Strategic quality choice and charter schools

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Abstract

Proponents of Charter schools argue that competition will improve the educational outcomes of both Charter and public students. A model of quality choice has been used to examine this claim. With capacity constraints, there is an equilibrium in which the Charter school offers a higher quality which the public school will not match. Competition from Charter schools may therefore have only modest effects on public school quality, if any. © 2002 Elsevier Science B.V. All rights reserved.

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1. Introduction

School choice is currently a hotly-debated topic in the United States. One option currently being tried is Charter schools. For the 1999–2000 school year, the Center for Educational Reform reports 1689 Charter schools in 31 states and the District of Columbia, with a total enrollment of 434 000 students. Laws governing the founding, regulation, and funding of Charter schools vary across states. Some Charter schools are for-profit institutions. Where available, students can enroll in an approved Charter school tuition free. The school receives a fixed amount per student enrolled. This presumably entails a corresponding reduction in public

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school funding. Proponents claim that the reduced regulation of Charter schools will improve educational outcomes for those who attend. The most appealing claim is that the competition provided by Charter schools will improve public schools as well.

Evidence on the effects of school competition has been mixed, due in part to the lack of data and the difficulty of dealing with selection bias. This is improving as results of experiments and innovations are gathered. Hoxby (1994) finds evidence that private school competition improves public schools. Bettinger (2001), using school-level data, finds weak evidence that Charter schools provide better schooling, but fails to find evidence that competition for students raises public school quality. Theoretical work on school quality has focused on peer effects and per-pupil spending, as opposed to modeling quality competition directly. Epple and Romano (1998) and Nechyba (2000) are recent examples examining the effects of educational vouchers in the choice between public and private schools. In these models public schools do not act strategically.

The model in this paper explores the nature of quality competition between a public school and a Charter school. The model is a variant of Gelman and Salop (1983), which follows a suggestion of Schelling (1960). In their model, the fierceness of Bertrand price competition that would follow a rival’s entry may prevent entry. However, it may be that an incumbent will not match the price cuts of a small-capacity entrant. There are several important differences. Public and Charter schools compete in quality with price fixed. It is the public school’s unwillingness to match costly quality, rather than price, which allows the entrant to survive. Second, schooling is free, so it is assumed that demand is inelastic. In some states excess demand for Charter schools is rationed by lottery (Michigan, for example), while in others schools are allowed some discretion in which students to admit (California). Both cases are considered.

The model has several interesting implications. First, if the Charter school enters without a capacity constraint there will be vigorous competition with Public school quality rising to match that of the Charter school. This seems to be the received intuition. However, such competition in the presence of sunk costs may prevent entry. Second, there might exist an equilibrium that allows the Charter school to enter: the Charter school enters the market with a low capacity and with a corresponding small improvement in quality, and the public school maintains its original quality. In this equilibrium, Public schools will raise quality in response to Charter school entry only if the reduced output lowers the marginal cost of quality.

2. A model of quality competition

An Incumbent firm, the public school, operates in a market with size normalized to one. The price, \( p \), of the good produced by the firm is fixed and is paid by an outside source. Therefore, consumers have inelastic demand for the good. The
Incumbent operates as a monopolist and has enough capacity to supply the entire market. Its only choice variable is its quality, $q$, which is constrained to lie in $[q, \bar{q}]$. The public school Administrator has preferences defined over profits and quality, as in Lakdawalla and Philipson (1998). Profits are defined as the difference between total revenues and total cost. This residual is used by the Administrator in ways that are personally beneficial but otherwise have no influence on quality. For example, the Administrator might raise salary and benefits above market levels, hire additional staff to reduce effort, and so on. Otherwise the Administrator might raise quality by increasing expenditures on facilities and equipment, by hiring more teachers to reduce class size, or by raising salaries to attract better teachers. An alternative assumption would be to make quality dependent on the Administrator’s effort level. In either case the Administrator likes quality but can only raise it at a personal utility cost. This creates potential for competition to force the Administrator to raise quality. The meaning of ‘school competition’ is not clear if we assume that the Administrator always chooses the highest feasible quality, constrained only by the available budget.

