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ABSTRACT

Can competition reduce quality?

In a spatial competition setting there is usually a non-negative relationship between competition and quality. In this paper we offer a novel mechanism whereby competition leads to lower quality. This mechanism relies on two key assumptions, namely that the providers are motivated and risk-averse. We show that the negative relationship between competition and quality is robust to any given number of fims in the market and whether quality and price decisions are simultaneous or sequential. We also show that competition may improve social welfare despite the adverse effect on quality. Our proposed mechanism can help explain empirical findings of a negative effect of competition on quality in markets such as health care, long-term care, and higher education.

JEL Classification: D21, D43, L13 and L30
Keywords: motivated providers, quality and price competition and risk-averse providers

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1 Introduction

Quality is a key concern for consumers in many sectors such as health care, long-term care, child care and education. Hospitals, nursing homes, schools and universities compete on quality to attract patients, residents and students. While in some countries prices are typically regulated, in other countries they are not. In this study we focus on institutional settings where providers compete both on quality and price. For example, prices are variable in the hospital sector in the US for patients who are not part of public programmes such as Medicare (for the elderly) or Medicaid (for the poor). In England, the government recently discussed whether public insurers should be able to negotiate prices with public hospitals, so that they would compete not only on quality but also on price. It was ultimately decided not to allow competition on prices due to concerns that quality may suffer (Kmietowicz, 2011). In the UK, France and the US, long-term care institutions (e.g., nursing homes, residential homes) compete on prices in addition to quality to attract residents. Universities in the US, and from 2012 in the UK, compete on prices in addition to quality. In the UK nurseries offer different services in combination with different prices for child care, and therefore also compete on price and quality.

In this study we investigate whether competition can lead to a reduction in quality when providers compete on both price and quality. We use a spatial competition framework with two providers where consumers trade off travelling distance relative to price and quality offered by the providers. This framework is widely used and well-suited for studying competition in markets such as health care, education, long-term care, etc., where consumers usually have a preference for the closest provider unless more distant providers offer a better quality and/or lower price.

We show that more competition reduces quality (and price) when two assumptions hold: i) the providers are motivated and have a genuine concern for quality; ii) the providers are risk averse and face decreasing marginal utility from profits. We think both assumptions are highly relevant for the providers in the type of sectors we have in mind. Provider motivation is widely recognised in the health economics and motivated agents literature.[1] Risk averse providers

[1] In health economics, see, e.g., Ellis and McGuire (1986), Chalkley and Malcomson (1998), Eggleston (2005), Jack (2005), and Brekke, Siciliani and Straume (2011). In the motivated agents literature, examples include Francois (2000); Besley and Gathak (2005); Delfgaauw and Dur (2008); Prendergast (2007); Makris (2009).

are less recognised, though there are some exceptions.[2] However, there are several reasons why providers act as if they are risk averse, including factors such as concentrated ownership, liquidity constraints, costly financial distress, and delegation of control to a risk-averse manager, whose pay is linked to firm performance, may cause the firm to behave in a risk averse manner.[3] In Section 2 we discuss these assumptions in greater detail.

The existing theoretical literature offers limited insight with respect to a potential negative relationship between competition and quality (when prices are flexible). A notable exception is Economides (1993) who applies a Salop model with n firms and shows that a higher number of firms leads to lower equilibrium quality under price-quality competition. However, this results from a pure demand effect (a higher number of firms implies that each firm faces less demand) and the analysis therefore only addresses a limited aspect of competition. Intuitively, a key implication of increased competition is that each firm's demand becomes more responsive to changes in quality and/or price. In a spatial competition framework with inelastic total demand, this effect is perfectly captured by measuring competition as the equivalent of lower transportation costs, which is a standard practice in the literature.

When increased competition makes demand more responsive to price/quality changes, there are two counteracting effects with respect to firms' incentives for quality provision. While more competition increases the incentives to supply high quality for given prices, more competition also reduces the price-cost margin, which, in turn, reduces the incentives to invest in quality. Ma and Burgess (1993) report that the direct effect of more competition on quality is exactly offset by the indirect effect via lower prices so that overall there is no effect of more competition on quality. The same result is reported by Gravelle (1999). However, Brekke, Siciliani and Straume (2010) show that the two above-mentioned effects do not cancel when allowing for income effects in consumer utility. They find that more competition tends to *increase* quality in the presence of such income effects.

