Tendering Ferry Services in Norway:
Ratchet Effects?

by

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June 1999

Abstract:

Fjord crossings by ferries are vital in the Norwegian trunk road system. The ferries are operated by ferry companies, each ferry company being a monopolist on a bundle of crossings. The government regulates prices and service frequencies and awards subsidies to the companies in order to make the ferry services economically viable. Tendering has been suggested as a means to induce cost efficiency and thus reduce costly subsidies. In order to gain experience with tendering on this area, this regime has recently been introduced on a few selected crossings. We argue that this small-scale experiment may not reveal the cost savings that may be obtained by a large-scale experiment. This is due to a ratchet effect: The incumbent ferry companies may not have the incentives to submit low tenders as by doing so, the ferry companies reveals that there is much to gain for the government by carrying through a large-scale tender competition in the future. Such a large-scale tender competition may be harmful to the companies as compared to status quo. Realising this, each company may be reluctant to submit low tenders in the competition for the selected tender crossings.

* Helpful comments and suggestions from Svein Braathen are gratefully acknowledged. Responsibility for any errors is, of course, retained by the author.

1 Introduction

Fjord crossings by ferries are vital in the Norwegian trunk road system. The ferry services are operated by ferry companies, each ferry company being a monopolist on a bundle of crossings. Prices and service frequencies are regulated by the central government. As prices are insufficient to make the services economically viable, ferry companies receive government subsidies. As there are reasons to expect that the ferry companies enjoys 'the quiet life' of being monopolists, tendering has been suggested as a means to induce cost efficiency and thus reductions in the costly subsidies. In order to gain experience with tendering on this area, this regime has recently been introduced on a few selected crossings. We argue that this small-scale experiment may not reveal the cost savings that may be obtained by a large-scale experiment. This is due to a ratchet effect: The port facilities (car gangways) requires specifically designed ferries making investments in ferries idiosyncratic. Such idiosyncratic investments may act as a barrier to entry which may prohibit potential entrants or 'outsiders' from participating in a tender competition. In that case, competition is limited to the incumbent ferry companies or the 'insiders'. However, the incumbent ferry companies may not have the incentives to submit low tenders as by doing so, the ferry companies reveals that there is much to gain for the government by carrying through a large-scale tender competition in the future. Such a large-scale tender competition may be harmful to the companies as compared to status quo. Realising this, each company may be reluctant to submit low tenders in the competition for the selected tender crossings. We analyse this by making use of a simple game-theoretic model which is presented in section 2. Section 3 through 5 analyses the game. The paper is concluded in section 6.

2 The model

Although there are several ferry companies in Norway, we will assume (for simplicity) that there are only two companies, company 1 and company 2. Company i's profits is:

$$\pi_i = \pi_{i1} + \delta\pi c_{i2} \qquad \text{(i = 1,2)}$$

where π_{i1} is the company's profit in period 1, π_{i2} is the company's profit in period 2 and δ is the discounting factor; $0 < \delta < 1$. Company i operates a share m_i of the total number of miles run per period denoted by Q. m_i is determined by history. For simplicity, we assume that there are constant returns to scale and that the cost per mile is c_i. Company i's total cost, C_i, is thus:

$$C_i = c_i m_i Q$$

Each company's cost per mile is either c^H or c^L; $c^H > c^L > 0$. Thus, there are three cases to consider:

Case 1: $c_1 = c_2 = c^H$

Case 2: $c_i = c^H$, $c_{-i} = c^L$

Case 3: $c_1 = c_2 = c^L$

Albeit a bit unrealistic perhaps, each company's cost is assumed to be common knowledge for the companies. That is, each company knows not only its own cost but also the cost of its competitor. This assumption simplifies the analysis. In order to make the analysis non-trivial, the government does not know each company's cost, only the probabilities:

$$prob(c_i = c^L) = p$$

$$prob(c_i = c^H) = 1 - p$$

where $0 < p < 1$. We assume that the companies collect the (exogenous) fares on behalf of the government. That is, the companies operate on 'gross cost' contracts in which each company receive a subsidy from the government in order to cover their costs. The government intends to minimise subsidies to the companies. Without knowing a company's true cost per mile however, the subsidy to a company must be based on the cost reported by the company provided that $c_i \leq c^H$. A company of the high-cost type will reveal truthfully its high cost since reporting a higher cost is no option and reporting a lower cost leads to a loss. By revealing truthfully a low cost, a low-cost company will not make any profits. By reporting falsely a high cost however, a low-cost company earns a profit equal to $c^H - c^L$ per mile. Thus, the government faces an incentive problem of hidden information.[1]