Costs, $C(q, 1)$, depend on quality alone, since output is fixed at one. In the absence of a rival the Administrator’s objective function is:

$$V(\Pi, q_i) = \Pi + U(q_i) = p - C(q_i, 1) + U(q_i)$$

where $U'(q) > 0$ and $U''(q) < 0$. Then the optimal quality $q_i^0$ is determined by

$$\frac{\partial C(q_i^0, 1)}{\partial q_i} = U'(q_i^0).$$

(1)

This means that a monopolist Administrator sets the marginal cost of quality equal to the marginal benefit, which is derived only through $U$. The Administrator need not necessarily value quality directly through $U(q)$. If not, then quality is set equal to $q$.

Suppose now that there is a single potential Entrant into the market, the Charter school. Assume that the Entrant moves first, choosing capacity $K$ and a quality $q_E$. The Incumbent observes $(q_E, K)$, then chooses its own quality $q_i$. The game is solved by backward induction, beginning with the Incumbent’s choice in the second stage. I maintain the assumptions of Gelman and Salop (1983) about consumer preferences. Namely, consumers strictly prefer the Incumbent when qualities are equal. If qualities are unequal, all consumers prefer the firm with the higher quality. The Entrant maximizes its utility $V^E(\Pi^E, q_E) = \Pi^E + U^E(q_E)$. Denote costs for the Incumbent and the Entrant $C(q_i, 1 - K)$ and $C^E(q_E, K)$, and assume that cost functions are increasing in both arguments. I also assume that $\partial C(q, 1 - K)/\partial (1 - K)|_{1 - K = 1} < p$ so that the Incumbent will always be willing to increase output. The Incumbent’s capacity is a sunk cost, but there are variable costs of output.
2.1. Quality competition with unlimited capacity

If the Entrant chooses \( K \geq 1 \), then either firm can cover the market. For any \( q_E \) chosen by the Entrant, the Incumbent can claim the entire market by matching the Entrant’s quality. If we impose the additional constraint that both firms must earn non-negative profits, then the Entrant can survive only if cost advantages enable it to offer a high \( q_E \) that the Incumbent cannot profitably match. If not, then the Entrant will not enter in stage 1. That is, the subgame perfect Nash equilibrium with identical firms has the Entrant remaining out of the market and the Incumbent supplying the market at monopoly quality, \( q^{0}_I \). Because capacity is unlimited for both firms, competition will be fierce if entry occurs, with the Incumbent matching the quality chosen by the Entrant. Anticipating this, the Entrant chooses not to enter.

For Charter schools in particular there may be differences in funding per student. In Michigan, for example, Charter schools receive only that portion of funding which comes from state and federal sources, as opposed to local sources. Let \( p_S \) be per student funds paid by state and federal sources, and \( p_L \) be local funding. This implies that public schools receive \( p_L + p_S \) per student, while a Charter school receives \( p_S \). This makes entry more difficult for the Charter school.

2.2. Quality competition with capacity constraints

Without capacity constraints competition among firms in the market is so intense that the Entrant remains out. The Incumbent is forced to match the Entrant’s quality or accept zero output. This section shows that an Entrant’s capacity constraint may soften quality competition enough to allow profitable entry. Assume that the Entrant constrains its output by setting a quality/capacity pair \((q_E, K)\) with \( K < 1 \). The Incumbent firm can now choose to Match quality, which would drive the Entrant out of the market, or it can Accommodate by conceding a market share \( K \) to the Entrant. Match utility is

\[
\Pi(q_E, 1) + U(q_E) = p_L + p_S - C(q_E, 1) + U(q_E),
\]

since the incumbent has market share 1 but operates at the quality set by the Entrant. In this case the Entrant would not enter, and the outcome is like the previous section. Utility in case the Incumbent Accommodates with quality \( q^*_I \) is

\[
\Pi(q^*_I, 1 - K) + U(q^*_I) = (p_L + p_S)(1 - K) - C(q^*_I, 1 - K) + U(q^*_I)
\]