The above-mentioned papers find that competition has either zero of positive effects on

[2] In health economics, the assumption of risk-averse hospitals has been used by, e.g., Hodgkin and McGuire (1994), Mougeot and Naegelen (2008) and Felder (2009). In the broader IO literature, see, e.g., Hviid (1989), Wambach (1999), Asplund (2002), Cheng (2002), Jellal and Wolff (2005), Banal-Estañol and Ottaviani (2006), Janssen and Karamychev (2009), Barreda-Tarrazone et al (2011) for analyses of risk-averse firms in oligopoly settings.

[3] In the UK, several hospital managers have been fired or threaten to be fired by the NHS trust boards due to bad performance such as large hospital deficits.

quality provision. To our knowledge, the existing literature does not offer any plausible theoretical mechanisms that make the indirect effect outweigh the direct one, thereby establishing a negative relationship between competition and quality.[4] The present paper fills this gap in the literature by showing that with motivated and risk-averse providers a third effect emerges and competition actually reduces quality. The intuition is that more competition leads to lower prices, which in turn reduces profits and increases the marginal utility from profits. Being motivated, the provider works at a negative marginal profit and will therefore respond optimally to fiercer competition by reducing quality in order to recover some of the profit losses generated by the price reduction.

We show that our key result that competition reduces quality is robust to two different modifications of the standard set-up. First, we extend our basic set-up to more than two firms ($n \geq 2$) using a Salop model, and show that both lower transportation costs and more firms leads to lower quality. While the first result relies exclusively on the assumptions that providers are motivated and risk averse, the latter does not but is reinforced by risk aversion since more firms reduce profits. Second, we allow for sequential quality and price decisions, reflecting that quality often is a more long-term decision than price. We show that the timing of decisions do not qualitatively change our main result. When providers can commit to a given quality level before competing in prices, we also show that this softens quality competition as providers take into account how quality affects own and rival pricing decisions in the subsequent stage. This result is in line with previous findings by Ma and Burgess (1993).[5]

We also investigate the welfare implications of more competition, where we show that the market provides too much quality compared to the first-best outcome. Thus, more competition may in fact be welfare improving despite the adverse effect it has on quality. However, in a second-best situation where provider preferences are explicitly taken into account, the effect of more competition on social welfare is in general ambiguous. More competition reduces quality, which (in contrast to first-best) is harmful to welfare, but more competition also reduces prices, which improves welfare. If the marginal utility of income is higher for consumers than for

[4] In a very different theoretical framework, with monopolistic competition, imperfect information and consumer search, Dranove and Satterthwaite (1992) show that improved price information might reduce quality provision, possibly to the extent that welfare is reduced.

[5] See also Economides (1993) for a similar result in the context of a Salop model.

providers, then we show that the second (price) effect dominates, implying that more competition always increases social welfare.

Our proposed mechanism might rationalise some of the empirical evidence which finds a negative relationship between quality and competition in health care markets. For example, Mukamel et al. (2002) find that hospital competition increased mortality from 1982 to 1989 in California; Volpp et al. (2003) investigate the effect of price deregulation in New Jersey from 1990 to 1996 and find an increase in mortality; Propper et al. (2004) and Burgess et al. (2008) find in England a negative relationship between competition and quality (a positive relation between competition and mortality rates for patients with heart attack) when fixed-price regulation was not yet introduced and prices were allowed to vary. Grabowski (2004) finds that competition reduces the quality of nursing homes in the US.[6]

The rest of the paper is organised as follows. In Section 2 we present our basic model, and derive our key result that competition reduces quality. In Section 3 we check the robustness of our key result by modifying our basic model along two dimensions: (i) more than two firms; (ii) sequential quality and price decisions. In Section 4 we conduct a welfare analysis, while in Section 5 we offer some concluding remarks.

2 Model and analysis

Consider a market with two providers, denoted by $i = 1, 2$, located at each endpoint of the line segment $S = [0, 1]$. Consumers are uniformly located on S with a total mass of one, and each consumer demands one unit from the most preferred provider. The utility of a consumer located at $x \in S$ and buying from provider i is given by

$$u_i(x) = \left\{ \; v + \beta q_i - p_i - t\,|x - z_i| \right. \quad , \tag{1}$$

where q_i and p_i are the quality and price, respectively, of product i, v is the gross consumer surplus, β is the marginal utility of quality, and t is the transport cost per unit of distance to the provider located at z_i, where $z_1 = 0$ and $z_2 = 1$. We assume v is sufficiently high, so that all consumers buy either product 1 or 2 (full market coverage).

