UNIVERSITÀ DEGLI STUDI DI ANCONA
DIPARTIMENTO DI ECONOMIA

MANAGERIAL INCENTIVES AND COMPETITION WITH FULLY STRATEGIC PRINCIPALS: COMMENTS ON RAITH

DOMENICO SCALERA & ALBERTO ZAZZARO

QUADERNO DI RICERCA n. 213

QUADERNI DI RICERCA

UNIVERSITÀ POLITECNICA DELLE MARCHE

DIPARTIMENTO DI ECONOMIA

MANAGERIAL INCENTIVES AND COMPETITION WITH FULLY STRATEGIC PRINCIPALS: COMMENTS ON RAITH

DOMENICO SCALERA & ALBERTO ZAZZARO

QUADERNO DI RICERCA n. 213

Luglio 2004

Managerial Incentives and Competition with Fully Strategic Principals: Comments on Raith

Domenico Scalera
Università del Sannio

Alberto Zazzaro*
Università Politecnica delle Marche

Abstract: We present a solution for a three stage spatial competition model that does not require restrictive assumptions on price expectations. This allows us to generalize the Raith (2003) model to the case where principals behave in a fully strategic fashion both in the price and in the compensation stage. Since managerial incentives are strategic complements, optimal managerial compensation is lower than in Raith while prices and expected profits are higher. In addition, fully strategic principals involve three surprising, but ultimately intuitive, implications: managerial incentives are higher under price regulation than competition; prices may increase with the number of firms; and consumer welfare may diminish in response to increasing competition.

JEL code: D43, L11, L13

Keywords: Product differentiation, competition, managerial incentives.

* Corresponding author: Alberto Zazzaro, Università Politecnica delle Marche, Dipartimento di Economia, Piazzale Martelli 8, 60121 – Ancona (Italy), Tel.: +39-071-2207086; Fax.: +39-071-2207102; e-mail: albertoz@dea.unian.it. We wish to thank Antonio Ciccone for helpful comments.

In an interesting article published in the September 2003 issue of the American Economic Review, Michael Raith returns to the long-debated question of the influence of product market competition on managerial incentives[1]. Raith presents a model of differentiated product market *à la* Salop (1979), with cost uncertainty and separation between firm ownership and control. Each firm is headed by a manager whose effort reduces marginal costs. Realized cost is assumed to be verifiable and contractible. Principals provide incentives to managers to exert effort through compensation. Managerial compensation is given by a fixed salary plus a piece rate that depends linearly on the observed cost reduction but does not vary with the produced quantity. The manager's compensation is set by the principal after the entry decision and before the price game among competitors takes place. Within this analytical framework, Raith studies the effects of three fundamentals of competition (product substitutability, market size, and the cost of entry) on managerial incentives both under a given market structure and in a free entry market regime.

Formally, Raith (2003) adds a cost reduction stage to an otherwise standard Salop model of competition on a circle[2]. This apparently straightforward extension leads to considerable additional complexities when solving for equilibria. Specifically, in solving the model by backward induction (starting with the price setting game), one has to consider that a firm, when choosing the price of its own product, knows that the prices of its immediate competitors will be affected by its cost reducing action. In turn, this price change will affect the price of the second-nearest competitors, whose changes will affect the price of the third-nearest competitors and so on, until the prices of all firms have changed. This implies that the optimal cost reducing strategy of fully strategic principals would take into account the "trickle-around" effect on all the other competitors' prices. As a consequence, even in the

[1] On this matter, a classical reference is Hart (1983). More recent contributions are Hermalin (1992), Martin (1993), and Schmidt (1997). For empirical evidence, see Nickell (1996).

[2] Several contributions have dealt with cost reducing investments in models of R&D and innovation under Cournot and Bertrand competition. Amongst others, see Dasgupta and Stiglitz (1980), Spence (1984), Qiu (1997) and Boone (2000). For a comprehensive survey see Vives (2004).

case of symmetric equilibrium, prices cannot be determined before deriving the optimal cost reducing action.

To simplify the problem, Raith assumes that all firms have identical expectations on prices of their neighboring competitors. Put differently, Raith assumes that principals assume that the expected prices of their neighboring competitors are not affected by their cost reducing action. This assumption allows Raith to solve the price game easily. However, by neglecting the effect of the cost reducing action on competitors' price, Raith implicitly assumes that principals do not act strategically vis-à-vis their two nearest competitors. This leads to an overestimate of managerial incentives, as principals do not take into account that an increasing piece rate not only reduces their own costs but also brings about a reaction of competitors who in turn increase their piece rate and reduce their costs and prices.

In this paper we show that a solution of the three stage Salop model proposed by Raith can be obtained without eliminating fully strategic behavior by the principals. Compared to the Raith solution, ours is characterized by lower managerial incentives, and higher average prices and expected profits. Moreover, our model presents three important and surprising implications. First, unlike what is commonly believed, managerial incentives prove higher in a regime of price regulation than in competition both in the short and long run, since regulation, by imposing a price, deprives managerial compensation of any strategic role for competition on the product market. Second, prices may not to be monotonically decreasing in the number of incumbent firms. In other words, it is possible that the optimal price reaches its minimum when profits are still positive. This leads to the third implication. When new firms enter the market, consumers may experience a reduction in welfare due to increasing prices.

I. The model

In this section we present a simplified version of the Raith (2003) model with risk neutral agents[3]. For the sake of comparison, when possible, we use the same notation as Raith.

Like Raith, we consider a horizontally differentiated product market populated by n firms supplying symmetric varieties $z_i = i/n$ at prices p_i, with $i = 1, \ldots, n$, and hy a continuum of consumers of measure m uniformly distributed on the product space represented by the unit circle.

