Intra-Industry Competitiveness and Economic Growth

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The Cass-Koopmans model of economic growth is reworked with imperfect competition in the final good sector. In the special case of the AK model, a direct link is shown between the degree of intra-industry competition and the rate of growth. Anti-trust enforcement which increases intra-industry competition, therefore, has growth effects and not just level effects. Imperfect competition generates excess profits at the expense of payments to labor and capital. Entry increases the competition for—and, therefore, the payments to—both of those factors. In response to the increase in the return to capital, capital accumulation increases and growth speeds up. © 1997 Temple University

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I. Introduction

The intensity of intra-industry competition is known to be an important determinant of the static efficiency of an economy. Indeed, anti-trust laws are a direct application of this idea. The link between the degree of intra-industry competition and the dynamic vigor of an economy is, however, less well understood. This paper explores the link between the growth rate of per capita income and the level of intra-industry competition. It reworks the seminal Cass-Koopmans model of economic growth with imperfect competition in the final good sector. In the related case of the by now familiar AK model of endogenous growth, this paper shows that an exogenous increase in the number of firms causes an increase in the growth rate of per capita income. This suggests that the rationale for anti-trust laws, which are

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intended to remove entry barriers, need not be based solely on the level effects of removing the static inefficiencies of imperfect competition; such laws have growth effects, as well.

The reason for the positive relation between intra-industry competition and growth is straightforward. Profits obtained under imperfect competition exceed those obtained under perfect competition. These extra profits, however, come at the expense of payments to labor and capital. When the number of firms increases, the extra profits dry up and the payments to labor and capital increase. In particular, the increase in the rental rate for capital encourages capital accumulation and raises the growth rate. (Diminishing returns to capital is not a problem in the linear AK model.)

The imperfect competition in the final good sector is assumed to take the form of Cournot competition. The reasons for this assumption are discussed below in this section and also in Section IV. Under Cournot competition, each firm is assumed to choose its own output taking the other firms' outputs as given. This assumption, which requires individual firms to pay close attention to the output choices of all other firms, while possibly appropriate in a model of an industry, may seem out of place in a model of an economy. But in an economy that is—more reasonably—composed of many different industries, each of which is under Cournot competition, a firm would be paying attention to the output decisions of only the other firms in its own industry. And in such an economy, the lessons of this paper's one sector model, especially the connection between competitiveness and growth, would continue to hold. Section IV makes this notion explicit.

This paper's approach—as has been indicated above—is to assume that the number of firms in the imperfectly competitive sector is exogenously given, and to examine the effects on growth of changes in the number of firms. In most models in the literature on economic growth under imperfect competition, however, entry is assumed to be unimpeded and an equilibrium condition of zero profits is used to endogenously determine the number of firms. Typically, the equilibrium number of firms and the price elasticity of demand for a typical firm's output increase over time, reflecting the intensification of competition. But, the changes in the number of firms over time are usually accompanied by changes in other factors, making it difficult to isolate the effect of intra-industry competitiveness on growth.¹ In Romer (1987), for instance, entry implies the introduction of new goods, which offer new opportunities for specialization. In Romer (1990), entry occurs because of the invention of new goods, which has the added benefit of having positive external effects on the research technology for the subsequent creation of new knowledge. And in Gali and Zilibotti (1994), the economy's capital stock increases along with the number of firms.

An exception to the general pattern is Smulders and Klundert (1995), in which the number of firms is exogenously given and the effects of entry on growth are analyzed. In Smulders and Klundert (1995) growth is driven by productivity improving R & D undertaken by monopolistic firms, each of which produces an

¹Although increases in the price elasticity of demand may indicate increases in competition, the fact that entry is free and profits are zero at all times suggests that competitiveness is, in another sense, maximal at all times in free-entry models.
intermediate good. The differentiated intermediate goods and a homogeneous good $Y$ are used to produce a consumption good. Entry affects R & D and, thereby, growth in several ways. One of these effects of entry, the monopolization effect, is comparable to the competitiveness effect of this paper. As the authors explained [see Smulders and Klundert 1995, p. 149], at higher levels of concentration (i.e., when the number of firms is smaller), "...firms set higher mark-up rates. The relative price of differentiated goods rises. The $Y$ sector will expand relative to the differentiated sector and each monopolistic firm realizes a smaller value of sales, which depresses the rate of return and therefore also the rate of growth." Another way of putting it is that the comforts of greater concentration (or less competition) makes resting on one's oars more profitable. Thus, there is less R & D and slower growth.

