Competition and Corporate Performance

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Are people right to think that competition improves corporate performance? My investigations indicate first that there are some theoretical reasons for believing this hypothesis to be correct, but they are not overwhelming. Furthermore, the existing empirical evidence on this question is weak. However, the results reported here, based on an analysis of around 670 U.K. companies, do provide some support for this view. Most important, I present evidence that competition, as measured by increased numbers of competitors or by lower levels of rents, is associated with a significantly higher rate of total factor productivity *growth*.

I. Introduction

Most people believe that competition is a good thing. From Adam Smith, who commented that "monopoly . . . is a great enemy to good management" (1976, bk. 1, chap. 11, p. 165; cited in Vickers [1994]), to Richard Caves, who remarked that economists have a "vague suspicion that competition is the enemy of sloth" (1980, p. 88), this theme has been ever present in the writings of both economists and men of affairs. Furthermore, as these quotes indicate, this belief does not simply reflect the well-known result that a competitive economy generates an efficient allocation of resources. It is far more general. It is a belief that competition exerts downward pressure on costs, reduces

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slack, provides incentives for the efficient organization of production, and even drives innovation forward. Furthermore, this belief has widespread consequences. It is the driving force behind numerous important policy changes ranging from the deregulation of numerous sectors in the OECD economies to *many* of the economic reforms in Eastern Europe.

However, this general belief in the efficacy of competition exists despite the fact that it is not supported either by any strong theoretical foundation or by a large corpus of hard empirical evidence in its favor. It is my purpose, therefore, to add a little to the rather meager body of knowledge in this area. I analyze the productivity performance of a large number of U.K. manufacturing companies, looking particularly at the impact of competition on both the level and the growth of total factor productivity. In what follows, I first give the theoretical and empirical background and then present my empirical model and results.

II. The Theoretical Background

I take an industry to be more competitive if there are fewer monopoly rents. The question I am directly concerned with here is the impact of competition on the efficiency and productivity growth rates of companies. Despite being in the currently rather passé structure, conduct, performance tradition, this is both a legitimate and an interesting issue to investigate. Two points are worth noting. First, it is a question that is very rarely pursued, much greater attention having been paid to profitability, which competition probably reduces, rather than to efficiency and productivity growth, which, it is hypothesized, competition increases. Since it is productivity growth that is the cause of the "wealth of nations," this emphasis on profitability is rather curious. Second, care must be exercised in any investigation of questions of this type because the degree of competition is not, in the long run, independent of company behavior. Thus, for example, high-performing companies may, eventually, gain a position of market power. This makes the interpretation of cross-section correlations very tricky,[1] particularly those at the industry level.

With this in mind, why should competition influence company performance? An obvious answer is that the existence of monopoly rents gives the company stakeholders, in particular managers and workers, the potential to capture these rents in the form of slack or lack of effort. But this is simplistic. The owners of monopolistic firms will be just as keen to prevent slacking by managers and workers as the

[1] This is closely related to the discussion in Demsetz (1973).

owners of competitive firms. However, it may be argued that the latter are in a better position to do so, at least under the uncontroversial assumption that managers know more about what is going on than owners. Concerning managerial effort, the work of Holmstrom (1982*b*), Nalebuff and Stiglitz (1983), and Mookherjee (1984) suggests that explicit incentive schemes will generate sharper incentives the greater the number of players involved. This arises because of the greater opportunities for comparison of performance. Hart (1983) provides a model of managerial incentives that demonstrates explicitly how competition between firms may sharpen incentives. He supposes there to be two types of firm in an industry, "managerial" (M), where there is a principal-agent problem, and "entrepreneurial" (E), where the "principal" runs the firm. All firms face common cost shocks. When (marginal) costs are low, E firms expand output whereas M firms have managers who take advantage of the good times to slack. This is consistent with the optimal incentive scheme under the condition that managers are not "too responsive" to monetary incentives. If the proportion of E firms is higher, industry output in good times (low cost) is higher, industry prices are lower, and the potential for managerial slack in the M firms is lower. This might be interpreted as an increase in competition leading to less slack. However, this is not a robust result. Scharfstein (1988) notes that the position is reversed if managers are highly responsive to monetary incentives. Then "competition" leads to more slack.

An alternative analysis is based on an idea in Meyer and Vickers (1995, sec. 2.1), which utilizes a model of *implicit* rewards due to Holmstrom (1982*a*). The idea is that while current managerial effort does not influence current earnings, it may influence future market-based rewards via its impact on the market's estimate of the manager's ability. The market cannot observe either effort or ability directly, but in future periods it can use knowledge of managerial output, which depends on effort, ability, and unobserved productivity shocks. The manager, therefore, has an incentive to raise effort early in her career because this will tend to increase future market estimates of her ability and, hence, future rewards.

What is the role of competition in all this? The notion is that the existence of other firms in the industry leads to a sharpening of effort incentives because the unobserved productivity shocks are likely to be correlated across firms operating in the same industry. In Meyer and Vickers (1995), it is shown that in a two-period model, first-period effort incentives are greater when there are two firms if both productivity shocks and managerial abilities are nonnegatively correlated, with the former correlation being larger than the latter, a not unlikely scenario. In fact this result extends to n firms, with managerial effort incentives increasing in n (see Nickell 1994). If a rise in n corresponds to an increase in competition, this implies that competition can tend to raise managerial effort and, hence, company performance.