Firms are owned by principals and conducted by managers. Marginal production costs are decreasing with the effort exerted by managers e_i, and depend on the realization of a normally distributed random variable u_i, whicb has zero mean and finite variance (σ^2):

(1) $$c_i = \bar{c} - e_i - u_i$$

Realized costs are firms' private information but are verifiable by a court and, therefore, contractible. To provide an incentive for managerial effort, eacb firm (principal) offers its manager a compensation that varies with the observed cost reduction, which may be expressed as follows:

(2) $$w_i = s_i + b_i(\bar{c} - c_i)$$

where s_i is a fixed salary and b_i is the marginal cost reduction piece rate. Assuming that exerting effort generates a quadratic utility cost to risk-neutral managers, the optimal level of effort is obtained by maximizing the expected utility $E(w_i) - ke_i^2/2$ and is equal to:

(3) $$e_i^* = \frac{b_i}{k}$$

The fixed salary paid by principals is such that, given the optimal managerial effort, the expected utility of managers is exactly equal to their reservation utility. If this is normalized to zero, the salary is therefore:

(4) $$s_i = -\frac{b_i^2}{2k}.$$

Substituting (3) and (4) in (2), we have:

(5) $$w_i = \frac{b_i^2}{2k} + b_i u_i .$$

Each consumer buys one unit of good at most, whatever its price, provided that the surplus she derives from her purchase is nonnegative. Let a be the utility arising from consuming one unit of the most preferred good and t the consumers' preference for variety (or the transport cost). The surplus that a consumer whose most preferred variety is x derives from purchasing variety z_i is:

(6) $$V_i(x) = y + a - p_i - t(z_i - x)^2,$$

where $t(z_i - x)^2$ measures the disutility of the distance between the purchased variety and the preferred one, assumed to be quadratic.

Consumers choose their favored variety to maximize surplus, subject to the rationality constraint $V_i(x) \geq 0$. Given the assumption of symmetric varieties, the marginal consumers (i.e., those who are indifferent between two neighboring varieties z_i and z_{i+1}) from the right x^- and from the left x^+ are respectively characterized by the ideal varieties $x^- = \frac{2i-1}{2n} + \frac{n(p_i - p_{i-1})}{2t}$ and $x^+ = \frac{2i+1}{2n} + \frac{n(p_{i+1} - p_i)}{2t}$.

Like Raith, to keep the model tractable we restrict the analysis to the case in which, in equilibrium, every firm i believes it has to compete only with its closest neighbors. This belief is sensible when the variance of cost shocks is sufficiently small that each firm can exclude almost with certainty (i.e. with probability higher than 0.999) the possibility of its marginal cost being so low as to capture all of its neighbor's clients. Considering that firm i does not know its neighbors' costs, this amounts to making:

[3] The Raith model allows for risk averse managers. The simplification made here does not affect any of the results of this paper and is made only to avoid more cumbersome notation.

ASSUMPTION 1: $\sigma^2 < t^2/3\bar{n}^4$

where $\bar{n} = am/F$ is the largest conceivable equilibrium number of firms, with F are fixed costs of entry[4].

If a is sufficiently high to allow all consumers to buy one unit of good, firm individual demand is:

(7) $$q_i = \frac{m}{n} + \frac{mn(p_{i+1} + p_{i-1} - 2p_i)}{2t},$$

while profits are:

(8) $$\pi_i = \left[p_i - \bar{c} + \frac{b_i}{k} + u_i \right] \left[\frac{m}{n} + \frac{mn}{2t}(p_{i-1} + p_{i+1} - 2p_i) \right] - \frac{b_i^2}{2k} - bu_i - F$$

Firms take part in a sequential three stage game. In the first stage, each firm decides whether to enter the market. In the second and third stage firms simultaneously choose piece rate and price. The solution is a sub-game perfect Nash equilibrium.

II. Equilibrium

Consider the price sub-game first. At this stage, firms have already stated their compensation strategy and observed their own actual cost. However, since each firm does not know the actual cost of its competitors, in order to choose the price strategy, it has to consider expected demand. Substituting the expected value of (7) into (8) and maximizing with respect to p_i yields the reaction function of firm i:

(9) $$p_i = \frac{t}{2n^2} + \frac{E(p_{i-1})}{4} + \frac{E(p_{i+1})}{4} + \frac{c_i}{2}$$

[4] The highest possible price coincides with the utility of consuming the preferred variety a. Therefore, expected profits are zero when $\bar{n} = am/F$.

To find the vector of equilibrium price, we take expectations on (9), and solve the system[5]:

(10) $$\mathbf{\Lambda E(p)=y}$$

where:

$$\underset{(n\times n)}{\mathbf{\Lambda}}=\begin{bmatrix} 1 & -1/4 & 0 & 0 & 0 & 0 & .... & -1/4 \\ -1/4 & 1 & -1/4 & 0 & 0 & 0 & .... & 0 \\ 0 & -1/4 & 1 & -1/4 & 0 & 0 & .... & 0 \\ 0 & 0 & -1/4 & 1 & -1/4 & 0 & .... & 0 \\ .... & ..... & ..... & ..... & ..... & ..... & .... & ..... \\ .... & .... & .... & .... & .... & .... & .... & .... \\ -1/4 & 0 & 0 & 0 & .... & 0 & -1/4 & 1 \end{bmatrix}; \text{ and } \underset{(n\times 1)}{\mathbf{y}}=\begin{bmatrix} \frac{1}{2}\left(\frac{t}{n^2}+\bar{c}-\frac{b_1}{k}\right) \\ ..... \\ ..... \\ \frac{1}{2}\left(\frac{t}{n^2}+\bar{c}-\frac{b_i}{k}\right) \\ ..... \\ ..... \\ \frac{1}{2}\left(\frac{t}{n^2}+\bar{c}-\frac{b_n}{k}\right) \end{bmatrix}$$

Recalling from (9) that $p_i = E(p_i)-u_i/2$, the equilibrium price vector is given by:

(11) $$\mathbf{p=\Lambda^{-1}y-\frac{1}{2}u}$$

where $\mathbf{u}$ is the column vector of cost shocks.