[6]See Gaynor (2006) for survey on the effects of competion on quality in health care markets.

Each consumer makes a utility-maximising choice of provider, which gives the demand for provider 1 as

$$D_1 = \frac{1}{2} + \frac{1}{2t}\left(\beta\left(q_1 - q_2\right) - p_1 + p_2\right), \tag{2}$$

while demand for provider 2 is $D_2 = 1 - D_1$. Lower travelling costs make demand for each provider more price- and quality-elastic. Thus, following the standard practice in the literature, we will measure the degree of competition in the market by t^{-1}.

Profits for provider i is given by

$$\pi_i = (p_i - c)D_i - g\left(q_i\right), \tag{3}$$

where c is the marginal cost of producing the product and $g\left(q_i\right)$ is the fixed cost of quality with $g_{q_i} > 0$ and $g_{q_i q_i} > 0$.

The objective function of provider i is given by

$$U^i\left(q_i, \pi_i\right). \tag{4}$$

We make two critical assumptions regarding the shape of this function. First, we assume that providers are concerned about quality: $U_{q_i} > 0$ and $U_{q_i q_i} \leq 0$. This could be due to motivation or altruism, which is highly relevant in the health, long-term care and education sectors, as well as other public sector industries. In the health economics literature, it has long been recognised that providers (doctors, nurses, health care managers) are, at least to some extent, altruistic.[7] This assumption is also made in the recent literature on motivated agents in the broader public sector, where the agent is assumed to share, to some extent, the objective function of the principal.[8] The main idea is that organisations that provide public (or publicly-provided private) goods have a mission, and individuals who work in such organisations are 'mission-oriented' or 'motivated'. Examples given in this literature include doctors and nurses who are committed to improve health, teachers who care about good learning, and researchers who are committed to expanding knowledge.

[7] See, e.g., Ellis and McGuire, 1986; Chalkley and Malcomson, 1998; Eggleston, 2005; Jack, 2005; Brekke, Siciliani and Straume (2011).

[8] See, e.g., Francois (2000); Besley and Gathak (2005); Delfgaauw and Dur (2008); Prendergast (2007); Makris (2009).

Second, we also allow for risk-averse providers by assuming that $U^i_{\pi_i} > 0$ and $U^i_{\pi_i\pi_i} < 0$. There are several reasons why firms or organisations in general might display risk-averse behaviour, such as concentrated ownership or delegation of control to risk-averse managers whose remuneration is linked to firm performance. A firm's payoff function might also be concave in profits due to liquidity constraints and costly financial distress. If external financing is more costly than internal financing, the firm's marginal value of profits will decrease with the profit level. Thus, the assumption of decreasing marginal utility of profits might be particularly relevant for organisations that have small profit margins or that are close to breaking even.[9] In the context of health care markets, the assumption of risk-averse hospitals has been used by, e.g., Hodgkin and McGuire (1994), Mougeot and Naegelen (2008) and Felder (2009).

To keep the analysis simple we assume that the objective function of each provider is separable in quality and profits, i.e., $U^i_{\pi_i q_i} = 0$. Towards the end of this section we will show that relaxing this assumption does not qualitatively affect our main result unless $U^i_{\pi_i q_i} < 0$ *and* this effect is sufficiently large in magnitude.

We assume that the two providers choose price and quality simultaneously. The first-order conditions for the optimal quality and price for provider i are, respectively,[10]

$$U^i_{q_i} + U^i_{\pi_i}\left(\frac{(p_i - c)\,\beta}{2t} - g_{q_i}\right) = 0 \tag{5}$$

and

$$U^i_{\pi_i}\left(D_i - \frac{p_i - c}{2t}\right) = 0. \tag{6}$$

The symmetric Nash equilibrium, denoted by q^* and p^*, has quality and price given by

$$U_{q^*} + U_{\pi}\left(\frac{(p^* - c)\,\beta}{2t} - g_{q^*}\right) = 0 \tag{7}$$

and

$$U_{\pi}\left(\frac{1}{2} - \frac{p^* - c}{2t}\right) = 0. \tag{8}$$

[9] See, e.g., Asplund (2002) and Banal-Estañol and Ottaviani (2006) for further discussions of risk-averse firms.