The sequential choice and the assumption that ties go to the Incumbent simplify the equilibrium and ensure existence. Alternatively, we could assume simultaneous quality choices. In this case competition would drive both qualities up to \( \tilde{q} \), or perhaps to some level at which profits are zero. Unless we assume constant returns to scale, we will not have an equilibrium in pure strategies.
The Incumbent should Accommodate if and only if Eq. (3) \( \equiv \) Eq. (2). This means that the Entrant can induce Accommodation if there exists a pair \((q_\text{E}, K)\) such that the following holds:

\[
C(q_\text{E}, 1) - C(q_1^*, 1 - K) \equiv (p_L + p_S)K + U(q_\text{E}) - U(q_1^*) \tag{4}
\]

Recall that by assumption \(C(q_1, K)\) is increasing in its arguments. Therefore \(K\) must be chosen small enough for a given \(q_\text{E}\). If \(U(q_\text{E}) - U(q_1^*)\) is small enough, then it will be possible (though not always optimal) to induce Accommodation. It is harder to induce Accommodation when \(p_L + p_S\) is large, since this makes the Incumbent more anxious to recover the ‘lost’ market share \(K\). If the Incumbent’s costs are more convex, then Accommodation becomes easier to sustain since the difference in costs on the left side of Eq. (4) will then be larger.

Given that it chooses to Accommodate, the Incumbent chooses \(q_1\) to maximize

\[
V(\Pi, q_1) = (p_L + p_S)(1 - K) - C(q_1, 1 - K) + U(q_1).
\]

Then \(q_1^*\) will be set to solve \(\partial C(q_1^*, 1 - K)/\partial q_1 = U'(q_1^*)\), or the marginal cost of quality equal to marginal utility of quality. Compare this with the monopoly solution \((K = 0)\) given by Eq. (1). The difference is that the monopolist has higher output. Therefore, the Entrant will only affect the Incumbent’s quality choice (in case of Accommodation) if output affects the marginal cost of quality. If higher output lowers (raises) the marginal cost of quality, then the presence of the Entrant raises (lowers) \(q_1\). In the case of separable costs of output and quality, there is no effect. There is also no effect if the Entrant is unable to induce Accommodation.

Moving to the first stage, the Entrant anticipates the incumbent’s responses and chooses \((q_\text{E}, K)\) to maximize

\[
\Pi^E(q_\text{E}, K) + U^E(q_\text{E}) = p_SK - C^E(q_\text{E}, K) + U^E(q_\text{E})
\]

subject to \(C(q_\text{E}, 1) - C(q_1(K), 1 - K) \equiv (p_L + p_S)K + U(q_\text{E}) - U(q_1(K))\), where \(q_1(K)\) incorporates the Incumbent’s optimal choice in the second stage. Assuming that Eq. (4) holds with equality, \(q_\text{E}\) will be determined by the constraint as the minimum level of quality needed to induce Accommodation for any given \(K\).

First order conditions from this constrained–optimization problem reveal the following:

\[
\frac{\partial C^E(q_\text{E}, K)}{\partial q_\text{E}} - U^E(q_\text{E}) = p_L + p_S - \frac{\partial C(q_1^*, 1 - K)}{\partial q_1} + \left[ \frac{\partial C(q_1^*, 1 - K)}{\partial q_1} - U'(q_1) \right] q_1^*(K)
\]

\[
\frac{\partial C(q_\text{E}, 1)}{\partial q_1} - U'(q_\text{E})
\]
The fact that firms value quality for its own sake, reflected in the $U'(q)$ terms, affects the outcome by making each firm behave as though its marginal cost of quality were actually lower. The Entrant’s behavior allows it to appropriate $p_s K$, which costs the Incumbent $(p_L + p_s)K$. Assuming Eq. (4) holds with equality, it is easily seen that $d q_E / d K > 0$ along the constraint. That is, to maintain Accommodation, the Entrant must raise quality in order to increase capacity.

