Research in Economics (2002) **56**, 299–332
doi:10.1006/reec.2001.0278
Available online at http://www.idealibrary.com on IDEAL®

Product market competition, corporate governance and firm performance: an empirical analysis for Germany

SILKE I. JANUSZEWSKI[†], JENS KÖKE[‡] AND JOACHIM K. WINTER[§]

[†]*Massachusetts Institute of Technology*
[‡]*Centre for European Economic Research (ZEW), Mannheim*
[§]*University of Mannheim*

(*Received 5 March 2001, accepted 13 November 2001*)

Summary

This study examines the impact of product market competition and corporate governance on productivity growth in German manufacturing. Using a panel of almost 500 firms over the years 1986 to 1994, we find that firms experience higher productivity growth when operating in markets with intense competition. Similarly, productivity growth is higher for firms under control of a strong ultimate owner, but not when the ultimate owner is a financial institution (a group that consisted almost exclusively of German banks and insurance firms in our sample period). Our results also indicate that competition and tight control are complements: The positive effect of competition is enhanced by the presence of a strong ultimate owner.
© 2002 University of Venice

J.E.L. Classification: D24, D43, G32.
Keywords: competition, corporate governance, productivity.

1. Introduction

Productivity growth has been slow in many continental European countries such as Germany and France over the last few decades, especially in comparison with the United States. Improving productivity is important not only to improve firm value, but also from a public policy perspective. For example, social security systems in many countries move away from pay-as-you-go financing into partially or fully funded systems, and therefore the rate of return on capital will be even more important as a determinant of future

 © 2002 University of Venice

generations' welfare than it has been in the past, as pointed out by Börsch–Supan and Winter (2001).

Many economists argue that there are two main reasons for poor firm performance in continental European countries, lack of product market competition and poor corporate governance; see Baily and Gersbach (1995), McKinsey Global Institute (1997), Börsch–Supan (1998), and Allen and Gale (2000). A number of theoretical papers investigate the effects of competition and corporate governance on firm performance, but the theoretical predictions are far from unambiguous. Moreover, empirical evidence is sparse, in particular at the level of individual firms. In this paper, we aim to close this gap with an econometric analysis of firm performance in Germany. We use a unique panel data set with detailed information on almost 500 manufacturing firms over the 1986 to 1994 period, and we apply an econometric approach which alleviates endogeneity problems that typically plague empirical studies of firm performance.

In order to get a preliminary understanding of productivity differences between countries, it is helpful to look at how labour, capital and total factor productivity have evolved over time. Figure A shows productivity comparisons between the United States and the continental European countries of Germany and France for 1970 to 1995; the productivity estimates are taken from McKinsey Global Institute (1997). The top panels demonstrate that the gap in capital productivity between Germany and the United States has been much larger than the gap in labour productivity. The bottom left panel suggests a possible reason for this: capital intensity has been higher in Germany than in the United States, favouring relatively high labour productivity, while at the same time total factor productivity has been low. Taken together, these figures show that labour and capital productivity have been higher in the United States than in Germany and France throughout this entire period, leading to substantially higher total factor productivity in the United States (bottom right panel).

The existing empirical evidence also suggests that poor capital performance in Germany, France and other continental European countries results in low rates of return on capital (Mueller and Yurtoglu, 2000; Börsch–Supan, 1998). In addition, sector-specific product market regulations in many European countries constrain exposure to international competition and cause firms to innovate less and rely on less efficient production processes, which also reduces productivity growth (see Baily and Gersbach, 1995).

So far, little empirical work has been done on the interaction of corporate governance and product market competition in determining productivity at the firm level. Nickell *et al*. (1997) are the first to analyse this question directly using a panel of U.K. firms. Bottasso and Sembenelli (2001) investigate the relationship

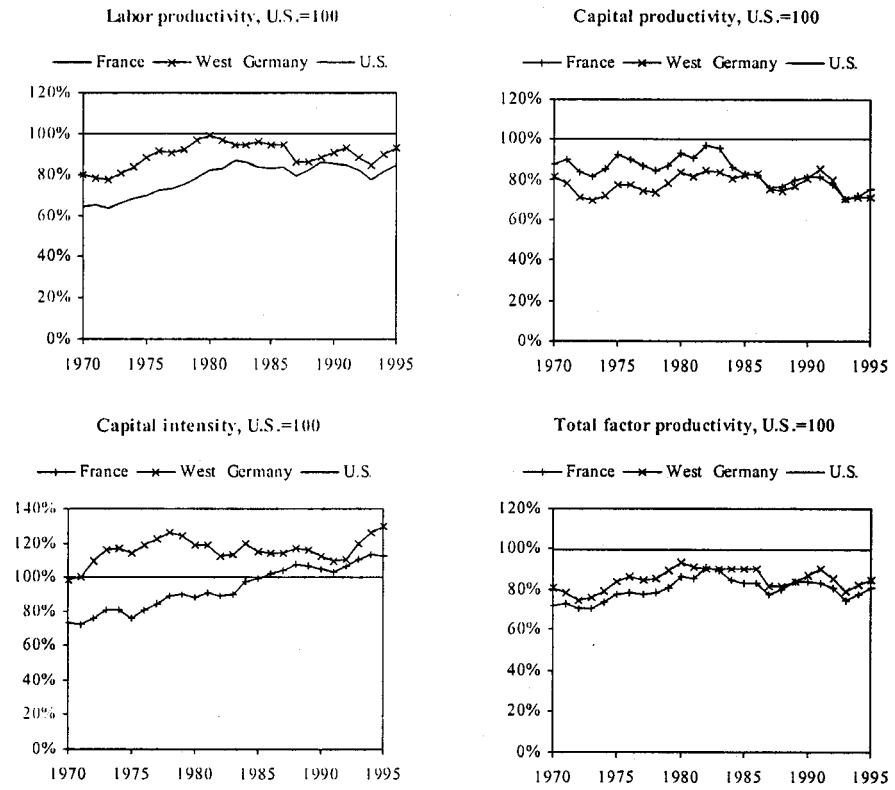

FIGURE A. Productivity trends in France, Germany, and the United States.

between market power and factor productivity in Italy. To our knowledge, there is no other formal firm-level study of productivity growth for bank-based continental European economies in which corporate governance problems are judged to be more severe than in market-based economies such as the United Kingdom or the United States. (Edwards and Fischer, 1994).

In this paper, we follow the approach of Nickell *et al.* (1997) and analyse the role of product market competition and corporate governance as determinants of productivity growth in German manufacturing firms. We restrict our attention to the manufacturing sector, because productivity dynamics in service industries are much more difficult to measure and to estimate in empirical models. Our empirical approach improves on existing empirical studies on corporate governance in Germany, such as Cable (1985) and Edwards and Nibler (2000), in two important respects, a very broad sample of firms and an econometric technique that controls for endogeneity problems.

In contrast with much of the existing empirical literature on corporate governance, with the exceptions of Nickell *et al.* (1997)

and Bottasso and Sembenelli (2001), our econometric approach allows us to control for the endogeneity of both product market competition and corporate governance. We estimate productivity growth equations using a fixed-effects generalized method of moments estimator introduced by Arellano and Bond (1991). While such an approach certainly does not solve all potential econometric problems, we believe that it is a step in the right direction.

Our main findings are (i) firms experience higher productivity growth when operating in markets with intense competition; (ii) productivity growth is higher for firms under control of a strong ultimate owner, but not when the ultimate owner is a financial institution; and (iii) competition and tight control are complements, that is, the positive effect of competition is enhanced by the presence of a strong ultimate owner.

The remainder of this paper is structured as follows. In Section 2, we review the existing theoretical and empirical literature on the relationship between product market competition, corporate governance and firm performance. We then describe the firm-level data used in our empirical analysis (Section 3). In Section 4, we present some preliminary evidence on the relationship of product market competition, corporate governance and firm productivity. Section 5 contains our empirical model of productivity growth and details of the generalized method of moments (GMM) estimation procedure. In Section 6, we present our estimation results. Section 7 concludes.

2. Literature on the determinants of firm productivity

The aim of corporate governance is to overcome incentive problems generated by the separation of ownership and control in non-owner operated firms. The main mechanisms by which corporate governance works are internal control and management compensation, designed to align managers' incentives with the owners' goals (see Shleifer and Vishny, 1997). However, corporate governance may not always be effective. Factors like concentration of share ownership, capital structure and board structure determine the owners' incentives to incur the cost of installing effective governance mechanisms.

Even in the presence of weak corporate governance, fierce product market competition may act to align managers' goals with the aim of efficient production; Allen and Gale (2000) provide a review. For example, Holmström (1982) and Nalebuff and Stiglitz (1983) show in a setting with cost functions which are stochastic but identical across agents (or firms, respectively) that perfect competition reveals full information to the owners about the realization of common cost shocks. In this case, relative performance evaluation can

induce optimal management performance. Hart (1983) compares two situations with independent and with positively correlated cost functions, respectively, showing that, when costs are correlated, competition reduces the amount of managerial slack. However, Scharfstein (1988) shows that Hart's results depend on the extent of managers' assumed risk aversion. Scharfstein presents a model that is similar to Hart's but assumes a different utility function. The result is contrary to Hart's: increased product market competition leads to more slack.