[10] The second-order conditions are: i) $\partial^2 U^i/\partial q_i^2 = U_{q_i q_i} - U_{\pi_i} g_{q_i q_i} + U_{\pi_i\pi_i}\left(\frac{(p_i-c)\beta}{2t} - g_{q_i}\right)^2 < 0$, ii) $\partial^2 U^i/\partial p_i^2 = U_{\pi_i\pi_i}\left(D_i - \frac{p_i - c}{2t}\right)^2 - U_{\pi_i}\left(\frac{1}{t}\right) = -U_{\pi_i}\left(\frac{1}{t}\right) < 0$; iii) $\left(\partial^2 U^i/\partial q_i^2\right)\left(\partial^2 U^i/\partial p_i^2\right) - \left(\partial^2 U^i/\partial q_i \partial p_i\right)^2 > 0$, where $\partial^2 U^i/\partial q_i \partial p_i = U_{\pi_i\pi_i}\left(\frac{\beta}{2t}\right)$.

From the optimality condition on price we obtain:

$$p^* = c + t. \tag{9}$$

Thus, more competition, in the form of lower transportation costs, reduces price. Substituting $p^* = c + t$ into the condition for optimal quality yields

$$U_{q^*} + U_\pi \left(\frac{\beta}{2} - g_{q^*} \right) = 0. \tag{10}$$

What is the effect of more competition on quality? Differentiating (10) with respect to q^* and t, and keeping in mind that equilibrium profit is $\pi^* = \frac{t}{2} - g(q^*)$, we derive

$$\frac{\partial q^*}{\partial t} = -\frac{U_{\pi\pi}}{2V_{qq}} \left(\frac{\beta}{2} - g_{q^*} \right) > 0, \tag{11}$$

where $V_{qq} := U_{qq} - U_\pi g_{qq} - U_{\pi\pi} \left(\frac{\beta}{2} - g_q \right) g_q < 0$. From (10), notice that $\beta/2 - g_q = -U_q/U_\pi < 0$ at $q = q^*$. We therefore obtain the following result:

Proposition 1 *In a Hotelling model where providers set price and quality simultaneously, more competition, measured by lower transportation costs, leads to lower quality when providers are motivated* ($U_q > 0$) *and risk averse* ($U_{\pi\pi} < 0$).

The intuition for our key result is the following. More competition generates three effects. First, it makes the demand more responsive to a marginal increase in quality. For a given mark-up ($p^* - c = t > 0$), this effect tends to increase quality. However, more competition also reduces the mark-up, which reduces the marginal profit from an increase in quality. These two effects offset each other completely.[11] Under our two critical assumptions, there is however a third effect. More competition reduces the price, which in turn reduces profits and increases the marginal utility from profits. Since providers are motivated, the marginal profit of quality is negative in equilibrium ($\beta/2 - g_q < 0$). Therefore, each provider responds optimally to more competition by reducing quality in order to recover some of the profit losses generated by the price reduction.

[11] This is why there is no (net) effect of competition (measured by transportation cost) on quality in many of the spatial competition studies; see e.g., Ma and Burgess (1993) and Gravelle (1999).

Notice the criticality of our two key assumptions. If marginal utility does not decrease with higher profits, then $U_{\pi\pi} = 0$ and $\partial q^*/\partial t = 0$. If the marginal utility is constant, variations in profits do not affect the relative willingness to provide quality. If the provider is not motivated, then $U_q = 0$, $\frac{1}{2} - g_q = 0$ and $\partial q^*/\partial t = 0$. In this case, quality is set to maximise profits so that, by the Envelope Theorem, a marginal reduction in quality has no effect on profits.

What happens if we relax the assumption of $U_{\pi q} = 0$? In this case, we get the following relationship between competition and quality:

$$\frac{\partial q^*}{\partial t} = -\frac{1}{2\overline{V}_{qq}} \left[U_{\pi\pi} \left(\frac{\beta}{2} - g_q \right) + U_{q\pi} \right], \tag{12}$$

where $\overline{V}_{qq} := U_{qq} - U_\pi g_{qq} - U_{\pi\pi} \left(\frac{\beta}{2} - g_q \right) g_q + U_{q\pi} \left(\frac{\beta}{2} - 2g_q \right) < 0$ (by the second-order condition). Thus, the competition effect is strengthened (reduced) if there is a positive (negative) relationship between profits and quality in the provider's utility function. One could argue that motivated providers ($U_q > 0$) may value quality less if profit is low, suggesting a positive relationship. However, one could possibly also argue that highly motivated providers (high U_q) value (one extra unit of) profits lower than less motivated providers (low U_q), suggesting a negative relationship. In the following we maintain our assumption of $U_{\pi q} = 0$.