Matrix $\mathbf{\Lambda}$ is a symmetric circulant Leontief matrix. As a Leontief matrix, $\mathbf{\Lambda}$ is positive definite and invertible, so that system (11) admits solution. The inverse $\mathbf{\Lambda^{-1}}$ is in turn symmetric and circulant and all its elements are nonnegative. Thus, we can state the following lemma.

LEMMA 1:

[5] Here Raith assumes that $E(p_{i-1})=E(p_{i+1})=E(p)$ and then solves for symmetric equilibrium imposing $p_i=E(p)$. This implicitly amounts to assuming the symmetry of the piece rate action, right from the price stage. Thus, he can write firm i profits as a function of its piece rate only (see Raith's equation (A4), p. 1433), unlike our equation (13), in which profits depend on the piece rates chosen by all the competitors.

Let λ^{ij} be a generic element of matrix $\mathbf{\Lambda^{-1}}$. For any value of n, the following properties hold: (1) $\lambda^{ii}>1$ for any i; (2) $\sum_j \lambda^{ij}=1/\sum_j \lambda_{ij}$ for any i; (3) $0\le\lambda^{ij}<1$ for any i and $j\neq i$; (4) $\lambda^{i-1,i}=\lambda^{i+1,i}$ for any i.

PROOF:

Property 1 derives from the fact that positive definite matrices have $\lambda^{i,i}\ge 1/\lambda_{ii}$, with equality if and only if $\lambda_{ii}=0 \quad \forall j\neq i$ (see Rao (1973), page 74, property 20.2). In our case clearly $\lambda_{ii}=1$, $\lambda_{ij}\neq 0$ for $j=i\pm 1$ and $\lambda_{ij}=0$ otherwise, so that $\lambda^{i,i}>1$. To prove property (2), consider a generic row of matrix $\mathbf{\Lambda}$, say, without loss of generality, the first row. Multiplying by $\mathbf{\Lambda^{-1}}$, one gets the system

$$\begin{aligned} &\lambda_1\lambda^1+\lambda_2\lambda^n+...+\lambda_{n-1}\lambda^3+\lambda_n\lambda^2=1 \\ &\lambda_1\lambda^2+\lambda_2\lambda^1+...+\lambda_{n-1}\lambda^4+\lambda_n\lambda^3=0 \\ &..... \\ &\lambda_1\lambda^n+\lambda_2\lambda^{n-1}+...+\lambda_{n-1}\lambda^2+\lambda_n\lambda^1=0 \end{aligned}$$

where λ_j and λ^j are respectively the *j-th* element of the first row of $\mathbf{\Lambda}$ and $\mathbf{\Lambda^{-1}}$. By summing by column, one obtains:

$$\lambda_1\sum\lambda^j+\lambda_2\sum\lambda^j+...+\lambda_{n-1}\sum\lambda^j+\lambda_n\sum\lambda^j=1$$

hence:

$$\sum\lambda^j=1/\sum\lambda_j .$$

In our specific case, $\sum\lambda_j=1/2$ whence $\sum\lambda^j=2$. Recalling that $\mathbf{\Lambda^{-1}}$ has only nonnegative elements, property (3) follows from (1) and (2), whereas property (4) follows from the fact that $\mathbf{\Lambda^{-1}}$ is symmetric and circulant.

On the basis of Lemma 1, the equilibrium price charged by firm i is:

(12) $$p_i = \frac{t}{n^2} + \bar{c} - \frac{1}{2k}\lambda^i \mathbf{b} - \frac{u_i}{2}$$

where λ^i denotes the i-th row of matrix Λ^{-1} and $\mathbf{b}$ is the (column) vector of the managerial bonus rates $(b_1, b_2, ..., b_n)$.

Moving to the second stage, each firm sets the piece rate for its manager by maximizing the expected profits under the optimal price strategy (12). Substituting (12) into (8) and taking expectation on it we obtain:

(13)

$$E(\pi_i) = \left[\frac{t}{n^2} + \frac{b_i}{k} - \frac{1}{2k}\lambda^i \mathbf{b}\right]\left[\frac{m}{n} + \frac{mn}{2t}\left(-\frac{1}{2k}\lambda^{i+1}\mathbf{b} - \frac{1}{2k}\lambda^{i-1}\mathbf{b} + \frac{1}{k}\lambda^i \mathbf{b}\right)\right] + \frac{nm}{4t}\sigma^2 - \frac{b_i^2}{2k} - F$$

As in Raith, in order to get strict concavity of expected profits (13) in b_i, we assume that the disutility parameter of managerial effort is sufficiently high. Specifically:

ASSUMPTION 2: $k > \frac{m\bar{n}}{t}\left(1 - \frac{\lambda^{i,i}}{2}\right)\left(\lambda^{i,i} - \lambda^{i-1,i}\right)$

Then, deriving (13) with respect to b_i and setting $b_i = b^*$ for any i, we get the symmetric equilibrium managerial bonus rate. In particular, by recalling properties (2) and (4) of Lemma 1, we have:

(14) $$b^* = \left(1 - \frac{\lambda^{i-1,i}}{2}\right)\frac{m}{n} = \left(1 - \frac{\lambda^{i-1,i}}{2}\right) b^{Raith}$$

where the second equality is obtained by comparing the first equality of equation (14) with equation (5) in Raith (p. 1428), in the case of managers' risk neutrality.

Substituting (14) back in (12) and (13), we get the symmetric equilibrium price and expected profit:

(15) $$E(p)^* = \frac{t}{n^2} + \bar{c} - \frac{m}{nk}\left(1 - \frac{\lambda^{i-1,i}}{2}\right) = E(p)^{Raith} + \frac{m}{nk}\frac{\lambda^{i-1,i}}{2}$$

(16) $$E(\pi_i)^* = \frac{mt}{n^3} + \frac{nm}{4t}\sigma^2 - \frac{m^2}{2kn^2}\left(1 - \frac{\lambda^{i-1,i}}{2}\right)^2 - F = E(\pi_i)^{Raith} + \frac{m^2}{2kn^2}\lambda^{i-1,i}\left(1 - \frac{\lambda^{i-1,i}}{4}\right)$$

where, as before, the second equalities are obtained by comparison with equation (4) and (6) in Raith (p. 1428) respectively. Therefore:

RESULT 1:

There exists a unique symmetric sub-game perfect Nash equilibrium in piece rates and prices given by (14) and (15). Compared to Raith's solution, piece rates chosen by firms are strictly lower, while prices and expected profits are strictly higher.