Hermalin (1992) identifies four mechanisms of the influence of product market competition on management performance. These are an income effect of reduced profits in a more competitive environment, a risk-adjustment effect if profit risks vary with the degree of competition, an effect of change in returns to managerial effort, and the effect of improved information in the presence of more rival firms. None of these effects is unambiguous in the sense of either reducing or increasing agency costs with increased competition, but Hermalin shows that if the income effect is positive (i.e. if agency goods are normal) and dominates the other three effects, then agency costs decrease with intensified competition. Schmidt (1997) analyses the impact of competition on the threat of bankruptcy and resulting managerial effort. He finds that competition increases the likelihood of bankruptcy for inefficient firms and should, therefore, improve management performance.

In summary, theoretical analyses of the effects of product market competition and corporate governance on firm performance do not provide us with a clear prediction for the sign of these effects. Turning to the existing empirical literature, Caves (1992), Green and Mayes (1991), Blundell *et al*. (1995), and Nickell (1996) present evidence that increased product market competition is associated with higher firm productivity or higher productivity growth. In a recent study with Norwegian establishment-level data, Klette (1999) provides evidence for a negative relationship between price-cost margins, as a measure for product market competition, scale economies and productivity.

The evidence on the effect of shareholder control on productivity is mixed; see Short (1994) for a survey of the empirical literature on ownership and firm performance. In a recent empirical study of the relationship between managerial ownership and firm performance, Himmelberg *et al*. (1999) stress that both ownership and performance are determined endogenously by changes in the firm's contracting environment. Controlling for observed firm characteristics and firm fixed effects, they find no evidence for the notion that changes in managerial ownership affect firm performance.

Finally, there is a small, but growing empirical literature on the interaction of corporate governance and product market competition in their influence on firm performance. Nickell *et al*. (1997) estimate the effect of product market competition, shareholder control, and debt levels on firm-level productivity growth in the United Kingdom, including interaction terms. Their results show a positive influence of product market competition, ownership control and financial pressure on productivity growth. In addition, they find evidence that both competition in product markets and financial pressure can substitute for internal control. In a similar framework, Nickell and Nicolitsas (1999) investigate how financial pressure affects firm behaviour, also using data from the United Kingdom. They find that an increase in financial pressure has a large negative effect on employment while it has a small positive effect on productivity. Bottasso and Sembenelli (2001) exploit the impact of the EU Single Market Program to assess the relationship between market power and productivity. Their main finding is that after an exogenous reduction in market power, productivity increases.

To our knowledge, there are no other empirical studies on the interaction of product market competition and corporate governance for continental European countries. Many studies (e.g. Edwards and Fischer, 1994) argue that control is much tighter in market-based than in bank-based economies. It is therefore interesting to compare the findings obtained by Nickell *et al*. (1997) for the United Kingdom—a market-based economy—with our empirical findings for Germany, an economy with a bank-based system of corporate governance and a complex ownership structure characterized by cross-holdings and poor external control structures. Köke (2001) provides descriptive evidence on ownership structures in German manufacturing.

3. Data and measurement issues

The sample used in this analysis is based on firm-level data for the years 1986 to 1994. The unbalanced panel comprises 491 German firms that operate in the manufacturing sector, with a total of 3465 firm years. In contrast to previous empirical studies on corporate governance in Germany (e.g. Cable, 1985; Gorton and Schmid, 2000; Becht and Böhmer, 2001) we do not restrict our analysis to large firms listed on the stock exchange, but also include non-listed firms. This is significant because it alleviates the selection bias caused by restricting the analysis to listed firms. Companies from former Eastern Germany are included only after 1990. In general, we follow Nickell *et al*. (1997) and Nickell and Nicolitsas (1999) in the construction of our variables, with some

adjustments to take account of data availability and institutional factors in Germany. In this section, we explain the composition of our sample and the economic principles that guide the construction of the variables used in our empirical analysis; precise definitions of these variables can be found in the data appendix.

3.1. DATA SOURCES

The analysis of product market competition and corporate governance and their impact on productivity growth is based on three sources of data. The first main pillar—balance sheet data used to estimate productivity growth—comes from Hoppenstedt's Balance Sheet Database (henceforth, BSD). An important feature of this data source is that it contains information on listed and non-listed corporations, both public (*Aktiengesellschaft*, AG) and private (*Gesellschaft mit beschränkter Haftung*, GmbH). We take 1986 as the starting year because a change in disclosure rules makes data from annual reports before and after the year 1986 incompatible.† The last year of the sample is 1994 because publication of our main source of ownership data, to be described shortly, was discontinued in that year. For the period 1986 to 1994, BSD contains 5222 firms (22 732 firm years) for which consolidated balance sheet data are available. We eliminate all firms that do not operate primarily in the manufacturing sector because productivity in industries such as financial (bank or insurance) or non-financial services (wholesale or retail trade) is hard to compare with productivity in manufacturing. We also eliminate firms operating in the utility, traffic and telecommunications industries, which were predominantly government-owned during the period of observation. Selection by industry leaves us with data on 1799 firms.

The second main pillar—data on ownership structures—is obtained from annual reports published by former Bayerische Hypotheken- und Wechsel-Bank (in short, Hypobank). These reports contain information on direct ownership of common stock for all listed and large non-listed German corporations. Hypobank reports the size and the name of a direct owner when the size of the ownership block exceeds 5%. However, the Hypobank data on *direct* ownership rights cannot readily be used because ownership complexity of German firms requires to examine *ultimate* firm ownership, as pointed out by Köke (2001). Therefore,

† In 1985 several changes were introduced in German corporate law (§289 HGB), most of them triggered by the European Community's Fourth Company Law Directive on the harmonization of national requirements pertaining to financial statements.

this study reconstructs voting rights information in a bottom-up approach from information on direct ownership rights (see Section 3·3).

After matching ownership data, we are left with a sample of 1057 firms. Because of missing values for important balance sheet items, another 140 firms must be eliminated. This selection procedure generates a sample of 917 firms (4001 firm years) with at least one year of balance sheet and ownership data during the years 1986 to 1994. Since the dynamic panel estimator, which we apply in the empirical analysis, requires at least three consecutive years of data, we further eliminate 426 firms for which we have less than three years of consecutive data. Almost all of these deleted firms have data only for the year 1994 since Hoppenstedt substantially increased firm coverage in 1994. The final sample contains 491 firms (3465 firm years).

The third main pillar of data—measures of product market competition—comes from several sources. Information on firm concentration at the four-digit industry level is obtained from biennial reports of the Federal Anti-Trust Commission (Monopolkommission, 1996). Information on the value of imports and domestic production at the two-digit industry level is obtained from the Federal Statistical Office, from *Außenhandelsstatistik* and *Produktionsstatistik* (Fachserie 4, Reihe 3·1), respectively. On the basis of these industry-level data we construct measures of competition, domestic as well as from abroad. In addition, we construct a firm-specific measure of competition based on balance sheet data (see Section 3·2).

The sample is fairly representative for the universe of large German corporations. Taking the number of all incorporated German firms in the year 1992 as a reference, coverage is high for listed firms (48·9%), all of which are public corporations. The sample includes all firms listed on any German stock exchange that mainly operate in the manufacturing sector. For non-listed firms, coverage is small for public corporations (8·9%) and weak for private corporations (0·02%). Controlling for firm size, the sample includes 66·1% of all public corporations with total sales exceeding 100 million DM, and more than 3% of large private corporations.

Sample attrition is a concern since it might result in selection biases. To test for a potential selection bias, we analyse information on firms' survival status. For firms leaving the sample before 1994, information is obtained from BSD and telephone interviews. We find that 31 out of 54 firms that exit the sample before 1994 still existed in 1994 without a change in ultimate ownership—they simply changed their name or stopped reporting owing to reasons determined within the firm. In 16 cases, operation was shut down due to liquidation or bankruptcy. In 7 cases, a firm had been taken

over by another entity. Hence, the majority of firm exits during the sample period are not related to firm failure or acquisition.†

3.2. MEASURING COMPETITION

The main variable used to measure competition is the firm's rents from production (*RENT*), which can be interpreted as an *ex post* measure of market power. The motivation for using this measure is that firms operating in less competitive markets should be able to sell their products well above marginal cost, and therefore earn higher rents after covering their expenses (on capital, labour and materials). The abstract definition of production rents, R_t, is as follows:

$$R_t = \frac{S_t - r_t^K p_t^K K_t}{Q_t}. \tag{1}$$

The denominator, Q_t, is real output (total sales), $p_t^Y Y_t$.‡ The numerator is a measure of the firm's real operating surplus, S_t, less real cost of capital, $r_t^K p_t^K K_t$. In this notation, Y_t is nominal output, L_t, K_t, and M_t are nominal labour, capital and materials inputs, while p_t^Y, p_t^L, p_t^K and p_t^M are the corresponding prices. Finally, r_t^K is the user cost of capital.