Suppose that the government decides to carry through a tender competition on a few selected ferry links in order to gain experience with tendering as a means to cut subsidies. Furthermore, suppose that the ferry links to be tendered constitutes a share n of the total miles run per period; $0 < n < 1$. After observing the outcome of this small-scale tender competition experiment, the government decides whether to introduce a large-scale tender competition on all ferry links or not. Entry costs are assumed to be prohibitively high so that the tender competition is between the two incumbent companies only. We consider first-price sealed bid

[1] See for instance Arrow (1986) on incentive problems.

tender competitions (or auctions). This constitutes a dynamic game. In stage 1 of the game, sometimes referred to as period 1, the two companies decide simultaneously what to bid for the tendered routes. In stage 2 of the game, the government decides whether to carry through a large-scale tender in the succeeding period or not. If the government decides to carry through a large-scale tender competition in the succeeding period, period 2, then the two companies decides their bids simultaneously in stage 3 of the game. Dynamic games are solved backwards. Thus, we start by analysing the subgame at stage 3 and then proceed by analysing the subgame at stage 2 and eventually analyse the subgame at stage 1.[2]

3 Stage 3: The large-scale tender competition

In stage 3 of the game, the government has either chosen to tender all ferry links or not. If not, then each company runs its share m_i of the total miles and the government pays a subsidy c^H per mile. If the government has decided to tender all ferry links and thus all Q miles run per period, each company must choose their bid. Each company's bid is the subsidy per mile demanded. Let b_{ij} be company i's bid in the tender competition in period j and let $b_{ij}(b_{-ij})$ be company i's optimal bid conditional on its competitors bid b_{-ij}. Furthermore, let $b_{ij}*$ denote the equilibrium strategy of company j. The tender competition is a first-price sealed bid auction. Bids exceeding c^H are rejected. In case of even bids, the ferry links are split evenly among the companies. We consider the tender competition for the three cases in turn.

<u>Case 1: $c_1 = c_2 = c^H$</u>

This subgame has a trivial solution: As bids exceeding c^H are rejected while a high-cost company would run a deficit by bidding less than c^H, the Nash equilibrium is
$b_{12}* = b_{22}* = c^H$.

<u>Case 2: $c_i = c^H$, $c_{-i} = c^L$</u>

Consider the low-cost company, company -i. Suppose that its competitor, company i, is bidding $b_{i2} > c^L$. If company -i bids $b_{-i2} > b_{i2}$, then company i wins the tender competition and $\pi_{-i2} = 0$. If company i bids b_{i2} however, that is $b_{-i2} = b_{i2}$, then the tendered ferry links are split evenly among the companies and company -i's profit in period 2 is:

[2] See for instance McAfee & McMillan (1987) for a review on auctions. Se for instance Fudenberg & Tirole (1992) on game theory.

$$\pi_{-i2} = (b_{i2} - c_i)Q/2$$

which is strictly positive for $b_{i2} > c^L$. If company -i bids $b_{i2} - \varepsilon$, $\varepsilon > 0$, then the company wins the tender competition and the company's profit in period 2 is:

$$\pi_{-i2} = (b_{i2} - \varepsilon - c_i)Q$$

If $\varepsilon \to 0^+$, then π_{-i2} approaches $(b_{i2} - c^L)Q$ which exceeds $(b_{i2} - c^L)Q/2$ for $b_{i2} > c^L$. Thus, it is optimal for a low-cost company to bid just below its competitors bid as long as the competitors bid exceeds the company's cost per mile. Concerning the high-cost competitors bid, the optimal bid is c^H as bids exceeding c^H are rejected while the company would run a deficit by bidding less than c^H. As a result, the Nash equilibrium is $b_{i2}^* = c^H$ and $b_{-i2}^* = c^H - \varepsilon$.