In the present paper, the entry-growth connection works differently. As was said before, entry raises the reward for both of the two factors, labor and capital. Capital accumulation responds to this inducement and growth speeds up. In Smulders and Klundert (1995), there is no capital, only labor. In their monopolization effect, entry encourages the reallocation of labor into research and out of the other uses of labor. And this raises the growth rate.

Returning to the use of Cournot competition in this paper, an important difference between growth models with monopolistic competition and this paper's growth model with Cournot competition is that in Cournot competition each firm takes the other firms' outputs as given, and in monopolistic competition each firm takes the other firms' prices as given. Now if the substitutability between the differentiated goods in the monopolistic competition model is gradually increased, then in the limit monopolistic competition becomes Bertrand competition. In Bertrand competition under constant costs, entry makes no essential difference to competitiveness (or to anything else, for that matter) as long as there are two or more firms. So, although the monopolistic competition model does show a link between entry and growth when substitutability is imperfect (and allows an analysis of the changing nature of this link as the degree of substitutability changes), it also shows the total absence of such a link when substitutability is perfect. The value of the Cournot model is that one can show the effect of entry on growth even when all firms produce the same good.

Cournot competition has also been used in Gali and Zilibotti (1994). But there are differences between Gali and Zilibotti (1994) and the present paper. First, the number of firms is endogenous in Gali and Zilibotti (1994), and I have discussed earlier why such models do not effectively address the issues I am interested in. Moreover, in Gali and Zilibotti (1994), Cournot competition prevails only in the markets of intermediate goods (of which there is a continuum), whereas in this paper it is the market for the one all-purpose Cass-Koopmans-type produced good in which Cournot competition prevails. Finally, while optimality issues are important in this paper, Gali and Zilibotti (1994) restricted themselves to the analysis of equilibria.

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2 I am grateful to an anonymous referee for drawing my attention to the paper by Gali and Zilibotti (1994).
The rest of this paper is as follows. Section II briefly discusses consumer behavior in a dynamic economy. Section III studies the Cournot growth model. Section IV discusses some generalizations. Section V concludes the paper.

II. The Consumer

This paper's assumptions about the maximization of lifetime utility are just as in the Cass-Koopmans model. There is one consumer who, at time $t$, owns one unit of labor, $k_t$ units of capital, and all the shares of the economy's firms. Let $c_t$ denote consumption and let $\rho > 0$ denote the rate of time preference. It is well known that if we use the iso-elastic functional form $U(c) = c^{1-\theta}/1-\theta$, $\theta > 0$ and $\theta \neq 1$, as instantaneous utility, then the Euler equation for the maximization of lifetime utility, $\int_0^\infty U(c_t)\exp(-\rho t)\,dt$, will be:

$$g_{ct} = \frac{\dot{c}_t}{c_t} = \frac{r_t - \rho}{\theta},$$

(1)

where $r_t$ is the real (i.e., in units of the final good) interest rate of capital, and the law of motion would be:

$$\dot{k}_t = w_t + r_t k_t + \pi_t - c_t,$$

(2)

where $w_t$ is the real wage of labor, and $\pi_t$ is total real profit. (A variable with a dot on top is its time derivative; thus $\dot{c}_t = dc_t/dt$.)

III. The Instantaneous Cournot Equilibrium

This section focuses on the economy at time $t$ so as to find expressions for $w_t$, $r_t$ and $\pi_t$ in terms of $k_t$. Such expressions would turn equations (1) and (2) into two differential equations in $k_t$ and $c_t$ only. (The subscript $t$ will be dropped below except where necessary.)