In the literature (e.g. Nickell, 1996), raw operating surplus, S_t, is measured by "earnings before interest, taxes and depreciation" (also known as EBITDA). This quantity contains a number of balance-sheet items that can potentially distort the economic content of this variable, resulting in values of EBITDA that are downward-biased measures of raw operating surplus. This problem is particularly severe in Germany, where firms are entitled to retain a large fraction of earnings to build up reserves. In our sample, this effect is large enough to make the mean of the rents variable negative in the pooled sample, with the implication that, loosely speaking, a large number of firms make losses most of the time. We therefore do not use balance-sheet EBITDA as a measure of raw operating surplus. Instead, we use an economic definition of raw operating surplus: sales less costs for materials and labour, hence $S_t = p_t^Y Y_t - p_t^M M_t - p_t^L L_t$. In economic terms, this definition is equivalent to the definition of EBITDA.

The user cost of capital is given by $r_t^K = \delta + r_t$, where δ is the depreciation rate and r_t is the risk-free market interest rate. An

† A more detailed analysis of sample representativeness and of potential biases introduced by our sample selection procedure is available on request. In addition, see Köke (2000) for an analysis of selection, entry, and attrition biases in a panel of firms that is identical to the one we use.

‡ We have also used real value added, $p_t^Y Y_t - p_t^M M_t$, in the denominator to check for robustness. All results reported below remain qualitatively unchanged.

alternative definition, which follows Nickell *et al.* (1997), also includes a firm-specific risk premium, $\tilde{r}_t$, implying $r_t^K = \delta + r_t + \tilde{r}_t$. In analogy to Nickell (1996), the risk premium is equal to the firm's average stock market return over the period 1986 to 1994 less the average short-term interest rate over the same period. For non-listed firms, we use the average industry- and year-specific risk premium that is observed for listed firms. In this study, we report results using both definitions: *RENT* is rents without risk adjustment, while *RENTR* uses the risk-adjusted interest rate. With this in mind, the abstract definition of firm rents in (1) can be rewritten in terms of observable quantities as follows:

$$R_t = \frac{(p_t^Y Y_t - p_t^M M_t - p_t^L L_t) - r_t^K p_t^K K_t}{Q_t}. \tag{2}$$

In addition to firm-specific rents, we use the market share of the six largest producers (*CR*6) and the respective Herfindahl index (*HHI*), both measured at the four-digit industry level, as proxy variables for competition. As a proxy for competition from abroad we use the ratio of imports to total market size (i.e. the sum of domestic production and imports), measured at the two-digit industry level (*IMPORT*).

There are two important caveats with respect to all measures of competition used in this paper. Firstly, we acknowledge that these variables do not reflect some important facets of competition, namely, potential entry and firm conduct. Secondly, as we do not have firm-specific data on market shares, we can only assign companies to their primary four-digit industry group, but we cannot adjust Herfindahl indices and concentration ratios using firms' market shares.

To illustrate our measures of competition, Table 1 describes the intensity of competition using all of these measures, separately for the 22 two-digit manufacturing industries contained in the sample. We find that German manufacturing firms earned rents of about 15% during the years 1986 to 1994. On average, the six largest producers cover more than one-third of the domestic market, and imports make up for about one-fourth of the total market. However, Table 1 indicates some remarkable differences between industries. Imports represent a large fraction of the total market in textiles, clothing, leather, machines for data processing and other vehicles (e.g. ships). Correspondingly, the market share of the six largest producers is low in textiles and machines for data processing, but high for tobacco. Industries with low *RENT* are textiles, metals and other vehicles. As we could expect, *RENT* is negatively correlated with industry concentration and import penetration. However, this correlation is weak. This implies that the empirical analysis should include firm-level as well as industry-level measures of competition.

TABLE 1 *Firm and industry-specific measures of competition*

	Firm level		Industry level		Observations	
	RENT	*CR6*	*HHI*	*IMPORT*	Number	Percent
Food (15)	23·3%	23·2%	1·6%	18·6%	523	15·1%
Tobacco (16)	22·3%	97·6%	20·0%	n.a.	47	1·4%
Textiles (17)	7·9%	36·5%	3·6%	45·9%	188	5·4%
Clothing (18)	24·7%	12·7%	0·6%	58·2%	67	1·9%
Leather (19)	18·2%	35·2%	3·5%	60·4%	17	0·5%
Wood (20)	16·2%	26·5%	2·2%	24·2%	20	0·6%
Paper (21)	14·0%	20·9%	1·6%	27·8%	113	3·3%
Publishing, printing (22)	16·1%	15·1%	0·7%	6·4%	26	0·8%
Coal, oil processing (23)	13·5%	82·1%	12·9%	41·9%	32	0·9%
Chemicals (24)	19·7%	38·6%	3·5%	25·4%	308	8·9%
Rubber, plastic products (25)	14·8%	46·3%	5·3%	19·3%	212	6·1%
Rock, stone, glass (26)	17·0%	61·4%	9·8%	17·7%	231	6·7%
Metals (27)	4·5%	35·5%	3·3%	22·7%	195	5·6%
Metal products (28)	14·9%	29·7%	2·5%	14·5%	179	5·2%
Machinery (29)	12·8%	34·7%	3·1%	16·6%	599	17·3%
Equ. for data processing (30)	14·1%	8·3%	0·3%	57·1%	132	3·8%
Equ. for power generation (31)	13·4%	42·6%	4·7%	27·7%	126	3·6%
Equ. for broadcasting and TV (32)	11·9%	42·3%	5·3%	n.a.	87	2·5%
Medical and optical instruments (33)	15·6%	37·9%	4·7%	36·2%	69	2·0%
Cars, car parts (34)	11·3%	35·5%	3·1%	20·0%	156	4·5%
Other vehicles (35)	4·6%	55·8%	7·1%	70·7%	86	2·5%
Furniture, jewelry, toys (36)	22·4%	35·6%	3·8%	25·8%	52	1·5%
Total	15·2%	36·0%	3·9%	25·7%	3465	100·0%
Correlation with RENT	1·000	−0·060	−0·024	−0·082	—	—

Notes: Firm and industry-specific measures of competition, separately by two-digit industry (NACE codes are given in parentheses): the ratio of total operating surplus less costs of capital (without risk premium adjustment) to total sales (*RENT*), the market share of the six largest producers (*CR6*), the Herfindahl index of producer concentration (*HHI*), and the ratio of imports to total market size (*IMPORT*). The sample comprises 491 firms.

3.3. MEASURING CORPORATE GOVERNANCE

The main variable used to measure corporate governance is an indicator of whether a firm has an ultimately controlling owner or not (*CONTROL*). This measure takes into account complex ownership structures, which are frequently encountered in large German firms. Therefore, it is not only based on measures of direct ownership, which can be misleading, in particular, for conglomerates (Köke, 2000; Becht and Böhmer, 2001). Similarly, it clearly identifies one single owner. This allows us to classify firms according to the type of their ultimate owner.

The identification of the ultimate owner for each firm is based on German corporate law and involves two steps. Firstly, we identify the ultimate owner for each direct shareholder using the following three rules. Rule 1 (strong ownership rule): A chain of control is pursued to the next level if the shareholder being analysed is owned to 50% or more by a shareholder on the next level, while all other shareholders on the next level own less than 50%. Rule 2 (weak ownership rule): If rule 1 does not apply, a chain of control is pursued to the next level if the shareholder being analysed is owned to 25% or more by a shareholder on the next level, while all other shareholders on the next level own less than 25%. Rule 3 (stop rule): If neither rule 1 nor rule 2 applies, a chain of control is not pursued further. These rules guarantee that no more than one ultimate owner is identified for each direct shareholder. Note that if a shareholder has split his ownership stake in a particular company into several smaller stakes, for example into two blocks of 50% held by two subsidiary firms, we combine these smaller stakes into one single block. We set the first cut-off point at 50% because German law allows an investor owning 50% of all shares to appoint management.† The second cut-off point is set at 25% because an investor owning 25% of the shares has the right to veto decisions. In a second step in determining the ultimate owner for each sample firm, we apply the three rules to all direct shareholders. This allows us to identify one single shareholder that is in ultimate control. When no single shareholder fulfills the criteria, this firm is seen to have no ultimate owner.

To illustrate our measure of corporate governance, Table 2 describes how average concentration of ownership evolves over time. Besides *CONTROL*, Table 2 also shows two other measures of ownership concentration commonly used in the literature: the size of the largest block (*BLOCK*) and the Herfindahl index (*HERF*) calculated for all large share blocks. Note that *BLOCK* as well

† A 50% majority is sufficient to dismiss management after their regular period of office. But a majority of 75% is required to dismiss management during its period of office (§103 (1) AktG).