An alternative framework relies not on the possibility that competition may give more precision to incentives based on relative performance but on the fact that competitive forces in the product market may raise the sensitivity of profits to the actions of managers. So if competition makes profits more responsive to managerial effort, for example, then owners have a greater incentive to ensure that managerial effort is kept high and inefficiency will be lower. Willig (1987) presents a model along these lines in which he demonstrates that in the context of a simple principal-agent framework, a ceteris paribus increase in the firm's product demand elasticity causes the firm's owners to induce the manager to raise her effort. However, a ceteris paribus fall in demand will have the opposite effect, so increased competition will raise effort and efficiency only if the demand elasticity effect dominates the demand reduction effect. Since an increase in competition may both raise the demand elasticity and reduce demand for the individual firm, the effort outcome is ambiguous. Some ambiguity also arises in the model due to Hermalin (1992), but no such ambiguity arises in similar models constructed by Martin (1993) and Horn, Lang, and Lundgren (1994). In both cases, they find that increased competition tends to be associated with *reduced* managerial effort! Schmidt (1994), however, points to a force in the opposite direction arising from the fact that competition raises the probability of bankruptcy and thereby generates strong incentives for managers to avoid this fate by improving efficiency.

As well as managerial effort, competition may also influence the effort of workers. This follows naturally from the notion that product market rents may be shared with workers. Such sharing occurs because this makes the life of managers more comfortable (expense preference; e.g., Smirlock and Marshall 1983), it enables unions to be kept out (e.g., Dickens and Katz 1987), or already entrenched unions use their bargaining strength to enforce it (e.g., Stewart 1990). Since rents may be captured in the form of higher wages or reduced effort, there is a direct connection between the degree of competition and the level of workers' effort. Since the majority of U.K. companies considered here are unionized, it is natural to focus on a union bargaining framework. In this context, it may be shown that, in a world in which unions and firms bargain over both wages and effort,[2] in-

[2] The proof of this result may be found in Nickell (1994). Incidentally, the majority of union-firm wage bargains in the United Kingdom also cover staffing ratios and

creases in product market competition lead directly to increases in bargained effort.

While the main argument in favor of a positive relationship between competition and productivity performance rests on the opportunities for slack introduced by monopoly power, there are alternatives. For example, consider the impact of competition on incentives for research and development. It is generally the case that cost-reducing improvements in productivity will generate larger increases in profit in a more competitive environment, thereby raising the incentives for R & D expenditure. However, following Schumpeter (1943), it has also been argued that more monopolistic firms can more readily fund R & D expenditure because they face less market uncertainty and have a larger, more stable cash flow (Levin, Cohen, and Mowery [1985] provide a useful summary of the arguments). Finally, it may be argued that in oligopolistic industries, resources may be spent on deterring rivals, and this can lead directly to production inefficiency. The use of excess capacity (too high capital intensity) to make entry deterrence credible is an example of this.

Overall, therefore, there is some theoretical basis for the belief that competition drives productivity improvements forward. But the basis is not, as yet, a strong one.

III. The Empirical Background

Perhaps the most compelling evidence on the power of competition to generate productivity growth is the most broad-brush. Three simple examples follow. First, the low level of productivity in Eastern Europe relative to that in Western Europe is an impressive example of what can be achieved by repressing the forces of market competition. Second, Porter (1990) demonstrates clearly the key role of domestic competition in generating world-beating industries. For example, the Japanese success stories (e.g., cars, motorcycles, cameras, video recorders, and musical instruments) are precisely those industries in which domestic competition is intense. Those Japanese industries in which domestic competition is feeble have little or no international success (e.g., construction, commodity chemicals, and paper). Third, deregulation is generally followed by significant productivity gains (see, e.g., Graham, Kaplan, and Sibley [1983] on the U.S. airline industry).

What of more "scientific" evidence? Here I consider a number of areas in turn.

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other effort-related variables (see Daniel and Millward 1983, pp. 197, 182; Millward and Stevens 1986, p. 248). So the notion that firms and unions bargain over wages and effort is quite consistent with the facts.

Competition and R & D.—Expenditure on R & D has an impact on productivity growth (see, e.g., Griliches 1986). Much effort has been devoted to analyzing the relationship between competition and R & D expenditure. Studies usually take the form of investigating industry cross-section partial correlations between market structure and R & D intensity. Unfortunately, these studies are typically uninformative because they control inadequately for technological opportunities, which differ substantially across industries and tend to be correlated with market concentration.[3] One study that avoids this problem is Geroski (1990), which uses panel data. This enables Geroski to control for technological opportunities by using industry fixed effects, and the evidence then suggests that concentration and other measures of monopoly power tend to *reduce* the rate of innovation and, hence, productivity growth.

Competition and technical efficiency.—In recent years there have been a number of comprehensive studies of technical efficiency, which are reported in Caves and Barton (1990), Green and Mayes (1991), and Caves et al. (1992). These studies make use of frontier production function techniques to estimate technical efficiency indices and relate them to variables of interest. The relevant finding is that an increase in market concentration above a certain threshold tends to reduce technical efficiency. This result emerges in a number of countries and is consistent with the finding in the management literature, discussed in Caves (1980, pp. 85–86), that competition leads to companies' employment of more efficient decision-making structures.

Competition, productivity, and productivity growth.—The Caves and Green/Mayes studies are cross-section based, but similar competition effects on the level of productivity are confirmed with panel data on industries (Haskel 1990) or firms (Nickell, Wadhwani, and Wall 1992; Hay and Liu 1994). In both examples, a fixed-effects framework is used to discover that market concentration or market share has an adverse effect on the *level* of (total factor) productivity. By the nature of the fixed-effects estimation procedure, what this means in practice is that an increase in market concentration or market share is followed by a ceteris paribus fall in productivity. This view relates the result to the observation by the Massachusetts Institute of Technology commission in the United States (Dertouzos, Lester, and Solow 1989) that plants at the top of the productivity distribution rest on their laurels and lose their competitive advantage.[4]

[3] For example, in the simple Dasgupta and Stiglitz (1980) framework, technological opportunities, as captured by the elasticity of cost reduction with respect to R & D expenditure, are positively correlated with both R & D intensity and market concentration.