PROOF:

Result 1 straightforwardly descends from property (3) of Lemma 1, for which $0 \le \lambda^{i-1,i} < 1$.

The intuition behind Result 1 is simple and lies in the strategic content of the piece rate choice. Like prices, also piece rates are strategic complements: if a firm increases incentives for its own manager, other firms do so as well, in order not to lose market shares. As a consequence, the profitability of higher incentives is reduced, compared to the case in which this interaction is neglected.

So far the analysis has been carried out for a given number of firms. To move to an endogenous market structure, we must take into account that the matrix Λ^{-1} changes over n. However, from numerical computations (see Table 1) we note that $\lambda^{i,i}$ and $\lambda^{i-1,i}$ are only slightly decreasing with n and approximately constant for $n \ge 6$. Thereafter, to keep the

analysis tractable, we assume that expected profits for $n=6$ are strictly positive. This amounts to making:

ASSUMPTION 3: $E(\pi_i)^*_{|n=6} > 0 \Leftrightarrow F < \frac{m}{2}\left(\frac{t}{108} + 3\sigma^2 - \frac{0.02m}{k}\right)$.

Table 1. Numerical computations on elements of the matrix Λ^{-1}.

N	$\lambda^{i,i}$	$\lambda^{i-1,i}$
3	1.2	0.4
6	1.156	0.311
7	1.155	0.309
15	1.155	0.309
300	1.155	0.309

Given Assumptions 2 and 3, it is easy to verify that, like in Raith, expected profits decrease when the number of incumbent firms rises[6]. This implies that his Propositions 4 and 5 remain qualitatively unaltered. Specifically, from (16), the zero profit equilibrium number of firms increases with market size and decreases with product substitutability and the cost of entry[7]. Therefore, when n is endogenously determined by the free entry condition, the influence of market competition on managerial incentives depends on the specific fundamental of competition that one is considering: equilibrium piece rates are higher in

[6] The derivative of (16) with respect to n may be written as $\frac{\partial E(\pi_i)^*}{\partial n} = m\left(\frac{\sigma^2}{4t} - \frac{t}{n^4}\right) + \frac{m}{n^3}\left[\frac{m}{k}\left(1 - \frac{\lambda^{i-1,i}}{2}\right)^2 - \frac{2t}{n}\right]$. The first term is negative due to Assumption 1. Moreover, numerical computations indicate that $\left(1 - \frac{\lambda^{i,i}}{2}\right)\left(\lambda^{i,i} - \lambda^{i-1,i}\right) = \frac{1}{2}\left(1 - \frac{\lambda^{i-1,i}}{2}\right)^2$, so that due to Assumption 2 the second term is negative too.

larger markets and in markets with more substitutable products, but lower with lower entry costs[8]. However, when piece rates are chosen strategically, the effect of a change in the competitive factors on managerial incentives is quantitatively less pronounced than in the Raith case.

III. Three implications

Beside the effects on managerial incentives, prices and profits, the strategic choice of the piece rate has some relevant and unexpected implications on: A) The relationship between regulation and incentives; B) Price dynamics; C) Social welfare.

A. *Managerial incentives under price regulation*

Under price regulation, the choice of piece rates loses its strategic content just because prices are fixed by the regulator. Therefore, managerial incentives to exert effort tend to be higher than under competition. In particular, one can easily derive:

RESULT 2:

For a given market structure, under price regulation the incentive to managers is higher than under competition, and exactly equal to Raith's equilibrium piece rate. With an endogenous market structure this result may still hold unless the regulatory price is set at a sufficiently high level, i.e. unless $\bar{p} > E(p_i)^* + \frac{n^2}{4t}\sigma^2 - \frac{m}{2kn}\left(\frac{\lambda^{i-1,i}}{2}\right)^2$.

PROOF:

[7] For a formal proof, see Raith (2003, p. 1434).
[8] For a formal proof, see Raith (2003, p. 1434).

Let $\bar{p}$ be the regulatory price. Firm's expected profits are: $E(\pi_i)=\left[\bar{p}-\bar{c}+\frac{b_i}{k}\right]\frac{m}{n}-\frac{b_i^2}{2k}-F$. Maximizing this expression with respect to b_i we have $b^{**}=\frac{m}{n}=b^{Raith}$. Therefore, for a given number of firms, $b^{**}>b^{*}$. Substituting b^{**} into expected profits we have $E(\pi_i)^{**}=[\bar{p}-\bar{c}]\frac{m}{n}+\frac{m^2}{2kn^2}-F$. With an endogenous market structure, incentives under regulation can be lower than under competition only if the equilibrium number of firms is higher. This happens if $E(\pi_i)^{**}>E(\pi_i)^{*}=0$, i.e., if $\bar{p}>E(p_i)^{*}+\frac{n^2}{4t}\sigma^2-\frac{m}{2kn}\left(\frac{\lambda^{i-1,i}}{2}\right)^2$ holds.

The intuition for Result 2 is similar to that of Result 1. As under regulation prices are no longer a strategic variable, when choosing pieee rates, firms keep into account only the effect on managers' effort to reduce their own costs. This implies that under a given market structure, firms pay larger incentives to their managers. However, with an endogenous market structure, if the regulatory price is sufficiently high to involve a sufficiently larger (zero profits) number of firms and smaller individual market shares, managerial incentives may be lower than in a free-market regime.