Let the consumer's income be $M$, in some unit of account. All of this income will be spent on the final good—because there is nothing else to buy. Part of the amount purchased will be consumed and the rest will go towards capital accumulation—as in Section II. If $P_y$ is the price (in the unit of account) of the final good—as all firms sell the same product they must all charge the same price—the inverse demand function will be:

$$P_y = M/Y,$$

(3)

where $Y$ is the total amount sold of the final good. There are $n$ firms, $i = 1, 2, \ldots, n$, which produce the final good, and $n \geq 2$ is exogenously given. In Cournot competition, firm $i$ takes as given $Y_{-i}$, the total output of all firms other than $i$. Thus, the inverse demand faced by firm $i$ would be:

$$P_y = \frac{M}{Y_i + Y_{-i}}.$$

(4)
Firm $i$ produces the final good, using capital and labor according to the technology $Y_i = F(K_i, L_i)$, which is assumed to be quasi-concave and homogeneous of degree one.

A Cournot equilibrium is a price $P_i^*$ and outputs $Y_i^*$, $i = 1, 2, \ldots, n$, such that each firm $i$ maximizes its profits $P_i Y_i^* - W L_i - R K_i$ using equation (4), with $Y_{-i} = \sum_{j \neq i} Y_j^*$ substituted, as its demand, $F(\cdot, \cdot)$ as its technology, and taking $W$ and $R$, the unit of account prices of labor and capital, as given. The equilibrium for the economy would further require $W$ and $R$ to clear the factor markets.

A symmetric equilibrium in which $Y_i = Y/n$ for all $i$ can be shown to exist, and, for simplicity, only this equilibrium will be discussed here.

Firm $i$ maximizes

$$
\Pi_i = \frac{MF(K_i, L_i)}{F(K_i, L_i)} + Y_{-i} - W L_i - R K_i
$$

with respect to $K_i$ and $L_i$. The first-order conditions yield:

$$
R = \frac{MY_{-i} F_K(K_i, L_i)}{(F(K_i, L_i) + Y_{-i})^2}
$$

and

$$
W = \frac{MY_{-i} F_L(K_i, L_i)}{(F(K_i, L_i) + Y_{-i})^2}.
$$

As the representative individual is endowed with one unit of labor and $k$ units of capital, in any symmetric equilibrium $K_i = k/n$ and $L_i = 1/n$ must prevail for all $i$. Constant returns to scale implies that $Y_i = F(k/n, 1/n) = F(k, 1)/n$. Defining $f(k) = F(k, 1)$, we get $Y_i = f(k)/n$ and $Y_{-i} = (n - 1)f(k)/n$. Moreover, $F_K(K_i, L_i) = F_k(k/n, 1/n) = f'(k)$, as marginal products are homogeneous of degree zero.

Using these expressions, and Euler's Theorem $KF_K + LF_L = F$, equations (6) and (7) give the real factor prices in terms of $k$:

$$
r = R/P = (n - 1)n^{-1}f'(k)
$$

$$
w = W/P = (n - 1)n^{-1}[f(k) - kf''(k)].
$$

And from equation (5), a firm's real profits are:

$$
\pi_i = \frac{\Pi_i}{P_i} = \frac{f(k)}{n^2}.
$$

Total dividends earned by the representative individual are $\pi = \sum_{i=1}^n \pi_i = f(k)/n$. (In the derivation of equations (8)–(10), an abstract unit of account was used. Instead, one could choose, say, labor as the numeraire. The entire profit maximization could be redone with $W = 1$ and everything else unchanged. In that case, $M,$
\( P_Y, \Pi_i, \text{ and } R \) would be in units of labor. \( w = 1/P_Y, \ r = R/P_Y \) and \( \pi_i = \Pi_i/P_Y \) would then give wages, rent and profits in terms of the final good. The expressions in terms of \( k \) would be the same either way.)

The Euler equation (1) then becomes:

\[
\frac{\dot{c}_t}{c_t} = \frac{1}{\theta} \left\{ \frac{n-1}{n} f'(k_t) - \rho \right\}
\]

and the law of motion, equation (2) becomes:

\[
\dot{k}_t = f(k_t) - c_t.
\]

Equations (11) and (12), together with a transversality condition

\[
\lim_{t \to \infty} k_t c_t^{-\theta} \exp(-\rho t) = 0
\]

and the initial condition that \( k_0 \) is given, fully determine the growth path of the Cournot economy.