3. Comparative statics

The solution in the case of Accommodation allows for comparative statics analysis of the effects of changes in the prices $p_L$ and $p_s$ on the Charter school’s optimal capacity and quality. Assume that the Entrant choose $(K, q_E)$ and that the Incumbent Accomodates with quality $q^*_I$. Because the prices enter both the objective function and the constraint, little can be said in general about their effects on $K$ and $q_E$. Some progress can be made if we assume that firms’ utility and cost functions are identical and separable in output and quality, which means that second order mixed partials are zero. This implies that the Lagrange multiplier $\lambda^*$ equals one, and the Jacobian simplifies enough to sign some of the derivatives. The Jacobian $J$ simplifies to

$$ J = \begin{bmatrix} \frac{\partial^2 C(q^*_E, K)}{\partial K^2} - \frac{\partial^2 C(q^*_I, 1 - K)}{\partial (1 - K)^2} & 0 & -\left[ p_L + p_s - \frac{\partial C(q^*_I, 1 - K)}{\partial (1 - K)} \right] \\ 0 & 0 & \frac{\partial C(q^*_I, 1)}{\partial q_E} - U'(q_E) \\ -\left[ p_L + p_s - \frac{\partial C(q^*_I, 1 - K)}{\partial (1 - K)} \right] & \frac{\partial C(q^*_I, 1)}{\partial q_E} - U'(q_E) & 0 \end{bmatrix} $$

The desired derivatives are found by solving the following systems of equations:

$$ \begin{bmatrix} \frac{\partial K}{\partial p_L} \\ \frac{\partial q_L}{\partial p_L} \\ \frac{\partial \lambda^*}{\partial p_L} \\ \frac{\partial K}{\partial p_s} \\ \frac{\partial q_L}{\partial p_s} \\ \frac{\partial \lambda^*}{\partial p_s} \end{bmatrix} = \begin{bmatrix} \lambda^* - 1 \\ 0 \\ K \end{bmatrix} $$

and

$$ \begin{bmatrix} \frac{\partial K}{\partial p_L} \\ \frac{\partial q_L}{\partial p_L} \\ \frac{\partial \lambda^*}{\partial p_L} \end{bmatrix} = \begin{bmatrix} \lambda^* \\ 0 \\ K \end{bmatrix} $$
This reveals that an increase in $p_S$ has no effect on $K$, but raises $q_E$. An increase in $p_L$ lowers $K$ and has an ambiguous effect on $q_E$.

Return to the general problem by dropping the assumptions about cost and utility functions made above and consider the total effect of raising $p_S$ and lowering $p_L$, which would reflect the effect of a change in school funding from local to state level. This would increase Charter funding while leaving public school funding unchanged. $J$ is the same in each case, so the differences can be found by solving:

\[
\begin{pmatrix}
\frac{\partial K}{\partial p_S} - \frac{\partial K}{\partial p_L} \\
\frac{\partial q_E}{\partial p_S} - \frac{\partial q_E}{\partial p_L} \\
\frac{\partial \lambda^*}{\partial p_S} - \frac{\partial \lambda^*}{\partial p_L}
\end{pmatrix} = \begin{pmatrix}
-1 \\
0 \\
0
\end{pmatrix}
\]

This reveals that moving a dollar from local to state sources increases both $K$ and $q_E$, so a change toward greater state-level financing of schools increases both the size and quality of Charter schools. The effect on public school quality will depend on how changes in $K$ affect the marginal cost of quality, as mentioned before.

4. Non-random rationing

Every consumer strictly prefers the higher quality firm. Since capacity is constrained, the excess demand must be rationed somehow. The model above assumes random rationing of the Entrant’s excess demand. If consumers are identical, then the rationing rule won’t matter. If consumers are different in that they affect firm profitability, then the rationing rule matters.