B. *Price dynamics*

Equilibrium prices defined by (15) clearly resemble the corresponding prices in Salop (1979). However, the fact that part of fixed costs (i.e., managerial compensation) are endogenously chosen by firms and are decreasing with n makes the sign of the dependence of prices on the number of firms ambiguous. This implies that, given the market structure, one cannot rule out the possibility that new entries may lead to increasing prices. Moreover, even when the

market structure is endogenous, equilibrium expected prices may increase along with the equilibrium number of firms.

RESULT 3:

Let $\underline{n}^{p}=\arg\min_{n} E(p)^{*}$ *. For a given market structure, if entry costs are sufficiently small and market size and product substitutability sufficiently large, the entry of new firms may increase equilibrium expected prices. In the case of an endogenous market structure, as long as* $\underline{n}^{p}<n^{*}$ *, any increase in market size and decrease in product substitutability and entry costs raises equilibrium expected prices.*

PROOF:

To prove the first part of Result 3, we consider the derivative of (15) with respect to n, that is $\frac{\partial E(p_i)^{*}}{\partial n}=-\frac{2t}{n^3}+\frac{m}{kn^2}\left(1-\frac{\lambda^{i-1,i}}{2}\right)$. Setting this equal to zero, we find the minimal[9] optimal price number of firms $\underline{n}^{p}=\frac{kt}{m}\frac{4}{(2-\lambda^{i-1,i})}$. Substituting this expression in (16), we have $E(\pi_i)^{*}_{n=\underline{n}^{p}}>0$ if $\frac{m^4}{64k^3t^2}\frac{\lambda^{i-1,i}}{2}(2-\lambda^{i-1,i})^3+\frac{k\sigma^2}{2-\lambda^{i-1,i}}-F>0$. In such a case, clearly $\underline{n}^{p}<n^{*}$ and new entries may lead to higher prices. To prove the second part of Result 3, consider two different equilibrium number of firms such that $n_1^{*}>n_0^{*}$, which may happen when products are less substitutable, market size is larger or the cost of entry is lower (see above, Section 2). From equation (15), we have $E(p)^{*}_{n=n_1^{*}}>E(p)^{*}_{n=n_0^{*}}$ if

[9] The second order condition is easily verified.

$t\left(\frac{n_0^*+n_1^*}{n_0^* n_1^*}\right) < \left(1-\frac{\lambda^{i-1,i}}{2}\right)\frac{m}{k}$, or, treating n as a continuous variable, if $n^* > \frac{kt}{m}\frac{4}{(2-\lambda^{i-1,i})} = \underline{n}^P$.

The explanation for Result 3 is the following. For a given market structure, the entry of an additional firm gives rise to conflicting effects on prices and profits, as shown by the derivatives of expected profits and prices with respect to n. Firstly, competition increases and this pushes prices and profits downward (*competition effect*). Secondly, increasing n makes the equilibrium market share shrink and the quantity produced by each firm decline (*demand effect*). This lowers the benefit that principals derive from providing incentives to managers and in equilibrium reduces managerial compensations and increases firms' profits (*wage effect*). In turn, lower compensation reduces managers' effort and leads marginal costs and prices upward (*cost effect*). Finally, as n increases, the reaction of consumers to price reduction due to cost shock increases and so do profits (risk effect).

Concerning profits, under Assumption 1 the demand effect dominates the risk effect, while under Assumption 2 the competition effect dominates the wage effect, such that profits are always decreasing with n. For prices, matters are different because, when the product market is sufficiently competitive, the cost effect may exceed the competition effect even under Assumption 2. It is worth noting that this cannot happen in Raith, where the fact that the piece rate choice is not fully strategic (i.e., $\lambda^{i-1,i}=0$) means that the ratio between cost effect and competition effect on prices is identical to the ratio between wage effect and competition effect on profits. Therefore, Assumption 2 is sufficient to ensure that both profits and prices are monotonically decreasing with n.

When the market structure is endogenous, since the competition effect decreases (in absolute value) more than the cost effect as n increases, if $n^* > \underline{n}^P$ any increase in market size and decrease in product substitutability and entry costs raises equilibrium expected prices.

Result 3 has an interesting empirical implication. In contrast with a commonly-held opinion, when dealing with differentiated product markets characterized by rigid overall demand and large firms with substantial agency costs or significant cost reducing actions, deregulation may turn into increasing prices even in the presence of increasing competition. For example, this is what has happened since the deregulation of European motor insurance markets in the early 1990s, as premiums have boomed while insurance company profits have remained stable or decreased[10].

C. *Consumer surplus and expected welfare*

Since in equilibrium expected profits and managers' utility are both zero, per capita consumer surplus corresponds to the per capita expected welfare. When varieties are symmetric, it may be written as:

$$(17) \qquad cs = a - E(p)^* - \frac{2nt}{m}\int_0^{1/2n} x^2 = a - \bar{c} + \frac{m}{kn}\left(1-\lambda^{i-1,i}\right) - \frac{13}{12}\frac{t}{n^2}$$

Obviously, if the effect of increases in n on $E(p)^*$ is ambiguous, the effect on consumer surplus will be ambiguous as well. In particular, following Raith, it is easy to show:

RESULT 4:

If $n^* \leq \frac{13}{12}\underline{n}^P$, *an increase in competition leads, as in Raith, to higher expected consumer surplus, whatever the fundamental of competition that one considers (greater product*

[10] See Scalera and Zazzaro (2004).

substitutability, larger markets or lower entry costs). By contrast, when $n^* > \frac{13}{12}\underline{n}^P$, *expected welfare definitely increases with entry costs while it may increase or decrease in response to market size changes.*

PROOF:

Concerning the effects of changes in F and m, we derive (17) to get:

$$\frac{\partial cs}{\partial F} = \frac{\partial n^*}{\partial F}\left(\frac{1}{n^*}\right)^2\left[\frac{13t}{6n^*} - \frac{m}{k}\left(1 - \frac{\lambda^{i-1,i}}{2}\right)\right]$$

$$\frac{\partial cs}{\partial m} = \frac{\gamma}{kn^*} + \frac{\partial n^*}{\partial m}\left(\frac{1}{n^*}\right)^2\left[\frac{13t}{6n^*} - \frac{m}{k}\left(1 - \frac{\lambda^{i-1,i}}{2}\right)\right]$$

From Assumption 2, the expression $\left[\frac{13t}{6n^*} - \frac{m}{k}\left(1 - \frac{\lambda^{i-1,i}}{2}\right)\right]$ is positive (negative) if $n^* <(>) \frac{2}{2-\lambda^{i-1,i}}\frac{13kt}{6m}$, i.e., if $n^* <(>) \frac{13}{12}\underline{n}^P$. Taking into account that $\partial n^*/\partial F < 0$ and $\partial n^*/\partial m > 0$ (see above, Section 2, and Raith's Proposition 4), the Result is therefore established. As regards the effects of changes in t, since $\partial n^*/\partial t > 0$ and t/n^2 is increasing in t, $\partial cs/\partial t < 0$ for any n (the proof is the same as in Raith, 2003, p. 1434).

The intuition of Result 4 is now immediate. When the number of firms increases, managerial incentives reduce and costs go up (Result 1). If $n^* > \underline{n}^P$, equilibrium prices increase along with the number of firms (Result 3). In this case, the price increase may outweigh the reduction in transport costs connected to the larger number of firms and this in turn may lead consumer surplus to shrink.

IV. Conclusions

In this article we propose a generalized version of the Raith (2003) model not requiring restrictive *a priori* assumptions on price expectations. Our approach is characterized by fully strategic principals who determine their optimal managerial incentive strategy taking due account of their competitors' reaction. This behavior implies that each firm's action will involve a change in the whole piece rate and price vectors. Compared to Raith, our solution yields lower managerial incentives, and higher average prices and expected profits. Moreover, considering fully strategic principals produces three (apparently) surprising implications: managerial incentives are higher with price regulation than in competition; prices may prove increasing with the number of firms; consumer welfare may diminish in response to increasing competition.

REFERENCES

Boone, Jan. "Competitive Pressure: The Effects on Investments in Product and Process Innovation.", *Rand Journal of Economics*, Autumn 2000, 31(3), pp. 549-69.

Dasgupta, Partha and Stiglitz, Joseph. "Industrial Structure and the Nature of Innovative Activity", *Economic Journal*, June 1980, 90, pp. 266-93.

Hart, Oliver. "The Market as an Incentive Mechanism." *Bell Journal of Economics*, Autumn 1992, 14(2), pp. 366-82.

Hermalin, Benjamin E. "The Effect of Competition on Executive Behavior." *Rand Journal of Economics*, 1992, 23(3), pp. 350-65.

Martin, Stephen. "Endogenous Firm Efficiency in a Cournot Principal Agent Model." *Journal of Economic Theory*, April 1993, 59(2), pp. 445-50.

Nickell, Stephen. "Competition and Corporate Performance." *Journal of Political Economy*, August 1996, 104(4), pp. 724-46.

Qiu, Larry D. "On the Dynamic Efficiency of Bertrand and Cournot Equilibria." *Journal of Economic Theory*, 1997, 75(1), pp. 213-29.

Raith, Michael. "Competition, Risk and Managerial Incentives." *American Economic Review*, September 2003, 93(4), pp. 1425-36.

Salop, Steven C. "Monopolistic Competition with Outside Goods." *Bell Journal of Economics*, Spring 1979, 10(1), pp. 141-56.

Scalera, Domenico and Zazzaro, Alberto. "From Regulation to Free Market: The Experience of the European Motor Insurance Markets." Quaderni di ricerca, No. 205, Università Politecnica delle Marche, March 2004.

Schmidt, Klaus M. "Managerial Incentives and Product Market Competition." *Review of Economic Studies*, April 1997, 64(2), pp. 191-213.

Spence, Michael. "Cost Reduction, Competition, and Industry Performance." *Econometrica*, January 1984, 52(1), pp. 101-22.

Vives, Xavier. "Innovation and Competitive Pressure." CEPR Discussion Paper, No. 4369, April 2004.

QUADERNI DEL DIPARTIMENTO DI ECONOMIA degli ultimi 5 anni

127 **Davide TICCHI,** *Investment and uncertainty with recursive preferenc*. gennaio 2000.

128 **Fabio FIORILLO, Stefano STAFFOLANI,** *To redistribute or not? Unemployment benefit, workfare and citizen's income in a dual labour market,* marzo 2000.

129 **Davide IACOVONI, Alberto ZAZZARO,** *Legal System Efficiency, Information Production, and Technological Choice: A Banking Model,* aprile 2000.

130 **Riccardo MAZZONI,** *I fattori di competitività dei settori tradizionali italiani: sintesi di un dibattito,* aprile 2000.

131 **Antonio G. CALAFATI,** *How Do Collective Agents Think?,* aprile 2000

132 **Antonio G. CALAFATI,** *Albert O. Hirschman on Economic Evolution,* aprile 2000.

133 **Antonio G. CALAFATI,** *On Industrial Districts,* aprile 2000.

134 **Alberto BUCCI,** *On Scale Effects, Market Power and Growth when Human and Technological Capital are Complements,* maggio 2000.

135 **Luca PAPI, Alberto ZAZZARO,** *How Does the EU Agenda Influence Economies Outside the EU? The Case of Tunisia,* giugno 2000.

136 **Roberto ESPOSTI,** *Public R&D Design and Technological Spill-Ins. A Dynamic Model,* giugno 2000.

137 **Alessandro STERLACCHINI,** *L'accesso alle professioni regolamentate: un' analisi empirica sui laureati degli atenei marchigiani,* luglio 2000

138 **Alberto BUCCI, H. Cagri SAGLAM,** *Growth Maximizing Patent Lifetime,* luglio 2000.

