2^A-\tau(1-2x)} f(v^B)dv^B dx + \int_{\widehat{x}}^1 \int_{E(v^A)+q_2^A-q_2^B-\tau(2x-1)}^{\overline{v}} f(v^B)dv^B dx. \tag{A6}$$

Using the definition of $F(v)$, and easing notation by writing $v^A = v^B = v$, (A5) and (A6) can be expressed as (8)-(9).

The effect of current demand on future quality provision

We start out by deriving the second-period demand responsiveness to quality, which, from (8)–(9), is given by

$$\frac{\partial D_2^i}{\partial q_2^i} = \int_0^{\widehat{x}} f\left[E(v) + q_2^j - q_2^i - \tau(1-2x)\right] dx + \int_{\widehat{x}}^1 f\left[E(v) + q_2^i - q_2^j - \tau(2x-1)\right] dx. \tag{A7}$$

At the symmetric equilibrium, where $\widehat{x} = 1/2$ and $q_2^i = q_2^j$, this simplifies to

$$\frac{\partial D_2^i}{\partial q_2^i} = \frac{F[E(v)] - F[E(v)-\tau]}{\tau}. \tag{A8}$$

By totally differentiating the first-order condition defining the optimal second-period quality level of Hospital i, given by (11), with respect to D_1^i, we obtain

$$\begin{aligned} - c\frac{\partial D_2^i}{\partial q_2^i}\frac{\partial q_2^{i*}}{\partial D_1^i} + (p - cq_2^{i*}) \left[\frac{\partial^2 D_2^i}{\partial (q_2^i)^2}\frac{\partial q_2^{i*}}{\partial D_1^i} + \frac{\partial^2 D_2^i}{\partial q_2^i \partial q_2^j}\frac{\partial q_2^{j*}}{\partial D_1^i} + \frac{\partial^2 D_2^i}{\partial q_2^i \partial D_1^i}\right] \\ - c\left(\frac{\partial D_2^i}{\partial q_2^i}\frac{\partial q_2^{i*}}{\partial D_1^i} + \frac{\partial D_2^i}{\partial q_2^j}\frac{\partial q_2^{j*}}{\partial D_1^i} + \frac{\partial D_2^i}{\partial D_1^i}\right) - \gamma\frac{\partial q_2^{i*}}{\partial D_1^i} = 0. \end{aligned} \tag{A9}$$

Evaluated at the symmetric equilibrium, where $D_1^i = 1/2$ and $\partial q_2^{i*}/\partial D_1^i = -\partial q_2^{j*}/\partial D_1^i$, this becomes

$$-\left(3c\frac{\partial D_2^i}{\partial q_2^i} + \gamma\right)\frac{\partial q_2^{i*}}{\partial D_1^i} - c\frac{\partial D_2^i}{\partial D_1^i} = 0. \tag{A10}$$

By substituting the previously derived expression for $\partial D_2^i/\partial D_1^i$ from (10), and solving with respect to $\partial q_2^{i*}/\partial D_1^i$ $(= -\partial q_2^{j*}/\partial D_1^i)$, we arrive at the expression given by (12).

First-period demand responsiveness to quality

Consider a patient located at x. Denote by $U_1^A(x)$ the expected utility this patient derives from choosing Hospital A in the first period, when taking into account how the experienced at this hospital is likely to affect the choice of hospital in the future. This expected utility is given by

$$\begin{aligned} U_1^A(x) = E(v^A) + q_1^A - \tau x + \delta^P \int_{E(v^B)+q_2^B-q_2^A-\tau(1-2x)}^{\overline{v}} (v^A + q_2^A - \tau x) f(v^A) dv^A \\ + \delta^P \int_{\underline{v}}^{E(v^B)+q_2^B-q_2^A-\tau(1-2x)} [E(v^B) + q_2^B - \tau(1-x)] f(v^A) dv^A, \end{aligned} \quad \text{(A11)}$$