TABLE 2 *Ownership concentration*

	Mean			Median	
	CONTROL	*BLOCK*	*HERF*	*BLOCK*	*HERF*
1986	79·8%	58·9%	46·0%	53·0%	36·0%
1987	84·1%	65·0%	53·2%	68·0%	50·0%
1988	85·8%	68·3%	57·5%	75·7%	57·8%
1989	87·1%	70·8%	60·2%	77·3%	60·3%
1990	88·8%	71·4%	60·8%	77·3%	60·4%
1991	89·4%	72·7%	62·2%	79·6%	63·4%
1992	90·5%	74·7%	64·9%	83·9%	70·3%
1993	90·5%	75·6%	65·7%	84·0%	70·5%
1994	89·9%	74·5%	64·5%	83·7%	70·1%
Average	88·1%	71·4%	60·8%	77·3%	61·1%
Correlation with *CONTROL*	1·000	0·639	0·499	0·639	0·499

Notes: Concentration of ownership in a given year for the period 1986 to 1994. Measures of ownership concentration include the average size of the largest share block (*BLOCK*), the average Herfindahl index of ownership concentration (*HERF*), and the fraction of firms for which an ultimate owner can be identified (*CONTROL*). The sample comprises 491 firms.

as *HERF* refer to the direct level of ownership. We find that ownership is highly concentrated. Examining ownership at the ultimate level, we identify a controlling owner for, on average, 88·1% of sample firms during the years 1986 to 1994. At the direct level of ownership, the largest block is also very large with 71·4% at the mean and 77·3% at the median. Similarly high concentration is found when using the Herfindahl index. Both *BLOCK* and *HERF* are highly correlated with *CONTROL*. Hence, collinearity problems would be likely when using all three measures simultaneously in the empirical analysis. The degree of complexity in ownership structures makes *CONTROL* a more appealing measure of ownership concentration, hence, *CONTROL* is our preferred measure of corporate governance in this study.

Finally, we include the type of the ultimate owner (*TYPE*) and a measure of ownership complexity (*CROSS*). The largest fraction of firms is ultimately controlled by individuals (42·2%) and by non-financial firms (36·9%). Only 4·4% of firms are ultimately controlled by a bank, and 2·2% are controlled by other financial institutions. Note that actual voting power of banks might be greater in practice when banks make use of proxy voting. However, recent evidence suggests that proxy voting is extremely unlikely to significantly enhance bank voting power (Edwards and Nibler, 2000). Only 2·2% of firms are controlled by government agencies, and 11·9% of firms have dispersed ownership. Regarding ownership complexity, 7·1% of sample firms are controlled by a firm that belongs to the

well-known web of German industrial and financial conglomerates (Wenger and Kaserer, 1998).

4. Preliminary evidence on competition, corporate governance and productivity

We begin our empirical analysis with some suggestive evidence based on a simple measure of firm productivity. We estimate a standard two-factor Cobb–Douglas production function with value added as the dependent variable (i.e. we indirectly account for materials as third input factor), and we interpret the residuals from this static regression as a measure of relative firm productivity (i.e. relative to the regression mean). The concept of relative productivity has a long tradition in applied productivity analysis; see Doms *et al*. (1995) for an application. Table 3 reports the results from several specifications. In these regressions, the estimates of the unrestricted coefficients do not allow us to reject the hypothesis of constant returns to scale with respect to labour and capital.

To get a first impression of the effects of product market competition and corporate governance on firm productivity, we split the sample into two groups: firms with above and firms with below average productivity. In Table 4, we report means of some key measures of competition and corporate governance for both splits. As a proxy for productivity, we use the residual from

TABLE 3 *Cobb–Douglas production function estimates without time dynamics*

Independent variables	Dependent variable: Log output (y_{it})			
	Pooled OLS		Fixed effects	
Log labour (l_{it})	0·874***	0·951***	0·752***	0·742***
	(0·015)	(0·017)	(0·039)	(0·039)
Log capital (k_{it})	0·135***	0·074***	0·337***	0·318***
	(0·014)	(0·016)	(0·063)	(0·063)
Intercept	9·937***	10·507***	6·858***	7·173***
	(0·202)	(0·295)	(1·191)	(1·189)
Industry dummies	no	yes	no	no
Time dummies	no	yes	no	yes
Number of observations	3465	3465	3465	3465
R^2	0·813	0·827	0·804	0·807

Notes: Estimates of a static two-factor Cobb–Douglas production function. Results are reported for pooled OLS and fixed effects regressions, with and without industry and time dummies. Asymptotic standard errors (reported in parentheses) are robust to general cross-section and time-series heteroskedasticity.
***indicate significance at the 0·10, 0·05, and 0·01 levels, respectively.

TABLE 4 *Bivariate analysis of productivity, competition and corporate governance*

	Forward-looking horizon/relative performance					
	0 years		2 years		4 years	
	Negative	Positive	Negative	Positive	Negative	Positive
Panel A: Level of total factor productivity						
Industry concentration (*HHI*)	3·9%	3·8%	3·8%	3·9%	3·8%	3·9%
Import penetration (*IMPORT*)	26·1%***	24·8%	25·6%***	23·9%	24·3%**	22·6%
Rent (*RENT*)	11·1%***	18·5%	11·1%***	17·6%	11·9%***	17·6%
Owner concentr. (*CONTROL*)	84·9%***	90·5%	84·0%***	89·5%	82·2%**	87·5%
Owner (*TYPE* = private)	45·6%***	39·0%	46·6%***	38·1%	46·9%***	38·6%
Owner (*TYPE* = financial firm)	4·8%***	8·4%	4·6%***	8·4%	4·0%***	9·1%
Owner (*TYPE* = non-fin. firm)	32·1%***	41·5%	30·7%***	41·2%	28·6%***	38·4%
Owner (*TYPE* = government)	2·3%	1·5%	2·2%	1·7%	2·8%	1·4%
Cross ownership (*CROSS*)	4·9%***	9·0%	4·7%***	8·9%	3·8%***	9·0%
Number of observations	1570	1895	1173	1310	732	811

Continued overleaf

TABLE 4 *Continued*

	Forward-looking horizon/relative performance					
	0 years		2 years		4 years	
	Negative	Positive	Negative	Positive	Negative	Positive
Panel B: Growth of total factor productivity						
Industry concentration (*HHI*)	3·9%	3·8%	4·0%***	3·6%	4·2%***	3·4%
Import penetration (*IMPORT*)	25·9%*	25·0%	25·5%***	23·8%	24·1%**	22·7%
Rent (*RENT*)	16·6%***	13·8%	16·0%***	12·9%	15·4%	14·2%
Owner concentr. (*CONTROL*)	88·1%	87·5%	86·2%	87·2%	81·5%***	88·3%
Owner (*TYPE* = private)	42·7%	41·9%	43·1%	42·1%	43·2%	43·1%
Owner (*TYPE* = financial firm)	6·6%	6·5%	6·6%	5·6%	6·6%	5·6%
Owner (*TYPE* = non-fin. firm)	37·0%	37·1%	34·4%	37·6%	29·4%***	37·7%
Owner (*TYPE* = government)	1·7%	2·1%	2·1%	1·9%	2·3%	2·0%
Cross ownership (*CROSS*)	7·0%	7·0%	6·8%	6·2%	6·4%	5·6%
Number of observations	1493	1481	1087	905	622	504

Notes: Bivariate analysis of competition and corporate governance and their relation to productivity and productivity growth. Productivity is approximated by the residual from pooled OLS estimation of a Cobb–Douglas production function with time and two-digit industry dummies. Productivity growth is approximated by the first difference in these residuals. Productivity is measured at three forward-looking time horizons: zero years (residual in year t), two years (average of residuals in years t through $t+2$), and four years (average of residuals in years t through $t+4$). All other variables are observed in year $t-1$. The test statistics are heteroskedastic t-tests of equal means.

*, **, *** indicate significance at the 0·10, 0·05, and 0·01 levels, respectively.

the pooled ordinary least squares (OLS) productivity regression with industry and time dummies (column 2 of Table 3). Panel A of Table 4 displays the results for the *level* of productivity, and panel B displays the corresponding results for productivity *growth*, which is approximated by taking the first difference of the productivity residuals. The reason for considering both levels and first differences is that some of our variables for product market competition should be highly endogenous to the level of productivity. Since productivity growth is less persistent than productivity levels, the endogeneity problem may be less severe if lagged values of competition and corporate governance are used; see also the discussion in Nickell (1996). In the econometric analysis reported below, we use productivity growth as a dependent variable, and address the potential endogeneity by using an instrumental variables approach. Here we simply use all variables that are supposed to explain productivity with a one-year lag. Taking into account that competition and corporate governance might affect productivity or productivity growth in the long-run rather than in the short-run, we report results for three different forward-looking time horizons: zero years, two years, and four years. For example, for a time horizon of two years, we calculate productivity as the average of productivity in year t, year $t + 1$, and year $t + 2$.