139 **Riccardo MAZZONI,** *Alcuni vincoli del processo di accumulazione,* agosto 2000.

140 **Riccardo LUCCHETTI,** *Inconsistency Of Naive GMM Estimation For QR Models With Endogenous Regressors,* luglio 2000.

141 **Alberto BUCCI, Fabio FIORILLO, Stefano STAFFOLANI,** *Can Market Power influence Employment, Wage Inequality and Growth?,* ottobre 2000.

142 **Alessandro STERLACCHINI,** *The determinants of export performance: A firmlevel study in Italian Manufacturing,* ottobre 2000.

143 **Renato BALDUCCI, Stefano STAFFOLANI,** *Quota del lavoro e occupazione in presenza di contrattazione efficiente,* ottobre 2000.

144 **Giorgio BARBA NAVARETTI, Enrico SANTARELLI, Marco VIVARELLI,** *The Role of Subsidies in Promoting Italian Joint Ventures in Least Developed and Transition Economies,* dicembre 2000.

145 **Roberto ESPOSTI, Pierpaolo PIERANI,** *Building the Knowledge Stock: Lags, Depreciation and Uncertainty in Agricultural R&D,* gennaio 2001.

146 **Francesco TROMBETTA,** *Il sistema economico locale di Fabriano e le sue articolazioni funzionali,* febbraio 2001.

147 **Antonio CALAFATI, Francesca MAZZONI,** *Conservazione, sviluppo locale e politiche agricole nei parchi naturali,* marzo 2001.

148 **Maria Rosaria CARILLO, Alberto ZAZZARO,** *Innovazione, ricerca della rendita e prestigio sociale: verso una teoria dinamica delle professioni,* maggio 2001.

149 **Marco GALLEGATI, Mauro GALLEGATI,** *European Business Cycles: 1960-1998,* maggio 2001.

150 **Luca NUNZIATA, Stefano STAFFOLANI,** *On Short-term Contracts Regulations,* maggio 2001.

151 **Massimiliano BRATTI,** *Oltre la scuola dell'obbligo. Un'analisi empirica della decisione di proseguire nell'istruzione post-obbligo in Italia,* maggio 2001.

152 **Massimiliano BRATTI, Stefano STAFFOLANI,** *Performance accademica e scelta della facoltà universitaria: aspetti teorici e evidenza empirica,* giugno 2001.

153 **Fabio FIORILLO, Giulio PALOMBA,** *Un modello CGE per l'analisi del federalismo fiscale all'italiana,* giugno 2001.

154 **Massimiliano BRATTI,** *Labour Force Participation and Marital Fertility of Italian Women: The Role of Education,* settembre 2001.

155 **Riccardo LUCCHETTI, Alessandro STERLACCHINI,** *Factors Affecting the Adoption of ICTs Among SMEs: Evidence From an Italian Survey,* ottobre 2001.

156 **F. CHELLI, L. ROSTI,** *Youth Unemployment and Self-Employment in Italy,* novembre 2001.

157 **Alberto ZAZZARO,** *The Allocation of Entrepreneurial Talent under Imperfect Lending Decisions,* novembre 2001.

158 **Luca De BENEDICTIS, Massimo TAMBERI,** *A note on the Balassa Index of Revealed Comparative Advantage,* gennaio 2002.

159 **Enrico GUZZINI,** *The Liberal Paradox and Non-Welfarist Theories: To What Extent Is There a Compatibility?,* febbraio 2002.

160 **Luca De BENEDICTIS, Massimo TAMBERI,** *Il modello di specializzazione italiano: normalità e asimmetria,* febbraio 2002.

161 **Marco GALLEGATI,** *Financial Constraints and the Balance Sheet Channel: a Re-Interpretation,* febbraio 2002.

162 **Paolo ZAGAGLIA,** *On (Sub)Optimal Monetary Policy Rules under Untied Fiscal Hands,* marzo 2002.

163 **Alberto ZAZZARO,** *How Heterodox Is the Heterodoxy of the Monetary Circuit Theory? The Nature of Money and the Microeconomy of the Circuit,* aprile 2002.

164 **Massimo GIULIODORI,** *Monetary Policy Shocks and the Role of House Prices Across European Countries,* maggio 2002.

165 **Giuseppe RICCIARDO LAMONICA,** *La funzionalità nelle zone omogenee delle Marche,* maggio 2002.

166 **Roberto ESPOSTI, Alessandro SORRENTINO,** *Regolamentazione delle Innovazioni Biotecnologiche in Agricoltura e Accordi Multilaterali: Conflitti, Negoziazione e Innovazione Istituzionale,* luglio 2002.

167 **Maria Rosaria CARILLO, Alberto ZAZZARO,** *The Enigma of Medieval Craft Guilds: A Model of Social Inertia and Technological Change,* luglio 2002.

168 **Fabiano COMPAGNUCCI,** *Sviluppo senza crescita: il sistema locale del Casentino,* luglio 2002.

169 **Paolo ZAGAGLIA,** *Matlab Implementation of the AIM Algorithm: A Beginner's Guide,* luglio 2002.

170 **Massimiliano BRATTI, Stefano STAFFOLANI,** *Student Time Allocation and Educational Production Functions,* luglio 2002.

171 **Antonio G. CALAFATI, Francesca MAZZONI,** *Conservation Policies as Local Development Policies: The Case of the Italian National Parks,* settembre 2002.

172 **Fabiano COMPAGNUCCI, Francesca MAZZONI,** *Il territorio dei parchi nazionali italiani,* settembre 2002.

173 **Antonio G. CALAFATI,** *Conservazione e sviluppo locale nei parchi naturali: un'agenda di ricerca,* settembre 2002.

174 **Massimiliano BRATTI,** *Parents' Current Income, Long-term Characteristics and Children's Education: Evidence from the 1970 British Cohort,* ottobre 2002.

