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REVERSING ROLES:

STACKELBERG INCENTIVE CONTRACT EQUILIBRIUM

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ABSTRACT

This analysis derives the optimal incentive contracts owners offer
managers who engage in Stackelberg-quantity competition. In contrast to the Coumot case, the owner of the leading firm motivates his manager to strictly maximize profits and thereby gives no incentives for increased production. This results in a reversal of the usual Stackelberg outcome; output and profits for the leading firm are less than those of the followe"'s. In another reversal of the standard Stackelberg result, the leade"'s output and profits are lower compared to when outputs are chosen simultaneously whereas the followe"'s are greater. While the owner of the leading firm then wants his manager to engage in simultaneous quantity competition, the manager always chooses to be a leader irrespective of his incentive contract.

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INTRODUCTION

The separation

not occur in a duopoly setting.
Stackelberg equilibria compares favorably with Coumot equilibria
conceptually. With a general downward-sloping demand function, Robson [1990] proves under mild conditions that Stackelberg equilibria exists in pure strategies whereas Coumot equilibria need not exist (see McManus [19641 or Roberts and Sonnenschein [1977]).
Although incentive contracts and leadership individually confer advantages upon the firm, it is not clear whether in combination such an advantage would be sustained. For example, incentive contracts enable an owner to strategically act like a Stackelberg leader relative to his rival's manager. When his manager is the de-facto leader in a Stackelberg setting, the owners ability to strategically use incentive contracts to increase sales may become quite limited. Thus, we may expect significant differences in a model with sequential output and incentive contracts in comparison with the incentive contract equilibrium for the Cournot model.
This paper examines the equilibrium incentive contracts when Stackelberg-quantity competition takes place. It is shown that, in contrast to the Coumot-quantity game, the leader's owner will motivate his manager to strictly profit maximize, thereby providing no incentives for increased production. As a result, the manager of the leading firm acts like the usual Stackelberg leader. In contrast, the follower's owner provides greater incentives for increased sales. By motivating his manager to produce more output, he strategically induces the leader's manager, who is aware of the rival manager's incentives, to produce less. The equilibrium results in a reversal of the usual Stackelberg outcome. When the firms' cost functions are comparable, the follower's output exceeds that of the leader's. Consequently, the leading firm's profits are strictly less than the follower's. The leader is worse off relative to the follower. Rather than confering

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an advantage, the ability to produce first has proven detrimental to the leader's owner. The leading firm's output and profits are also strictly less than its output and profits under Coumot competition with optimal incentive contracts, while the follower's are strictly greater.
Since the profits of the leading firm's owner would increase if his firm
produced simultaneously instead of first, he has an incentive to induce his f83s 0 Td (his )Tj 0.019 0Tc 1.609997.106 0 Td_6s, output his

managers to give to profits is represented by 01 E 9l , j = 1 , 2. Thus firm jts manager will seek, by the appropriate choice of output, qi, to maximize
OJ = O11tj + (1 - O1)Sj, i = 1, 2. (1)
This is the same class of contracts specified in F & J.
The cost function of each firm, C(Qj) = Cjqj, i = 1,2, has constant marginal
cost where Cj is the unit cost of firm i. Both firms' costs are common knowledge. We assume, for ease of exposition, that c1 = ~ = c. However, our results are

1's manager afterwhich firm 2's manager chooses <12. Price then adjusts to clear the market, the managers are paid

[a - c( 4 - 2(1) + u2c][ a - 2up + u2c ]j8b if u1 < tJ. 1 and u2 < (j.2
t~(al'~)· [a-upf/4b ifu1<{j.1andu2~1l2 (8) o if u1 ~ /).1 all U2
[a - c( 4 - ( 2) +

choose an <lj less than unity which shifts their best response functions out to

. f and .~. This causes the equilibrium to shift from A to B. Note that both

firm's outputs have increased since managers act as if <ljci is the marginal cost of production.
In the standard Stackelberg game without incentive contracts, firm 1, the
leader, preemptively expands its production beyond the Coumot level. This causes the follower, firm 2, to produce less than its Coumot equilibrium output resulting in the Stackelberg equilibrium C. When incentive contracts are introduced into the Stackelberg setting, the leader's owner offers his manager a profit maximizing contract so that there is no change in the best response function. Thus the leader's best response function in this game, yfi, is the same as his Coumot best response function, ,~. Since firm 2's owner chooses a lower value for ~ in the Stackelberg game compared to the Coumot game, his manager has increased incentives to expand output causing the follower's best response function to shift out past .~ to .~. By virtue of his being a leader, firm

1 again produces at a point off his best response function .r and Stackelberg

incentive equilibrium occurs at 0 where firm 1's profits are lower than at the other equilibria. Firm 2 has more than completely offset firm 1's leadership advantage. Followers do better with incentive contracts than do leaders.
A comparison of the equilibria for different games is provided in Table 1. It
is still true that price at the Stackelberg incentive equilibrium is below that at the Coumot incentive equilibrium, as is the case without incentive contracts. The Coumot incentive equilibrium price is (a + 4c)/S, whereas the Stackelberg incentive equilibrium price is lower at (a still different

to standard Coumot competition.

