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Quality Competition with Profit Constraints*

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Abstract

Firms in markets such as health care and education are often profit constrained due to regulation or their non-profit status, and they are often viewed as being altruistic towards consumers. We use a spatial competition framework to study incentives for cost containment and quality provision by altruistic firms facing profit constraints. If prices are regulated, profit constraints lead to lower cost containment efforts, but higher quality if and only if firms are sufficiently altruistic. Under price competition, profit constraints reduce quality and cost containment efforts, but lead to lower prices if and only if firms are sufficiently altruistic. Profit constrained firms' cost containment efforts are below the first-best, while their quality might be too high or too low. If prices are regulated, profit constraints can improve welfare and be a complement or substitute to a higher regulated price, depending on the degree of altruism.

Keywords: Profit constraints, Quality competition, Altruistic providers

JEL classification: D21, D43, L13, L30

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1 Introduction

In many markets, goods or services are provided by firms that face constraints on profit distribution, either because they have non-profit status or because they are subject to regulation which limits the amount of profits that can be distributed to the owners of the firm. In these cases, profits must be (wholly or partially) reinvested in the firm or spent on 'perquisites'.

In this paper we analyse theoretically how profit constraints affect firms' choices regarding quality, price, and cost containment. The main applications of our analysis are regulated markets such as health care, child care, long-term care and education, and we are particularly interested in analysing whether profit-constrained firms in such markets are likely to offer higher or lower quality than firms that do not face any constraints on profit distribution. This goes to the heart of the question of whether owners of private firms that receive public funding should be allowed to distribute profits, which is often a hotly contested policy issue with regulatory practices that vary across countries.

To give a motivating example from education markets, in 1992, Sweden embarked on a radical education reform programme, which has recently become the subject of intense debate in the UK.[1] The Swedish reform introduced free school choice and liberalised entry by removing school ownership restrictions, including the ban on private for-profit schools. Private schools receive public funding corresponding to the average cost per student for each student from the municipality in which the school is located, but are not allowed to charge any top-up fees or 'cherry pick' pupils according to background. The Conservatives claim that the Swedish experiment has been successful and consider introducing school choice and removing the ban on for-profit schools in the UK. Labour, in contrast, claim that the Swedish reform has failed, and in April 2010, Ed Balls (then Secretary of State for Education) wrote a letter to Michael Gove (the current Secretary of State for Education), stating the following: '*Parents and taxpayers across the country will be rightly shocked that you are willing to allow taxpayers' money to be diverted from its intended purpose – the education of our children – to the profits of the private companies you want to prove it, even more so because the evidence from Sweden is that this very*

[1] See, for instance, the article 'Swedish-Style "Free Schools" Won't Improve Standards' in the Guardian (9 February 2010).

policy caused educational standards across the country to fall.'[2]

In this paper we directly address the concern expressed in the above statement by analysing how firms' incentives for quality provision (for example, the 'educational standards' of schools) depend on their ability to distribute profits. We analyse this question within a theoretical framework that is commonly used for studying competition in markets such as health care and education, namely a spatial competition model where consumers make their purchasing decisions based on travelling distance, quality and price. In the main version of the model, we assume that prices are regulated and that firms compete only on quality. Subsequently, we extend the model to allow for price competition. We also allow the firms to become more cost efficient by investing in cost containment effort. Quality is taken to be observable, but non-contractible, as is commonly assumed in the literature,[3] and we assume that there are both monetary and non-monetary costs associated with quality provision. Furthermore, we assume that firms are altruistic in the sense that they care about profits and (to some extent) consumers' benefit. Finally, we model profit constraints as being equivalent to a tax on profits,[4] the basic underlying assumption being that owners prefer compensation in cash over alternative modes of compensation, such as perquisites.[5]

Taken together, these model ingredients are particularly suited to describe provider behaviour in markets such as education, health care, long-term care and child care. In all these markets, quality is an important competition variable, whereas prices might be regulated or not. Travelling costs also play a potentially important role in determining demand, e.g., distance to nearest school, hospital, kindergarten, nursing home, etc.[6] Furthermore, altruistic provider preferences are generally acknowledged to be a relevant characteristic of such markets.[7] Finally, in many

[2] Balls, Ed. 'Profit-Making Schools - My Letter to Michael Gove'. 11 April, 2010 (http://www.edballs.co.uk)

[3] See Ma (1994) and Chalkley and Malcomson (1998a, 1998b) for a detailed discussion on this issue in the health care context. Our approach follows closely the literature on quality competition, like Ma and Burgess (1993), Wolinsky (1997) and Brekke, Nuscheler and Straume (2006).

[4] A similar approach is used by Glaeser and Shleifer (2001) and Ghatak and Mueller (2011) in the context of non-profit firms. See also Hansmann (1980, pp. 873-875) for anecdotal support for this formulation. Lakdawalla and Philipson (2006) model the distribution constraint on non-profit firms as a (potentially binding) profit cap, whereas in Easley and O'Hara (1983) the non-profit firm's profit is set in a contract between the firm and the society.

[5] Non-pecuniary compensation ('perquisites') may involve different types of improvement in the working environment, such as lower effort levels, free meals, shorter workdays, longer vacations, better office facilities, etc.

[6] Empirical studies of the US health care market show that travelling distance and quality are the main predictors of hospital choice (Kessler and McClellan, 2000; Tay, 2003).

[7] In the literature on health care provision, the assumption that health care providers (e.g., doctors and nurses) are, at least to some extent, altruistic, is widely used and recognised. See, e.g., Ellis and McGuire

countries, a significant share of education, health care, long-term care and child care services is provided either by non-profit institutions or by for-profit ones that are subject to some form of profit regulation.[8]

In contrast to the main bulk of the literature on non-profit firms[9], constraints on profit distribution are taken to be exogenous in our analysis. The main reason for this is that we do not confine our study to non-profit firms, but to profit-constrained firms more broadly. Indeed, many firms are profit-constrained not by choice but by regulation. For instance, most European countries do not allow for-profit schools to operate in their publicly funded educational system, as highlighted by our example from the UK. Another interesting example is Norway, where regulatory practices regarding profit distribution differ enormously between two otherwise similar markets: education and child care.[10] Whereas owners of private government-dependent schools are not allowed to distribute any profits, owners of private government-dependent kindergartens have so far not been subject to any profit constraints, although the government has recently aired the idea of introducing profit caps that limit the amount of profits that can be distributed in the child care market.

Similar regulatory restrictions often apply to hospitals and nursing homes. An interesting example is provided by the English National Health Service. Before 2003 all publicly-funded hospitals had the status of Acute Trusts with severe restrictions on how to spend surpluses. By 2014 all NHS Trusts will have a new status known as Foundation Trusts. Foundation status implies greater financial flexibility: hospitals can retain financial surpluses, they do not have to break even, can invest in new services and reward staff with higher salaries (Marini et al., 2008;

(1986), Chalkley and Malcolmson (1998a, 1998b), Eggleston (2005), Heyes (2005), Jack (2005), Kaarbøe and Siciliani (2010), Brekke, Siciliani and Straume (2011a), Brekke and Nyborg (2010) and Choné and Ma (2011). An alternative approach, suggested by Iversen and Lurås (2000), is that physicians have lexicographic preferences in patients' health and income, so that health services are provided until the marginal health effect is equal to zero. There is also a recent literature on 'motivated agents' in the broader public sector (Besley and Ghatak, 2006; Halonen-Akatwijuka and Propper, 2008; Makris, 2009). See Francois and Vlassopoulos (2008) for an extensive review of the motivated agents literature. The empirical evidence also suggests that altruism and motivation are important components of healthcare workers job (Page, 1996; Le Grand, 2003) and that job satisfaction depends on both pecuniary and non-pecuniary aspects of employment (Shields and Ward, 2001; Antonazzo et al, 2007; Ikenwilo and Scott, 2007; Leonard and Masatu, 2010; Godager amd Wiesen, 2011; Henning-Schmidt et al., 2011).

[8] Rose-Ackerman (1996) reports figures showing that health and education institutions constitute well over 70 percent of the non-profit sector in the US, while the equivalent average figure for a group of 7 Western countries is close to 50 percent. A similar (slightly lower) figure for a different group of Western countries (excluding the US) is reported by Salamon et al. (2007).

[9] See Section 2 for a literature review.

[10] In both markets, prices are regulated and quality is the main competition variable.

between 2003 and now the new status was voluntary and hospitals had to apply for obtaining the different status). Thus, with the above-mentioned examples in mind, we focus on the *impact* and not the source of profit constraints, and we therefore set up a modelling framework that captures important features of markets where profit constraints are highly relevant.

The results from our analysis show that, while a constraint on profit distribution always leads to less cost efficiency, the effect on quality and (if not regulated) prices are more ambiguous. If prices are regulated (as for most publicly-funded hospitals and schools in Europe) and firms compete only on quality, profit-constrained firms provide higher (lower) quality in equilibrium if the degree of altruism is sufficiently high (low). The reason is that altruistic providers choose a quality level that exceeds the profit-maximising level. A profit constraint will then reduce the negative marginal profits and thus induce a higher quality level given that the providers are sufficiently altruistic. In the case of quality-and-price competition (as for example in the child-care and nursing-homes markets), the imposition of a profit constraint always leads to lower quality, while prices will decrease if firms have sufficiently altruistic preferences and increase otherwise. The reason for the negative effect on quality is that prices and thus profit margins are reduced for high levels of altruism, which in turn reduces the profit incentive for investing in quality. However, we show in an extension that if the altruistic firms only care about the quality and not about the price consumers have to pay, then a profit constraint increases quality under price competition if and only if firms are sufficiently altruistic.

We also perform a welfare analysis where we show that cost efficiency is too low for profit-constrained firms, while quality may be over- or underprovided in the market equilibrium. If prices are set by the firms, quality is always underprovided if there are constraints on profit distribution. However, if prices are set by a regulator, but not necessarily at the first-best optimal level, profit constraints may improve welfare for low or intermediate degrees of altruism, depending on the price level. If price regulation is optimal, we show that price and profit constraints can be either complements or substitutes, depending on the degree of altruism. For example, markets with non-profit (as opposed to for-profit) firms should optimally face a lower (higher) price if the degree of altruism is sufficiently high (low).

The remainder of the paper is organised as follows. In Section 2 we offer a more detailed discussion of related literature, before presenting the model in Section 3. The model is then

analysed for the cases of price regulation (Section 4) and price competition (Section 5). Welfare issues are analysed and discussed in Section 6, before Section 7 closes the paper with some concluding remarks.

