Sunk Costs, Managerial Incentives and Firm Productivity

Empirical Evidence for German Corporations

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Summary

In this paper, we use a production function approach to examine the impact of ownership concentration, product market competition and financial pressure on German firm productivity. Additionally, we are interested in the influence of ownership identity and changes in ownership structure. We also test whether the specificity of assets affects productivity performance. Based on a panel of 361 German manufacturing companies for the time period of 1991–1996 we find that supplier concentration has a positive influence on firm productivity. There is also some evidence for a discipline-of-debt effect. Interestingly, the presence of several strong shareholders affects productivity negatively. In high sunk costs industries an owner change is negatively correlated with firm productivity whereas in low sunk costs industries productivity increases after owners have changed.

1. Introduction

What drives firm productivity? While investment in R&D and in physical and human capital has been center-stage in the debate for a long time, a new line of reasoning focusing on "soft" factors like corporate governance structures and incentive schemes has gained momentum only recently.[1] Corporate governance systems are being discussed extensively as determinants of firm performance.[2] It is controversial though whether the design of the corporate governance mechanism matters for productivity and which role other factors such as product market competition play. Theoretical and empirical studies analyzing the effects of product market competition, ownership concentration and capital structure on firm productivity have produced ambiguous results. The identity of owners, highlighted by Leach and Leahy (1991) as an important governance indicator, or changes in ownership structure have been largely ignored as determinants of firm productivity. Moreover, the main body of empirical work refers to firms from the market-oriented Anglo-Saxon governance systems. Far less attention has been paid to the potential link between firm productivity performance and corporate governance in relationship-based governance systems such as in Continental Europe.[3]

This paper is an attempt to fill some of the outlined gaps by investigating (1) firm-level productivity of German corporations and (2) the interplay of "hard" and "soft" factors. The impact of corporate governance on firm productivity should be particularly interesting to investigate for Germany because creditors (especially banks) and stakeholders (e.g. employees via codetermination) have better

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[1] See Bartelsman and Doms (2000) for a general overview on productivity.

[2] See for discussion and references e.g. Short (1994), Allen and Gale (2000) and Lehmann and Weigand (2001).

[3] Relationship-based or network-oriented governance systems are characterized by low stock market capitalization and a "closed-shop" environment with reference to corporate ownership and the trading of blockholdings. Through cross-holdings, pyramidal structures (ownership cascades) and long-term lender-borrower relations industrial firms have established close ties among themselves and to financial institutions (banks), thus making takeover attempts, an important governance mechanism in the Anglo-Saxon market-based system, vain attempts.

contractual or legal protection than shareholders in the relationship-based German system.[4] Based on a large panel data set we use a production function approach to test the impact of ownership concentration, product market competition and financial pressure on productivity. We also consider the location of control rights, i.e. the identity of owners, and changes in ownership structure. Moreover, asset specificity, i.e. potential sunkenness of costs, might have an impact on productivity performance since a firm facing high potential sunk costs is less able to put these assets into a more productive use when the business environment changes. This lack of flexibility might harm productivity performance.

The paper is organized as follows. Section 2 discusses the supposed link between product market competition, corporate governance, sunk costs and productivity. Section 3 presents the data set, the empirical model, and the hypotheses tested. The regression results are discussed in Section 4. Section 5 summarizes and concludes.

2. Theoretical and Empirical Background

2.1 The "carrots and sticks" of competition and corporate governance — how to prevent managers from shirking

Since Berle and Means (1932) pointed out the problems generated by the separation between ownership and control in large modern corporations, the alignment of managerial interests with shareholders' interests has been at the heart of corporate governance. The typical widely-held and traded corporation has many small investors. Due to the free-rider problem they are in general not particularly able or inclined to monitor the managers hired to run the firm. As contracts are incomplete by nature, delegation of decision-making to hired managers is prone to informational asymmetries because managers are better informed about the firm's investment opportunities than investors detached from the daily running of the firm.[5] However, it is not clear that this principal-agent conflict is necessarily detrimental to the shareholders. A manager needs to be better informed — this is his superior skill for which he is hired in the first place. Therefore, it is natural that managers capture a substantial part of the residual control rights. This discretion may be misused by the managers for expropriating wealth (e.g. higher salaries, empire building, etc.).