We find strong evidence that firms earning higher rents tend to show significantly higher levels of productivity (panel A of Table 4). Hence, firms facing intense competition appear to be less productive. This result holds irrespective of whether we consider short-run or long-run productivity.† We also find that firms are less productive when operating in markets that are subject to intense competition from abroad via imports. Regarding the type of ultimate owner, we find that a significantly larger fraction of firms under control of a large private owner belongs to the group of less productive firms than to high productive firms. This suggests that firms under control of a private owner tend to be less productive. Vice versa, firms under control of a financial or non-financial firm are significantly more productive. Finally, there is strong evidence that firms being controlled by the well-known web of cross-held German firms (Wenger and Kaserer, 1998) are more productive.

Regarding productivity growth, we again find a strong relationship between *RENT* and our measure of productivity (panel B of Table 4). However, the suggested impact of *RENT* is now the opposite: firms earning higher rents, that is, operating in less competitive markets, tend to show significantly lower productivity

† This result also holds when *RENT* is corrected by a risk premium, as suggested by Nickell *et al*. (1997), when *RENT* is measured as the average over two consecutive years, or when *RENT* is measured relative to value added instead of total sales.

growth. This result is confirmed by an industry-level measure of competition: Firms operating in markets with lower producer concentration (*HHI*) tend to see higher productivity growth. This result holds when industry-level competition is measured by the fraction of the six largest producers (*CR*6), but not when measured by the import ratio. Tight control structures (*CONTROL*) have a positive effect on productivity growth only at the long (four-year) horizon.

In summary, the preliminary evidence suggests that in German manufacturing, product market competition and corporate governance are positively related to differences in productivity growth. The observed negative relation between competition and the level of productivity could, as argued above, result from endogeneity of rents with respect to the level of productivity, which we believe to be significant. Note that this purely descriptive analysis ignores all potential endogeneity problems. In the remainder of this paper, we address these problems in a dynamic model of productivity growth estimated with instrumental variable techniques.

5. An empirical model of productivity growth

In this section, we present an empirical model of productivity growth derived from the firm's production function. This model is augmented with a set of variables that capture the influence of product market competition and corporate governance on productivity growth. This approach follows Nickell (1996) and Nickell *et al*. (1997). There are two reasons for estimating growth equations. Firstly, measurement problems are much more severe for levels equations than for growth equations. Secondly, measures of industry competition might well be endogenous with respect to the productivity level, but we would argue that this endogeneity problem is less severe if productivity growth is the dependent variable.

The starting point of our analysis is a Cobb–Douglas production function with two factor inputs,

$$Y_{it} = {L_{it}}^{\beta_L} {K_{it}}^{\beta_K} A_{it}, \tag{3}$$

where Y_{it} is value added, L_{it} is labour, K_{it} is capital, and A_{it} is a measure of total factor productivity for firm i in year t. Since we use value added as the output measure, we implicitly allow for materials as a third input. We interpret the level of total factor productivity, A_{it}, as the compound effect of past variables that shape a firm's productivity. After differencing, we can parameterize these determinants of productivity by *level* measures of product market competition and corporate governance.

In order to arrive at that growth version, we transform the production function (3) in several steps. Firstly, we take logs

and include lagged output as an explanatory variable to allow for endogenous persistence, using a weight λ. We also allow for unobserved firm heterogeneity, α_i, and include an error term, ε_{it}, which is assumed to be serially uncorrelated over time. This yields our basic log-linear empirical production function, with small letters denoting logs:

$$y_{it} = \lambda y_{it-1} + (1-\lambda)\beta_L l_{it} + (1-\lambda)\beta_K k_{it} + (1-\lambda)a_{it} + \alpha_i + \varepsilon_{it}. \quad (4)$$

Secondly, taking first differences eliminates the fixed firm effect α_i. We obtain the differenced growth version of the Cobb–Douglas production function in equation (3):

$$\begin{aligned}\Delta y_{it} = {} & \lambda \Delta y_{it-1} + (1-\lambda)\beta_L \Delta l_{it} + (1-\lambda)\beta_K \Delta k_{it} \\ & + (1-\lambda)\Delta a_{it} + \Delta \varepsilon_{it}. \end{aligned} \quad (5)$$

Finally, we parameterize productivity growth (i.e. the first difference of total factor productivity) as a linear function of time effects (τ), a contemporaneous industry-specific proxy variable that captures business cycle effects on competition (*CYCLE*), the lagged firm-specific measure of competition (*RENT*), a set of lagged industry-specific variables that capture differences in product market competition (*HHI, IMPORT*),† and a set of lagged corporate governance variables (*CROSS, CONTROL, TYPE*). In some specifications, we also include interactions of *RENT* and the corporate governance variables. Thus, productivity growth is modelled as

$$\begin{aligned}\Delta a_{it} = {} & (\tau_t - \tau_{t-1}) + \beta_1 CYCLE_{it} + \beta_2 RENT_{it-1} \\ & + \beta_3 (HHI, IMPORT)_{it-1} \\ & + \beta_4 (CROSS, CONTROL, TYPE)_{it-1} \\ & + \beta_5 [RENT_{it-1} \cdot (CROSS, CONTROL, TYPE)_{it-1}]. \end{aligned} \quad (6)$$

The empirical model of productivity growth is given by equation (5) together with equation (6). The structure of this model corresponds to the differenced panel model with lagged endogenous variables considered by Arellano and Bond (1991). They propose a GMM estimator that allows to exploit lags of the lagged dependent variable as well as lags of the explanatory variables as instruments. In our application, using this approach addresses the potential endogeneity problems with respect to the competition

† Of the three industry-level competition variables that we discussed above, we exclude *CR*6 because of multicollinearity problems. However, all results are qualitatively robust to using *CR*6 instead of *HHI*.

and corporate governance variables that enter the right-hand side of equation (5).†

Arellano and Bond (1991) show that endogenous variables lagged two or more periods are valid instruments, provided there is no serial correlation in the time-varying component of the error terms in equation (4); we test this condition for all specifications. The instruments we use are y_{it-j} for $j \geq 2$, l_{it-2}, k_{it-2}, and the second lags of all time-varying measures of industry-level competition and of ownership structure. We test for instrument validity using a Sargan test of over-identifying restrictions.‡ We report those tests together with the estimation results and standard errors that are robust with respect to general heteroskedasticity in the next section.

While the Arellano-Bond approach can in principle deal with potential endogeneity problems in our application, there is a caveat. Blundell and Bond (1998) show that in autoregressive models with persistent series, the first-difference estimator can be subject to finite sample bias as a result of weak instruments, and that these biases could be greatly reduced by the inclusion of levels equations in a GMM system estimation procedure (see, e.g. Bond *et al*., 1999). We do not estimate a model with equations in both levels and first differences, because of the structure of our empirical model—as noted before, we assume that the level of competition influences productivity growth, following Nickell (1996) and Nickell *et al*. (1997). Hence, while our formulation has the advantage that we do not have to compare levels of productivity across firms and industries, but only changes in productivity, it has the disadvantage of potentially weak instruments (which is, however, difficult to assess in a given empirical application).

6. Estimation results for the productivity growth models

In this section, we present estimation results for our productivity growth model. In Table 5, we report GMM estimates of productivity growth equations with various measures of product market competition. These are our industry-level competition variables

† An alternative estimation approach for dynamic panel data models is the standard IV estimator proposed by Anderson and Hsiao (1981). However, since we have modelled the influence of competition and corporate governance on productivity *growth* using the parameterization in equation (6), the Anderson-Hsiao IV estimator is not readily applicable in our setting.

‡ Following Arellano and Bond (1991), we use the two-step version of the GMM estimator to obtain the Sargan test statistic, while coefficient estimates are based on the one-step version. Arellano and Bond report that the one-step Sargan test is sensitive to heteroskedasticity, tending to over-reject the null.