3 Extensions

In this section we check the robustness of our main result in Proposition 1. First, we extend the basic model to n firms using a Salop model. This gives us one additional measure of competition. Second, we consider a sequential game where quality is set before prices, which captures that quality often is a more long-term decision than price.

3.1 Salop model with n firms

Consider a market where $n \geq 2$ firms are symmetrically (equidistantly) located on a circle with circumference equal to 1. On the circle there is a uniform distribution of consumers with density normalised to 1. Consumer utility is given by (1) with the only modification that $i = 1, ..., n$. Since the model is symmetric, all providers will set the same price and quality in equilibrium.

If provider i's neighbours (competitors) set equal price and quality, i.e., $p_{i-1} = p_{i+1} = p_j$ and $q_{i-1} = q_{i+1} = q_j$, the demand for provider i is given by

$$D_i(q_i, q_j) = \frac{1}{n} + \frac{1}{t}\left(\beta(q_i - q_j) - p_i + p_j\right). \tag{13}$$

The profits and utility to provider i are given by (3) and (4). Using (13) and assuming that all providers simultaneously choose prices and qualities to maximise utility in (4), we obtain the following symmetric Nash equilibrium:

$$p^* = c + \frac{t}{n}, \tag{14}$$

$$U_{q^*} + U_\pi\left(\frac{\beta}{n} - g_{q^*}\right) = 0, \tag{15}$$

with equilibrium profits given by $\pi^* = t/n^2 - g(q^*)$. As usual, a larger number of providers (higher n) reduces price and profits. Differentiating (15) with respect to q^*, t and n, we obtain

$$\frac{\partial q^*}{\partial t} = -\frac{1}{\widehat{V}_{qq}n^2}\left(\frac{\beta}{n} - g_{q^*}\right)U_{\pi\pi} > 0, \tag{16}$$

$$\frac{\partial q^*}{\partial n} = \frac{1}{\widehat{V}_{qq}n^2}\left[\beta U_\pi + \frac{t}{n}\left(\frac{\beta}{n} - g_{q^*}\right)U_{\pi\pi}\right] < 0, \tag{17}$$

where $\widehat{V}_{qq} := U_{qq} - U_\pi g_{qq} - U_{\pi\pi}\left(\frac{\beta}{n} - g_q\right)g_q < 0$. Notice again that $\frac{\beta}{n} - g_g < 0$ at $q = q^*$. Thus, we have the following result:

Proposition 2 *In a Salop model where providers set price and quality simultaneously, more competition, measured either by lower transportation cost or more providers, leads to lower quality when providers are motivated* ($U_q > 0$) *and risk averse* ($U_{\pi\pi} < 0$).

The effect of lower transportation costs on quality is analogous to the benchmark analysis (see Proposition 1). A larger number of providers also leads to lower quality in equilibrium. This relationship relies on two different effects that work in the same direction:

(i) More providers in the market lead to lower demand for each provider, which makes demand more elastic and implies a lower optimal price. This reduces the profit margin of each provider and therefore weakens incentives to invest in quality. Thus, if providers are pure profit maximisers, more competition (due to a larger number of providers) leads to lower quality. This is precisely the effect identified by Economides (1993) and is captured by the first term in the square brackets in (17).

(ii) This effect is *reinforced* by allowing for provider motivation and risk aversion. A higher number of providers leads to lower prices and profits. With risk-averse providers this implies that the marginal utility of profit increases in the number of providers. Since providers are motivated, the marginal profit of quality is negative in equilibrium. Therefore, each provider responds optimally to a larger number of providers by reducing quality in order to recover some of the profit losses generated by the price reduction. This effect is captured by the second term in the square brackets in (17).

3.2 Sequential quality-price game

Here we allow for quality to be a more long-term decision than prices by considering a two-stage game where the providers set quality at stage 1 before they compete in prices at stage 2. The main purpose of this section is to study the possible impact the timing of the strategic choices may have on our key result that more competition reduces quality. Allowing providers to commit to a given quality level before competing in prices could possibly influence the providers' price setting and in turn their choice of quality. We solve the game by backward induction, applying the benchmark Hotelling set-up with two providers.