The question addressed by an extensive literature is how to solve this agency problem by inducing managers to maximize shareholder value. Two general strategies have been identified to induce efficient production and foster firm performance: the "carrot method" covering the optimal design of incentive schemes for managers, and the "stick method" which involves monitoring or supervision. Incentives can be provided by external factors like product market competition and the market for corporate control or internal factors like debt levels and executive compensation packages. In this paper, we are particularly interested in the effect of competition and debt levels with respect to the incentive structure and the influence of shareholders and debtholders regarding control within a firm.

2.1.1 Product market competition and managerial incentives

Whether product market competition mitigates incentive problems by forcing firms toward economic efficiency has been a matter of controversial debate. On the one hand, competition is supposed to improve productivity performance by changing the information structure (Holmström, 1982, Hart, 1983, Nalebuff, Stiglitz 1983). More players on the same playing field make it easier for external investors to evaluate a manager's actions by way of comparison. More transparency should alleviate moral hazard problems and make monitoring of managers more effective. Further, product market competition increases the probability of bankruptcy (Schmidt, 1997) and lowers profits. Managers need to eliminate slack to make the firm survive (Aghion, Howitt, 1997) and — in the presence of variable compensation — to keep up their income level under intense competitive pressure (Hermalin, 1992). Moreover, competition curbs monopoly rents, which provide managers with the incentive to capture them through reduced effort or investing in fancy own-interest projects.

The idea that competition necessarily reduces slack may be too simplistic, however: The incentive for a monopoly owner to prevent his managers from shirking should be just as high as for the owner of a competitive firm (Jensen, Meckling, 1976). Theoretical arguments have also been advanced supporting the hypothesis that a perfectly competitive environment affects firm productivity negatively. In an oligopoly with intense rivalry among firms managers may have a strong incentive to cut costs and increase productivity and owners can induce them to do so by designing proper remuneration schemes (see Fershtman, Judd, 1987). As shown by Schmidt (1997), the probability that a firm can reach a leading (or monopoly) position increases in such a market environment. Scharfstein (1988) demonstrates that competition might also reduce managerial effort if managers are highly responsive to pecuniary incentives. Increased competition may

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[4] See Shleifer and Vishny (1997) and Tirole (2001) on the *shareholder* and *stakeholder* models of corporate governance.

[5] See for this "incomplete contracts" view Grossman and Hart (1980, 1986), Hart and Moore (1990), Hart (1995) and Tirole (1999) among others.

take away demand from a firm ("business stealing effect", Mankiw, Whinston, 1986) and, consequently, lower managerial incentives to improve productivity. Following Schumpeter (1942) it has been argued that monopoly power enhances productivity because innovation is facilitated by providing more internal funds for R&D investment, reducing risk, and supporting the appropriation of R&D returns.

The predictions of the available theoretical models are not clear-cut. The theoretical effect of competition on incentive schemes and economic efficiency strongly depends on the specification of managerial preferences, the classification of agency goods and the specification of the bargaining structure between managers and shareholders (Scharfstein, 1988, Hermalin, 1992). Empirical evidence does not provide a definite insight either. Caves and Barton (1990), Green and Mayes (1991), Caves et al. (1990), Nickell (1996) and Gort and Sung (1999) report a positive effect of competition on productivity performance. Nickell et al. (1997) find a weak positive and, under certain conditions, even a negative relationship. Dilling-Hansen et al. (1997) also provide evidence of a negative influence of product market competition on firm productivity.

The study of Dilling-Hansen et al. (1997) is the first one to look at this link for a Continental European country (Denmark). Since Continental European countries have been accused of constraining product market competition by regulation and raising barriers to entry and exit to the advantage of incumbent firms, it should be interesting to investigate the nature of the relationship between competition and productivity for German firms as opposed to U.S. or U.K. companies.