TABLE 5 *Effects of competition on productivity growth, GMM results*

Independent variables	Dependent variable: output growth (Δy_t)			
	Model (1)	Model (2)	Model (3)	Model (4)
Lagged output growth (Δy_{t-1})	−0·014	−0·002	−0·043	0·119
	(0·058)	(0·059)	(0·064)	(0·165)
Labour growth (Δl_t)	1·080**	1·066**	1·056**	0·767***
	(0·474)	(0·458)	(0·457)	(0·147)
Capital growth (Δk_t)	0·668	0·724	0·627	−0·079
	(0·474)	(0·491)	(0·459)	(0·223)
Business cycle ($CYCLE_t$)	0·030	0·031	0·029	0·030
	(0·025)	(0·026)	(0·025)	(0·026)
Industry concentration (HHI_{t-1})	−11·721	−11·291	−11·587	−12·428
	(14·646)	(14·701)	(14·540)	(13·512)
Import penetration ($IMPORT_{t-1}$)	1·236	1·013	1·178	0·978
	(1·608)	(1·600)	(1·592)	(1·203)
Rent ($RENT_{t-1}$)	−1·449***			
	(0·429)			

Continued overleaf

TABLE 5 *Continued*

Independent variables	Dependent variable: output growth (Δy_t)			
	Model (1)	Model (2)	Model (3)	Model (4)
Rent, risk-adjusted ($RENTR_{t-1}$)		−1·353***		
		(0·404)		
Rent, firm average ($RENTAF_{t-1}$)			−1·344***	
			(0·395)	
Rent, ind, average ($RENTAI_{t-1}$)				−3·314*
				(1·850)
Intercept	−2·840	−2·927	−2·532	−2·213
	(2·676)	(2·703)	(2·338)	(2·205)
Number of observations	2389	2389	2389	2389
Instrument validity (Sargan)	$P = 0{\cdot}254$	$P = 0{\cdot}145$	$P = 0{\cdot}182$	$P = 0{\cdot}578$
Second-order correlation of residuals	$P = 0{\cdot}346$	$P = 0{\cdot}355$	$P = 0{\cdot}384$	$P = 0{\cdot}365$
Constant returns to scale	$P = 0{\cdot}271$	$P = 0{\cdot}258$	$P = 0{\cdot}263$	$P = 0{\cdot}249$

Notes: GMM regression results using the Arellano and Bond (1991) method. All regressions include time and two-digit industry dummies. Instruments are y_{it-j} for $j \geq 2$, l_{it-2}, k_{it-2}, and the second lags of all industry-level measures of competition. Asymptotic standard errors (reported in parentheses) are robust to general cross-section and time-series heteroskedasticity.
*, **, ***indicate significance at the 0·10, 0·05, and 0·01 levels, respectively.

and different versions of rents, our *ex post* measure of competition at the firm level. All competition variables enter with a one-year lag. In model (1), the baseline version, we use our preferred definition, *RENT*, as discussed in Section 3·2. Its coefficient is significantly negative. Recall that rents is an inverse measure of competition—the more intense competition on product markets, the smaller the rents that firms can appropriate. A negative coefficient therefore implies that more intense competition is associated with higher rates of productivity growth.

In models (2) through (4), we present results for three alternative definitions of the rents variable to check for robustness. In model (2), we use the risk-adjusted measure of firm rents (*RENTR*), as described in Section 3·2. In models (3) and (4), we use two versions of the rents variable that address potential endogeneity issues. *RENTAF* is the average of the firm's rents over the past two years. This time aggregation should smooth short-run firm-specific shocks that affect output directly and hence affect rents. *RENTAI* is the year-specific average of our firm-specific rents measure across the respective two-digit industry. This cross-sectional aggregation also wipes out firm-specific shocks, and therefore avoids potential endogeneity problems associated with the rents variable. We find a significantly negative effect of rents on productivity growth for all three alternative definitions. This robustness check gives us some confidence that our general approach—controlling for endogeneity problems using an instrumental variables GMM method—is appropriate, and we continue to build our specifications on model (1) in our subsequent analysis.

In terms of substance, our results do not reject the hypothesis that competition has a positive effect on productivity growth, as judged by our *ex post* measure of competition. Industry-level measures of competition are, however, not significantly associated with productivity growth. The business cycle proxy is also insignificant. These insignificant coefficients might be due to the fact that time and industry dummies absorb most of the variation in these industry-level variables. Also, as reported in the data appendix, we cannot assign industry-level competition variables to firms perfectly, because we only have industry codes for the firms' primary products.

Note that all versions of our GMM model are generally supported by the standard battery of specification tests. The Sargan tests do not reject the hypothesis of instrument validity. Also, the tests for second-order serial correlation of the residuals do not reject the null of zero correlation. Wald tests cannot reject the hypothesis of constant returns to scale. Finally, in all specifications we report, the slope coefficients and the sets of time and industry dummy variables are jointly significant according to our Wald tests (not reported). In general, our results for the impact of competition (as

measured by the lagged rents variable) are also robust against variations of the lag length chosen for the instruments.

We now turn to the effects of corporate governance on productivity growth. Table 6 reports regressions that augment the specification in model 1 of Table 5 with our proxy variables for corporate governance structures. Note that coefficients of the other variables do not change qualitatively as a result of adding corporate governance variables. In model (5), we begin by adding dummies for the existence of cross ownership (*CROSS*), and for a highly concentrated ownership structure (*CONTROL*). The coefficients for these variables are not significant. However, once we add an interaction with rents in model (6), the coefficients for both the ownership concentration dummy and the interaction term are significant, while the coefficient of the rents variable itself becomes insignificant. These results suggest that firms which have a single ultimate owner, that is, which operate under strong ownership, experience higher productivity growth. This effect is increased by stronger product market competition (i.e. lower values of the rents variable).

Since these results indicate that ownership structure appears to be quite important for productivity growth, we end our analysis by looking more closely at different types of ultimate owners.† We add dummies for the following types of the ultimate owner: private individuals, financial firms and government authorities. The reference category is non-financial firms, while the last category, dispersed ownership, is already accounted for by a zero value of the ownership dummy. The coefficients of the dummy variable for the existence of an ultimate owner and its interaction with rents remain significant, and increase in magnitude. Hence, firms under ultimate control of a non-financial firm have significantly higher productivity growth than firms with dispersed ownership. Firms under ultimate control of a private owner or a government agency do not experience significantly different productivity growth relative to the reference group. In contrast, firms whose ultimate owner is a financial firm have significantly lower productivity growth. The interactions with the competition measure suggest that productivity growth is higher for firms owned by the government if there is more competition, but competition influences productivity growth negatively for firms owned by financial institutions.

These results support the notion that firms with a dominant owner tend to experience higher productivity growth, in particular when competition on product markets is strong. However, the opposite is true if the ultimate owner is a financial institution—which

† This was suggested by one of the referees.

TABLE 6 *Effects of competition and corporate governance on productivity growth, GMM results*

Independent variables	Dependent variable: output growth (Δy_t)		
	Model (5)	Model (6)	Model (7)
		Interactions $RENT_{t-1}$	Interactions $RENT_{t-1}$
Lagged output growth (Δy_{t-1})	−0·019	−0·022	−0·032
	(0·059)	(0·058)	(0·051)
Labour growth (Δl_t)	0·925**	0·882**	0·893**
	(0·413)	(0·404)	(0·441)
Capital growth (Δk_t)	0·553	0·483	0·641
	(0·481)	(0·471)	(0·503)
Business cycle ($CYCLE_t$)	0·031	0·031	0·032
	(0·025)	(0·025)	(0·026)
Industry concentration (HHI_{t-1})	−11·277	−11·527	−11·416
	(15·092)	(15·090)	(14·430)
Import ratio ($IMPORT_{t-1}$)	1·168	1·057	0·850
	(1·610)	(1·613)	(1·635)
Rent ($RENT_{t-1}$)	−1·400***	−0·388	−0·394
	(0·426)	(0·289)	(0·279)
Cross ownership ($CROSS_{t-1}$)	−0·152	−0·152	−0·055
	(0·130)	(0·131)	(0·075)

Continued overleaf

TABLE 6 *Continued*

Independent variables	Dependent variable: output growth (Δy_t)				
	Model (5)	Model (6)		Model (7)	
			Interactions $RENT_{t-1}$		Interactions $RENT_{t-1}$
Owner concentr. ($CONTROL_{t-1}$)	0·010	0·186***	−1·069***	0·204**	−1·131**
	(0·026)	(0·058)	(0·316)	(0·099)	(0·512)
Owner ($TYPE_{t-1}$ = private)				0·006	−0·159
				(0·118)	(0·645)
Owner ($TYPE_{t-1}$ = financial)				−0·454**	1·832**
				(0·234)	(0·943)
Owner ($TYPE_{t-1}$ = government)				0·077	−1·767*
				(0·108)	(0·973)
Intercept	−2·672	−2·782		−3·013	
	(2·342)	(2·359)		(2·765)	
Number of observations	2389	2389		2389	
Instrument validity (Sargan)	$P = 0{\cdot}216$	$P = 0{\cdot}237$		$P = 0{\cdot}160$	
Second-order correlation of residuals	$P = 0{\cdot}343$	$P = 0{\cdot}336$		$P = 0{\cdot}349$	
Constant returns to scale	$P = 0{\cdot}442$	$P = 0{\cdot}542$		$P = 0{\cdot}406$	

Notes: GMM regression results using the Arellano and Bond (1991) method. All regressions include time and two-digit industry dummies. Instruments are y_{it-j} for $j \geq 2$, l_{it-2}, k_{it-2}, the second lags of all industry-level measures of competition, and the second lags of all time-varying measures of ownership structure. The reference category of owner type is 'non-financial firms'. Asymptotic standard errors (reported in parentheses) are robust to general cross-section and time-series heteroskedasticity.
*, **, *** indicate significance at the 0·10, 0·05, and 0·01 levels, respectively.

is not a very favourable account of the bank-based system of corporate governance in Germany. We also find significant effects of product market competition on productivity growth. Even though our research design is more complex due to differences in institutional arrangements, some of our findings stand in contrast to those obtained by Nickell *et al*. (1997) for the market-based U.K. system. Specifically, they find that strong ownership and product market competition are substitutes in improving productivity, while we find that they are complements. Taken together, these findings add weight to existing evidence on the differential performance of Anglo-Saxon and continental European firms obtained in aggregate or industry-level studies. In general, the results of our dynamic econometric approach are in line with the preliminary analysis in Section 4.