2 Literature review

Our theoretical analysis bridges two different literatures. The modelling approach follows the literature on quality competition in regulated markets, particularly the strand of literature focusing on spatial competition with applications to health and education. General contributions that share many features of our modelling framework include Ma and Burgess (1993), Wolinsky (1997) and Brekke, Nuscheler and Straume (2006), while similar papers focusing more exclusively on competition in health care markets include Gravelle (1999), Lyon (1999), Beitia (2003), Brekke, Nuscheler and Straume (2007), Karlsson (2007) and Brekke, Siciliani and Straume (2011a).[11] To our knowledge, the present paper is the first attempt to analyse quality competition in regulated markets when firms face profit constraints. Moreover, with the exception of Brekke, Siciliani and Straume (2011), this strand of the literature has generally not considered altruistic provider preferences.[12]

Our specific modelling of profit constraints follows the literature on non-profit firms. In this literature, the relationship between non-profit status and quality provision has also been addressed. There are two main theories which offer a similar answer to the question of whether non-profit firms offer higher or lower quality than for-profit firms, but for very different reasons (see Malani et al., 2003, for an overview of the literature). The oldest formal theory of non-profit firms explains the existence of such institutions by altruistic preferences. A recent example of this strand of the literature is Lakdawalla and Philipson (2006), who assume that non-profit firms are altruistic in the sense that they maximise an objective function that has output and profits as separate arguments, and this gives them a competitive advantage (due to lower *effective* marginal costs) against for-profit firms. By extending this framework to include also preferences for quality (see Malani et al., 2003), this theory predicts that non-profit firms will offer higher

[11] While Brekke, Siciliani and Straume (2011a) allow for altruistic providers, this paper do not consider cost-containment effort, price competition, and, importantly, constraints on the distribution of profits.

[12] In a framework of spatial competition, Del Rey (2001) analyses quality competition between state universities that maximise objective functions that could be intepreted as reflecting altruistic preferences.

quality than for-profit firms. This follows straightforwardly from the altruism assumption, where owners of non-profit firms are assumed to have a preference for quality.

In another class of models the existence of non-profit firms is explained as a partial solution to an incomplete contracting problem. A relevant example of this approach is Glaeser and Shleifer (2001), who consider quality choices by non-profit versus for-profit firms.[13] They assume that the market transaction takes place prior to the quality choice, and that quality is non-contractible. This creates a moral hazard problem with firms having an incentive to shirk on quality. Since non-profit firms cannot distribute the profits from shirking, they have a lower incentive to shirk and will therefore choose a higher quality level. Thus, similar to the models based on altruism, the prediction from this strand of the literature is that non-profit firms will provide higher quality.

The theoretical framework in the present paper differs from the above-mentioned approaches in several important aspects. First, as stressed in the previous section, we are not interested in explaining the existence of non-profit firms but rather to analyse the effects of profit constraints *per se*. Therefore we do not assume any relationship between profit constraints and altruism. In this particular sense our approach is more related to the incomplete contracts approach in the literature on non-profit firms. On the other hand, our model also differs sharply from this approach since we study quality choices in a spatial setting of quality competition between different providers, using a framework that is motivated by our examples from health care and education markets, and where price regulation is often an important feature of such markets. In addition, we introduce cost containment effort and non-monteary costs of quality provision, both commonly used assumptions in the literature on health care provision, but not in the literature on non-profit firms. Indeed, both of these assumptions are shown, all else equal, to contribute to a negative relationship between profit constraints and quality provision, introducing potentially important mechanisms that are not captured by the existing theoretical literature on non-profit firms.

[13] The study by Glaeser and Shleifer (2001) builds on the seminal work by Hansmann (1980, 1996), where the benefit of non-profit firms is to mitigate 'contract failure' problems. Another paper in this strand of literature is Easley and O'Hara (1983) who stress more speficially asymmetric information between consumers and firms (output cannot be observed). Ghatak and Mueller (2011) also use an agency approach and show that the choice of non-profit versus for-profit status can arise from competition for motivated workers. However, quality is not an issue in that paper.

Our theoretical analysis could also offer some insights for interpreting the rich empirical literature dealing with the question of whether non-profit hospitals provide better quality of care than their for-profit counterparts. As observed by Malani et al. (2003), despite the fact that a positive effect of non-profit status on quality provision is one of the more clear-cut theoretical relationships established in the literature on non-profit firms, the general picture emanating from a number of empirical studies is considerably more ambiguous. Sloan (2000) offers an extensive review of this literature and concludes that the evidence appears to be mixed.[14] A recent meta-analysis by Eggleston et al. (2008) on US hospitals reports that the results depend on the context (region, data source, period), but concludes that "studies representative of the US as a whole tend to find lower quality among for-profits than private nonprofits".[15]

Empirical evidence on the effect of non-profit status on quality provision in nursing home markets is also somewhat mixed. The review studies by Hillmer et al. (2005) and Grabowski and Hirth (2003) suggest that quality is higher for non-profit nursing homes in the US. Grabowski and Stevenson (2008) instead find that conversions from for-profit to non-profit status and from non-profit to for-profit had no effect on quality. Chou (2002) shows that non-profit nursing homes provide higher quality only when the degree of asymmetric information between residents and the provider is more pronounced (as measured by whether residents have received a visit from a spouse or a child within a month from admission). Otherwise, no differences in quality are detected. Therefore, it is only when for-profit nursing homes have to compete effectively for demand that they raise quality to the level of non-profit ones, which is consistent with our results.

The mixed empirical evidence on the relationship between ownership type and quality provision may be somewhat hard to explain from existing theories in the non-profit literature and we believe that our theoretical analysis, which introduces some novel mechanisms, could offer some useful contributions in this respect.

[14] Sloan (2000) also reviews the theoretical literature related to non-profit firms in general and discusses its relevance for the hospital market.

[15] Other relatively recent empirical studies on the relationship between hospital ownership type and quality provision include Picone et al.(2002), Shen (2002), Milcent (2005), Lien et al. (2008) and Jensen et al. (2009). The overall picture emanating from these studies remains rather mixed.

3 Model

Two firms are located at the endpoints of the line segment $S = [0, 1]$. Firm 1 is located at the left endpoint while Firm 2 is located at the right endpoint. Consumers are uniformly distributed on S with total mass equal to one. Each consumer demands one unit from the most preferred firm. The utility of a consumer located at z and buying from Firm i is given by

$$U(z,i) = \begin{cases} v + q_i - p_i - tz & if \quad i = 1 \\ v + q_i - p_i - t(1-z) & if \quad i = 2 \end{cases}, \tag{1}$$

where $v > 0$ is the gross utility of consuming the good, q_i is the quality of the good, p_i is the price of the good and $t > 0$ is a transportation cost parameter. From the consumers' utility-maximising problems we derive the demand functions:

$$x_1(p_1,p_2,q_1,q_2) = \begin{cases} 0 & if \quad q_1 - q_2 \leq p_1 - p_2 - t \\ \overline{z} & if \quad p_1 - p_2 - t < q_1 - q_2 \leq p_1 - p_2 + t \\ 1 & if \quad q_1 - q_2 > p_1 - p_2 + t \end{cases}, \tag{2}$$

$$x_2(p_1,p_2,q_1,q_2) = \begin{cases} 1 & if \quad q_1 - q_2 \leq p_1 - p_2 - t \\ 1 - \overline{z} & if \quad p_1 - p_2 - t < q_1 - q_2 \leq p_1 - p_2 + t \\ 0 & if \quad q_1 - q_2 > p_1 - p_2 + t \end{cases}, \tag{3}$$

where

$$\overline{z} = \frac{1}{2} + \frac{1}{2t}[q_1 - q_2 - p_1 + p_2] \tag{4}$$

is the location of the consumer who is indifferent between the two firms.

The monetary cost of supplying the good is given by $c(x_i, q_i, e_i)$, where e_i is the amount of cost containment effort expended by Firm i. We assume that the cost function has the following general characteristics: $c_x > 0$, $c_q > 0$, $c_e < 0$, $c_{xx} \geq 0$, $c_{qq} > 0$, $c_{ee} \geq 0$, $c_{xq} \gtrless 0$, $c_{xe} \leq 0$ and $c_{qe} \leq 0$. Notice that we allow for output and quality to be either cost substitutes ($c_{xq} > 0$) or cost complements ($c_{xq} < 0$). Firm i's profit function is then given by

$$\pi_i(x_i, q_i, e_i) = p_i x_i - c(x_i, q_i, e_i), \quad i = 1, 2. \tag{5}$$

In addition to cost containment effort, we also assume that there is a non-monetary (effort) cost associated with supplying quality above a minimum level (which is normalised to zero).[16] The non-monetary costs of Firm i are given by the function $g(e_i, q_i)$, where $g_e > 0$, $g_{ee} > 0$, $g_q > 0$, $g_{qq} > 0$ and $g_{eq} = 0$. We also allow firms to have altruistic preferences by assuming that they care about the utility of their consumers. The objective function of Firm i is given by

$$\Omega_i(x_i, q_i, e_i; \delta, \alpha) = (1-\delta)\pi_i(x_i, q_i, e_i) + \alpha b_i(q_i, x_i) - g(e_i, q_i), \tag{6}$$

where

$$b_1 = \begin{cases} 0 & if \quad q_1 - q_2 \leq p_1 - p_2 - t \\ \int_0^{\overline{z}} (v + q_1 - p_1 - ts)\, ds & if \quad p_1 - p_2 - t < q_1 - q_2 \leq p_1 - p_2 + t \\ \int_0^1 (v + q_1 - p_1 - ts)\, ds & if \quad q_1 - q_2 > p_1 - p_2 + t \end{cases} \tag{7}$$

and

$$b_2 = \begin{cases} \int_0^1 (v + q_2 - p_2 - t(1-s))\, ds & if \quad q_1 - q_2 \leq p_1 - p_2 - t \\ \int_{\overline{z}}^1 (v + q_2 - p_2 - t(1-s))\, ds & if \quad p_1 - p_2 - t < q_1 - q_2 \leq p_1 - p_2 + t \\ 0 & if \quad q_1 - q_2 > p_1 - p_2 + t \end{cases}, \tag{8}$$

and where the parameter $\alpha \in (0,1)$ measures the degree of altruism on the part of the firms.

The parameter $\delta \in [0,1)$ plays a key role in our analysis, as it measures the degree to which the firm is profit-constrained. In the context of for-profit versus non-profit firms, the former is captured by $\delta = 0$ while the latter is characterised by $\delta > 0$. Owners of non-profit firms cannot distribute profits in cash but have to spend any positive net revenues on perquisites. Under the assumption that owners prefer compensation in cash over compensation in perquisites, a monetary net surplus (profit) has lower value for the owner of a non-profit firm than for the owner of a for-profit firm, i.e., $\delta > 0$.[17] More generally, the above formulation of the firms' objective function is relevant for any market where a regulator places a constraint on the firms'

[16] This is a commonly used assumption in the context of health care providers. See, e.g., Ma (1994) and Chalkley and Malcomson (1998a, 1998b). For example, a doctor might improve the quality of care by working harder on diagnosing and/or treating patients without affecting monetary costs like salary, capitation payments, etc. The same argument applies to nurses, teachers, researchers, etc.