**Optimality**

How does the growth path under Cournot competition differ from the growth path under perfect competition? The Euler equation is different in the two cases because \( r = f'(k) \) under perfect competition, not \( (n-1)n^{-1}f'(k) \). Note, however, that when \( n \) increases in the Cournot economy, \( w \) and \( r \) both increase (by the same proportion, so that \( w/r \) remains unchanged) and \( \pi \) decreases. In the limit, as \( n \) becomes infinite, we get \( r = f'(k), \ w = f(k) - kf'(k), \) and \( \pi = 0, \) just as in perfect competition which, as is well known, is also Pareto Optimal. Thus, the Cournot time path is suboptimal, but becomes optimal as \( n \) tends to infinity.

The saddle-point dynamics of the Cass-Koopmans model apply under Cournot competition as well. Increases in \( n \) raise the steady state of stock of capital, reaching the competitive level as \( n \) becomes infinite.

**The AK Model**

The special case of \( F(K, L) = AK \) has attracted a lot of attention in the growth literature [see Rebelo (1991); Barro and Sala-i-Martin (1995)]. In this case, \( f(k) = Ak, \) and equations (11) and (12) can be solved explicitly to give the time paths for \( k_t, \) and \( c_t, \) under Cournot competition. These are as follows: \( k_t = k_0 \exp(gt), \ c_t = (A-g)k_t, \) and \( Y_t = Ak_t, \) where

\[
g = \frac{1}{\theta} \left\{ \frac{n-1}{n} A - \rho \right\}.
\]

It can be checked, by substitution, that these time paths satisfy equations (11) and (12).

Note that \( k_t, c_t, \) and \( Y_t \) all grow at the rate \( g. \) Note, also, that \( g \) is increasing in \( n. \) Imperfect competition makes profits possible, but only at the expense of the rewards to other factors of production. As new firms enter, profits gradually dry up
as the demand for and, therefore, the prices of productive factors increase. In particular, the rate of return on investment increases, and this pushes growth rates up.

The number of firms in an industry, \( n \), is exogenous here. It reflects the existence of entry barriers. The use of anti-trust measures may increase \( n \) or at least prevent its decrease. Increases in \( n \) imply increases in intra-industry competitiveness. For example, the Lerner Index of competitiveness or the price-cost margin, \( (P_Y - MC)/P_Y \), where \( MC \) is the marginal (also average) cost, can be shown to be \( 1/n \), which is decreasing in \( n \) and becomes zero as \( n \) tends to infinity. Thus, equation (13) essentially shows a positive relation between growth and intra-industry competitiveness. In particular, a decrease in intra-industry competition may turn a growing economy into a stagnant economy.\(^3\) To see this, suppose \( \rho < A < 2\rho \). Then it is clear that the growth rate in equation (13) is positive for large \( n \), but non-positive for \( n = 2 \) (recall that \( n \geq 2 \) has been assumed throughout this paper).

The connection between growth and entry shown above for the \( AK \) model also obtains for general constant returns to scale technologies \( F(K, L) \), where labor, and not just capital, is necessary for production, if \( \lim_{k \to \infty} f'(k) = A > \rho \). For examples of technologies which meet these requirements, see Section 4.5 of Barro and Sala-i-Martin (1995).

**IV. Generalizations\(^4\)**

In Cournot equilibrium, each firm \( i \) is assumed to know \( Y_{i} \), the total output of the other firms. This assumption, while perhaps appropriate in modeling an industry, may seem inappropriate in modeling an economy. This difficulty can, however, be dealt with by modifying the model slightly. If we introduce \( m \) final goods (instead of just one), each good serving both as consumption good and capital good, and if instead of \( U(c) \) as instantaneous utility, we had \( U([c_1, c_2, \ldots, c_m]^{1/m}) \), and if instead of \( Y = F(K, L) \) as the production function, we had \( Y = F([K_1, K_2, \ldots, K_m]^{1/m}, L) \), then the analysis of this modified model would be essentially the same—aside from notation changes—as the earlier analysis. The benefit of the modification is that here, as in the industrial organization literature, Cournot competition applies only *within* an industry in an economy consisting of many industries.

It was also assumed earlier that firms take \( M \), the income (and, therefore, the expenditure) of the representative consumer, as given. \( M \) includes not only factor earnings from labor and capital, but also dividend income. Therefore, changes in a firm's actions may change the consumer's income and, thus, the firm's demand. The \( m \)-sector modification discussed above addresses this issue as well, because when

\(^3\)The possibility of stagnation was pointed out to me by an anonymous referee, to whom I am thankful.