[4] This result is not, however, confirmed by Baily, Hulten, and Campbell (1992).

With regard to productivity *growth* effects, Nickell et al. (1992) find that firms with high market share tend to have *higher* productivity *growth*, the reverse of the productivity level effect previously mentioned. This growth effect is, however, a cross-section result and therefore suffers from the problem that, in the long run, firms with relatively high productivity growth will tend to grow faster and gain market share. So one cannot interpret it as a genuine competition effect. More informative is the evidence presented in the study by Van Wijnbergen and Venables (1993), who find that the trade liberalization and deregulation undertaken by Mexico during 1986–88 led directly to an increase in competition and a significant increase in productivity growth.

To summarize, there is some evidence that competition is good for technical efficiency, total factor productivity, and innovation. Formal evidence is, however, very thin, and, in particular, there is very little useful econometric evidence on the more interesting relationship between competition and productivity *growth*.

IV. The Empirical Formulation

I intend to use panel data on U.K. manufacturing sector companies to shed further light on the relationship between competition and productivity performance. In this section, I consider the basic model and data, measurement, and estimation problems.

The Productivity Equation

My framework utilizes a constant-returns, Cobb-Douglas production function, although I shall consider the effects of relaxing both the constant-returns and the Cobb-Douglas constraints. My basic model has the log-linear form

$$\begin{aligned} y_{it} = \beta_i + \beta_t + \lambda y_{it-1} + (1-\lambda)\alpha_i n_{it} + (1-\lambda)(1-\alpha_i)k_{it} \\ + \alpha_1 h_{it} + c_{it} + c_i t + \epsilon_{it}, \end{aligned} \tag{1}$$

where y_{it} is log real (value-added) output, n_{it} is log employment, k_{it} is log capital stock, h_{it} is a cyclical component, c_{it} reflects all factors capturing the impact of competition on the *level* of productivity, c_i reflects those factors that cover the impact of competition on productivity *growth*, i is the firm subscript, t is the time subscript, and β_i and β_t are firm effects and time effects. The former covers all unobserved company-specific factors influencing the level of productivity, and the latter captures shocks common to all firms. Finally, ϵ_{it} captures all other shocks to company productivity, and I suppose this error to be serially uncorrelated. Absence of serial correlation is assisted by the inclusion of dynamics in the form of a lagged dependent variable. This is the simplest way of capturing the fact that, whenever factors of production are changed, it typically takes some time for output to reach its new long-run level. For example, if new capital goods are purchased, it may take a considerable time before the new machines are fully operational.

Estimation

Before I discuss how I measure competition effects, it is useful to see how I intend to estimate the parameters of this model. To eliminate the firm effects, β_i, I simply difference the production equation (1) to obtain, after some rearrangement,

$$\Delta(y_{it} - k_{it}) = \Delta\beta_t + \lambda\Delta(y_{it-1} - k_{it}) + (1 - \lambda)\alpha_i\Delta(n_{it} - k_{it}) + \alpha_1\Delta h_{it} + \Delta c_{it} + c_i + \Delta\epsilon_{it}. \tag{2}$$

In order to see the implications of this, note first that important components of the error term are those productivity shocks that are directly related to employment or capital intensity.[5] For example, autonomous shocks to effort (e.g., increasing the speed of the production line) may induce a rise in output and a possible fall in employment. In order to avoid the corruption of the parameter estimates caused by possible correlations between n_{it} or k_{it} and ϵ_{it}, I treat both employment and capital as endogenous. Furthermore, note that, after differencing, y_{it-1} is correlated with the equation error. As long as the basic error, ϵ_{it}, is serially uncorrelated, all lags on y, n, and k beyond $t - 1$ are valid instruments. Instrumental variable estimators based on this fact are essentially generalized method of moments estimators, making use of the moment restrictions generated by the serially uncorrelated error. This technique is due to Arellano and Bond (1991) and, of course, depends crucially on the absence of serial correlation in ϵ_{it}. This may be investigated using serial correlation tests developed by Arellano and Bond as well as via standard instrument validity tests.

Data Definitions and Measurement Issues

My data source is the published accounts of around 700 U.K. manufacturing companies over the period 1972–86. These data are aug-

[5] The other important component of the error is the skill composition of the workforce. Of course, only variations in this matter since the fixed effects deal with the remainder. Any cyclical components of skill variation will be captured by h_{it}, and there seems no obvious reason why noncyclical variations should be correlated with any of the included variables.

mented by a postal survey of a subset of the companies carried out by me and Sushil Wadhwani in 1989. From this, I obtain usable data from 147 companies. There is an unbalanced panel, with the sample peaking in 1977. The rapid decline in the sample size after 1981 does not reflect sample attrition but simply the fact that, because of changes in the reporting of employment in company accounts in 1982, consistent employment series are not available for the majority of companies across that date.

Data definitions for some of the variables are worth discussing here because they have important implications for the interpretation of the results. Complete definitions are available in the Data Appendix.

Output, y_{it}.—I use two alternatives to capture log value-added: (1) the value of sales deflated by a three-digit industry-specific price deflator and (2) value-added deflated in the same way. The reason why I use sales at all is that the value-added data are not quite as accurate. To generate the latter, I use accounting data on the wage bill plus pretax profits plus interest payments and depreciation. Unfortunately, accounting data on profits may differ somewhat from the true numbers, which causes the problem with value-added estimates.[6]

Employment elasticity, α_i.—This coefficient may vary across companies, so I either treat it as a constant, allowing the random elements to revert to the error term (incidentally producing another reason for the endogeneity of n and k), or suppose that $\alpha_i = \Sigma_j \alpha_j d_j$, where d_j are two-digit industry dummies.