[17] This is way of modelling the difference between non-profit and for-profit firms is also used by Glaeser and Shleifer (2001) and Ghatak and Mueller (2011).

ability to distribute profits.

4 Quality competition with price regulation

We consider first the case where prices are regulated and thus exogenous to the firms; i.e., $p_1 = p_2 = p$. This assumption holds for example in the hospital sector of many European countries, where hospitals are paid according to a DRG (Diagnosis Related Group) system, which specifies a different tariff for every diagnosis or procedure. In the education sector, schools' funding is often related to the number of pupils, and in some countries (like the UK) universities can charge students fees but the fees are regulated and do not vary across universities.

We assume that quality and cost containment effort are chosen simultaneously and independently. The first-order conditions for the optimal choices by Firm i are given by

$$\frac{\partial \Omega_i}{\partial q_i} = (1-\delta)\left[(p - c_x)\frac{\partial x_i}{\partial q_i} - c_q\right] + \alpha\frac{\partial b_i}{\partial q_i} - g_q = 0, \tag{9}$$

$$\frac{\partial \Omega_i}{\partial e_i} = -(1-\delta)c_e - g_e = 0. \tag{10}$$

Notice that each firm chooses the optimal level of quality by balancing three different considerations: net revenues (π), consumer benefit (b) and effort of quality provision (g). Quality is optimal when the sum of the marginal financial benefit from quality and the non-financial benefit arising from concerns for consumers' utility is equal to the marginal monetary and non-monetary (disutility) cost. All else equal, altruistic preferences push the optimal quality above the profit maximising level. Profit constraints reduce the relative weight given to financial considerations as opposed to non-financial ones.

Using (2) and (7) to calculate the marginal effects of quality investments on demand and aggregate consumer utility, and subsequently setting $q_i = q$ and $e_i = e$ for $i = 1, 2$, quality and cost containment effort in the unique symmetric pure-strategy Nash equilibrium, (q^*, e^*), are given by the following pair of equations:

$$(1-\delta)\left[\frac{p - c_x}{2t} - c_q\right] + \frac{\alpha}{2}\left(\frac{1}{2} + \frac{v + q^* - p}{t}\right) - g_q = 0, \tag{11}$$

$$-(1-\delta)\,c_e - g_e = 0. \tag{12}$$

By the implicit function theorem, the effect of profit constraints on the equilibrium choices of quality and cost containment effort are given by

$$\frac{\partial q^*}{\partial \delta} = -\frac{1}{\Delta}\left[c_e\,(1-\delta)\left(c_{eq} + \frac{c_{ex}}{2t}\right) + \left(\frac{p-c_x}{2t} - c_q\right)\left((1-\delta)\,c_{ee} + g_{ee}\right)\right], \tag{13}$$

$$\frac{\partial e^*}{\partial \delta} = -\frac{1}{\Delta}\left[c_e\left(-(1-\delta)\left(\frac{c_{xq}}{2t} + c_{qq}\right) + \frac{\alpha}{2t} - g_{qq}\right) - (1-\delta)\,c_{eq}\left((p-c_x)\,\frac{1}{2t} - c_q\right)\right], \tag{14}$$

where

$$\Delta := \left((1-\delta)\left(\frac{c_{xq}}{2t} + c_{qq}\right) - \frac{\alpha}{2t} + g_{qq}\right)\left((1-\delta)\,c_{ee} + g_{ee}\right) - (1-\delta)^2\,c_{eq}\left(c_{eq} + \frac{c_{ex}}{2t}\right) > 0. \tag{15}$$

As an instructive way to analyse the effects of profit constraints on quality incentives, we will first consider four special cases. These special cases, which will be presented as four Lemmas, allow us to isolate each of the different mechanisms at play.[18]

Lemma 1 *If there is no altruism, no cost containment, and no disutility of providing quality, profit constraints have no effect on equilibrium quality provision when prices are regulated.*

This is the 'standard' case of profit-maximising firms where all benefits and costs are monetary. In this case, profit constraints reduce marginal revenues and marginal costs by the same proportion, like a non-distortionary profit tax, and have thus no effect on the optimal quality choice.

Lemma 2 *If there is no altruism and no cost containment, but a non-monetary cost of quality provision, profit constraints lead to lower quality when prices are regulated.*

In this case, profit constraints reduce the marginal profit gain of providing quality while the marginal disutility of quality provision remains unchanged, thereby reducing the firms' incentives to provide quality. Thus, the presence of non-monetary quality costs introduces a new mechanism that has (to our knowledge) not been previously explored in the theoretical

[18] The proofs of all Lemmas and Propositions in the paper are given in Appendix A.

literature on non-profit firms, contributing to a negative relationship between profit constraints and quality provision.

Lemma 3 *If there is no altruism and no disutility of providing quality, but firms can reduce their production costs through cost containment effort, profit constraints lead to lower quality when prices are regulated.*

Similar to non-monetary quality costs, the presence of cost containment effort also contributes to a negative relationship between profit constraints and quality provision. The reason is that a profit constraint reduces the incentive for cost containment and therefore lowers the equilibrium level of cost containment effort. With a lower price-cost margin, $(p - c_x)$, the incentive for providing quality is correspondingly reduced. This is a mechanism that is specific to the case of price regulation, since firms are not able to adjust prices according to changes in marginal costs. It is also a mechanism that has (to our knowledge) not been previously explored in the literature.

Lemma 4 *If there is no cost containment and no disutility of providing quality, but firms are altruistic, profit constraints lead to higher quality when prices are regulated.*

Altruism introduces the following mechanism: Altruistic firms choose a level of quality provision where the marginal net revenue loss is balanced against the marginal altruistic benefit. Placing a profit constraint on the firms reduces the marginal net revenue loss while leaving the marginal altruistic benefit unchanged, implying that the objective function of each firm is maximised at a higher level of quality. Thus, all else equal, altruistic preferences contributes to a positive relationship between profit constraints and quality provision. This result superficially resembles the established result in the literature on altruistic non-profit firms. However, there is a crucial difference. While, in the referred literature, non-profit firms offer higher quality because they are altruistic, the result in Lemma 4 shows the quality effect of profit constraints *per se*, when firms are altruistic. Once more, the mechanism behind this result relies on prices being fixed and does not necessarily carry over to the case of price competition, as we will show in Section 5.

Lemmas 1-4 treat each of the different mechanisms at play separately. In the general case, with altruistic preferences and non-monetary costs of quality and cost containment, the effect

of profit constraints on the firms' incentives for quality provision depends qualitatively on the sum of the two terms in the square brackets in (13). The first term is positive while the second term has an *a priori* ambiguous sign. If the degree of altruism is sufficiently low, so that $\frac{\alpha}{2}\left(\frac{1}{2}+\frac{v+q^*-p}{t}\right)-g_q<0$ at the equilibrium level of quality, the second term is also positive (since $\frac{p-c_x}{2t}>c_q$), implying that the equilibrium level of quality is always lower when firms face a profit constraint. However, if the degree of altruism is sufficiently high, the second term in (13) is negative and might dominate the first term, thus reversing the relationship between profit constraints and incentives for quality provision.

We can further explore this trade-off by assigning some specific parametric forms to the cost and effort functions. Suppose that the monetary costs take the following linear-quadratic form

$$c_i=(c-e_i)\,x_i+\frac{k}{2}q_i^2, \tag{16}$$

while the non-monetary (effort) costs are assumed to be given by

$$g_i=\frac{w}{2}e_i^2+\frac{\theta}{2}q_i^2. \tag{17}$$

We assume that $w>\frac{1}{2c}$, which ensures that the Nash equilibrium outcome is an interior solution (i.e., $c-e^*>0$). We also assume that $p\in(c,v-t)$. The lower and upper bounds on p ensure, respectively, that the firms have a positive price-cost margin and that the net utility of any consumer is non-negative when buying from either firm, at any quality level $q_i\geq 0$.

Applying (16)-(17) in (11)-(12), equilibrium quality and cost containment effort are given by

$$q^*=\frac{(1-\delta)\,(p-(c-e^*))+\alpha\left(\frac{t}{2}+v-p\right)}{2t\,(\theta+k\,(1-\delta))-\alpha} \tag{18}$$

and

$$e^*=\frac{(1-\delta)}{2w}. \tag{19}$$

Uniqueness and stability of the Nash equilibrium requires

$$\alpha<\overline{\alpha}:=2t\,(\theta+k\,(1-\delta))\,. \tag{20}$$

While the effect of profit constraints on equilibrium cost containment effort is clearly negative, inserting (19) into (18) we can establish an exact condition for profit constraints to increase quality incentives in equilibrium:

Proposition 1 *Under quality competition with price regulation, there exists a non-empty set* $A = (\widehat{\alpha}, \overline{\alpha})$*, where*

$$\widehat{\alpha} := \frac{kt\left(1-\delta\right)^2 + 2t\theta\left(1-\delta\right) + 2tw\theta\left(p-c\right)}{\left(1-\delta\right) + w\left(p-c\right) + kt^2w + 2ktw\left(v-p\right)}, \tag{21}$$

such that placing a constraint on profits leads to higher quality if $\alpha \in A$*, and lower quality otherwise. Profit constraints always lead to less cost containment in equilibrium.*

Thus, placing a profit constraint on firms leads to higher quality provision in equilibrium if and only if the firms are sufficiently altruistic. Otherwise, incentives for quality provision are dampened by profit constraints. One policy implication of this result is that policy makers who are worried about underprovision of quality in education or health care markets should actually allow government-dependent schools or hospitals to distribute profits, but only if the providers are sufficiently profit-oriented.

The intuition for this result follows from the discussion of the more general case above. The parametric example demonstrates that the possibility of a positive relationship between profit constraints and incentives for quality provision always exists in equilibrium. From (21) it can also be shown that $\widehat{\alpha} = 0$ if $w \to \infty$ and $\theta = 0$, while $\widehat{\alpha} > 0$ otherwise. This confirms the results from the special cases outlined in Lemmas 1-4.

The main flavour of the results derived in this section is maintained if profit-constrained firms face competition from firms that are not subject to any constraints on profit distribution. This is confirmed in Appendix B, where we derive the equilibrium outcome for a mixed duopoly, where only one of the firms face profit constraints.

5 Quality and price competition

Let us now extend the model to allow also for price competition between the firms. This assumption holds for example in several markets for long-term care, like nursing homes or care homes for the elderly. We assume here that all decisions are made simultaneously and

independently. In Appendix C we show that the relationship between profit constraints and equilibrium quality is qualitatively similar if we instead let the firms commit to their quality choices before making their price and cost containment decisions.