while the corresponding expected utility of choosing Hospital B is

$$\begin{aligned} U_1^B(x) = E(v^B) + q_1^B - \tau(1-x) + \delta^P \int_{E(v^A)+q_2^A-q_2^B-\tau(2x-1)}^{\overline{v}} [v^B + q_2^B - \tau(1-x)] f(v^B) dv^B \\ + \delta^P \int_{\underline{v}}^{E(v^A)+q_2^A-q_2^B-\tau(2x-1)} [E(v^A) + q_2^A - \tau x)] f(v^B) dv^B. \end{aligned} \quad \text{(A12)}$$

The patient who is indifferent between the two hospitals in the first period is located at $\widehat{x}$, which is implicitly defined by

$$U_1^A(\widehat{x}) = U_1^B(\widehat{x}). \quad \text{(A13)}$$

By totally differentiating (A13) with respect to q_1^A, we derive

$$1 - \tau\left(2 + \delta^P[1 - 2F(\alpha)] + \delta^P[1 - 2F(\beta)]\right) \frac{\partial \widehat{x}}{\partial q_1^A} + \delta^P[1 - F(\alpha) - F(\beta]\frac{\partial(q_2^A - q_2^B)}{\partial q_1^A} = 0, \quad \text{(A14)}$$

where $\alpha := E(v) + q_2^B - q_2^A - \tau(1-2x)$ and $\beta := E(v) + q_2^A - q_2^B - \tau(2x-1)$. Evaluated at the symmetric equilibrium, where $\widehat{x} = 1/2$, (A14) reduces to

$$1 - 2\tau\left[1 + \delta^P(1 - 2F[E(v)])\right] \frac{\partial \widehat{x}}{\partial q_1^A} + \delta^P(1 - 2F[E(v)])\frac{\partial(q_2^A - q_2^B)}{\partial q_1^A} = 0. \quad \text{(A15)}$$

Solving (A15) for $\partial \widehat{x}/\partial q_1^A$, and noting that $D_1^A = \widehat{x}$ and $D_2^B = 1 - \widehat{x}$, we obtain the expression for the first-period demand responsiveness to quality given by (14).

Appendix B: Proofs

Proof of Lemma 2

The first-period demand responsiveness to quality is higher than in the benchmark case if the sum of the second and third terms in (16) is negative. The sum of these terms can be written as

$$2\tau\delta^P((1-2F[E(v)])\left[1+\frac{c(1-2F[E(v)])}{3c(F[E(v)]-F[E(v)-\tau])+\gamma\tau}\right]. \quad \text{(B1)}$$

(i)-(ii) Suppose first that $F[E(v)] < 1/2$. In this case, the expression in (B1) is negative if

$$\frac{c(1-2F[E(v)])}{3c(F[E(v)]-F[E(v)-\tau])+\gamma\tau} < -1, \quad \text{(B2)}$$

which is true if

$$c < \widetilde{c} := -\frac{\tau\gamma}{3(F[E(v)]-F[E(v)-\tau])+(1-2F[E(v)])}, \quad \text{(B3)}$$

where $\widetilde{c} < 0$ if $F[E(v)] < 1/2$. The parameter set characterised by (B3) is non-empty if $\widetilde{c} > \underline{c}$. In order to determine the conditions for $\widetilde{c} > \underline{c}$, we need to provide a more complete characterisation of the lower bound $\underline{c}$. Recall that $\underline{c}$ is defined such that

$$\gamma + c\frac{\partial D_1^i}{q_1^i} \geq 0 \text{ for } c \geq \underline{c}. \quad \text{(B4)}$$

For $c < 0$, the inequality in (B4) can be re-written as

$$\frac{\partial D_1^i}{\partial q_1^i} \leq -\frac{\gamma}{c} \quad \text{(B5)}$$