Cycle measure, h_{it}.—Here I follow Muellbauer (1984) and use $\alpha_{11}(H_{ojt}/H_{njt}) + \alpha_{12}(H_{ojt}/H_{njt})^{-1}$, where H_o measures overtime hours per worker in industry j and H_n measures standard hours per worker. This form captures the asymmetry due to the fact that, in slumps, measured hours tend to overstate hours actually worked.

Competition measures, c_{it}, c_i.—The following relevant data are available: measures of market share at the firm level (mksh_{it}), measures of concentration (conc_{jt}) and import penetration (imp_{jt}) at the three-digit industry level, a survey-based measure of competition at the firm level for one time period only (comp_i), and a measure of average rents normalized on value-added (rents_i). These last two are important variables, so it is worth indicating how they are defined. The first of these (comp) is a dummy taking the value one if the management of the company answers yes to the question "Have you more than five competitors in the market for your product(s)?" and zero if the management answers yes to the question "Have you five or fewer competitors in the market for your product(s)?" The evidence pro-

[6] For example, bad debts are taken out of profits, realized gains on quoted investments are included, and some firms write off R & D expenditures against profits.

vided by Stewart (1990) indicates that this variable has considerable discriminatory power. For example, union wage effects are considerably smaller in "competitive" firms.[7] The second variable (rents) is an average over the sample period of profits less capital costs, normalized on value-added. Because I have no information on skill levels, I make no attempt to take account of worker rent capture by using alternative wages, instead of actual wages, as the measure of labor costs. So my rents measure reflects the ex post rents available to shareholders rather than the theoretically preferable ex ante rents that are potentially available to all stakeholders and may be dissipated in the form of higher pay and lower effort. However, it seems likely that the ex post rents, although lower, are highly correlated with ex ante potential rents.

Before I go into these measures in detail, it is worth noting that, because of the use of the fixed-effects panel data framework, the attempt to isolate the impact of competition on the *level* of productivity is essentially a search for a time-series effect. Indeed, it is clear from (2) that we are concerned with the impact of changes in the level of competition (Δc_{it}) on changes in productivity. This contrasts starkly with the investigation of the impact of competition on productivity *growth*. From equation (2) again, it is clear that this involves looking at the cross-section correlation between competition (c_i) and productivity growth. This distinction is very important for the specification of the model, as we shall see.

The role of market share.—There are a number of problems associated with the use of market share as a measure of market power (an inverse measure of competition). (i) Collusion depends not only on the size of the various firms involved relative to the market but also on other factors that are hard to control. They include asymmetries in cost and the ability of companies to "hide" their price changes, for example. (ii) Potential as well as actual competition influences market power. (iii) My measure of market share does not fully reflect foreign competitors. (iv) My measure of market share uses three-digit industry sales as the denominator. This is far from the correct measure because the three-digit industry does not represent anything like the "market." More particularly, the ratio of the true market size to the measured market size could vary enormously from firm to firm, even within an "industry."

These problems suggest that my estimate of market share has little value as a cross-section measure of market power. However, if it is

[7] Somewhat fortuitously, the number five appears to be quite important according to the evidence in Bresnahan and Reiss (1991). They find that increases in the number of firms operating in a market up to around five have significant effects in reducing market power.

used as a time-series measure of market power, the problems above are less serious. The omitted and unobservable factors are likely to be relatively stable over time, which implies that one might expect there to be some correlation between changes in the measure of market share and changes in a true measure of market power. Thus it is worth using Δmksh_{it} as an inverse measure of changes in the extent of competition. Furthermore, to eliminate reverse causality (high productivity growth leading to improvements in market share), I shall lag the variable two years and use $\Delta \text{mksh}_{it-2}$.

Turning now to the impact of competition on productivity *growth,* here I intend to focus on the survey measure of competition (comp_i) and on the ex post measure of the absence of competition (rents_i). With regard to the survey measure, since the managers of a company are more aware than anybody of the identity of their competitors, one can argue that problems iii and iv do not apply to this variable. Furthermore, it seems likely that the most significant cross-section variation in the omitted factors noted under problems i and ii occurs *between* industries, so the use of industry dummies would deal with much of this problem. Concerning the rents measure, we see the rents as being generated by lack of competition, and because it is an ex post measure, it can be viewed as complementary to the survey-based variable. Finally, we must note the reverse causality problem. Firms with relatively high productivity growth may, in the long run, become dominant in their market. Since we are looking at a cross-section correlation here, this problem is hard to avoid. We can attempt an instrumental variables approach, but this is rarely persuasive in a cross-section context because of the lack of good instruments. Luckily, however, reverse causality yields the opposite sign. High productivity growth in a company strengthens its market position and *reduces* the effective competition it faces. So if we find a *positive* relationship between productivity growth and competition, we might argue that the true relationship is even stronger.