The first-order condition for the optimal price chosen by Firm i is

$$\frac{\partial \Omega_i}{\partial p_i} = (1-\delta)\left[x_i + (p_i - c_x)\frac{\partial x_i}{\partial p_i}\right] + \alpha \frac{\partial b_i}{\partial p_i} = 0, \tag{22}$$

while the first-order conditions for optimal quality and cost containment effort are given by (9) and (10), respectively. The optimal price is such that the marginal revenue is equal to the marginal cost, where the latter also includes the reduction in consumers' utility due to altruism. We can also write the price-cost margin as

$$p_i - c_x = \left(x_i + \frac{\alpha}{1-\delta}\frac{\partial b_i}{\partial p_i}\right)\frac{1}{-\partial x_i/\partial p_i}. \tag{23}$$

With zero altruism, the price mark up is proportional to the inverse of the price elasticity of demand, $(p_i - c_x)/p_i = \frac{x_i/p_i}{-\partial x_i/\partial p_i}$. With positive altruism, for a given quality and effort, higher altruism implies a lower price since the provider is willing to charge a lower price the more she cares about the consumers. Notice that the price effect of altruism is stronger for profit-constrained firms. The cost of reducing the price (for altruistic reasons) is a loss of profits, but these lost profits are less valuable for a profit-constrained firm. Such a firm is consequently willing to reduce the price more.

Substituting (23) into (9) the optimal condition for quality can be rewritten as:

$$(1-\delta)\, x_i \frac{\partial x_i/\partial q_i}{-\partial x_i/\partial p_i} + \alpha\left(\frac{\partial b_i}{\partial q_i} + \frac{\partial b_i}{\partial p_i}\frac{\partial x_i/\partial q_i}{-\partial x_i/\partial p_i}\right) = (1-\delta)\, c_q + g_q, \tag{24}$$

The marginal benefit of quality is such that the marginal benefit from higher revenues and higher consumers' utility is equal to the marginal monetary and non-monetary cost. Notice that the altruism parameter is multiplied by two terms with opposite signs. On the one hand, higher altruism implies a higher direct incentive to increase quality because the provider benefits from higher consumer utility ($\partial b_i/\partial q_i > 0$). On the other hand, higher altruism also implies a lower price (as argued above), which compresses the marginal financial benefit (through higher

revenues) to increase quality. Using the explicit expressions for demand and consumer utility, it turns out that $\frac{\partial b_i}{\partial q_i} = \frac{\partial b_i}{\partial p_i}\frac{\partial x_i/\partial q_i}{\partial x_i/\partial p_i}$. Thus, the two effects cancel each other out, implying that the optimal provision of quality does not depend on the degree of altruism when firms are able to optimally adjust their prices. The optimality condition (24) therefore reduces to

$$(1-\delta)(x_i - c_q) = g_q. \tag{25}$$

As long as there are non-monetary costs of quality provision (i.e., $g_q > 0$), profit constraints always lead to lower quality since such constraints reduce marginal revenues more than they reduce marginal costs (of quality provision).

Although the above analysis is made for a given level of cost containment effort, the result that profit constraints reduce quality provision also holds in equilibrium, since the condition in (25) does not depend on marginal production costs. However, in order to assess the effect of profit constraints on equilibrium prices, we need to solve explicitly for the Nash equilibrium. Applying the specific cost and effort functions given by (16)-(17), and using the derived demand and consumer benefit functions, (2)-(3) and (7)-(8), respectively, the symmetric Nash equilibrium outcome is

$$q^* = \frac{1-\delta}{2(\theta + k(1-\delta))}, \tag{26}$$

$$e^* = \frac{(1-\delta)}{2w}, \tag{27}$$

$$p^* = \frac{(2(1-\delta)(t+c-e^*) - \alpha(2v+t))(\theta + k(1-\delta)) - \alpha(1-\delta)}{2(1-\delta-\alpha)(\theta + k(1-\delta))}. \tag{28}$$

Uniqueness and stability of the Nash equilibrium require

$$\alpha < \overline{\overline{\alpha}} := 1-\delta. \tag{29}$$

Equilibrium cost containment is the same as under price regulation. Each firm optimally chooses the level of cost containment effort such that the marginal benefit, $(1-\delta)x_i$, equals the marginal cost, we_i. Due to the assumptions of unit demand and full market coverage, which imply that total demand is perfectly inelastic, the marginal benefit of cost containment effort is given by $(1-\delta)/2$ in any symmetric equilibrium and does not depend on the quality

and price levels. This explains why price competition does not affect the equilibrium level of cost containment effort. Correspondingly, the effect of profit constraints on equilibrium cost containment effort is qualitatively and quantitatively independent of whether prices are regulated or subject to competition.

The following proposition summarises the effects of δ on p^*, q^* and (for completeness) e^*:

Proposition 2 *Under quality and price competition, placing a constraint on profits leads to lower quality and less cost containment in equilibrium. The equilibrium price increases (decreases) if the degree of altruism is below (above) a strictly positive threshold level* $\widehat{\alpha}_p < \overline{\overline{\alpha}}$.

We have already discussed why profit constraints lead to lower cost containment effort and lower quality in equilibrium. How do profit constraints affect the equilibrium price? There are two counteracting incentives at work. On the one hand, profit constraints imply that the price-reducing effect of altruism is stronger, as previously discussed. On the other hand, profit constraints lead to less cost containment effort, implying higher marginal production costs with a corresponding higher optimal price. If altruism is sufficiently low, the second effect dominates and equilibrium prices are higher under profit constraints. This is perhaps surprising, as intuitively we may expect profit constraints to reduce prices since the firm can less easily appropriate the profits from higher prices. However, the profit constraints also affect the optimal choice of cost containment effort. The reduction in effort translates into higher production costs, which ultimately lead to an increase in equilibrium prices.

5.1 Extension: Alternative formulation of altruism

We have so far assumed that firms' altruism considerations are perfectly aligned with consumer preferences and b_i is equal to the aggregate utility of consumers buying from firm i, which depends on both price and quality (see (7) and (8)). It may instead be argued that firms care more about quality and less about price when considering consumers' preferences. To emphasise the implications of this alternative assumption, we assume that firms care only about gross consumer utility and do not take consumers' puchasing expenditures into account. The

altruistic component of the firm is now defined as $\alpha\widetilde{b}_i$, where

$$\widetilde{b}_1 = \begin{cases} 0 & if \quad q_1 - q_2 \leq p_1 - p_2 - t \\ \int_0^{\overline{z}} (v + q_1 - ts)\, ds & if \quad p_1 - p_2 - t < q_1 - q_2 \leq p_1 - p_2 + t \\ \int_0^1 (v + q_1 - ts)\, ds & if \quad q_1 - q_2 > p_1 - p_2 + t \end{cases} \tag{30}$$

and an analogous expression holds for Firm 2, $\widetilde{b}_2$. We do not investigate such extension in the presence of price regulation (as in Section 4) since the results are qualitatively unaffected by this new assumption (see Brekke, Siciliani and Straume, 2011b). This is intuitive: since prices are fixed, consumers' purchasing expenditures cannot be affected by the firm. It is only when prices are endogenous that the results differ. The first-order conditions for quality and price are analogous to (22) and (24) where b_i is replaced by $\widetilde{b}_i$. As before, higher altruism implies a higher incentive to increase quality because it increases consumers' utility. However, if the firms' altruistic concerns do not encompass consumers' purchasing expenditures, higher altruism does not have a direct negative effect on prices. Thus, $\frac{\partial \widetilde{b}_i}{\partial p_i} = 0$ and $\frac{\partial \widetilde{b}_i}{\partial q_i} + \frac{\partial \widetilde{b}_i}{\partial p_i} \frac{\partial x_i / \partial q_i}{-\partial x_i / \partial p_i} = x_i > 0$. The optimality condition (24) therefore reduces to

$$(1 - \delta)(x_i - c_q) + \alpha x_i = g_q, \tag{31}$$

and, for a given level of effort, it is now the case that higher altruism leads to higher quality.[19] If firms are sufficiently altruistic, profit constraints will reduce the marginal profit loss of quality investments and the firms will optimise at a higher quality level. Applying the specific cost and effort functions given by (16)-(17), the symmetric Nash equilibrium quality is

$$q^* = \frac{1 - \delta + \alpha}{2(\theta + k(1 - \delta))}. \tag{32}$$

The results for cost-containment effort and price are qualitatively similar to those presented in the Proposition 2 and are therefore not repeated here (see Brekke, Siciliani and Straume, 2011b). The following proposition summarises the effects of profit constraints on quality for the alternative formulation of altruistic preferences:

[19] Notice that, in the symmetric equilibrium, we have $(1 - \delta)\left(\frac{1}{2} - c_q\right) + \frac{\alpha}{2} = g_q$.

Proposition 3 *Suppose that the firms care about gross consumer utility excluding expenditures. Under quality and price competition, placing a constraint on profit distribution leads to a higher level of quality in equilibrium if and only if altruism is sufficiently high, i.e.,* $\alpha > \theta/k$.

6 Welfare analysis

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 and non-monetary costs of quality, output and cost containment. 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. The maximisation problem is thus

$$\max_{q_1,q_2,e_1,e_2} \quad W = \int_0^{\frac{1}{2}} (v + q_1 - tx)\, dx + \int_{\frac{1}{2}}^1 (v + q_2 - t(1-x))\, dx - \sum_{i=1}^{2} \left[c\left(\frac{1}{2}, q_i, e_i\right) + g(q_i, e_i) \right]. \tag{33}$$

Using the cost and disutility functions given by (16) and (17) we obtain the first-best quality and cost containment effort:

$$q_1 = q_2 = q^{FB} = \frac{1}{2(k+\theta)}, \tag{34}$$

$$e_1 = e_2 = e^{FB} = \frac{1}{2w}. \tag{35}$$

Comparing (35) with (19) or (27), notice that, whether prices are regulated or not, the market provides the optimal level of cost containment only in the absence of profit constraints. Otherwise (for $\delta > 0$) the degree of cost efficiency is suboptimally low. Equilibrium quality, on the other hand, might be underprovided or overprovided. As will be shown below, this depends partly on whether prices are regulated or not.

6.1 Price regulation

For the case of regulated prices, we ask two separate questions. First, what is the first-best price and how does it vary with profit constraints? Second, for a given price, is the imposition of profit constraints welfare increasing or welfare reducing?

6.1.1 The first-best price

By setting p such that the equilibrium quality, given by (18), coincides with the first-best quality, given by (34), we obtain

$$p^{FB} = \frac{(1-\delta)(c-e^*) + t\frac{\theta+k(1-\delta)}{(k+\theta)} - \alpha\left(\frac{1}{2(k+\theta)} + \frac{t}{2} + v\right)}{1-\delta-\alpha}, \tag{36}$$

where $e^* = \frac{(1-\delta)}{2w}$.