2.1.2 The discipline-of-debt effect

An important strand of the corporate governance literature has focused on the role of debt as an internal company means of disciplining managers. It has been argued that debt service reduces the cash flow available for spending at their discretion (Jensen, 1976, 1988). Consequently, debt serves as a substitute for dividends, committing managers to their promise to pay out future cash flows. Further, a higher level of debt raises the probability of bankruptcy, since lenders may withdraw their money. Outside monitoring of managers might be enforced by lenders, alleviating the free-rider problem associated with dispersed shareholdings (Short, 1994). Thus, by implementing a debt contract, creditors take over a part of the residual control rights previously exercised by managers. In this line of reasoning, the higher the pressure of debt, the stronger is the managers' incentive to have the firm perform well.

However, there is also another side to the story: According to Jensen and Meckling (1976) a high amount of debt financing induces managers to undertake more risky projects. Myers (1977) argues that a firm with a high debt capital might refuse advantageous projects since a large part of its profits goes to lenders. When it comes to testing the relevant hypotheses on the discipline-of-debt effect, though, the empirical findings are more clear-cut: Nickell et al. (1992, 1997) as well as Dilling-Hansen et al. (1997) find a positive effect of debt levels on British and Danish firm productivity: Debt indeed seems to be a means of effectively disciplining managers.

2.1.3 Ownership structure and control

Ownership concentration is supposed to account for differences in monitoring across firms. Whereas a firm is generally classified as owner-controlled if there is a dominant stockholding interest owning a specified fraction of the company, a management-controlled firm refers to the case of widely dispersed stockholding interests. If a higher degree of ownership concentration is consistent with hired managers being under tighter control by the firms' owners because the free-rider problem is reduced, and further, if tighter control leads to more productive investment, productivity should be higher in more owner-concentrated firms. Available empirical studies testing the effect of ownership concentration on firm performance do not allow for a definite conclusion: Most studies find some support for a positive relationship but their results are often insignificant (see Short, 1994, for a survey).

Leech and Leahy (1983) suggest that the location of control rights, i.e. the identity of owners, is a more important indicator for owner-control than ownership concentration. Nickell et al. (1997) distinguish between internal and external shareholdings proposing that external shareholders might be exclusively interested in firm performance whereas internal owners are frequently following other objectives as well. Indeed they find some empirical support for their hypothesis: If the dominant shareholder in their sample of British companies is an external financial institution, productivity is positively affected. If the dominant shareholder is internal, there is no effect. External ownership by non-financial companies has a negative effect on productivity growth, though.

In the Continental European systems of corporate governance, control rights in non-financial firms are often concentrated in the hands of families, non-financial companies, or financial institutions either directly or indirectly via complex arrangements of inter-firm relationships (cross-shareholdings, pyramidal structures, holding companies). Compared to purely market-based economies like the U.S. or the U.K., Germany has a relatively high concentration of share ownership with banks having played an important role until now (see Boehmer, 2000, Lehmann, Weigand, 2000). Therefore, it might be parti-

cularly interesting to investigate the effect of types of owners on productivity performance of German firms.

2.2 Sunk costs and productivity

2.2.1 Direct effects of sunk costs

In perfect markets firms can rent labor and capital on the spot market at any time at the competitive price. Inefficient use of resources will be punished by the market mechanism (inefficient firms are replaced by efficient ones). Therefore, managers or owners cannot afford to under-invest in the firm's productive assets at will to enjoy private but unproductive benefits. In the real world, however, production capital is highly specific and potentially sunk so that it cannot be rented at any time. Sunk costs are incurred whenever the value of an irreversible investment exceeds its value in alternative uses. Since investment decisions are typically made in an uncertain environment and are costly to reverse once they have been carried out, most investment decisions entail an element of irreversibility and therefore a certain amount of sunk costs. In general, sunk costs are associated with both tangible and intangible assets. Sunk costs can be specific physical or knowledge capital but also specific human capital in form of investment in human skills. People who "sink" capital to start production expose themselves to a considerable risk because sunk costs have to be recouped over time. When the business environment and technology change quickly a firm with highly specific assets faces particular problems in restructuring its operations by selling off outmoded assets and in tapping external sources to finance state-of-the-art technologies.[6] Firms facing high potential sunk costs are less flexible and inclined to keep operating with obsolete production capital at the expense of efficiency. This fact might harm productivity performance.