The price subgame. At stage 2 provider i sets a price that maximises utility given by (4). Using (2) and (3), we obtain the following first-order conditions:

$$\frac{\partial U_i}{\partial p_i} = U_\pi^i \left[\frac{1}{2} + \frac{\beta (q_i - q_j) - 2p_i + p_j + c}{2t} \right] = 0, \tag{18}$$

where $i, j = 1, 2$ and $i \neq j$. For a given pair of quality levels, (q_1, q_2), the equilibrium in the price subgame is characterised by the first-order conditions from which we obtain

$$p_i (q_i, q_j) = c + t + \frac{\beta (q_i - q_j)}{3}. \tag{19}$$

From (19) we can easily derive the relationships between quality and prices: $\partial p_i / \partial q_i = \beta/3$ and $\partial p_i / \partial q_j = -\beta/3$.

Quality choices. Inserting the equilibrium values from the price subgame given by (19) into (3), we can express provider i's profits as a function of qualities only.

$$\pi_i = \left(t + \frac{\beta(q_i - q_j)}{3}\right)\left(\frac{1}{2} + \frac{\beta(q_i - q_j)}{6t}\right) - g(q_i). \tag{20}$$

Assuming each provider sets quality simultaneously to maximise utility given by (4), provider i's optimal quality is given by the following first-order condition:

$$\frac{\partial U_i}{\partial q_i} = U_{q_i} + U_{\pi_i}\left[\beta\left(\frac{1}{3} + \frac{\beta(q_i - q_j)}{9t}\right) - g_{q_i}\right] = 0. \tag{21}$$

Applying symmetry, equilibrium quality, denoted q^s, is characterised by

$$U_{q^s} + U_\pi\left(\frac{\beta}{3} - g_{q^s}\right) = 0. \tag{22}$$

with

$$p^s = c + t \text{ and } \pi^s = \frac{t}{2} - g(q^s). \tag{23}$$

What is the effect of more competition on quality? Differentiating (22) with respect to q^s and t we obtain

$$\frac{\partial q^s}{\partial t} = \frac{U_{\pi\pi}}{-2V_{qq}}\left(\frac{\beta}{3} - g_{q^S}\right) > 0, \tag{24}$$

where $\widetilde{V}_{qq} := U_{qq} - U_\pi g_{qq} - U_{\pi\pi}\left(\frac{\beta}{3} - g_q\right)g_q < 0$. From (22), notice that $(\beta/3 - g_{q^s}) < 0$ at $q = q^s$. Thus, we have the following result:

Proposition 3 *In a Hotelling model where providers set quality before price, more competition, measured by lower transportation costs, leads to lower quality when providers are motivated* ($U_q > 0$) *and risk averse* ($U_{\pi\pi} < 0$).

Our key result that more competition reduces quality is therefore robust to whether quality and price decisions are made sequentially or simultaneously by the providers. The effect of lower transportation costs on quality is qualitatively similar, though the magnitude differs.

Comparing the equilibrium outcomes of the sequential quality-price game in (22)-(23) with the simultaneous quality-price game in (9)-(10), we observe that the equilibrium prices are identical, while equilibrium quality is lower and thus equilibrium profits higher in the sequential game. Thus, quality competition is softer when providers can commit to quality before competing in prices. The reason is that, in the sequential game, provider i takes into account the (negative) effect a higher quality has on provider j's pricing in the following stage. If one provider has lower quality than the other, this provider will be more aggressive in the price game and undercut its rival to compensate for the quality difference. This is exactly the result found by Ma and Burgess (1993). Here, we show that the this result is also valid when providers are motivated and risk averse.

4 Welfare

Even if more competition leads to lower quality, it does not necessarily follow that competition is welfare detrimental. In this section we explore the welfare implications of increased competition, using two alternative approaches.

4.1 First-best

As a welfare benchmark with which to compare the previously derived Nash equilibria, we define the first-best outcome as the one that maximises aggregate gross consumers' utility net of the monetary costs of quality and output. That is, we define the first-best outcome as the one that would ensue if a welfarist regulator produces the good himself, using the available technology (given by the cost functions and firm locations).