\(^4\)Apart from the first two paragraphs, this section is based heavily on comments made by the anonymous referees of this Journal. Not only did they raise the issues discussed here, they also indicated how the problems could be resolved. Needless to say, I am deeply thankful.
\( m \) is large, each firm, even if significant in its own industry, is insignificant in the economy. Even General Motors, it may safely be conjectured, does not factor in the effect of its dividend payments on the demand for its cars.

General equilibrium models with imperfect competition must address yet another important issue regarding the appropriate maximand of a firm. If the owners of a firm and the buyers of the firm's product are the same group of people, it would clearly make sense for the firm to maximize not its profits—as has been assumed in this paper—but the utility of its owners/consumers. Moreover, this issue would remain even if the firm concerned is small relative to the economy; so, the \( m \)-sector modification discussed earlier would be of no help. However, profit maximization would make sense if only a small part of a typical firm's output was bought by its owners. This is not too strong a requirement: continuing with the analogy of the oligopolistic automobile industry, it is probably true that only a small fraction of the output of General Motors is bought by its shareholders. Moreover, if share ownership is highly concentrated, this issue tends to be less important, and given, for example, the concentration of wealth in the United States (which tends to be more highly concentrated than the distribution of income), it is appropriate to ignore this issue as a first approximation.

Finally, this paper makes no real distinction between consumption goods and capital goods. It would be useful to have a model which can decide whether the degree of intra-industry competition in the consumption goods sector is as important for growth as the degree of intra-industry competition in the capital goods sector. A quote from Rebelo (1991, page 502) is suggestive: "All that is required for the feasibility of perpetual growth in the existence of a 'core' of capital goods that is produced with constant returns to scale technologies and without the direct or indirect use of non-reproducible factors." This indicates that all that would be required to assure perpetual growth would be a suitably high degree of competitiveness in the capital goods sector. The degree of competitiveness in the consumption goods sector is unlikely to be crucial for growth.

V. Conclusion

There is a rich Schumpeterian tradition that sees monopoly power as essential to the progress of modern economies which depend heavily on innovative activity. This paper has looked at the growth-retarding aspects of imperfect competition. It has been shown here that the enforcement of competition and the prevention of monopolization by the use of anti-trust laws has growth effects as well as level effects.

Appendix on Optimality

Continuing the discussion in Section III (Optimality), a somewhat less intuitive result regarding the optimality of the Cournot growth path is that the inefficiency caused by imperfect competition in the Cournot economy is equivalent to a more familiar kind of inefficiency; namely, that caused by an externality.

The social planner's problem is to maximize \( \int_0^\infty U(c_t) \exp(-\rho t) \, dt \)—with the iso-elastic functional form \( U(c) = c^{1-\theta}/1 - \theta \) used for simplicity—subject to the
law of motion, equation (12). Suppose, however, that the social planner misperceives the production function to be:

\[ G(K, L; \hat{k}, n) = \left(1 - \frac{1}{n}\right)F(K, L) + \frac{1}{n}F(\hat{k}L, L), \]

where \( \hat{k} \) is some constant. This implies that the law of motion in per capita terms is misperceived to be:

\[ \dot{\hat{k}}_t = \left(1 - \frac{1}{n}\right)f(k_t) + \frac{1}{n}f(\hat{k}_t) - c_t. \]

Suppose the planner maximizes lifetime utility subject to equation (14) and only later substitutes \( \hat{k} = k_t \). It can be shown that the paths for \( k_t \) and \( c_t \) chosen by the social planner in this case follow all the equations of the Cournot economy.

The analytical device used above is a standard trick in the analysis of competitive economies which have externalities. The main point is that the initial misperception is later corrected by setting \( \hat{k}_t = k_t \), but only in the Euler equation for the misperceived problem.

Recall that \( \pi = f(k)/n \) represents the total profits in the Cournot economy. But this is a precise measure of the misperception. Thus, the Cournot economy behaves just like a competitive economy in which the representative individual misperceives part of her earnings to be exogenous profits when, in fact, they are factor earnings which depend on her supplies of labor and capital. In the case of labor which is inelastically supplied and not accumulated, the misperception makes no difference, but in the case of capital the underperceived returns lead to slower growth.

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