From (16) it is easily verified that $\partial D_1^i/\partial q_1^i$ is a strictly decreasing function of c and that $\lim_{c\to c_0^+}(\partial D_1^i/\partial q_1^i) = \infty$, where

$$c_0 := -\frac{\tau\gamma\left[1+\delta^P(1-2F[E(v)])\right]}{3\left(F[E(v)]-F[E(v)-\tau]\right)\left[1+\delta^P(1-2F[E(v)])\right]+\delta^P(1-2F[E(v)])^2} < 0. \quad \text{(B6)}$$

Notice also that $-\gamma/c$ is a strictly increasing function of c in $(c_0, 0)$ and that $\lim_{c\to 0}(-\gamma/c) = \infty$. Thus, $\partial D_1^i/\partial q_1^i$ and $-\gamma/c$ intersect exactly once in $(c_0, 0)$, and this occurs at $c = \underline{c}$. Furthermore, given the shapes of $\partial D_1^i/\partial q_1^i$ and $-\gamma/c$, it also follows that (B4) holds. Given these results, it follows that $\widetilde{c} > \underline{c}$ if $-\gamma/c > \partial D_1^i/\partial q_1^i$ at $c = \widetilde{c}$. Since, by definition, $\partial D_1^i/\partial q_1^i = 1/(2\tau)$ at $c = \widetilde{c}$, the condition for $\widetilde{c} > \underline{c}$ is that $-\gamma/\widetilde{c} > 1/(2\tau)$. Using the expression for $\widetilde{c}$ in (B3), the condition is given by

$$\frac{3(F[E(v)] - F[E(v) - \tau]) + (1 - 2F[E(v)])}{\tau} > \frac{1}{2\tau}, \tag{B7}$$

which holds if

$$F[E(v)] > 3F[E(v) - \tau] - \frac{1}{2}. \tag{B8}$$

(iii) Suppose now that $F[E(v)] > 1/2$. In this case, the expression in (B1) is negative if

$$\frac{c(1 - 2F[E(v)])}{3c(F[E(v)] - F[E(v) - \tau]) + \gamma\tau} > -1, \tag{B9}$$

which is always true if $c < 0$. To see what it takes for the condition to hold if $c > 0$, it is convenient to re-write (B9) as

$$c\,(F[E(v)] - 3F[E(v) - \tau] + 1) > -\gamma\tau. \tag{B10}$$

If $F[E(v)] - 3F[E(v) - \tau] + 1 < 0$, (B10) holds if

$$c < -\frac{\gamma\tau}{F[E(v)] - 3F[E(v) - \tau] + 1} = \widetilde{c}, \tag{B11}$$

where $\widetilde{c}$ is now strictly positive.

(iv) On the other hand, if $F[E(v)] - 3F[E(v) - \tau] + 1 > 0$, (B10) holds if

$$c > -\frac{\gamma\tau}{F[E(v)] - 3F[E(v) - \tau] + 1} = \widetilde{c}, \tag{B12}$$

where $\widetilde{c}$ in this case is strictly negative. However, we already know that the condition in (B10) holds for all $c < 0$ if $F[E(v)] > 1/2$. Thus, if $F[E(v)] > \max(1/2, 3F[E(v) - \tau] - 1)$, the condition holds for all c.

Proof of Proposition 1

(i) If $F[E(v)] < 1/2$, the condition for quality to be higher than in the benchmark, (19), can be expressed as

$$\delta^H A > \delta^P B, \tag{B13}$$

where

$$A := \frac{p - cq_2^{i*}}{p - c\overline{q}} = \frac{c + 2\tau\gamma}{2\left(c\left(F\left[E\left(v\right)\right] - F\left[E\left(v\right) - \tau\right]\right) + \tau\gamma\right)} \tag{B14}$$

and

$$B := \frac{c(1 + F[E(v)] - 3F[E(v) - \tau]) + \gamma\tau}{2c(F[E(v)] - F[E(v) - \tau]) + \gamma\tau}. \tag{B15}$$