Notice that, if $\alpha = \delta = 0$, then $p^{FB} = c - e^* + t$. Without altruism and profit constraints, the optimal first-best price is equal to the marginal production costs plus the transportation cost parameter t. Higher transportation costs reduce quality which needs to be compensated with a higher price. If $\alpha = 0$ and $\delta > 0$, then

$$p^{FB} = (c-e^*) + t\left[\frac{(1-\delta)k+\theta}{(1-\delta)(k+\theta)}\right] > c - e^* + t. \tag{37}$$

With no altruism, profit constraints imply a higher optimal price. Since profit constraints reduce quality and increase the marginal cost of provision (through lower effort e^*), a higher price is needed to achieve the first-best outcome, i.e., $\partial p^{FB}/\partial\delta > 0$.

In the presence of altruism, however, constraints on profit distribution do not necessarily lead to a higher first-best price. The reason is that profit constraints can increase quality for sufficiently high altruism (cf. Proposition 1), which may induce a lower first-best price.

Proposition 4 *Profits constraints increase (reduce) the first-best regulated price if the degree of altruism is sufficiently low (high).*

This result implies that price and profit constraints can be regulatory complements or substitutes. If altruism is low, they are complements: the imposition of profit constraints leads to

a higher price. If altruism is high, they are substitutes: profit constraints are accompanied by a lower price.

6.1.2 Welfare effects of profit constraints

Evaluating social welfare at the equilibrium level of quality and cost containment under price regulation, but where the price is not necessarily at the first-best level given by (36), yields

$$W\left(q^*(p,\delta),e^*(p,\delta)\right)=2\left[\int_0^{\frac{1}{2}}\left(v+q^*-tx\right)dx-c\left(\frac{1}{2},q^*,e^*\right)-g\left(q^*,e^*\right)\right]. \tag{38}$$

The welfare effect of imposing profit constraints is thus given by

$$\frac{dW}{d\delta}=\frac{\partial W}{\partial q^*}\frac{\partial q^*}{\partial \delta}+\frac{\partial W}{\partial e^*}\frac{\partial e^*}{\partial \delta}. \tag{39}$$

Notice that $\partial W/\partial e^*=0$ for $\delta=0$, since cost containment is at the first-best level in the absence of profit constraints. This means that the imposition of a sufficiently small profit constraint will always improve social welfare if it brings quality closer to the first-best level, i.e., if $\frac{\partial W}{\partial q^*}\frac{\partial q^*}{\partial \delta}>0$. The welfare effects of introducing a small ('low impact') profit constraint can be qualitatively characterised as follows:

Proposition 5 *Consider the imposition of a sufficiently small profit constraint on firms that are subject to price regulation. (i) For a sufficiently low price, there exist strictly positive lower and upper threshold levels of α, such that the profit constraint improves welfare for intermediate levels of altruism. (ii) For a sufficiently high price, there exists a strictly positive upper threshold level of α, such that the profit constraint improves welfare if the degree of altruism is below this level.*

If the price is sufficiently low, there is underprovision (overprovision) of quality if the degree of altruism is below (above) a certain threshold level. In this case, there always exists an intermediate range of α such that a 'low impact' profit constraint improves welfare, either by increasing quality when it is underprovided or by reducing it when it is overprovided. On the other hand, if the price is sufficiently high, quality is always overprovided and a small profit constraint will in this case increase welfare as long as it leads to lower quality provision, i.e., if

$\alpha < \widehat{\alpha}$.

The analysis would be slightly different in the case of a tightening of an existing profit constraint (where $\delta > 0$ to begin with). This is more likely to reduce welfare as $\partial W/\partial e^* > 0$ and $\partial e^*/\partial \delta < 0$. Even if profit constraints bring equilibrium quality closer to the first-best level, the welfare effect is ambiguous since the reduction in quality distortion is counteracted by the welfare loss of lower cost efficiency. Substituting for $\frac{\partial W}{\partial e^*}\frac{\partial e^*}{\partial \delta}$, the overall welfare effect is given by

$$\frac{dW}{d\delta} = \frac{\partial W}{\partial q^*}\frac{\partial q^*}{\partial \delta} - \frac{\delta}{4w}. \tag{40}$$

Since the first term does not depend on the marginal disutility of effort, w, it follows that the result stated in Proposition 5 holds qualitatively also for a tightening of an existing profit constraint if the marginal disutility of effort is sufficiently high. Intuitively, if cost containment is sufficiently costly, distortions along this dimension will be small and the welfare effect of tighter profit constraints will mainly be determined by the quality response.

6.2 Quality and price competition

Suppose that firms compete in terms of quality and price. Comparing (26) and (34), it is straightforward to verify that $q^* < q^{FB}$ if $\delta > 0$ and $q^* = q^{FB}$ if $\delta = 0$. Thus, under quality and price competition, quality is always underprovided in the presence of profit constraints. This result represents an intuitive extension to the existing literature. If $\alpha = \delta = 0$, our model corresponds to the one analysed by Ma and Burgess (1993), who conclude that the market provides the optimal level of quality if quality and price decisions are made simultaneously.[20] Since equilibrium quality does not depend on the degree of altruism and profit constraints lead to lower quality (cf. Proposition 2), the above-stated result follows directly. Profit-constrained firms that compete on both quality and price will offer quality that is below the optimal first-best level, regardless of whether the firms have altruistic preferences or not. The policy implications of this result are straightforward, and can be summarised as follows:

Proposition 6 *When firms compete on quality and price, welfare is maximised with no constraints on profit distribution. Imposing such constraints on the firms will always reduce welfare*

[20] Brekke, Siciliani and Straume (2010) show that this result does not hold in the presence of income effects in demand.

due to lower quality and less cost containment effort.

7 Concluding remarks

In this paper we have analysed the impact of profit constraints on altruistic firms' incentives to invest in quality and cost efficiency. Using a spatial competition approach, where consumers choose providers based on travelling distance, quality and price, we have derived the market equilibrium under quality competition with regulated prices and under quality-price competition. We have also analysed the welfare effects of price regulation and profit constraints.

Our analysis has offered two sets of insights. In terms of *market outcomes*, we have showed that a constraint on profit distribution always leads to less cost efficiency, whereas the effect on quality and prices are more ambiguous. If prices are regulated, profit constraints lead to increased quality provision only if the firms are sufficiently altruistic. Otherwise, for low (or zero) levels of altruism, profit-constrained firms offer lower quality than firms that are not profit-constrained. On the other hand, if firms are allowed to compete on both quality and price, profit constraints always have a negative effect on quality provision, while the effect on prices is ambiguous; profit constraints lead to lower (higher) prices if the degree of altruism is sufficiently high (low).

In terms of *welfare outcomes*, we have showed that profit constraints lead to too low levels of cost efficiency, while quality may be over- or underprovided in the market equilibrium, depending on the degree of altruism, if prices are regulated. Consequently, profit constraints might improve welfare if the regulated price is not set at the optimal level. Under optimal price regulation, profit constraints increase (reduce) the regulated price if altruism is sufficiently low (high), implying that price and profit constraints are either complements or substitutes. For example, markets with non-profit (as opposed to for-profit) firms should optimally face a lower (higher) price if the degree of altruism is sufficiently high (low). On the other hand, if prices are set by the firms, the imposition of profit constraints always reduce welfare due to underprovision of quality and insufficient cost containment.

Before concluding the paper, let us briefly mention some possible extensions and limitations of our study. We have considered an oligopoly model with competition between a fixed number firms. The number of firms could have been endogenised, for instance, by deriving the free-entry

equilibrium.[21] This is likely to generate different results with respect to the effects of profit constraints, but would require a different set up, and is thus beyond the scope of our study. The kind of markets where profit-constrained firms are frequently observed, such as health care, long-term care, education, etc., typically have restrictions on entry. Our analysis of oligopolistic competition between a fixed number of (profit-constrained) firms should therefore be highly relevant.

Another possible extension is to allow firms to select the location in addition to the quality and price. By placing the firms at the endpoints of the Hotelling line, we implicitly assume that firms would choose maximum (horizontal) product differentiation. However, this assumption is consistent with existing literature that show that firms will locate at maximum distance in order to dampen quality (and price) competition (e.g., Economides, 1989; Brekke, Nuscheler and Straume, 2006). Thus, endogenising location choices is not likely to provide any additional insight from the analysis.

[21] Lakdawalla and Philipson (2000) analyse competition between non-profit and for-profit providers in an industry with free entry.

Appendix A: Proofs

Proof of Lemma 1. Setting $\alpha = c_e = g_q = 0$, the expression in (13) is reduced to

$$\frac{\partial q^*}{\partial \delta} = \frac{-\left[\frac{p-c_x}{2t} - c_q\right]}{(1-\delta)\left(\frac{c_{xq}}{2t} + c_{qq}\right)}. \tag{A1}$$

From (11), $\alpha = g_q = 0$ implies that $\frac{p-c_x}{2t} - c_q = 0$, which means that $\partial q^*/\partial \delta = 0$. *Q.E.D.*

Proof of Lemma 2. Setting $\alpha = c_e = 0$, the expression in (13) reduces to

$$\frac{\partial q^*}{\partial \delta} = \frac{-\left[\frac{p-c_x}{2t} - c_q\right]}{(1-\delta)\left(\frac{c_{xq}}{2t} + c_{qq}\right) + g_{qq}}, \tag{A2}$$

while (11) reduces to

$$(1-\delta)\left[\frac{p-c_x}{2t} - c_q\right] - g_q = 0,$$

implying that $\frac{p-c_x}{2t} - c_q > 0$ in equilibrium. Since the denominator in (A2) is positive (by the second-order condition), this implies $\partial q^*/\partial \delta < 0$. *Q.E.D.*

Proof of Lemma 3. Setting $\alpha = g_q = 0$, the first-order condition (11) is reduced to

$$(1-\delta)\left[\frac{p-c_x}{2t} - c_q\right] = 0,$$

which implies that (13) and (14) reduce to, respectively,

$$\frac{\partial e^*}{\partial \delta} = \frac{1}{\Delta} c_e (1-\delta)\left(\frac{c_{xq}}{2t} + c_{qq}\right) < 0 \tag{A3}$$

and

$$\frac{\partial q^*}{\partial \delta} = -\frac{1}{\Delta} c_e (1-\delta)\left(c_{eq} + \frac{c_{ex}}{2t}\right) < 0. \tag{A4}$$

Q.E.D.