<u>Case 3: $c_1 = c_2 = c^L$</u>

As shown in the previous subsection, it is optimal for a low-cost company to bid just below its competitors bid as long as the competitors bid exceeds the company's cost per mile. In other words, $b_{-i2}(b_{i2} > c^L) = b_{i2} - \varepsilon$ where $\varepsilon \to 0^+$. As a result, the Nash-equilibrium in the second-period large-scale tender competition does not involve bids exceeding c^L. As companies would run a deficit if bids where below c^L, the Nash equilibrium is $b_{12}^* = b_{22}^* = c^L$.[3]

4 Stage 2: The government's decision

In stage 2 of the game, the government is to decide whether to carry through a large-scale tender competition in the succeeding period or not. It is assumed that the government is minimising its expected subsidy payment. If the government does refrain from a large-scale tender competition in period 2, the subsidy payment is:

$$ES_2 = c^H Q$$

[3] Actually, the tender competition is a Bertrand price game with exogenous demand. Se for instance Fudenberg & Tirole (1992) on Bertrand price games.

The expected subsidy payment by choosing a large-scale tender competition depends on the outcome of the small-scale tender competition in the first period. In order to make the decision non-trivial, the government incurs an administration cost A if it chooses a large-scale tender competition in period 2.

Case i: $b_{11} < c^H$, $b_{21} < c^H$

As a high cost company would run a deficit if it is bidding below c^H, it follows that:

$$prob(c_1 = c_2 = c^L \mid b_{11} < c^H, b_{21} < c^H) = 1$$

In this case, $b_{12}^* = b_{22}^* = c^L$ and the (expected) subsidy payment in period 2 is:

$$ES_2 = c^L Q$$

if the government choose to carry through a large-scale tender competition in period 2. In order to make the game non-trivial, it is assumed that the (expected) gain by choosing a large-scale tender competition in period 2 outweighs the administration cost:

$$(c^H - c^L)Q > A$$

Thus, if both companies reveals that they are of the low cost type by bidding below c^H in the small-scale tender competition in period 1, then the government will choose a large-scale tender competition with certainty.

Case ii: $b_{i1} = c^H$, $b_{-i1} < c^H$

If it is in the interest for low cost companies to reveal their true cost in the tender competition in period 1, then $prob(c_i = c^H, c_{-i} = c^L \mid b_{i1} = c^H, b_{-i1} < c^H) = 1$. In stage 3 of the game, it is shown that if there are one company of each type, $b_{i1}^* = c^H$ and $b_{-i1}^* = c^H - \varepsilon$ where $\varepsilon \rightarrow 0^+$. In this case, the (expected) subsidy payment in period 2 is:

$$ES_2 = (c^H - \varepsilon)Q$$

if the government choose to carry through a large-scale tender competition in period 2. The expected net gain by choosing a large-scale tender competition in period 2 is:

$$\varepsilon Q - A < 0$$

as $\varepsilon \to 0^+$. Thus, if it is revealed truthfully in the tender competition in the first stage that one company is of a low cost type while the other is of the high cost type, then it is optimal for the government to refrain from a large-scale tender competition. The reason is that the competition in the large-scale tender competition will be too weak for there to be sufficiently large cuts in subsidies that may outweigh the administration costs.

Suppose however that it is in the interest for one of the low cost companies to conceal that it is of a low cost type by bidding c^H in the tender competition in period 1. As prob($c_1 = c_2 = c^L$) = p^2 and prob($c_i = c^H$, $c_{-i} = c^L$) = 2p(1-p), it follows that:

$$\text{(4.1)} \qquad prob\left(c_1 = c_2 = c^L \middle| b_{i1} = c^H, b_{-i1} < c^H\right) = \frac{p^2}{p^2 + 2p(1-p)}$$

$$\text{(4.2)} \qquad prob\left(c_i = c^H, c_{-i} = c^L \middle| b_{i1} = c^H, b_{-i1} < c^H\right) = \frac{2p(1-p)}{p^2 + 2p(1-p)}$$