To summarize, therefore, I shall specify the competition effect on the level of productivity, c_{it}, as

$$c_{it} = \alpha_2 \text{mksh}_{it-2} \tag{3}$$

and the productivity growth effect, c_i, as

$$\begin{aligned} c_i = \alpha_3 \text{comp}_i + \alpha_4 \text{rents}_i + \sum_j \alpha_4^j d_j + \alpha_{51} \text{size}_i \\ + \alpha_{52} \text{conc}_{j.} + \alpha_{53} \text{imp}_{j..} \end{aligned} \tag{4}$$

In the latter formulation, I include two-digit industry dummies and averages of firm size, industry concentration, and industry import penetration simply as additional cross-section controls. The impact of industry concentration and import penetration on productivity growth may be of some interest, although the effects of comp and rents are the keys, as I have already indicated. In conclusion, the equation I estimate has the form

$$\begin{aligned} y_{it} = {} & \beta_i + \beta_t + \lambda y_{it-1} + (1-\lambda)\alpha_i n_{it} + (1-\lambda)(1-\alpha_i)k_{it} \\ & + \alpha_{11}\left(\frac{H_{ojt}}{H_{njt}}\right) + \alpha_{12}\left(\frac{H_{ojt}}{H_{njt}}\right)^{-1} + \alpha_2 \text{mksh}_{it-2} \\ & + \left(\alpha_3 \text{comp}_i + \alpha_4 \text{rents}_i + \sum_j \alpha_4^j d_j + \alpha_{51}\text{size}_i \right. \\ & \left. + \alpha_{52}\text{conc}_{j.} + \alpha_{53}\text{imp}_{j.}\right) t + \epsilon_{it}. \end{aligned} \tag{5}$$

The results of the investigation are reported in the next section.

V. Results

The main results are presented in tables 1 and 2. I have a sequence of estimated equations to investigate the robustness of the key results, with regard to both changes in the equation specification and changes in the data sample. In table 1, I use an unbalanced panel of 147 companies for which I possess management survey data on the number of competitors. In columns 1–5, I compare the impact of the survey-based measure of competition and the rents-based measure, using a number of different measures of rent. Then in column 6 I allow the output-employment elasticity to vary across industries, and in column 7 I relax the Cobb-Douglas restriction. In column 8, I restrict the instruments to those dated $t - 3$ or before, and then in columns 9 and 10 I replace sales as the output variable by a measure of value-added. In table 2, I report results from a much larger sample of 676 companies that does not contain management survey information on the number of competitors. All the equations have company effects and time effects as well as two-digit industry-specific time trends.[8] They control for fixed company-specific and aggregate effects on the level of productivity and fixed industry effects on productivity growth.

Returning to the results in table 1, we see first that the rents measure dominates the survey-based competition measure (see col. 2),

[8] The industry-specific time trends simply reflect industry dummies in the estimated first-difference model.

TABLE 1

ESTIMATES OF THE PRODUCTION FUNCTION (Eq. [5]), 1975–86

Dependent Variable: y_{it}

Independent Variable	Basic Equation (1)	Includes Competition (2)	Excludes Rent (3)	Includes Alternative Measures of Rent (4)	Includes Alternative Measures of Rent (5)	Employment Interacted with Industry Dummies[†] (6)	Adds CES Term (7)	Instruments Dated $t-3$ (8)	Value-Added as Dependent Variable: Basic Equation (9)	Value-Added as Dependent Variable: Includes Competition (10)
$^*y_{it-1}$	.28	.26	.34	.29	.28	.21	.28	.07	.06	.15
	(3.2)	(3.0)	(4.0)	(3.3)	(3.1)	(2.6)	(3.1)	(.6)	(.6)	(1.5)
$^*n_{it}$	.41	.45	.52	.43	.38		.53	.57	.51	.60
	(3.0)	(3.8)	(4.2)	(3.0)	(2.7)		(3.0)	(3.1)	(3.6)	(4.7)
$^*k_{it}$	.31	.29	.14	.28	.34		.19	.36	.43	.25
H_{ojt}/H_{njt}	1.53	1.54	1.84	1.48	1.58	1.13	1.71	1.15	1.60	1.95
	(2.4)	(2.4)	(2.7)	(2.3)	(2.4)	(1.4)	(2.7)	(1.7)	(1.6)	(1.9)
$10^{-3}(H_{ojt}/H_{njt})^{-1}$	.63	.61	.48	.67	.56	.79	.47	.60	.088	.12
	(1.5)	(1.4)	(1.0)	(1.6)	(1.3)	(1.3)	(1.2)	(1.1)	(.1)	(.1)
mksh_{it-2}	−3.49	−3.42	−3.17	−3.41	−3.72	−2.02	−3.34	−4.46	−4.38	−4.19
	(2.1)	(2.0)	(2.1)	(2.0)	(2.2)	(1.1)	(1.8)	(2.2)	(1.8)	(1.8)
$(\text{conc}_j.)t$	−.12	−.14	−.11	−.097	−.13	−.13	−.13	−.16	−.17	−.17
	(2.1)	(1.9)	(2.0)	(1.8)	(2.3)	(1.8)	(2.3)	(2.3)	(1.9)	(2.2)

$(\text{imp}_{j\cdot})t$	.084	.11	.11	.073	.079	.086	.083	.12	.13	.17
	(1.6)	(1.4)	(1.5)	(1.3)	(1.4)	(1.1)	(1.5)	(1.7)	(1.3)	(1.8)
$^*(\text{size}_i)t$	.40	.53	.84	.39	.30	−.13	.29	.59	.39	.39
	(1.3)	(1.4)	(1.9)	(1.3)	(1.0)	(.3)	(.9)	(1.7)	(1.0)	(.8)
$^*(\text{comp}_i)t$		.026	.065							.071
		(.6)	(2.0)							(1.8)
$^*(\text{rent}_{1i})t$	−.13	−.11				−.15	−.13	−.18	−.12	
	(2.9)	(2.2)				(2.7)	(3.0)	(3.7)	(2.3)	
$^*(\text{rent}_{2i})t$				−.16						
				(2.7)						
$^*(\text{rent}_{3i})t$					−.13					
					(3.0)					
$^*(n_{it} - k_{it})^2$							.046			
							(1.3)			
Serial correlation [$N(0, 1)$]	.70	.70	.73	.74	.78	.20	.76	.67	−1.15	−.99
Instrument validity	$\chi^2(68) = 73.4$	$\chi^2(67) = 74.4$	$\chi^2(68) = 78.9$	$\chi^2(68) = 74.8$	$\chi^2(68) = 72.5$	$\chi^2(56) = 60.4$	$\chi^2(67) = 73.0$	$\chi^2(65) = 74.5$	$\chi^2(68) = 78.2$	$\chi^2(68) = 78.5$
Standard error	.094	.092	.095	.094	.094	.107	.095	.092	.126	.123