Proof of Lemma 4. Setting $c_e = g_q = 0$, (13) reduces to (A1). However, the first-order condition (11) is now reduced to

$$(1-\delta)\left[\frac{p-c_x}{2t} - c_q\right] + \frac{\alpha}{2}\left(\frac{1}{2} + \frac{v + q^* - p}{t}\right) = 0,$$

implying that $\frac{p-c_x}{2t} - c_q < 0$ in equilibrium, which further implies that $\partial q^*/\partial\delta > 0$. *Q.E.D.*

Proof of Proposition 1. From (18), the effect of a (stronger) profit constraint on equilibrium quality is given by

$$\begin{aligned}\frac{\partial q^*}{\partial \delta} &= \frac{(\alpha - 2t\theta)(1-\delta+w(p-c)) + ktw\alpha(t+2(v-p)) - kt(\delta-1)^2}{w(2t(\theta+k(1-\delta))-\alpha)^2} \\ &< (>)\,0 \quad if \quad \alpha < (>)\,\widehat{\alpha} := \frac{kt(1-\delta)^2 + 2t\theta(1-\delta) + 2tw\theta(p-c)}{(1-\delta)+w(p-c)+kt^2w+2ktw(v-p)}.\end{aligned}$$

The set $A = (\widehat{\alpha}, \overline{\alpha})$ is non-empty since

$$\overline{\alpha} - \widehat{\alpha} = kt\frac{2w(t(2(v-p)+t)(k(1-\delta)+\theta)+(1-\delta)(p-c))+(1-\delta)^2}{1-\delta+w(kt(2(v-p)+t)+p-c)} > 0.$$

The effect of profit constraints on cost containment follows directly from (19). *Q.E.D.*

Proof of Proposition 2. Using (26), the effect of a (stronger) profit constraint on equilibrium quality is given by

$$\frac{\partial q^*}{\partial \delta} = -\frac{\theta}{2(\theta+k(1-\delta))^2} < 0.$$

From (28), the effect on equilibrium prices is given by

$$\frac{\partial p^*}{\partial \delta} = \frac{(1-\delta)^2(\theta+k(1-\delta))^2 - \alpha\Phi}{2w(1-\delta-\alpha)^2(\theta+k(1-\delta))^2},$$

where

$$\Phi := (w(2(v-c)-t)+2(1-\delta))(\theta+k(1-\delta))^2 + w\left(k(1-\delta)^2+\alpha\theta\right).$$

The sign of $\frac{\partial p^*}{\partial \delta}$ is given by the sign of the numerator. This is clearly positive for $\alpha = 0$, while setting α at the highest permissible level, $\alpha = \overline{\overline{\alpha}}$, yields

$$-(1-\delta)(\theta+k(1-\delta))[w(1-\delta)+(\theta+k(1-\delta))(1-\delta+w(2(v-c)-t))] < 0.$$

The existence of a threshold value $\widehat{\alpha}_p$, such that $\partial p^*/\partial\delta > (<0)$ if $\alpha < (>)\,\widehat{\alpha}_p$, is confirmed by

noticing that $\alpha\Phi$ is monotonically increasing in α, since

$$\frac{\partial \Phi}{\partial \alpha} = w\theta > 0.$$

The effect of profit constraints on cost containment follows directly from (27). *Q.E.D.*

Proof of Proposition 3. From (32), the effect of a (stronger) profit constraint on equilibrium quality is given by

$$\frac{\partial q^*}{\partial \delta} = \frac{k\alpha - \theta}{2\left(\theta + k\left(1-\delta\right)\right)^2} > (<)\, 0 \quad if \quad \alpha > (<)\, \frac{\theta}{k}.$$

Q.E.D.

Proof of Proposition 4. From (36) we find that $\partial p^{FB}/\partial \delta < (>)\, 0$ if

$$\alpha > (<)\, \frac{\left(k+\theta\right)\left(1-\delta\right)^2 + 2tw\theta}{w\left(1+\left(t+2v\right)\left(\theta+k\right)\right) + 2\left(\left(k+\theta\right)\left(1-\delta\right) - w\left(k\left(c+t\right)+c\theta\right)\right)} > 0.$$

The positive sign of this expression is established by imposing the parameter restriction $v \geq c+t$, which combines the conditions that secure full market coverage and non-negative mark-ups. *Q.E.D.*

Proof of Proposition 5. Comparing (18) and (34), there is underprovision (overprovision) of quality when altruism is sufficiently low (high). Analytically,

$$q^*\left(p\right) < (>)\, q^{FB} \quad if \quad \alpha < (>)\, \widetilde{\alpha},$$

where

$$\widetilde{\alpha} := \frac{2t\left(\theta + k\left(1-\delta\right)\right) - 2\left(k+\theta\right)\left(1-\delta\right)\left(p - c + e^*\right)}{1 + 2\left(k+\theta\right)\left(\frac{t}{2} + v - p\right)}.$$

From Proposition 1 we know that profit constraints increase (reduce) equilibrium quality if $\alpha > (<)\, \widehat{\alpha}$. It is straightforward to confirm (by a simple numerical example) that the ranking of $\widetilde{\alpha}$ and $\widehat{\alpha}$ is ambiguous within the valid parameter space. Now consider the imposition of a sufficiently small profit constraint. There are four possible regimes:

1. If $\alpha > \max\{\widetilde{\alpha}, \widehat{\alpha}\}$, quality, which is overprovided, increases even further and welfare is reduced.

2. If $\alpha < \min\{\widetilde{\alpha}, \widehat{\alpha}\}$, quality, which is underprovided, reduces even further and welfare is reduced.

3. If $\widehat{\alpha} < \alpha < \widetilde{\alpha}$, quality, which is underprovided, increases and welfare improves.

4. If $\widetilde{\alpha} < \alpha < \widehat{\alpha}$, quality, which is overprovided, reduces and welfare improves.

Notice that $\widetilde{\alpha}(>) < 0$ if p is sufficiently low (high). Thus, for a 'high' regulated price (such that $\widetilde{\alpha} < 0$), only the first and last of the above regimes exist, implying that quality is always overprovided. *Q.E.D.*

Proof of Proposition 6. The result follows directly from comparing (26) with (34), and (27) with (35). *Q.E.D.*

Appendix B: Mixed markets

Suppose that the market consists of one firm that is profit-constrained ($\delta > 0$) and one that is not ($\delta = 0$); for example, a market where a non-profit firm competes against a for-profit firm.[22] We consider quality competition with regulated prices (as in Section 4) and use the specific cost and effort functions given by (16)-(17).

For *exogenous levels of cost efficiency*, equilibrium quality levels are given by[23,24]

$$q_{NC}^{*} = \frac{2\lambda_{PC}\widetilde{p}_{NC} - 2\alpha(1-\delta)\widetilde{p}_{PC} + \alpha\mu(\lambda_{PC} - \alpha)}{\lambda_{NC}\lambda_{PC} - \alpha^2}, \tag{B1}$$

$$q_{PC}^{*} = \frac{2(1-\delta)\lambda_{NC}\widetilde{p}_{PC} - 2\alpha\widetilde{p}_{NC} + \alpha\mu(\lambda_{NC} - \alpha)}{\lambda_{NC}\lambda_{PC} - \alpha^2}, \tag{B2}$$

where $\widetilde{p}_i := p - (c - e_i) > 0$ is the price-cost margin of Firm i, while $\mu := 2(v - p) + t > 0$, $\lambda_{NC} := 4t(\theta + k) - 3\alpha > 0$ and $\lambda_{PC} := 4t[\theta + (1-\delta)k] - 3\alpha > 0$.[25]

[22] Rose-Ackerman (1996) shows that in sectors where non-profit firms operate, they tend to coexist with for-profit firms.

[23] An interior equilibrium requires that $q_i^* > 0$ and $(q_i^* - q_j^*) \in (-t, t)$, $i, j = PC, NC$; $i \neq j$. These conditions are satisfied if the cost difference $|e_i - e_j|$ is not too large, otherwise the less efficient firm is driven out of the market. The exact conditions can be provided upon request.

[24] The profit-constrained firm is denoted by subscript PC, while the firm that does not face any profit constraints is denoted by subscript NC.

[25] Uniqueness and stability of the Nash equilibrium requires that $\lambda_{NC}\lambda_{PC} - \alpha^2 > 0$.

In equilibrium, each firm's quality choice increases with the level of cost efficiency, i.e.,

$$\frac{\partial q_{NC}^*}{\partial e_{NC}} = \frac{2\lambda_{PC}}{\lambda_{NC}\lambda_{PC} - \alpha^2} > 0, \quad \frac{\partial q_{PC}^*}{\partial e_{PC}} = \frac{2\left(1-\delta\right)\lambda_{NC}}{\lambda_{NC}\lambda_{PC} - \alpha^2} > 0.$$

The reason is that a lower marginal production cost increases the profit margin and thus the incentive to improve quality to attract consumers. This effect is weaker for the profit-constrained firm, since it only captures a fraction of the higher profit margin. Furthermore, if a firm becomes more efficient, the competing firm's quality incentives are discouraged, i.e.,

$$\frac{\partial q_{NC}^*}{\partial e_{PC}} = \frac{-2\alpha\left(1-\delta\right)}{\lambda_{NC}\lambda_{PC} - \alpha^2} < 0, \quad \frac{\partial q_{PC}^*}{\partial e_{NC}} = \frac{-2\alpha}{\lambda_{NC}\lambda_{PC} - \alpha^2} < 0.$$

This effect is due to firms' quality investments being *strategic substitutes*[26], which is explained by the firms' altruistic preferences.[27] A quality increase by one firm leads to a demand drop for the competing firm. Since lower demand reduces the marginal consumer benefit of quality, the optimal response for an altruistic firm is therefore to reduce its quality. Thus, quality investments generate a *negative externality* between the firms. This strategic effect is stronger for the profit-constrained firm, since the competing firm, which is not profit-constrained, responds more aggressively to a higher margin in terms of quality investments.

This strategic substitutability implies that the firms' responses to a tightening of the profit constraint always go in opposite directions. From (B1)-(B2) we have

$$\partial q_{PC}^*/\partial\delta < (>)\, 0 \Longleftrightarrow \partial q_{NC}^*/\partial\delta > (<)\, 0.$$

Thus, if a tightening of the profit constraint leads to an increase in the quality supplied by the profit-constrained firm, the competing firm will respond by lowering its quality level, and vice versa.

Comparing the equilibrium quality levels, it follows from (B1)-(B2) that, if the firms are equally efficient (implying $\widetilde{p}_{NC} = \widetilde{p}_{PC}$), the profit-constrained firm provides the higher quality

[26] This can easily be verified by observing that

$$sign\left(\frac{dq_i^*}{dq_j}\right) = sign\left(\frac{\partial^2\Omega_i}{\partial q_j \partial q_i}\right) = -\frac{\alpha}{4t} < 0.$$

[27] Notice that quality investments are strategic substitutes only if the firms are to some degree altruistic ($\alpha > 0$).

level if $\widetilde{p}_i(2t\theta-\alpha) < \mu\alpha kt$. This condition holds only if the degree of altruism is sufficiently high, for reasons provided by the discussion in Section 4.