We end this section with a discussion of some robustness checks we performed. With respect to instrument choice, results do not change qualitatively when we do not use the industry-level competition and ownership variables as instruments or when we use lags longer than two years for the factor inputs. As in Table 5, using alternative measures of rent does not affect the results in the specifications reported in Table 6. Using the Herfindahl index of ownership concentration (*HERF*) or the size of the largest block (*BLOCK*) as alternative measures of ownership concentration does not produce any significant results. Finally, all of our results are robust against alternative definitions of the capital stock. We experimented with capital stock measures constructed using the method of Wadhwani and Wall (1986), and later used by Nickell (1996) and Nickell *et al*. (1997). They also apply a perpetual inventory method, but they do not assume a constant rate of depreciation. We also experimented with annual depreciation rates of 4% and 12%, but our estimation results turned out to be robust.

7. Conclusion

In this paper, we present an empirical analysis of the effects of product market competition and ownership control on total factor productivity growth using a panel data set of almost 500 German manufacturing firms over the 1986 to 1994 period. We find a significantly negative impact of rents appropriated by firms, indicating that product market competition has a positive impact on productivity growth. The effects of industry concentration measures are insignificant. In our empirical model, the influence of competition is measured by (lagged) economic rents, a firm-specific *ex post* measure. Because of the fact that even lagged economic rents are endogenous, we use an instrumental variables technique to control for potential endogeneity. The negative impact

of lagged rents on productivity growth turned out to be extremely robust against various alternative specifications. We are therefore confident that even though the GMM method we apply might be subject to small sample biases, our main findings are reliable.

With respect to ownership structure, we find strong evidence that firms under tight control experience higher rates of productivity growth. However, when we look at different types of ultimate owners, we find that this result does not hold if the firm is owned by a financial institution. Since we do not find an impact of ownership concentration at the direct level (as opposed to ultimate ownership), our results suggest that for productivity growth, ultimate ownership matters rather than direct ownership. In empirical studies of corporate governance, measures of direct ownership—which are of course easier to obtain—might therefore be misleading. This is in line with findings by Köke (2000). Furthermore, interaction of the variables for ultimate ownership with our measure for firm-level competition reveals that the disciplining effect of product-market competition is enhanced by tighter control structures. Interestingly, firms whose ultimate owner is a financial institution show lower rates of productivity growth, even if they operate in markets with strong competition. This result is in contrast to findings by Nickell *et al*. (1997), but confirms worries about the role of banks for corporate governance in Germany. More research on this issue is certainly required, in particular, since in recent years financial institutions other than banks are becoming more important. Recall that our data end in 1994, and up to that point, the financial institutions recorded as ultimate owners were almost exclusively banks and insurance firms. As pointed out by Börsch–Supan and Winter (2001), the role of investment and pension funds is currently increasing, and they might have stronger incentives to improve corporate governance and to enhance productivity growth.

In addition to this characterization of banks' role in corporate governance, our results have other interesting policy implications. Our results suggest that while the role of financial institutions as ultimate owners is not very favourable, concentrated ownership that is often associated with a bank-based system has in itself a positive impact on productivity growth. Finally, our results add empirical support to some well-known hypotheses about the welfare effects of product market competition, as discussed by Allen and Gale (2000) and Börsch–Supan (1998). The implications for competition policy within continental Europe and the European Union at large are obvious—increased competition in the common market should have positive effects on productivity growth.

We end this paper by discussing a few unresolved issues. First of all, it might come as a disappointment that other than rents, our *ex*

post measure of competition, all variables that measure industry-level competition are generally not significant in the productivity growth regressions. This might be due to measurement problems. As noted before, the industry classification of firms at the four-digit level according to their primary product is quite unreliable. Also, concentration measures can only indicate potential, not actual competition, whereas *ex post* rents reflect the effects of the market power that a firm can actually exert. We would also argue that not much progress can be made by considering alternative measures of the level of competition in a given industry. It seems more promising to look at changes in competition triggered by exogenous events, but this approach is more suitable for industry-level studies, than for a sector-wide panel study of manufacturing firms. While there are, to our knowledge, as yet no such case studies available for Germany, recent product market deregulation in the German telecommunications and energy markets, and in the European Union at large, provide data suitable for empirical studies in the future, as in Bottasso and Sembenelli (2001).

We conclude this paper by discussing directions for future empirical research that focus on the role of ownership structure and corporate governance in Germany. As pointed out by Himmelberg *et al*. (1999), changes in the ownership structure should have important effects on productivity growth. Although these changes are endogenous as well, it should be worthwhile to identify changes in ownership structure in a panel of firms and investigate their effects on firm performance. Recent descriptive evidence for Germany reported by Köke (2000) suggests that following major changes in ownership, industry-adjusted productivity of poorly performing firms improves, but remains below the industry benchmark. In addition, ownership structure does not only affect productivity growth, but also firm survival and market exit decisions. To our knowledge, there are no empirical studies that investigate any of these issues in a systematic fashion for Germany, and they are well worth being explored.

Finally, there might be much more complex interactions of ownership structure, board structure, capital structure, and firm performance. Following Jensen (1986), a high degree of leverage is regarded as a device of disciplining management. Chevalier (1995) finds that highly leveraged firms are weak competitors in the product market. Similarly, the evidence presented in Kovenock and Phillips (1997) and Zingales (1998) indicates that the interaction of firm leverage and product market competition is important in determining future firm performance. All these empirical studies use data from the United States. For the United Kingdom, results by Nickell *et al*. (1997) and Nickell and Nicolitsas (1999) suggest that financial pressure has a positive effect on productivity growth. It would be interesting to investigate whether

a similar mechanism is at work in Germany's bank-based system of corporate governance. For example, Börsch–Supan (1998) reports that in Germany, creditors do not use their control potential to improve firm productivity. In future empirical work, direct measures of bank influence should therefore be used to investigate the role of banks, although such measures are hard to obtain.

Acknowledgements

We wish to thank Fred Ramb for providing some of the data used in this paper and Dominik Krupp for valuable research assistance. Axel Börsch–Supan, Herbert Buscher, Dietmar Harhoff, Norbert Janz, Melanie Lührmann, Anja Wodrich, three anonymous referees, the associate editor and seminar participants at the 2000 annual meetings of the European Economic Association and of the Verein für Socialpolitik provided helpful comments on earlier drafts of this paper. All remaining shortcomings are ours. Financial support by Deutsche Forschungsgemeinschaft through grant No. BO 934/7-1 and Sonderforschungsbereich 504 at the University of Mannheim is gratefully acknowledged.

References

Allen, F. & Gale, D. (2000). Corporate governance and competition. In X. Vives, Ed., *Corporate Governance: Theoretical and Empirical Perspectives*. Cambridge, U.K.: Cambridge University Press.

Anderson, T.W. & Hsiao, C. (1981). Estimation of dynamic models with error components. *Journal of the American Statistical Association*, **76**, 598–606.

Arellano, M. & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *Review of Economic Studies*, **58**, 277–297.

Baily, M.N. & Gersbach, H. (1995). Efficiency in manufacturing and the need for global competition. *Brookings Papers on Economic Activity—Microeconomics*, 307–347.

Becht, M. & Bölnner, E. (2001). Voting control in German corporations. *International Review of Law and Economics*, forthcoming.

Blundell, R. & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, **87**, 115–143.

Blundell, R., Griffith, R. & Reenen, J.V. (1995). A dynamic count data model of technological innovation. *Economic Journal*, **105**, 333–344.

Bond, S., Harhoff, D. & van Reenen, J. (1999). Investment, R&D and financial constraints in Britain and Germany. (unpubl.) manuscript, Institute for Fiscal Studies, London.

Börsch–Supan, A.H. (1998). Capital productivity and the nature of competition. *Brookings Papers on Economic Activity—Microeconomics*, 205–244.

Börsch–Supan, A.H. & Winter, J.K. (2001). Population aging, savings behavior and capital markets. Working Paper No. 8561, National Bureau of Economic Research (NBER), Cambridge, MA.