NOTE.—The number of firms is 147, and the number of observations is 978. The dependent variable is log(real sales) except in cols. 9 and 10, where it is log(real value-added). All equations are estimated in first differences and include both time dummies and two-digit industry dummies. Long-run constant returns is imposed in all equations by estimating the equation in the form of (2) in the text. Firm size is measured by $10^{-2}(n_{i\cdot})$. Instruments include $y_i(t-2, t-3)$, $k_i(t-2, t-3)$, and $n_i(t-2, t-3)$. In col. 8, instruments dated $t-2$ are omitted and those dated $t-4$ are included. The equations are estimated using the Dynamic Panel Data package, written and described by Arellano and Bond (1991). All columns report a consistent one-step estimator, where the minimized criterion takes no account of heteroskedasticity but the standard errors are robust to heteroskedasticity of general form. Results based on a two-step estimator, which is fully efficient, are much the same but with very much lower standard errors. However, these results are not reported because Monte Carlo experiments reported in Arellano and Bond indicate that the computed standard errors appear to overstate the efficiency gains, so the t-ratios are likewise overstated.

* Variables that are treated as endogenous.

† Col. 6 interacts the employment term with 13 two-digit industry dummies.

TABLE 2

ESTIMATES OF THE PRODUCTION FUNCTION USING ALTERNATIVE SAMPLE, 1975–86

Dependent Variable: y_{it}

Independent Variable	(1)		(2)		(3)	
$^*y_{it-1}$	.11	(1.7)	.16	(2.7)	.10	(1.6)
$^*n_{it}$	.77	(9.0)	.84	(10.4)	.73	(8.3)
$^*k_{it}$	.13		.0		.17	
H_{ojt}/H_{njt}	.97	(2.9)	1.00	(3.0)	.96	(2.9)
$10^{-3}(H_{ojt}/H_{njt})^{-1}$	.097	(.4)	.16	(.6)	.072	(.3)
mksh_{it-2}	−1.25	(2.4)	−1.13	(2.0)	−1.30	(2.5)
$(\text{conc}_{j}.)t$	−.053	(1.8)	−.024	(.8)	−.061	(2.0)
$(\text{imp}_{j}.)t$	−.018	(.6)	−.028	(1.0)	−.023	(.8)
$^*(\text{size}_i)t$	.48	(3.1)	.49	(3.3)	.39	(2.5)
$^*(\text{rent}_{1i})t$	−.16	(4.7)				
$^*(\text{rent}_{2i})t$			−.17	(4.8)		
$^*(\text{rent}_{3i})t$					−.17	(4.7)
Serial correlation [$N(0, 1)$]	1.04		.43		1.42	
Instrument validity	$\chi^2(68) =$	137.8	$\chi^2(68) =$	137.0	$\chi^2(68) =$	138.3
Standard error	.092		.094		.092	

NOTE.—The number of firms is 676, and the number of observations is 4,423. See also notes to table 1.

although they are jointly significant ($\chi^2(2) = 7.4$) and the survey-based measure is significant when the rents measure is dropped (see col. 3). This indicates some degree of collinearity but, nevertheless, reveals a strong impact of competition on productivity growth (i.e., a positive effect of number of competitors and a negative effect of rents). In columns 4 and 5, we see that the results are robust to the use of alternative measures of rents, the variation being in their treatment of the risk premium in the measure of the cost of capital (see the Data Appendix).

If we allow the output-employment elasticity to vary across industries (col. 6), there is no impact on the rents coefficient.[9] The same applies if we relax the Cobb-Douglas restriction (col. 7) or use deeper lags in the instruments (col. 8), thereby making them less susceptible to serial correlation in the errors. Furthermore, if we replace sales by value-added as the dependent variable (cols. 9 and 10), we again see

[9] It is also worth reporting that this remains true if we relax the constant-returns constraint. The key coefficients are

$$\underset{(2.3)}{-3.92\,\text{mksh}_{it-2}} - \underset{(2.4)}{0.12(\text{rent}_{1i})t}.$$

Freely estimated, the data push us rather strongly toward *diminishing* returns, which is not unusual in a dynamic time-series context. In my view, this is inherently most unlikely and probably arises because of inadequately controlled measurement error in n and k, strongly accentuated by differencing. For the purposes of investigating total factor productivity effects, it is better simply to impose constant returns.