From (B14) and (B15) we derive

$$A - B = -c\frac{2c\left(F\left[E\left(v\right)\right] - 3F\left[E\left(v\right) - \tau\right]\right)\left(F\left[E\left(v\right)\right] - F\left[E\left(v\right) - \tau\right]\right) + \tau\gamma\left(1 - 4F\left[E\left(v\right) - \tau\right]\right)}{2\left(c\left(F\left[E\left(v\right)\right] - F\left[E\left(v\right) - \tau\right]\right) + \tau\gamma\right)\left(2c\left(F\left[E\left(v\right)\right] - F\left[E\left(v\right) - \tau\right]\right) + \tau\gamma\right)}. \tag{B16}$$

It is immediately verified that $A = B > 0$ if $c = 0$, which implies that the condition in (B13) holds for $c = 0$ when $\delta^H > \delta^P$. Due to continuity, this must also be true in the neighbourhood of $c = 0$.

On the other hand, if $F\left[E\left(v\right)\right] > 1/2$, the condition for quality to be higher than in the benchmark, (19), is instead given by

$$\delta^H A < \delta^P B, \tag{B17}$$

By the same argument as above, this condition never holds in the neighbourhood of $c = 0$ when $\delta^H > \delta^P$.

(ii) Suppose that $3F\left[E\left(v\right) - \tau\right] < F\left[E\left(v\right)\right] < 1/2$ and $c < 0$. In this case, equilibrium quality is higher than in the benchmark case if (B13) holds. For $\delta^H > \delta^P$, this condition holds if $A > B$, which is true if the numerator in (B16) is positive. From Lemma 2 we know that the demand responsiveness to quality is higher than in the benchmark if $c \in (\underline{c}, \widetilde{c})$, which is a non-empty set for $F\left[E\left(v\right)\right] > 3F\left[E\left(v\right) - \tau\right]$. This means that both the demand responsiveness effect and the market share effect go in the same direction, implying that $A > B$ for $c < \widetilde{c}$. However, since the numerator in (B16) is monotonically increasing in c when $F\left[E\left(v\right)\right] > 3F\left[E\left(v\right) - \tau\right]$, this must be true, implying that (B13) holds, for all $c \in (\underline{c}, 0)$. By continuity, (B13) holds also for sufficiently small positive values of c.

(iii) If $F\left[E\left(v\right)\right] > 1/2$, quality is higher than in the benchmark case if (B17) holds. We know that this condition does not hold in the neighbourhood of c. A sufficient condition for (B17) not to hold for any $c > 0$ is that A is increasing in c while B is decreasing in c. From (B14) and (B15) we derive

$$\frac{\partial A}{\partial c} = \frac{\left[1 - 2\left(F\left[E\left(v\right)\right] - F\left[E\left(v\right) - \tau\right]\right)\right]\tau\gamma}{2\left(c\left(F\left[E\left(v\right)\right] - F\left[E\left(v\right) - \tau\right]\right) + \tau\gamma\right)^2} > 0 \text{ if } F\left[E\left(v\right)\right] < F\left[E\left(v\right) - \tau\right] + \frac{1}{2} \tag{B18}$$

and

$$\frac{\partial B}{\partial c} = \frac{\left(1 - F\left[E\left(v\right)\right] - F\left[E\left(v\right) - \tau\right]\right)\tau\gamma}{\left(2c\left(F\left[E\left(v\right)\right] - F\left[E\left(v\right) - \tau\right]\right) + \tau\gamma\right)^2} < 0 \text{ if } F\left[E\left(v\right)\right] > 1 - F\left[E\left(v\right) - \tau\right]. \tag{B19}$$

Thus, quality is lower than in the benchmark for all $c \geq 0$, and for sufficiently small negative values of c, if

$$\max\left\{\frac{1}{2}, 1 - F[E(v) - \tau]\right\} < F[E(v)] < F[E(v) - \tau] + \frac{1}{2}. \tag{B20}$$

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