Bottasso, A. & Sembenelli, A. (2001). Market power, productivity and the EU single market program: evidence from a panel of Italian firms. *European Economic Review*, **45**, 167–186.

Cable, J. (1985). Capital market information and industrial performance: the role of West German banks. *Economic Journal*, **95**, 118–132.
Caves, R.E. (1992). *Industrial Efficiency in Six Nations*. Cambridge, MA: MIT Press.
Chevalier, J.A. (1995). Capital structure and product-market competition: empirical evidence from the supermarket industry. *American Economic Review*, **85**, 415–435.
Doms, M., Dunne, T. & Roberts, M.J. (1995). The role of technology use in the survival and growth of manufacturing plants. *International Journal of Industrial Organization*, **13**, 523–542.
Edwards, J. & Fischer, K. (1994). *Banks, Finance and Investment in Germany*. Cambridge, U.K.: Cambridge University Press.
Edwards, J. & Nibler, M. (2000). Corporate governance in Germany: the role of banks and ownership concentration. *Economic Policy*, **15**, 237–267.
Gorton, G. & Schmid, F.A. (2000). Universal banking and the performance of German firms. *Journal of Financial Economics*, **58**, 29–80.
Green, A. & Mayes, D. (1991). Technical inefficiency in manufacturing industries. *Economic Journal*, **101**, 523–538.
Hart, O.D. (1983). The market mechanism as an incentive scheme. *Bell Journal of Economics*, **14**, 366–382.
Hermalin, B.E. (1992). The effects of competition on executive behavior. *RAND Journal of Economics*, **23**, 350–365.
Himmelberg, C.P., Hubbard, R.G. & Palia, D. (1999). Understanding the determinants of managerial ownership and the link between ownership and performance. *Journal of Financial Economics*, **53**, 353–384.
Holmström, B. (1982). Moral hazard in teams. *Bell Journal of Economics*, **13**, 324–340.
Jensen, M.C. (1986). Agency costs of free cash flow, corporate finance, and takeovers. *American Economic Review, Papers & Proceedings*, **76**, 323–329.
Klette, T.J. (1999). Market power, scale economies and productivity: estimates from a panel of establishment data. *Journal of Industrial Economics*, **47**, 451–476.
Köke, J. (2000). Control transfers in corporate Germany: their frequency, causes and consequences. Discussion Paper No. 00-67. Zentrum für Europäische Wirtschaftsforschung (ZEW), Mannheim.
Köke, J. (2001). New evidence on ownership structures in Germany. *Kredit und Kapital*, **34**, 257–292.
Kovenock, D. & Phillips, G.M. (1997). Capital structure and product market behavior: an examination of plant exit and investment decisions. *Review of Financial Studies*, **10**, 767–803.
McKinsey Global Institute (1997). *Removing Barriers to Growth and Employment in France and Germany*. Frankfurt, Paris, Washington: McKinsey Global Institute.
Monopolkommission (1996). *Wettbewerbspolitik in Zeiten des Umbruchs: Hauptgutachten 1994/1995*. Baden-Baden: Nomos.
Mueller, D.C. & Yurtoglu, B.B. (2000). Country legal environments and corporate investment performance. *German Economic Review*, **1**, 187–200.
Nalebuff, B.J. & Stiglitz, J.E. (1983). Information, competition, and markets. *American Economic Review, Papers & Proceedings*, **73**, 278–283.
Nickell, S. (1996). Competition and corporate performance. *Journal of Political Economy*, **104**, 724–746.
Nickell, S. & Nicolitsas, D. (1999). How does financial pressure affect firms? *European Economic Review*, **43**, 1435–1456.
Nickell, S.J., Nicolitsas, D. & Dryden, N. (1997). What makes firms perform well? *European Economic Review*, **41**, 783–796.
Scharfstein, D. (1988). Product-market competition and managerial slack. *RAND Journal of Economics*, **19**, 147–155.

Schmidt, K. (1997). Managerial incentives and product market competition. *Review of Economic Studies*, **64**, 191–213.
Shleifer, A. & Vishny, R.W. (1997). A survey of corporate governance. *Journal of Finance*, **52**, 737–783.
Short, H. (1994). Ownership, control, financial structure and the performance of firms. *Journal of Economic Surveys*, **8**, 203–249.
Wadhwani, S. & Wall, M. (1986). The U.K. capital stock: new estimates of premature scrapping. *Oxford Review of Economic Policy*, **2**, 44–55.
Wenger, E. & Kaserer, C. (1998). The German system of corporate governance: a model which should not be imitated. In S. Black & M. Moersch, eds, *Competition and Convergence in Financial Markets: The German and Anglo-American Models*. Amsterdam: Elsevier.
Zingales, L. (1998). Survival of the fittest or the fattest? Exit and financing decisions in the trucking industry. *Journal of Finance*, **53**, 905–938.

Appendix: Definition of variables

The variables we use in our econometric analysis are constructed in analogy to Nickell *et al*. (1997) wherever possible, in order to allow direct comparison with their results. Minor differences occur because we choose a slightly different method to construct our capital stock variable (see below). All variables used in this study are appropriately deflated and measured in prices of 1991. Sources of price and cost indexes and other aggregate variables are given below, together with details on how we constructed each variable used in the empirical analysis.

VALUE ADDED

The firm's value added, Y_t, is defined as output (total sales) less total materials costs. Real values are obtained using a two-digit industry-specific producer price index published by the Federal Statistical Office (Statistisches Bundesamt, Fachserie 17, Reihe 2, 1998) for output, and a combined input price index for materials. The latter does not vary by industry.

CAPITAL STOCK

The firm's capital stock, K_t, is defined as replacement costs of tangible assets including machines, buildings and land, deflated using a combined input price index for capital goods and land, weighted by their empirical distribution (Statistisches Bundesamt, Fachserie 17, Reihe 2, and Fachserie 17, Reihe 4, 1998). Replacement costs of capital are calculated using the method of Bond *et al*. (1999). They adjust the historical cost values for inflation and then apply a perpetual inventory method with a

constant annual depreciation rate of $\delta = 0{\cdot}08$. Specifically.

$$p_t^K K_t = (1-\delta) p_{t-1}^K K_{t-1} \frac{p_t^K}{p_{t-1}^K} + p_t^K I_t,$$

where K_t is the capital stock, p_t^K is the price index for capital goods, I_t is real investment and δ the depreciation rate. The starting value is the net book value of tangible assets, adjusted for inflation in previous years.

LABOUR

The firm's labour input, L_t, is defined as the total number of employees.

BUSINESS CYCLE PROXY

To control for business cycle effects, we use a survey-based index of capacity utilization at the two-digit industry level as a proxy variable (*CYCLE*). This index is part of the *ifo Geschäftsklima* and was obtained from the ifo Institut für Wirtschaftsforschung, Munich.

INDUSTRY-LEVEL COMPETITION

We use three measures to proxy for industry-level competition. As a measure of foreign competition, we use import penetration (*IMPORT*), defined as the ratio of the total value of imports to total market size. The latter is the sum of imports and domestic production, measured at the two-digit industry-level. Regarding industry concentration, we use the market share of the largest six producers, *CR*6, and the Herfindahl index of producer concentration. *HHI*, both of which are measured for four-digit output classes. This information is obtained from biennial reports of the German Federal Antitrust Commission, as reported in Monopolkommission (1996). Note that we cannot assign both competition measures perfectly to each firm for two reasons. Firstly, for the construction of this measure, the Antitrust Commission uses information on firms' sales in individual market segments. Hence, there are several competition measures for each firm depending on sales structure. Unfortunately, our main source of data, the Hoppenstedt database, assigns firms only to one industry, the primary product market. Hence, our competition measure may contain some classification error for large firms.

Secondly, the classification of industries used by the Antitrust Commission differs from the industry classification used in the Hoppenstedt database (European NACE code). Therefore, we had to assign some firms on an individual basis.

FIRM-LEVEL COMPETITION

The construction of our measure for firm-specific rents (*RENT*) is discussed in Section 3·2.

CORPORATE GOVERNANCE: OWNERSHIP CONCENTRATION

The construction of our preferred measure for ownership concentration (*CONTROL*), as well as two alternative measures (*BLOCK* and *HERF*) are discussed in Section 3·3.

CORPORATE GOVERNANCE: TYPE OF OWNER

We classify firms into five ownership categories (*TYPE*): private (including partnerships and foundations), financial firms (including banks and insurers), non-financial firms, government authorities. If a firm has no ultimate owner according to the definition of *CONTROL* as outlined in Section 3·3, the ownership category is "dispersed".

CORPORATE GOVERNANCE: OWNERSHIP COMPLEXITY

Ownership complexity is measured with an indicator variable for cross-ownership (*CROSS*). It takes the value of one if a firm's ultimate owner is part of the web of industrial and financial German firms identified by Wenger and Kaserer (1998) and if the ultimate owner indirectly owns a share block in itself, zero otherwise.