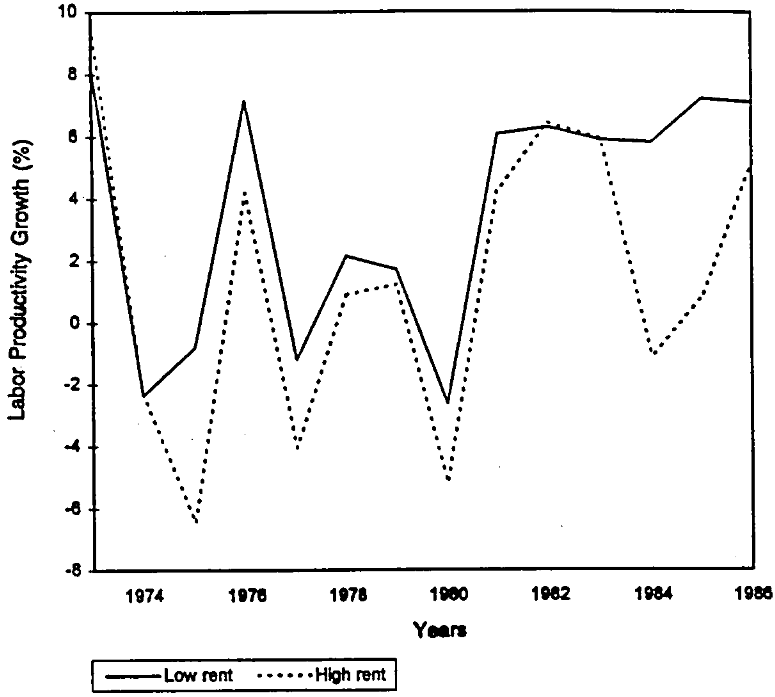

FIG. 1.—Labor productivity growth in high- and low-rent firms. The sample is divided into "low" and "high" at the median.

little change in the overall structure of the equation. So the overall conclusion from this sample is that we observe a robust and significant effect of the measures of competition on productivity *growth*, controlling for two-digit industry effects and firm size as well as concentration and import penetration in the three-digit industry in which the firm is located. Furthermore, even if a reverse causality problem remains after the relevant variables are treated as endogenous, the results still imply a significant effect for competition because reverse causality would tend to *reduce* its measured impact (higher productivity growth in a firm would tend to increase its market power and rents, reduce competition, and make the firm more dominant).

Next, we can ask whether or not the rents effect on productivity growth remains if the sample is expanded to include those firms for which there is no survey information on the number of competitors. This sample has over four times the number of firms, but, as we can see from table 2, the negative impact of rents on productivity growth is much the same and is highly significant. In order to confirm that this result does not follow from any econometric trickery, we see in figure 1 that if the sample is divided into high- and low-rent firms,

TABLE 3

PERCENTAGE POINT TFP GROWTH RATE DIFFERENTIALS GENERATED BY DIFFERENCES IN COMPETITION

Food, drink, and tobacco	−.2	Metal goods (other)	.8
Chemicals	−.8	Textiles	.9
Metal manufacture	−1.7	Clothing and footwear	1.0
Mechanical engineering	1.0	Bricks, pottery, and glass	2.0
Instrument engineering	−.6	Timber and furniture	1.6
Electrical engineering	−2.4	Paper, printing, and publishing	1.9
Vehicles	−1.3	Other manufacturing	−2.2

NOTE.—These are differentials from the unweighted mean.

the high-rent firms have *lower* labor productivity growth, on average, than the low-rent firms in almost every year of the sample period. Finally, it is worth remarking on the systematic negative effect of (three-digit) industry concentration, which hints that firms in less concentrated industries tend to have higher total factor productivity (TFP) growth rates, ceteris paribus.

Now that we have discovered that increased competition appears to be associated with higher TFP growth, it is worth trying to pin down the size of this important effect. If we take all the companies and rank them on the basis of rents (rent_1 is the measure used; see the Data Appendix), at the eightieth percentile, rents normalized on value-added are 0.29. At the twentieth percentile, the corresponding value is zero. When the rent_1 coefficients in table 1 and table 2 (col. 1) are used, this spread generates a ceteris paribus difference in TFP growth of between 3.8 and 4.6 percentage points in favor of the firm generating lower rents and, therefore, operating in the more competitive environment. This is clearly a significant effect, suggesting that competition can have an important role in influencing TFP growth.

Alternatively, we may use the rent and concentration ratio coefficients in column 1 of table 2 to generate a competition index equal to $-0.053\text{conc}_j - 0.16\text{rent}_1$. This measures the ceteris paribus impact of increases in rents and concentration in the firm's industrial sector on TFP growth. In table 3, I present the ceteris paribus industry TFP growth differentials generated by the differences in the average value of the competition index across industries. They capture differences in industry TFP growth rates caused by differences in the degree of competition. Again, these differences are quite substantial and are broadly consistent with other evidence on the extent of competition in various industries. It is, of course, important to recognize that these are differences in TFP growth generated by competition.

Technological opportunities will also differ substantially across industries and will have an important impact on the final outcome.

Let us now look at the impact of lagged market share on the *level* of productivity. This is essentially a time-series effect, where we attempt to detect falls in productivity two years after increases in market share. In all samples and all variants the effect is present, although sometimes only on the borders of significance.[10] However, its size differs systematically across the two samples (cf. table 1 with table 2). I pursued this last issue further by replacing absolute changes in market share by proportional changes. Now there are long-run effects that are closer in scale across the two samples, namely -0.042 and -0.028. This suggests that a 25 percent increase in market share leads to a 1 percent fall in total factor productivity in the *long run.*

VI. Summary and Conclusions

Are people right to think that competition improves corporate performance? Here I find that there are some theoretical reasons for thinking that competition might improve performance, but they are not overwhelming. I also see that there exists some empirical evidence in favor of this view, but again it is not overwhelming. Indeed, the broad-brush evidence from Eastern Europe and Japan is, if anything, more persuasive than any detailed econometric evidence. However, there is support for the general thesis in the empirical results. First, I find that market power, as captured by market share, generates reduced levels of productivity. Second and much more important, I present evidence that competition, measured either by increased numbers of competitors or by lower levels of rents, is associated with higher rates of total factor productivity growth. This is one of the first available pieces of systematic evidence that competition enhances growth rates.