In this case, the expected subsidy payment in period 2 is:

$$ES_2 = \frac{p^2}{p^2 + 2p(1-p)} c^L Q + \frac{2p(1-p)}{p^2 + 2p(1-p)} (c^H - \varepsilon) Q$$

if the government choose to carry through a large-scale tender competition in period 2. As $c^H - \varepsilon \approx c^H$ as $\varepsilon \to 0^+$, the expected net gain by choosing a large-scale tender competition in period 2 is approximately:

$$\text{(4.3)} \qquad \frac{p^2}{p^2 + 2p(1-p)} (c^H - c^L) Q - A$$

It is optimal for the government to choose a large-scale tender competition in period 2 only if this expected gain is positive.

Case iii: $b_{11} = c^H$, $b_{21} = c^H$

Suppose that none of the companies reveals that it is of the low cost type, that is both companies bids c^H in the tender competition in period 1. It turns out that in this case, we may rule out that only one of the firms is of a low cost type; see stage 1 of the game. Thus, prob($c_i = c^H$, $c_{-i} = c^L \mid b_{11} = b_{21} = c^H$) = 0. This leaves us with two possibilities, that either both companies are low cost types or that both companies are high cost types. If it is in the interest for at least one the low cost companies to reveal its true cost in the tender competition in period 1, then prob($c_1 = c_2 = c^H \mid b_{11} = b_{21} = c^H$) = 1. In this case, the (expected) subsidy payment in period 2 is:

$$ES_2 = c^H Q$$

if the government choose to carry through a large-scale tender competition in period 2. The expected net gain by choosing a large-scale tender competition in period 2 is:

$$-A < 0$$

Thus, if it is revealed truthfully in the tender competition in the first stage that both companies are high cost types, then it is optimal for the government to refrain from a large-scale tender competition. The reason is of course that there is nothing to gain from a large-scale tender competition as compared to status quo as subsidies would not alter.

Suppose however that it is in the interest for both low cost companies to conceal their true (low) costs in the small-scale tender competition in period 1. As prob($c_1 = c_2 = c^L$) = p^2 and prob($c_1 = c_2 = c^H$) = $(1-p)^2$, it follows that:

(4.4) $$prob\left(c_1 = c_2 = c^L \middle| b_{11} = b_{21} = c^H\right) = \frac{p^2}{p^2 + (1-p)^2}$$

(4.5) $$prob\left(c_i = c_2 = c^H \middle| b_{11} = b_{21} = c^H\right) = \frac{(1-p)^2}{p^2 + (1-p)^2}$$

From stage 3 of the game we know that $b_{12}^* = b_{22}^* = c^L$ when both companies are of the low cost type while $b_{12}^* = b_{22}^* = c^H$ when both companies are of the high cost type. In this case, the expected subsidy payment in period 2 is:

$$ES_2 = \frac{p^2}{p^2 + (1-p)^2} c^L Q + \frac{p^2}{p^2 + (1-p)^2} c^H Q$$

if the government choose to carry through a large-scale tender competition in period 2. The expected net gain by choosing a large-scale tender competition in period 2 is:

$$\frac{p^2}{p^2 + (1-p)^2}(c^H - c^L)Q - A \tag{4.6}$$

It is optimal for the government to choose a large-scale tender competition in period 2 only if this expected gain is positive.

5 Stage 1: The small-scale tender experiment

In stage 1 of the game, the small-scale tender competition, the two companies are making their bids simultaneously. As is common in game theory, the agents are assumed to be rational forward looking.

Case 1: $c_1 = c_2 = c^H$

This subgame has a trivial solution: As bids exceeding c^H are rejected while a high-cost company would run a deficit by bidding less than c^H, the Nash equilibrium is $b_{11}^* = b_{21}^* = c^H$ in case of a large-scale tender competition in period 2.