TABLE 1

Type of q1 CJ2 1tl 1t2 P

Com~tition

Coumot (a-c)13b = (a-c)13b (a-c)2I9b = (a-c)2I9b (a+2c)/3 Stackelberg (a-c)/2b > (a-c)/4b (a-c)2I8b > (a-c)2/16b (a+3c)/4 Coumot (a-c)/2.Sb = (a-c)/2.Sb (a-c)2/12.Sb = (a-c)2/12.Sb (a+4c)/S Incentive

Stackelberg (a-c)13b < (a-c)/2b (a-c)2/18b < (a-c)2/12b (a+5c)16 Incentive

MANAGER'S EQUILIBRIUM BEHAVIOR
Far from being beneficial, the

construct an incentive structure that will motivate his managa4.453 0 (his )Tj Tc 4.453 ructure

(a - 2a2c + ap)/3b
q2(a1,a2) - (a- a2c)/2b

o

if a2 < !J.~ and a1 <

cases require the owner to have extensive knowledge of the market. This familiarity is probably unlikely since it can only be attained by actively managing the firm, a task the owner hires a manager to do for him. In addition, it is not clear that one could specify such a penaJty in a contract or that the contract would be enforceable if such a clause were specified.

CONCLUDING REMARKS

When one manager can preemptively commit to a rate of production, the follower will resort to incentive contracts to strategically offset the inherent disadvantage from producing second. This reverses the outcome of the standard Stackelberg setting. In Stackelberg incentive equilibrium the follower's production and profit exceed the leader's. In addition, the leader's output and profit's are less than at the Cournot incentive equilibrium. Industry output is greater and price and industry profits are lower compared to the Cournot incentive equilibrium of F & J. The combination of leadership and incentive contracts produces a first-mover disadvantage.
This raises questions concerning the motivations for having a firm be a
leader. Our analysis, however, has focused only on the output decision of the firm. A firm may also compete with other firms through research and development, advertising, product differentiation, product quality, store location and other instruments. Strategic use of these decision variables may make it advantageous for a firm to produce first. Alternatively, it may simply be an institutional feature of an industry that one firm is the leader. Since expectations are fulfilled in equilibrium, this will be an industry eqUilibrium if all firms expect the firm to lead. Our model has revealed that being a leader may be disadvantageous. The leading firm, therefore, may want to change the institutional arrangement of the industry.

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Others papers have also

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FOOTNOTES
1 . If both managers try to produce the Stackelberg leader's output simultaneously, Stack:elberg warfare rather than Coumot competition results. A manager's Stack:elberg warfare compensation is less than either Coumot, leader or follower compensation, but leader compensation strictly exceeds Coumot or follower compensation. The only equilibrium that can emerge, therefore, is one in which one manager is the leader. Given that one manager produces first, the other manager prefers to follow

of manager's opportunity costs equivalent to maximizing only expected profits. The 0i result from the owners optimal choice of a'S and then the Ai's and Bi's are choosen to guarantee M. For more discussion of this point see F & J.
5. like F&J, we assume these contracts are common knowledge. Third party verification enables owners to credibly signal the contents of their manager's
contract. The recently proposed SEC requirement that compensation packages
be disclosed would enhance this verification. In addition, as we will show, an
owner has an incentive to truthfully reveal his manager's incentive contract. For
these reasons, we believe the assumption that <11 and ~ are commonly known is reasonable.

6. Even when the leader's costs are w33d60.022.657 0 Td (when mption ) hi6 lowerb1.922 0 36 11.3 2ec1.3395 0 0 cos32t o a

outcome will result. Since firm 2's profits will be less than those at the Stackelberg incentive equilibrium, it is in owner 2's interest to truthfully and credibly reveal ~.
8. This result holds when firms have different costs so long as each firm's
equilibrium output is positive.
9. George Mailath used the same extensive form to analyze the endogenous
sequencing of firm decisions (Mailath,G. [1988]).
10. If the owner knew the parameter b when the market cleared, he could
determine whether his manager had produced Coumot or Stackefberg output and punish accordingly.

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Figure 1

Stackelberg, Stackelberg Incentive Contract. Coumot. and Coumot Incentive Contract Equilibria

q~i
q~

q~ 'V~ q~ (

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