175 **Pietro ALESSANDRINI, Luca PAPI, Alberto ZAZZARO,** *Banche, territorio e sviluppo,* ottobre 2002.

176 **Roberto ESPOSTI, Pierpaolo PIERANI,** *Public R&D Investment and Cost Structure in Italian Agricolture, 1960-1995,* novembre 2002.

177 **Antonio G. CALAFATI, Francesca MAZZONI,** *Una città in nuce nelle Marche,* novembre 2002.

178 **Fabio FIORILLO, Claudio SOCCI,** *Quale politica fiscale regionale? Analisi del federalismo italiano attraverso un modello CGE,* dicembre 2002.

179 **Antonio G. CALAFATI,** *Economia della città dispersa,* marzo 2003.

180 **Emma SARNO, Alberto ZAZZARO,** *Structural Convergence of Macroeconomic Time Series: Evidence for Inflation Rates in EU Countries,* maggio 2003.

181 **Alberto ZAZZARO,** *Should Courts Enforce Credit Contracts Strictly?,* maggio 2003.

182 **Riccardo LUCCHETTI, Stefano STAFFOLANI, Alessandro STERLACCHINI,** *Computers, Wages and Working Hours in Italy,* maggio 2003.

183 **Renato BALDUCCI,** *Public Spendine and Economic Growth,* maggio 2003.

184 **Giuseppe RICCIARDO LAMONICA,** *La valutazione delle attività della pubblica amministrazione: una rassegna di metodi,* giugno 2003.

185 **Giulio PALOMBA,** *GARCH multivariati e approccio di Black-Litterman nell'asset allocation tattica: un'analisi empirica,* giugno 2003.

186 **Ugo FRATESI,** *Innovation Diffusion and the Evolution of Regional Disparities,* luglio 2003.

187 **Nicola MATTEUCCI,** *Entry Deterrence and Multidimensional Competition in the Satellite Pay-TV Market,* luglio 2003.

188 **Renato BALDUCCI, Stefano STAFFOLANI,** *Short-Run Bargaining, Factors Shares,* luglio 2003.

189 **Massimiliano BRATTI, Luca MANCINI,** *Differences in Early Occupational Earnings of UK Male Graduates by Degree Subject: Evidence from the 1980-1993 USR,* settembre 2003.

190 **Alessia Lo TURCO,** *South-South Regional Trade Agreements and Growth. A Panel Data Approach to the Evaluation of Three Latin American Trade Agreements,* settembre 2003.

191 **Claudio SOCCI,** Produzione e distribuzione del reddito in una Social *Accounting Matrix biregionale,* ottobre 2003.

192 **Pietro ALESSANDRINI, Marco CRIVELLINI,** *Fuà e la scuola di Economia di Ancona,* ottobre 2003.

193 **Nicola MATTEUCCI, Alessandro STERLACCHINI,** *ICT and Employment Growth in Italian Industries,* ottobre 2003.

194 **Adelino ZANINI,** *Un capitalismo incerto. Incertezza e normazione nel pensiero di Keynes (1921-1939),* ottobre 2003.

195 **Francesco CHELLI,** *Indicatori di sviluppo sostenibile e qualità della vita,* novembre 2003.

196 **Enzo VALENTINI,** *Reciprocità e stato sociale: una spiegazione delle differenze tra Stati Uniti ed Europa,* novembre 2003.

197 **Manuela CROCI,** *An Empirical Analysis of International Equity Market Co-movements: Implications for Informational Efficiency,* novembre 2003.

198 **Roberto ESPOSTI,** *Complementarità innovative e tragedia degli anticommons: il caso delle agrobiotecnologie,* dicembre 2003.

199 **Elvio MATTIOLI,** *The Measurement of Coherence in the Evaluation of Criteria and its Effect on Ranking Problems Illustrated Using a Multicriteria Decision Method,* dicembre 2003.

200 **Marcello MESSORI, Alberto ZAZZARO,** *Monetary Profits Within the Circuit: Ponzi Finance or "mors tua, vita mea"?,* gennaio 2004.

201 **Manuela CROCI,** *Country Pair-Correlations as a Measure of Financial Integration: the Case of the Euro Equity Markets,* gennaio 2004.

202 **Massimiliano BRATTI, Nicola MATTEUCCI,** *Is There Skill-Biased Technological Change in Italian Manufacturing? Evidence from Firm-Level Data,* gennaio 2004.

203 **Massimiliano BRATTI, Stefano STAFFOLANI,** *Effort-Based Career Opportunities and Working Time,* febbraio 2004.

204 **Ugo FRATESI,** *Regional Economies, Innovation and Competitiveness in a System Dynamics Representation,* febbraio 2004.

205 **Domenico SCALERA, Alberto ZAZZARO,** *From Regulation to Free Market: The Experience of the European Motor Insurance Market,* marzo 2004.

206 **Alberto NICCOLI,** *La riforma delle pensioni: un approccio territoriale,* aprile 2004.

207 **Adelino ZANINI,** *Etica ed Economia. Considerazioni su Adam Smith e J. M. Keynes,* maggio 2004.

208 **Paolo ERCOLANI,** *Reddito nazionale, vita media e benessere: Una nota,* maggio 2004.

209 **Alberto ZAZZARO,** *Assetti proprietari delle banche e attività economica: possiamo affidarci a Coase?,* maggio 2004.

210 **Gianluca LAGANÀ,** *Monetary Models of Exchange Rate and the Random Walk: the Italian Case Over the Recent Float,* maggio 2004.

211 **Giuseppe RICCIARDO LAMONICA,** *Analisi della Student Statisfaction nella Facoltà di Economia "G.FUA' di ANCONA",* giugno 2004.

212 **Davide DOTTORI,** *Crescita endogena e sindacato. Una rassegna della letteratura,* giugno 2004.

213 **Domenico SCALERA, Alberto ZAZZARO,** *Managerial Incentives and Competition with Fully Strategic Principals: Comments on Raith,* luglio 2004.