Case 2: $c_i = c^H$, $c_{-i} = c^L$

For the low-cost competitor, the optimal bid is c^H as bids exceeding c^H are rejected while the company would run a deficit by bidding less than c^H. Thus, $b_{i1}^* = c^H$. Concerning the optimal bidding strategy for a low-cost company, it turns out that a dominant strategy is to bid just below its competitor, that is; $b_{-i1}(b_{i1}^* = c^H) = c^H - \varepsilon$ where $\varepsilon \rightarrow 0^+$. The reason is as follows: If the company does not pay attention to the future, we may apply the same reasoning as in section 3 where it was argued that it is optimal for a low-cost company to bid just below its competitor as long as the competitors bid exceeds the company's cost. If departing from this strategy is to be optimal for the low-cost company, then it must be in order avoid a large-scale tender competition in the future by concealing its low cost by bidding c^H as well. However, it is not optimal for a low-cost company to avoid a large-scale tender competition in the future.

To see this, , notice that in case of a large-scale tender competition, we know from the stage 3 game that the low-cost company wins the tender competition in period 2 and is paid a subsidy c^H - ε per mile. As the company is assigned all the ferry links, its profits in period 2 is:

$$\pi_{-i2} = (c^H - \varepsilon - c^L)Q$$

In case of no tender competition in period 2, the low-cost company is paid a subsidy c^H per mile and is assigned its share m_i of the total miles run per period. In that case, its profits in period 2 is:

$$\pi_{-i2} = (c^H - c^L)m_i Q$$

The gain from a large-scale tender competition is thus:

$$\pi_{-i2} = (c^H - \varepsilon - c^L)Q - (c^H - c^L)m_i Q \approx (c^H - c^L)(1 - m_i)Q > 0$$

as $c^H - \varepsilon - c^L \approx c^H - c^L$ as $\varepsilon \rightarrow 0^+$ and as $0 < m_i < 1$. Thus, it is optimal for a low cost company facing a high cost competitor to reveal that it is of the low cost type. The reason is that facing a high-cost competitor, a low-cost company would actually gain from a large-scale tender competition as competition will be weak. Thus, the Nash equilibrium is $b_{i1}* = c^H$ and $b_{-i1}* = c^H - \varepsilon$ in case of a large-scale tender competition.

<u>Case 3: $c_1 = c_2 = c^L$</u>

From the above it follows that there is full revelation in the case where there is one high-cost company. The same may not hold in the case where there are two low-cost companies. To see this, notice that from stage 2 of the game we know that if both companies reveal low costs by bidding below c^H, the government will carry through a large-scale tender competition in period 2 with certainty. In that case, we know from stage 3 of the game that $b_{12}* = b_{22}* = c^L$ and thus $\pi_{12} = \pi_{22} = 0$ whereas $\pi_{i2} = (c^H – c^L)m_iQ > 0$ in case of no large-scale tender competition. Thus, the two companies loose profits in period 2 if there is a large-scale tender competition and hence, the companies *may* have an incentive to conceal their low costs in the small-scale tender competition in period 1.

Subcase 3.1: Full revelation equilibrium

Suppose that both companies reveal low costs in period 1, that is; $b_{11} < c^H$ and $b_{21} < c^H$. As already noted, when both companies reveal low costs the government will choose a large-scale tender competition in period 2 with certainty. In that case, we may apply the same reasoning as in section 2 where it was argued that it is optimal for a low-cost company to bid just below its competitor as long as the competitors bid exceeds the company's cost. Thus, $b_{i1}(b_{-i1} > c^L) = b_{-i1} - \varepsilon$ where $\varepsilon \to 0^+$. By symmetry, $b_{-i1}(b_{i1} > c^L) = b_{i1} - \varepsilon$ where $\varepsilon \to 0^+$. Thus, if both low-cost companies expect there to be a large-scale tender competition in period 2, there exists no Nash equilibrium in the small-scale tender competition in period 2 in which the companies bids above c^L. As bidding below c^L is ruled out as the companies would run a deficit, the Nash equilibrium is $b_{12}^* = b_{22}^* = c^L$.