Suppose that consumers are not identical, and that the Entrant can engage in cream-skimming to select only the highest-quality consumers. Suppose that the average quality of consumers supplied by the firm lowers costs\(^7\). Let $\theta_I(K)$ and $\theta_E(K)$ be cost parameters for the Incumbent and Entrant, respectively. $K$ is the Entrant’s market share. When $K$ is small, the Entrant supplies the good to a small number of high-quality consumers and $\theta_E(K)$ is high. As $K$ rises, $\theta_E(K)$ falls. Interestingly, $\theta_I(K)$ also falls. This is because the Entrant’s expansion of output forces it to take lower and lower quality consumers, but these same consumers are at the top of the Incumbent’s group. So raising $K$ has the same qualitative effect on both firms. Assume that $\theta_I(K)$ and $\theta_E(K)$, then, are declining functions of $K$.

\(^7\)The effects of average quality on costs was focused on. Variance might also matter.
Denote the new cost functions as \( C(q_t, 1 - K, \theta_t(K)) \) and \( C^E(q_t, K, \theta_t(K)) \), and assume that the functions are increasing in quality and output but decreasing in \( \theta_t \).

Matching profits are \( \Pi(q_t, 1) = p - C(q_t, 1, \theta_t(0)) \), and Accommodation profits are \( \Pi(q_t^*, 1 - K) = p(1 - K) - C(q_t^*, 1 - K, \theta_t(K)) \). The Accommodation set becomes

\[
\text{Accommodation quality is determined as before and solves}
\]

\[
C(q_t, 1, \theta_t(0)) - C(q_t^*, 1 - K, \theta_t(K)) \geq (p_1 + p_2)K + U(q_t) - U(q_t^*).
\]

Accommodation quality is determined as before and solves

\[
\frac{\partial C(q_t^*, 1 - K, \theta_t(K))}{\partial q_t} = U'(q_t^*)
\]

The difference between non-random rationing and the previous case is \( \theta_t(K) \). Since it is declining in \( K \), then for any \( K \) chosen by the Entrant the marginal cost of quality may be higher. It might be true, however, that \( K \) is lower than in the random rationing case. To see how the rationing rule affects the Accommodation set, note that with purely random rationing the qualities of both firms are always equal to average quality, which is the same as \( \theta_t(0) \). So for given \( p_1 + p_2 \) and \( K \), the elements of the Accommodation set are as before except for \( C(q_t^*, 1 - K, \theta_t(K)) \), which is larger since \( \theta_t(K) < \theta_t(0) \). Cream-skimming by the Entrant raises the Incumbent’s costs if it Accommodates, and therefore Accommodation will be harder for the Entrant to induce. That is, the level of quality necessary to induce Accommodation will be higher for each level of capacity.

5. Conclusion

The literature on school choice is filled with discussions of school competition, but what is meant by this is sometimes unclear. Our intuition about competition comes from simple models of price competition with fixed quality. This paper shows that attempts to translate this intuition into discussions of quality competition may be misleading. In this case, competition from a Charter school will not necessarily raise the quality of the public school. Whether Charter competition improves public schools depends on the interaction of quality and output in the cost function. An overcrowded public school might be more likely to improve if enrollment losses to a Charter school reduce its marginal cost of quality.

The results on strategic quality choice made in this paper are meant to complement those from other strands of the literature, such as peer-effects, tax effects, mobility, and so on. There are also other possible strategies to be considered. For example, schools might choose to differentiate in dimensions other than quality, such as discipline, or they might choose to specialize in particular areas such as science, the arts, or athletics. Travel costs are another consideration. These would seem to soften competition as well. A Charter school that offered the
same overall quality but with an emphasis in some area might establish a niche that the public school might ignore, perhaps because regulations prevent it from competing in that dimension.

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References