Since consumers are uniformly distributed on S, total transportation costs are minimised by letting each firm serve half the market. Using our basic model, as presented in Section 2, the maximisation problem is thus

$$\max_{q_1,q_2} W = \int_0^{\frac{1}{2}} (v + \beta q_1 - tx)\, dx + \int_{\frac{1}{2}}^{1} (v + \beta q_2 - t(1-x))\, dx - c - g(q_1) - g(q_2). \qquad (25)$$

The first-best quality, denoted q^F, is such that

$$\frac{\beta}{2} = g(q^F). \qquad (26)$$

In order to compare with the equilibrium quality level in the game described in Section 2, we can re-write the first-order condition, (10), for each provider as

$$\frac{U_{q^*}}{U_\pi} + \frac{\beta}{2} = g_{q^*} \tag{27}$$

It is straightforward to see that in the presence of a motivated provider, i.e., $U_q > 0$, this implies over-provision of quality by the market compared to the first best. Therefore, more competition reduces quality but improves welfare.

4.2 Welfare as the sum of consumers' and providers' surplus

An alternative specification for welfare is the sum of consumers' and providers' surplus:

$$\begin{aligned} W &= \int_0^{D_1} (v + \beta q_1 - p_1 - tx)\, dx + \int_{D_1}^1 (v + \beta q_2 - p_2 - t(1-x))\, dx \\ &\quad + U^1 (q_1, (p_1 - c)D_1 - g(q_1)) + U^2 (q_2, (p_2 - c)D_2 - g(q_2)), \end{aligned} \tag{28}$$

where D_1 is given by (2) and $D_2 = 1 - D_1$. This specification explicitly incorporates provider preferences in the formulation of social welfare. However, with motivated providers it may be argued that this specification leads to double-counting of consumers' utility. A more flexible specification can by obtained as follows. Since the utility of the provider is separable in quality and profits, we can redefine (with some abuse of notation) the utility of provider i as

$$U^i (q_i, (p_i - c)D_i - g(q_i)) := B^i (q_i) + \widetilde{U}^i ((p_i - c)D_i - g(q_i)). \tag{29}$$

Using (29), we can define welfare (in the symmetric equilibrium) as

$$W = 2\int_0^{\frac{1}{2}} (v + \beta q^* - p^* - tx)\, dx + 2\gamma B(q^*) + 2\widetilde{U}\left((p^* - c)\frac{1}{2} - g(q^*)\right), \tag{30}$$

where $\gamma \in \{0, 1\}$ is a binomial parameter indicating whether double counting is undertaken ($\gamma = 1$) or not ($\gamma = 0$).

Substituting for the optimal price, from (9), and totally differentiating (30) with respect to

t and W, the effect of lower transportation costs on welfare is

$$\frac{\partial W}{\partial t} = \left[\beta + 2\left(\gamma B_q - g_q \widetilde{U}_\pi\right)\right] \frac{\partial q^*}{\partial t} + (\widetilde{U}_\pi - 1) - \frac{1}{4}. \tag{31}$$

There are three types of effects generated by lower transportation costs: i) first, lower transportation costs reduce quality; whether this increases or reduces welfare depends on the expression in the square brackets in (31); ii) second, it reduces prices which increases consumers' utility but it also reduces profits, the net effect being given by the second term in (31); it is only in the special case $\widetilde{U}_\pi(\pi^*) = 1$ that the two effects coincide; iii) it directly increases consumers' utility.[12]

Although the effect of lower competition on welfare, as defined by (30), is generally ambiguous, we can derive some further insights by using the fact that $B_{q^*} - \widetilde{U}_\pi g_{q^*} = -\widetilde{U}_\pi \frac{\beta}{2}$ (from the first-order condition of the providers) and rewrite (31) as

$$\frac{\partial W}{\partial t} = \left(1 - \widetilde{U}_\pi\right)\left(\beta \frac{\partial q^*}{\partial t} - 1\right) - 2\left(1 - \gamma\right) B_q \frac{\partial q^*}{\partial t} - \frac{1}{4}. \tag{32}$$

Notice that any effects of more competition (beyond the direct cost-reducing effect) require that either $\widetilde{U}_\pi(\pi^*) \neq 1$ or $\gamma \neq 1$. If the marginal utility of profits is equal to one ($\widetilde{U}_\pi = 1$), the net effect on welfare of a monetary transfer from consumers to providers is zero. If, in addition, the benefits of quality are double-counted ($\gamma = 1$), then lower transportation costs increase consumers' utility due to cost savings (the third term in (32)), but there is no further effects on welfare because of increased competition.