Finally, it is worth entertaining the thought that we are barking up the wrong tree. Perhaps competition works not by forcing efficiency on individual firms but by letting many flowers bloom and ensuring that only the best survive (see, e.g., Jovanovic 1982). If there are lots of ways of doing things, competition allows many to be tried and then selects the best, something a monopoly finds hard to replicate. Focusing on the firms, as I have done, will not allow one to detect

[10] It has been suggested that because the numerator of the market share variable is the dependent variable, its second lag is simply picking up a negative second-order autoregression in output. If the second lag in output is included in the basic equation, it does indeed have a negative sign, but it is not significant (t = 0.4) and the coefficient on lagged market share is -3.94 (2.5), much the same as in the basic equation.

this kind of phenomenon. How to detect it in any general way is a problem awaiting a solution.

Data Appendix

The data are taken from the EXSTAT company database, which is based on the published accounts of U.K. quoted companies and is available from Extel Financial. The data take the form of an unbalanced panel, and the numbers of observations are given in table A1. Firms are selected from the EXSTAT data file of quoted companies in the manufacturing sector according to the following criteria: (i) they answered a postal questionnaire concerning the number of competitors (sample 1); (ii) there was enough information present to make an estimate of value-added; (iii) the number of consecutive periods for which data are held is at least six; and (iv) the accounts are prepared in a standard way; that is, the accounts marker is not relevant (item C25). The falloff in the numbers from 1982 corresponds to a change in the legal requirements concerning the reporting of employment in company reports, and only a small number of companies continued to report employment after July 1982 on a basis that was consistent with that used prior to that date.

Firm-Specific Variables

Output (y): Sales/turnover (EXSTAT item C31). This is normalized on an industry-specific price index (see below).

Value-added (y): Cost of employees (C16 + C18 + C72) + profits before tax (C34) + depreciation (C52) + interest payments (C53 + C54). This is normalized on an industry-specific price index (see below).

Employment (n): Number of employees (C15). This variable is recorded by EXSTAT as domestic employment. However, I have good reason to believe

TABLE A1

NUMBER OF OBSERVATIONS BY YEAR

	Sample 1	Sample 2
1972	92	423
1973	94	436
1974	98	451
1975	105	495
1976	143	650
1977	146	670
1978	145	665
1979	145	666
1980	144	662
1981	139	622
1982	72	309
1983	29	126
1984	26	103
1985	21	89
1986	20	84

that even in the small minority of firms in the sample that have overseas employees (around 14), this variable mostly reflects total employment.

Capital (k): This is based on transforming net tangible assets at historic cost into the same variable at current replacement cost and then normalizing on the price index for plant and machinery. This is an extremely complex calculation, and full details are provided in Wadhwani and Wall (1986).

Market share (mksh): Total sales in each industry (TSALS) is calculated as $\text{TSALS}_{jt} = N_j \text{AVSALS}_{jt}$, where AVSALS_{jt} is the average sales of a firm in industry j at year t and N_j is the number of firms in industry j in a chosen base year (1980). The number of firms is kept constant over years to correct for the changing firm base of the sample. (The sample used to obtain these data includes about 1,200 firms, including all the major quoted companies in the industry.) The market share is obtained as sales in firm in year t (EXSTAT item C31) $\div$ TSALS_{jt}.

Competition dummy (comp): This takes the value one if the managers of the firm answer yes to the question "Have you more than five competitors in the market for your product(s)?" and zero if the managers answer yes to either "Is your organization the main supplier of your product(s)?" or "Have you only a few ($\leq$ 5) competitors?" This is dated 1989. I also have this variable dated 1984. The values it takes are the same for all but a handful of firms, and if this is used instead of the 1989 variable, the results are much the same.

Rents nomalized on value-added (rents): Rents are defined as profits before tax (C34) + depreciation (C52) + interest payments (C53 + C54) − cost of capital × capital stock. The capital stock is the replacement cost capital stock at current prices (see above under capital). The cost of capital is equal to $rr + \delta + \lambda\rho$, where rr is the real interest rate, δ is the rate of depreciation, ρ is the risk premium, and λ is a weight ($0 \leq \lambda \leq 1$). The real interest rate is equal to the annual real gross redemption yield on 2 percent Treasury index linked 1996 securities. They were issued in 1981. Prior to this date, the real interest rate is assumed to be constant at its 1981 level. It is worth noting that the real interest rate measured in this way fluctuates very little. Between 1981 and 1986, the minimum is 2.81 percent and the maximum is 3.94 percent. The depreciation rate is assumed to be constant at 4 percent. The risk premium is equal to the firm's average stock market return over the period 1972–86 less the average short-term interest rate over the same period. The three rent variables used in the paper correspond to three different values of λ. The variable rent_1 has λ = shareholders' funds (C132) $\div$ [shareholders' funds (C132) + debentures (C136 + C137) + bank loans (C140) + other loans (C141) + bank overdrafts (C148) + acceptance credits (C149) + short-term borrowings (C150)]. That is, $\lambda \simeq$ equity/(equity + debt). The variable rent_2 has $\lambda = 0$, and rent_3 has $\lambda = 1$. The rents variable is normalized on nominal value-added defined above. Note that since the cost of capital depends on the stock market return and rents are decreasing in the cost of capital, this suggests that there will be a negative relationship between rents and stock market returns. If firms with market power have higher returns, this will generate an unfortunate negative correlation between rents and market power. Fortunately, the efficiency of the stock market ensures that firms with market power do not have higher returns, on average.

Industry-Specific Variables

Prices: Producers' price indices for three-digit industries taken from *British Business* (*Trade and Industry* until 1979) and unpublished data from the Business Statistics Office.

Concentration ratio (five firms) (conc): Source is the *Census of Production,* summary tables PA1002, table 13.

Import penetration (imp): Ratio of imports to home sales. Source is the *Census of Production,* summary tables.

Overtime hours (H_o): Weekly overtime hours per operative on overtime times the fraction of operatives on overtime.

Standard hours (H_n): Normal weekly hours. Both H_o and H_n are taken from the *Employment Gazette.*

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