When *cost efficiency is endogenous*, and firms choose quality and cost containment effort simultaneously, the equilibrium levels of quality and cost containment effort are given by

$$e^*_{NC} = \frac{2(p-c)w\delta(4t\theta-2\alpha)+tw\left(\lambda_{NC}\lambda_{PC}-\alpha^2\right)-2(1-\delta)^2(\lambda_{NC}+\alpha)-4kt\delta\mu w\alpha}{2w\left(tw(\lambda_{NC}\lambda_{PC}-\alpha^2)-(\lambda_{PC}+\alpha)-(1-\delta)^2(\lambda_{NC}+\alpha)\right)}, \quad \text{(B3)}$$

$$e^*_{PC} = (1-\delta)\frac{wt\left(\lambda_{NC}\lambda_{PC}-\alpha^2+4k\delta\mu\alpha\right)-2(\lambda_{PC}+\alpha)-4w\delta(2t\theta-\alpha)(p-c)}{2w\left(tw(\lambda_{NC}\lambda_{PC}-\alpha^2)-(\lambda_{PC}+\alpha)-(1-\delta)^2(\lambda_{NC}+\alpha)\right)}, \quad \text{(B4)}$$

$$q^*_{NC} = \frac{\left[\begin{array}{c}2w(p-c)(wt(\lambda_{PC}-(1-\delta)\alpha)-(1-\delta)(2-\delta))\\+tw\left(\lambda_{PC}-(1-\delta)^2\alpha\right)-2(1-\delta)^2-\alpha\mu w\left(1+(1-\delta)^2-tw(\lambda_{PC}-\alpha)\right)\end{array}\right]}{w\left(tw(\lambda_{NC}\lambda_{PC}-\alpha^2)-(\lambda_{PC}+\alpha)-(1-\delta)^2(\lambda_{NC}+\alpha)\right)}, \quad \text{(B5)}$$

$$q^*_{PC} = \frac{\left[\begin{array}{c}2w(p-c)(wt((1-\delta)\lambda_{NC}-\alpha)-(1-\delta)(2-\delta))\\+tw\left((1-\delta)^2\lambda_{NC}-\alpha\right)-2(1-\delta)^2-\alpha\mu w\left(1+(1-\delta)^2-tw(\lambda_{NC}-\alpha)\right)\end{array}\right]}{w\left(tw(\lambda_{NC}\lambda_{PC}-\alpha^2)-(\lambda_{PC}+\alpha)-(1-\delta)^2(\lambda_{NC}+\alpha)\right)}. \quad \text{(B6)}$$

The complexity of these expressions necessitates the use of numerical simulations. We focus on our two main parameters of interest, namely the degree of altruism (α) and the tightness of the profit constraint (δ). The remaining parameters are fixed as follows: $v = 4$, $p = w = 2$ and $c = g = k = \theta = t = 1$.[28]

[28] The parameter values are set such that they do not violate any of the conditions required for the interior equilibrium outcome given by (B3)-(B6).

Table A1. Quality competition in a mixed duopoly									
	$\alpha = 0$			$\alpha = 0.25$			$\alpha = 0.5$		
	$\delta = 0.1$	$\delta = 0.5$	$\delta = 0.8$	$\delta = 0.1$	$\delta = 0.5$	$\delta = 0.8$	$\delta = 0.1$	$\delta = 0.5$	$\delta = 0.8$
e_{NC}	0.26	0.28	0.31	0.25	0.27	0.28	0.25	0.24	0.23
e_{PC}	0.22	0.11	0.04	0.22	0.11	0.04	0.22	0.13	0.05
q_{NC}	0.31	0.32	0.33	0.50	0.51	0.51	0.71	0.71	0.70
q_{PC}	0.29	0.19	0.09	0.49	0.43	0.38	0.71	0.73	0.78
x_{NC}	0.51	0.57	0.62	0.51	0.54	0.57	0.50	0.49	0.46
π_{NC}	0.60	0.68	0.76	0.51	0.56	0.60	0.37	0.36	0.32
π_{PC}	0.55	0.46	0.39	0.48	0.42	0.38	0.36	0.31	0.26
$\sum b_i$	2.05	2.01	1.97	2.24	2.22	2.20	2.46	2.47	2.49
Ω_{NC}	0.48	0.55	0.61	0.61	0.66	0.70	0.67	0.65	0.59
Ω_{PC}	0.41	0.20	0.07	0.54	0.36	0.24	0.63	0.50	0.42

In the case of no altruism, an increase in δ induces the profit-constrained firm to choose a lower level of quality and cost containment effort since it appropriates less of the profit margin. The competing firm, which is not profit-constrained, responds by increasing its quality and effort levels due to the strategic substitutability explained above.[29] Consumer surplus decreases because of the quality reduction by the profit-constrained firm and the corresponding increase in travelling costs due to the marginal consumer being shifted away from the market centre.

Altruism ($\alpha > 0$) shifts up the quality levels for both firms, but the effect is stronger for the profit-constrained firm. Indeed, for high levels of altruism ($\alpha = 0.5$), the quality ranking is reversed and the profit-constrained firm offers higher quality than its competitor. This is consistent with Proposition 1. Consequently, the profit-constrained firm has a higher market share when altruism is sufficiently high. This also implies that the profit-constrained firm has the higher payoff (i.e., $\Omega_{PC} > \Omega_{NC}$ for $\alpha = 0.5$). Moreover, a tightening of the profit-constraint reduces the payoff of the firm that is not profit-constrained. In other words, for high levels of

[29] It is straightforward to show that these results ($e^*_{NC} > e^*_{PC}$ and $q^*_{NC} > q^*_{PC}$) hold for all valid parameter configurations when $\alpha = 0$.

altruism, the firm that is not profit-constrained suffers from competing with a profit-constrained firm. Nevertheless, the profit-constrained firm always remains the less efficient in equilibrium.[30]

How are consumers affected by a tightening of the profit constraint? This depends on the degree of altruism. For low levels of altruism, a stronger profit constraint reduces consumers' surplus. The reason is that the marginal consumer is distorted away from the market centre, and this is not offset by higher quality levels. However, for high levels of altruism ($\alpha = 0.5$), a tighter profit constraint improves consumer surplus, despite the fact that the marginal consumer is located even further away from the market centre. Thus, the quality improvements more than offset the higher travelling costs.

Appendix C: Quality-then-price competition

Here we show that the relationship between profit constraints and equilibrium quality under price competition (see Section 5) is qualitatively unaffected by the assumed sequence of the quality and price decisions. Suppose that, in contrast to the assumptions used in Section 5, firms can commit to a certain level of quality before setting prices. More specifically, consider the following sequence of moves:

1. The firms choose qualities,

2. The firms choose prices and cost containment efforts.

Solving the game by backwards induction, the subgame perfect Nash equilibrium outcome is:[31]

$$q^* = \frac{(1-\delta)\left(tw\left(4\left(1-\delta\right)-3\alpha\right)-\left(1-\delta\right)^2\right)}{4\left(tw\left(3\left(1-\delta\right)-2\alpha\right)-\left(1-\delta\right)^2\right)\left(\theta+k\left(1-\delta\right)\right)}, \tag{C1}$$

$$p^* = \frac{2\left(1-\delta\right)^2\left(3tw-\left(1-\delta\right)\right)\left(2w\left(t+c\right)-\left(1-\delta\right)\right)\left(\theta+k\left(1-\delta\right)\right)+\alpha w\Psi}{4w\left(1-\delta-\alpha\right)\left(tw\left(3\left(\left(1-\delta\right)\right)-2\alpha\right)-\left(1-\delta\right)^2\right)\left(\theta+k\left(1-\delta\right)\right)}, \tag{C2}$$

$$e^* = \frac{1-\delta}{2w}, \tag{C3}$$

[30] This result is hard to prove analytically, but extensive numerical simulations indicate that $e^*_{NC} > e^*_{PC}$ for parameter values within the valid range.

[31] Intermediate calculations are available from the authors upon request.

where

$$\Psi := (1-\delta)\left((1-\delta)^2 - tw\left(4\left(1-\delta\right)-3\alpha\right)\right) + 4\left(\theta + k\left(1-\delta\right)\right)tw\alpha\left(2v+t\right)$$

$$-2\left(\theta + k\left(1-\delta\right)\right)\left(1-\delta\right)tw\left(6\left(2t+c\right)+6v-5t-2c\right) + 2\left(\theta + k\left(1-\delta\right)\right)\left(1-\delta\right)^2\left(2v+3t\right). \tag{C4}$$

Non-negative values of q^* and p^* (and thus equilibrium existence) require that the parameter space is restricted by the following set of inequalities:

$$\alpha < 1-\delta < tw. \tag{C5}$$

From (C1) we have

$$\frac{\partial q^*}{\partial \delta} = -\frac{\Gamma}{4\left(\theta + k\left(1-\delta\right)\right)^2\left(tw\left(3\left(1-\delta\right)-2\alpha\right)-\left(1-\delta\right)^2\right)^2}, \tag{C6}$$

where

$$\begin{aligned}\Gamma \quad : \quad &= \theta\left(1-\delta\right)^4 + tw\left(1-\delta\right)^2\left(\left(1-\delta\right)\left(k\left(1-\delta\right)-6\theta\right)+12\theta tw\right)\\ &+tw\alpha\left(\left(1-\delta\right)^2\left(3\theta-2k\left(1-\delta\right)\right)+tw\left(\left(1-\delta\right)\left(k\left(1-\delta\right)-16\theta\right)+6\theta\alpha\right)\right).\end{aligned} \tag{C7}$$

The sign of $\partial q^*/\partial\delta$ depends on the sign of Γ. We can determine the sign of Γ by considering

$$\frac{\partial\Gamma}{\partial\theta} = \left(1-\delta\right)^4 + 6tw\left(1-\delta\right)^2\left(2tw-\left(1-\delta\right)\right) - \widetilde{\Gamma} \tag{C8}$$

where

$$\widetilde{\Gamma} := tw\alpha\left(\left(1-\delta\right)\left(16tw-3\left(1-\delta\right)\right)-6tw\alpha\right). \tag{C9}$$

Further,

$$\frac{\partial\widetilde{\Gamma}}{\partial\alpha} = tw\left[16tw\left(1-\delta\right)-3\left(1-\delta\right)^2-12tw\alpha\right]. \tag{C10}$$

The expression in square brackets is monotonically decreasing in α. At the upper limit of α,

$\alpha = 1 - \delta$, we have

$$16tw\left(1-\delta\right) - 3\left(1-\delta\right)^2 - 12tw\alpha = \left(1-\delta\right)\left(4tw - 3\left(1-\delta\right)\right) > 0, \tag{C11}$$

where the positive sign follows from (C5). Consequently, $\partial\widetilde{\Gamma}/\partial\alpha > 0$. It follows that $\partial\Gamma/\partial\theta$ reaches its minimum when α is at its upper limit. Setting $\alpha = 1 - \delta$ yields

$$\frac{\partial\Gamma}{\partial\theta} = \left(1-\delta\right)^2\left(tw - \left(1-\delta\right)\right)\left(2tw - \left(1-\delta\right)\right) > 0, \tag{C12}$$

where the positive sign is confirmed by (C5). Thus, Γ is monotonically increasing in θ and reaches its minimum value for $\theta = 0$. Inserting $\theta = 0$ in (C7) yields

$$\Gamma = ktw\left(1-\delta\right)^2\left(tw\alpha + \left(1-\delta\right)\left(1-\delta-2\alpha\right)\right) > 0, \tag{C13}$$

where the positive sign is confirmed by applying (C5). Using (C12), this implies that Γ is positive for all $\theta \geq 0$ and therefore, $\partial q^*/\partial\delta < 0$. Thus, imposing a profit constraint on the firms will always lead to lower quality in equilibrium. This confirms that the negative effect of profit constraints on quality provision reported in Proposition 2 is robust to the extension of sequential decision making, where firms choose qualities before prices.