If we do not allow for double-counting (i.e., $\gamma = 0$), increased competition has an additional positive effect on welfare (given by the second term in (32)). The reason is simply that the presence of provider motivation tends to result in overprovision of quality when the utility providers derive from quality is not included in the welfare function. This is the effect that was identified in Section 4.1. Thus, double-counting the benefits of quality provision tends to reduce the scope for a positive relationship between competition and welfare.

A third effect, with ambiguous sign, is introduced when $\widetilde{U}_\pi(\pi^*) \neq 1$, which is generally true

[12] Notice that this third effect follows directly from the use of t as an (inverse) measure of competition, but has little to do with competition *per se*.

when providers are risk-averse. Suppose that $\widetilde{U}_\pi < 1$, which implies that the marginal disutility from an increase in price to the consumer is higher than the benefits to the firm from higher profits. Lower transportation costs now have two counteracting effects on welfare. First, it reduces prices, which tends to increase welfare since the gain for the consumer is higher than for the firm (by assumption). Second, it reduces quality, which reduces consumer utility but increases profits, and net effect is negative (implying lower welfare) if $\widetilde{U}_\pi < 1$. It is relatively straightforward to show that, in equilibrium, $\beta \frac{\partial q^*}{\partial t} < 1$, implying that the positive effect of lower prices outweighs the negative effect of lower quality, making the first term in (32) negative.[13] Thus, if $\widetilde{U}_\pi < 1$, lower transportation costs will unambiguously increase welfare, not only because of the direct cost savings but also because of increased competition.

Proposition 4 *If we define social welfare as the sum of consumers' and providers' surplus, and if the marginal utility of income is higher for consumers than for providers, then increased competition unambiguously increases welfare. The positive effect of competition on welfare is reinforced if the benefits of quality provision are not double-counted in the welfare function.*

However, if $\widetilde{U}_\pi > 1$, then the first term in (32) is positive and the overall welfare effect of increased competition is ambiguous.

5 Conclusions

The relationship between competition and quality in sectors like health care, elderly care, child care and education, is a hotly debated policy issue in several countries. While several empirical studies have found a negative relationship between competition and quality in these sectors, the existing theoretical literature is lacking in terms of offering precise mechanisms that can explain these findings. In this paper we have offered one such possible (and novel) mechanism and shown that this mechanism relies on two key assumptions, namely that the providers are *motivated* and *risk-averse*. For given quality levels, fiercer competition results in lower profits due

[13] Using (11):

$$\beta \frac{\partial q^*}{\partial t} - 1 = \frac{B_{qq} - \widetilde{U}_\pi g_{qq} + \widetilde{U}_{\pi\pi} \left(\frac{\beta}{2} - g_q\right)^2}{-\left[B_{qq} - \widetilde{U}_\pi g_{qq} - \widetilde{U}_{\pi\pi} \left(\frac{\beta}{2} - g_q\right) g_q\right]} < 0.$$

to price reductions. We have shown that providers with the two above-mentioned characteristics will respond by lowering their quality in order to recover some of these profit losses.

Our analysis has been conducted within a spatial competition framework, for two main reasons. First, it is a widely used framework for studying competition in health care markets, which is one of our main applications. Second, a spatial competition framework with inelastic total demand allows us to capture the effect of competition on demand responsiveness by using the transportation cost parameter as an inverse measure of competition intensity. However, a potential drawback of this framework is precisely the assumption that total demand is inelastic. Although this might not be an unreasonable approximation in health care markets, for example, it is still a quite strong assumption. One way to relax this assumption is to introduce a monopoly segment of consumers who only decide whether or not to buy from the closest provider (because of lower willingness-to-pay), as in Brekke et al. (2008, 2011). It is relatively straightforward to show that this would not affect our main result as long as the monopoly segment is sufficiently small relative to the competitive segment. However, this approach involves another drawback, namely that the transportation cost parameter ceases to be a precise measure of competition intensity, since lower transportation costs also lead to higher total demand from the monopoly segment.

Finally, as we have shown in our welfare analysis, we would like to stress that a negative relationship between competition and quality does not necessarily imply that competition is welfare detrimental.

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