If $b_{12}^* = b_{22}^* = c^L$ is to be a Nash equilibrium however, it must not be in the interest of any company to conceal its low cost by bidding c^H in period 1: Suppose that $b_{-i1} = c^L$. If $b_{i1} = c^L$ (full revelation of low costs):

$$\pi_i = (c^H - c^L)(m_i - n_i)Q$$

while if $b_{i1} = c^H$ (no revelation of low cost) then:

$$\pi_i = (c^H - c^L)(m_i - n_i)Q$$

if there is a large-scale tender competition in period 2 and:

$$\pi_i = (c^H - c^L)(m_i - n_i)Q + \delta(c^H - c^L)m_i Q$$

if there is no tender competition in period 2. As can be seen, if concealing information (by bidding c^H in period 1) unilaterally does not prevent a large-scale tender competition, then a company has nothing to gain by bidding c^H rather than c^L. (Strictly speaking, the company has nothing to loose either as it earns no profit by participating in the tender competition in period 1). If concealing information unilaterally does prevent a large-scale tender competition however, then it is rational for a company to conceal its low costs as this increases the company's profits by:[4]

[4] Of course, if $b_{i1}=c^H$, then $b_{-i1}=c^L$ is not optimal; see subcase 3.2.

$$\delta(c^H - c^L)m_i Q$$

If a company is to prevent a large-scale tender competition in period 2 by unilaterally concealing its low cost however, it must be in the interest for the government to abstain from a large-scale tender competition. From stage 2 of the game we know that a large-scale tender competition is optimal in this case (that is; only one of the companies reveals a low cost) if:

(5.1) $$\frac{p^2}{p^2 + 2p(1-p)}(c^H - c^L)Q - A > 0$$

Thus, if inequality (5.1) is satisfied, then it is not optimal for a company to unilaterally conceal its low cost and $b_{12}* = b_{22}* = c^L$ is a Nash equilibrium of the subgame in period 1. As this equilibrium involves that both companies reveal truthfully their low costs, this is called the *full revelation equilibrium*.[5]

Full revelation equilibrium: If:

$$c_1 = c_2 = c^L$$

(5.1) $$\frac{p^2}{p^2 + 2p(1-p)}(c^H - c^L)Q - A > 0$$

then:

$$b_{11}* = b_{21}* = c^L$$

is an equilibrium in the small-scale tender competition.

The intuition behind inequality (5.1) is as follows: If full revelation of low costs is to be an equilibrium, it must not be rational for a company to unilaterally conceal its low cost. We have shown that it is rational for a company to unilaterally conceal its low cost provided that this makes the government to abstain from a large-scale tender competition in period 2. The reason is that the company by avoiding a large-scale company thus avoids a very aggressive tender competition in period 2. If the government is to abstain from a large-scale tendering in period 2 after observing that only one of the companies is of a low cost type however, the probability that both companies are of a low cost type must be sufficiently low as compared to the probability that only one of the companies is of a low cost type. If not, the expected

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[5] As the game is a dynamic game with incomplete information, the equilibrium is a perfect Bayesian equilibrium.

savings in subsidy payments by choosing a large-scale tender competition in period 2 outweighs the administration cost and the government will choose a large-scale tender competition in period 2.

Subcase 3.2: Partial revelation equilibrium

Suppose that (5.1) does not hold, that is:

$$(5.2) \qquad \frac{p^2}{p^2 + 2p(1-p)}(c^H - c^L)Q - A < 0$$

In that case, the government will abstain from a large-scale tender competition in period 2 after observing that (at least) one of the companies reveals a high cost. In that case, we have argued (in subcase 3.1) that $b_{-i1}(b_{i1}<c^H) = c^H$. As company i wins the tender competition in period 1 by bidding below c^H, the best response for company -i is not to bid c^L however. Rather, it is optimal for company i to bid just below its competitor, that is; $b_{i1}(b_{-i1}=c^H) = c^H - \varepsilon$ where $\varepsilon \to 0^+$. If $b_{i1} = c^H - \varepsilon$ and $b_{-i1} = c^H$ is to be an equilibrium, then $b_{-i1}(b_{i1}=c^H-\varepsilon) = c^H$: Suppose that $b_{-i1} = c^H - \varepsilon$ or $b_{-i1} = c^H - 2\varepsilon$. In both cases, both firms reveal their low cost and there will be a large-scale tender competition in period 2. In that case we have shown (in subcase 3.1) that it is optimal for a company to bid just below its competitor. Hence, $b_{-i1}(b_{i1}=c^H-\varepsilon) = c^H - 2\varepsilon$. In that case (that is; $b_{i1} = c^H-\varepsilon$, $b_{-i1} = c^H - 2\varepsilon$):