References

[1] Antonazzo, E., Scott, T, Skatun, D., Elliott, R.F., 2003. The labour market for nursing: a review of the labour supply literature. Health Economics, 12, 465–478.

[2] Beitia, A., 2003. Hospital quality choice and market structure in a regulated duopoly. Journal of Health Economics, 22, 1011–1036.

[3] Besley, T., Ghatak, M., 2006. Sorting with motivated agents: implications for school competition and teacher incentives. Journal of the European Economics Association (Papers and Proceedings), 4, 404–414.

[4] Brekke, K.A., Nyborg, K., 2010. Selfish bakers, caring nurses? A model of work motivation. Journal of Economic Behavior & Organization, 75, 377–394.

[5] Brekke, K.R., Nuscheler, R., Straume, O.R., 2006. Quality and location choices under price regulation. Journal of Economics & Management Strategy, 15, 207–227.

[6] Brekke, K.R., Nuscheler, R., Straume, O.R., 2007. Gatekeeping in health care. Journal of Health Economics, 26, 149–170.

[7] Brekke, K.R., Siciliani, L., Straume, O.R., 2010. Price and quality in spatial competition. Regional Science and Urban Economics, 40, 471–480.

[8] Brekke, K.R., Siciliani, L., Straume, O.R., 2011a. Hospital competition and quality with regulated prices. Scandinavian Journal of Economics, 113, 444–469.

[9] Brekke, K.R., Siciliani, L., Straume, O.R., 2011b. Quality competition with profit constraints: Do non-profit firms provide higher quality than for-profit firms? CEPR Discussion Paper 8284.

[10] Chalkley, M, Malcomson, J.M., 1998a. Contracting for health services with unmonitored quality. Economic Journal, 108, 1093–1110.

[11] Chalkley, M, Malcomson, J.M., 1998b. Contracting for health services when patient demand does not reflect quality. Journal of Health Economics, 17, 1–19.

[12] Choné, P., Ma, C.A., 2011. Optimal health care contracts under physician agency. Annales d'Economie et de Statistique, 101-102, 229–256.

[13] Chou, S-Y., 2002. Asymmetric information, ownership and quality of care: an empirical analysis of nursing homes. Journal of Health Economics, 21, 293–311.

[14] Del Rey, E., 2001. Teaching versus research: a model of state university competition. Journal of Urban Economics 49, 356–373.

[15] Easley, D., O'Hara, M., 1983. The economic role of the nonprofit firm. RAND Journal of Economics 14, 531–538.

[16] Economides, N., 1989. Quality variations and maximimal variety differentiation. Regional Science and Urban Economics, 19, 21–29.

[17] Eggleston, K., 2005. Multitasking and mixed systems for provider payment. Journal of Health Economics, 24, 211–223.

[18] Eggleston, K., Shen, Y.-C., Lau, J., Schmid, C.H., Chan, J., 2008. Hospital ownership and quality of care: what explains the different results in the literature? Health Economics, 17, 1345–1362.

[19] Ellis, R.P., McGuire, T., 1986. Provider behavior under prospective reimbursement: Cost sharing and supply. Journal of Health Economics, 5, 129–151.

[20] Francois, P., Vlassopoulos M., 2008. Pro-social motivation and the delivery of social services. CESifo Economic Studies, 54, 22–54.

[21] Ghatak, M., Mueller, H., 2011. Thanks for nothing? Not-for-profits and motivated agents. Journal of Public Economics 95, 94–105.

[22] Glaeser, E.L., Shleifer, A., 2001. Not-for-profits entrepreneurs. Journal of Public Economics, 81, 99–115.

[23] Godager, G., Wiesen, D., 2011. Profit or patients' health benefit? Exploring the heterogeneity in physician altruism. HERO Working Paper 7, University of Oslo.

[24] Grabowski, D.C., Hirth, R.A., 2003. Competitive spillovers across non-profit and for-profit nursing homes. Journal of Health Economics, 22, 1–22.

[25] Grabowski, D.C., Stevenson, D.G., 2008. Ownership conversions and nursing home performance. Health Services Research, 43, 1184–1203.

[26] Gravelle, H., 1999. Capitation contracts: access and quality. Journal of Health Economics, 18, 315–340.

[27] Halonen-Akatwijuka, M., Propper, C., 2008. Competition and decentralisation in government bureaucracies. Journal of Economic Behavior & Organization, 67, 903–916.

[28] Hansmann, H.B., 1980. The role of nonprofit enterprise. Yale Law Journal, 89, 835–901.

[29] Hansmann, H., 1996. The Ownership of Enterprise. Cambridge, MA: Harvard University Press.

[30] Henning-Schmidt, H., Selten, R., Wiesen, 2011. How payment systems affect physicians' provision behaviour – An experimental investigation. Journal of Health Economics, 30, 637–646.

[31] Heyes, A.G., 2005. The economics of vocation or 'why is a badly paid nurse a good nurse'? Journal of Health Economics, 24, 561–569.

[32] Hillmer, M. P., Wodchis, W.P., Gill, S.S., Anderson, G.M, Rochon, P.A, 2005. 'Nursing Home Profit Status and Quality of Care: Is There Any Evidence of an Association? Medical Care Research and Review, 62, 139–66.

[33] Ikenwilo, D., Scott, A., 2007. The effects of pay and job satisfaction on the labour supply of hospital consultants. Health Economics, 16, 1303–1318.

[34] Iversen, T., Lurås, H., 2000. Economic motives and professional norms: the case of general medical practice. Journal of Economic Behavior & Organization, 43, 447–470.

[35] Jack, W., 2005. Purchasing health care services from providers with unknown altruism. Journal of Health Economics, 24, 73–93.

[36] Jensen, P.H., Webster, E., Witt, J., 2009. Hospital type and patient outcomes: an empirical examination using AMI readmission and mortality records. Health Economics, 18, 1440–1460.

[37] Kaarbøe, O., Siciliani, L., 2010. Multitasking, quality and pay for performance. Health Economics, 20, 225–238.

[38] Karlsson, M., 2007. Quality incentives for GPs in a regulated market. Journal of Health Economics, 26, 699–720.

[39] Kessler, D., McClellan, M., 2000. Is hospital competition socially wasteful? Quarterly Journal of Economics, 115, 577–615.

[40] Lakdawalla, D., Philipson, T., 2006. The nonprofit sector and industry performance. Journal of Public Economics, 90, 1681–1698.

[41] Le Grand, J., 2003. Motivation, Agency and Public Policy: of Knights and Knaves, Pawns and Queens. Oxford University Press, Oxford.

[42] Leonard, K.L., Masatu, M.C., 2010. Professionalism and the know-do gap: exploring intrinsic motivation among health workers in Tanzania. Health Economics, 12, 1461–1477.

[43] Lien, H.-M., Chou, S.-Y., Liu, J.-T., 2008. Hospital ownership and performance: evidence from stroke and cardiac treatment in Taiwan. Journal of Health Economics, 27, 1208–1223.

[44] Lyon, T.P., 1999. Quality competition, insurance, and consumer choice in health care markets. Journal of Economics & Management Strategy, 8, 545–580.

[45] Ma, C.A., Burgess, J.F., 1993. Quality competition, welfare, and regulation. Journal of Economics, 58, 153–173.

[46] Ma, C.A., 1994. Health care payment systems: cost and quality incentives. Journal of Economics & Management Strategy, 3, 93–112.

[47] Makris, M., 2009. Incentives for motivated agents under an administrative constraint. Journal of Economic Behavior & Organization, 71, 428-440.

[48] Malani, A., Philipson, T., David, G., 2003. Theories of firm behavior in the non-profit sector: a synthesis and empirical evaluation. In: Glaeser, E.L. (Ed.). The Governance of Not-for-Profit Organizations. Chicago: National Bureau of Economic Research, University of Chicago Press, 181–216.

[49] Marini, G., Miraldo, M., Jacobs, R., Goddard, M., 2008. Giving greater financial independence to hospitals - does it make a difference? The case of English NHS Trusts. Health Economics, 17, 751–775.

[50] Milcent, C., 2005. Hospital ownership, reimbursement systems and mortality rates. Health Economics, 14, 1151–1168.

[51] Page, R.M., 1996. Altruism and the British Welfare State. Aldershot: Avebury.

[52] Picone, G., Shin-Yi, C., Sloan, F., 2002. Are for-profit hospital conversions harmful to patients and to Medicare? RAND Journal of Econonomics, 33, 507–523.

[53] Rose-Ackerman, S., 1996. Altruism, nonprofits, and economic theory. Journal of Economic Literature, 34, 701–728.

[54] Salamon, L.M., Haddock, M.A., Sokolowski, S.W., Tice, H., 2007. Measuring civil society and volunteering: initial findings from implementation of the UN Handbook on Nonprofit Institutions. Working Paper No. 23. The Johns Hopkins Center for Civil Society Studies, Baltimore.

[55] Shen, Y., 2002. The effect of ownership choice on patient outcomes after treatment for acute myocardial infarction. Journal of Health Economics, 21, 901–922.

[56] Shields, M.A., Ward, M., 2001. Improving nurse retention in the National Health Service in England: the impact of job satisfaction on intentions to quit. Journal of Health Economics, 20, 677–701.

[57] Sloan, F., 2000. Not-for-profit ownership and hospital behavior. In: Culyer, A., Newhouse, J., (Eds.). Handbook of Health Economics, Vol. 1B. Amsterdam: Elsevier, 1141–1174.

[58] Tay, A., 2003. Assessing competition in hospital care markets: the importance of accounting for quality differentiation. RAND Journal of Economics, 34, 786–814.

[59] Wolinsky, A., 1997. Regulation of duopoly: managed competition vs. regulated monopolies. Journal of Economics & Management Strategy, 6, 821–847.

Firms in markets such as health care and education are often profit constrained due to regulation or their non-profit status, and they are often viewed as being altruistic towards consumers. We use a spatial competition framework to study incentives for cost containment and quality provision by altruistic firms facing profit constraints. If prices are regulated, profit constraints lead to lower cost containment efforts, but higher quality if and only if firms are sufficiently altruistic. Under price competition, profit constraints reduce quality and cost containment efforts, but lead to lower prices if and only if firms are sufficiently altruistic. Profit constrained firms' cost containment efforts are below the first-best, while their quality might be too high or too low. If prices are regulated, profit constraints can improve welfare and be a complement or substitute to a higher regulated price, depending on the degree of altruism.

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