$$\pi_i = (c^H - c^L)(m_i - n_i)Q + (c^H - 2\varepsilon - c^L)nQ$$

while if $b_{-i1} = c^H$:

$$\pi_i = (c^H - c^L)(m_i - n_i)Q + \delta(c^H - c^L)m_i Q$$

By comparing the payoffs of these two strategies, $b_{-i1}(b_{i1}=c^H-\varepsilon) = c^H$ if:

$$(c^H - 2\varepsilon - c^L)nQ < \delta(c^H - c^L)m_i Q$$

As $\varepsilon \to 0^+$, this approximates to:

$$(5.3) \qquad n < \delta m_i$$

Thus, if inequality (5.2) and inequality (5.3) holds, then it is optimal for one low-cost company to conceal its low cost by bidding c^H in period 1 while it is optimal for its low cost competitor to bid just below c^H. As this equilibrium involves that only one of the low coast companies reveal truthfully their low cost, this is called the *partial revelation equilibrium*.

Partial revelation equilibrium: If:

$$c_1 = c_2 = c^L$$

(5.2) $$\frac{p^2}{p^2 + 2p(1-p)}(c^H - c^L)Q - A < 0$$

(5.3) $$n < \delta m_i$$

then:

$$b_{i1}^* = c^H, b_{-i1}^* = c^H - \varepsilon$$

is an equilibrium in the small-scale tender competition.[6]

The intuition behind inequality (5.2) is the opposite of that of inequality (5.1). The intuition behind inequality (5.3) is as follows: The reason that a company may find it worthwhile to conceal its true low cost, is that the loss of profits in period 2 associated with a large-scale tender competition exceeds the short run gain associated with winning the small-scale tender competition. However, if the company is discounting future profits heavily (low δ) or that the company's share of the total miles run per period (m_i) is low, the loss associated with a large-scale tender competition in the future is small. Also, if the ferry links tendered in the small-scale experiment constitutes a large share (n) of the total miles run per period, the short run gain by winning the tender competition in period 1 may be quite substantial. Thus, if n is large and/or δ and m_i is low for any company, then it would not be optimal for that company to conceal its low cost.

Subcase 3.3: The no revelation equilibrium

Suppose that inequality (5.1) holds so that the government will carry through a large-scale tender competition in period 2 after observing that (at least) one of the companies reveals a low cost. In that case, full revelation is an equilibrium while partial revelation is not an equilibrium. However, is no revelation, that is $b_{12}^* = b_{22}^* = c^H$, a Nash equilibrium?

[6] Actually, the tender competition in period 1 is a "stag-hunt" game with two equilibra rather than one unique equilibrium. In this case, both companies wants its competitor to bid c^H in period 1 of the game and thus be a "free rider".

If inequality (5.1) holds, both companies must conceal their costs in order to prevent a large-scale tender competition in period 2. Suppose that $b_{-i1} = c^H$. If no revelation is to be an equilibrium, then $b_{i1}(b_{-i1} = c^H) = c^H$. If $b_{i1} = c^H$:

$$\pi_i = (c^H - c^L)(m_i - n_i + n/2)Q + \delta(c^H - c^L)m_i Q$$

Suppose however that $b_{i1} = c^H - \varepsilon$ where $\varepsilon \to 0^+$. In that case, company i wins the tender competition in period 1 but triggers off a large-scale tender competition in period 2. In that case:

$$\pi_i = (c^H - c^L)(m_i - n_i)Q + (c^H - \varepsilon - c^L)nQ$$

By comparing the payoffs of these two strategies, $b_{i1}(b_{-i1}=c^H) = c^H$ if:

$$(c^H - \varepsilon - c^L)nQ < (c^H - c^L)\frac{n}{2}Q + \delta(c^H - c^L)m_i Q$$

As $\varepsilon \to 0^+$, this approximates to:

(5.4) $$\frac{n}{2} < \delta m_i$$

If $b_{12}^* = b_{22}^* = c^H$ is to be an equilibrium however, it must be optimal for the government to abstain from a large-scale tender competition in period 2 after observing $b_{12} = b_{22} = c^H$. In stage 2 of the game, we argued that this requires (4.6) to be negative:

$$\frac{p^2}{p^2 + (1-p)^2}(c^H - c^L)Q - A < 0$$

Combining this inequality and inequality (5.1) we obtain:[7]

(5.5) $$\frac{p^2}{p^2 + (1-p)^2} < \frac{A}{(c^H - c^L)Q} < \frac{p^2}{p^2 + 2p(1-p)}$$

[7] If (5.5) is to hold, $p < 1/3$.

Thus, if inequality (5.4) and inequality (5.5) holds, then it is optimal for both low-cost companies to conceal their low cost by bidding c^H in period 1. As this equilibrium involves that none of the low coast companies reveal truthfully their low cost, this is called the *no revelation equilibrium*.

No revelation equilibrium: If:

$$c_1 = c_2 = c^L$$

(5.5) $$\frac{p^2}{p^2 + (1-p)^2} < \frac{A}{(c^H - c^L)Q} < \frac{p^2}{p^2 + 2p(1-p)}$$

(5.4) $$\frac{n}{2} < \delta m_i$$

then:

$$b_{11}{*} = b_{21}{*} = c^H$$

is an equilibrium in the small-scale tender competition.

As the first part of inequality (5.5) is identical to inequality (5.1), the intuition is also the same. The intuition behind the second part of inequality (5.5) is as follows: In subsection 3.2 we showed that if a partial revelation of low cost is not sufficient to trigger off a large-scale tender competition in period 2, then it is optimal for one of the companies to reveal it is of the low cost type. If concealment from both companies is to be optimal then, a partial revelation must be sufficient to trigger of a large-scale tender competition in period 2. If the government is to carry through a large-scale tendering in period 2 after observing that one of the companies is of a low cost type, the (conditional) probability that both companies are of a low cost type must be sufficiently high. The intuition behind inequality (5.4) corresponds to that of inequality (5.3).

6 Conclusion

By making use of a simple game theoretic model, we have shown that a small-scale tender competition (in order to gain experience with tendering) may give a *too pessimistic* picture of the cost savings that may be obtained in a large-scale tender competition. The reason is that the incumbent companies may have an incentive to conceal their true (low) costs as this may make a large-scale tender competition less appealing to the government. By doing so, the incumbent companies may avoid a large-scale tender competition that is disadvantageous to the companies as compared to status quo. In the jargon of the theory of incentives, the agents may have an incentive to conceal their true information as revealing truthfully their information would jeopardise future information rents. In the theory of regulation, this is called a ratchet effect.[8]

A crucial assumption in our model is that there are prohibitively high entry costs so that only incumbent ferry companies participate in a large-scale tender competition. If entry costs are not prohibitively high so that the incumbent ferry companies faces the threat of entry by outsiders in a large-scale tender competition however, the optimal strategy of the incumbent companies may alter radically. The reason is that the government may decide to carry through a large-scale tender competition despite an unsuccessful small-scale tender competition as the cost savings in a large-scale tender competition may be substantial due to the entrance of outsiders. In that case, concealing their low costs in the small-scale tender competition is not an optimal strategy for the incumbent companies as there will be a large-scale tender competition anyway. In fact, it may be optimal for the incumbent companies to demonstrate rather than conceal their low costs in the small-scale tender competition. By demonstrating their low costs, the outsiders may refrain from participating in a large-scale tender competition, expecting that the competition will be too tough. Such an entry deterrence strategy may be optimal for the incumbent companies as this may soften the competition in a large-scale tender competition. If this low cost signal is to be credible however, such a strategy may in fact involve bids well below their incumbent companies true costs. In that case, the small-scale experiment gives a *too optimistic* picture of the cost savings that may be obtained in a large-scale tender competition.

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[8] Major contributions to the theory of regulation, including the ratchet effect, may be found in Laffont & Tirole (1993).

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