Moreover, the sunkness of assets might as well influence incentive and control mechanisms within the firm. The point we want to make is that not only the governance or financial structure of a firm but also the asset structure, in particular the specificity of assets, might be crucial in judging efficient production and thus productivity performance.

2.2.2 The link between sunk costs and managerial effort

Apart from hypotheses concerning direct effects on productivity performance, theory provides also links between asset specificity and the "carrots and sticks"-mechanisms. First, sunk costs may deter product market competition, thereby modifying the incentive structure of a firm. Traditionally, sunk costs have been viewed as a major barrier to entry and exit. Whereas incumbent firms have already committed themselves to an industry by investing in irreversible specific assets, potential entrants have not. Sunk costs therefore impose an asymmetry in the incremental costs and risks encountered by incumbents and potential entrants: The entrant's incremental cost incorporates the full amount of sunk costs which have already been recouped by the incumbent to a certain extent. In addition, this asymmetry may give rise to entry deterring strategies such as limit pricing. Empirically, sunk costs have indeed been found to deter entry and reduce the rate at which entry responds to positive profits of incumbents (Kessides, 1991, Mata, 1991). In this line of reasoning, sunk costs should reinforce the effect of product market competition on productivity performance.

Second, in the finance literature, some emphasis has been placed on investment in asset specifity as a strategy of management entrenchment. Managers may invest in sunk assets to bolster their positions and shelter themselves from being replaced by the owners of the firms in case of underperformance (see Shleifer, Vishny, 1988, 1997; Zwiebel, 1996, Fluck, 1999). Sunk costs may help managers to "entrench" their positions with respect to the owners of the firm. Sunk investment can be used as a strategic instrument and credible commitment device by managers. If manager-specific knowledge is incorporated in the sunk investment, managers can make themselves indispensable for the less informed shareholders and stakeholders (e.g. creditors) alike (Shleifer, Vishny, 1988), thus reducing managerial effort and productivity performance.

Third, sunk costs may also affect the choice of debt over equity finance since sunk investments may limit access to capital markets for groups of firms. A high share of specific assets lowers the prospects of debt financing (Williamson, 1988). It has been found empirically that in industries with high tangible sunk costs the cash flow effect on investment is larger than in low tangible sunk costs industries, i.e. high tangible sunk costs stress internal financing (Worthington, 1995). Given a motivational effect of debt, this would imply more managerial discretion. Therefore, sunk costs may have a negative impact on the discipline of debt and productivity. This point should be particularly interesting to investigate for German firms, since in Germany creditors have better legal protection than shareholders and debt financing traditionally plays an important role.

Fourth, sunk costs might as well harm the exercise of control through shareholders and stakeholders. Zeck-

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[6] The degree of asset specificity matters for the financing decision (Williamson, 1988). Highly specific assets have only low or no liquidation value and cannot serve as collateral to external financiers (Shleifer, Vishny, 1992).

hauser and Pound (1990) argue that monitoring by large shareholders will be difficult when assets are specific to the firm and its management, since firms with a high degree of asset specificity have a closed information structure. Therefore, a high proportion of specific assets might impede effective monitoring and lead to lower productivity.

3. Data, Empirical Model, and Hypotheses

To empirically explore the potential link between competition, corporate governance, sunk costs, and productivity, we apply a data set of 361 firms from the German mining and manufacturing sector. The time period covered is 1991 to 1996. Financial statement data for these firms originate with either the *Hoppenstedt Bilanzdatenbank* (a commercially sold data source), the *Bundesanzeiger* (a federal gazette), or annual reports received from the corporations on request. If available only unconsolidated company data were used. Holding companies are not included. The sample firms are overwhelmingly organized as stock corporations (*Aktiengesellschaften*, 300 companies).[7] The main industries covered are machinery (76 firms), chemicals & pharmaceuticals (60 firms), the electronic products industry (56 firms), and iron & steel (37 firms). Information on ownership structures was gathered from Commerzbank's *Wer gehört zu wem?* (Who owns whom?, issues 1988, 1990, 1992, 1994), Bayerische Hypotheken- und Wechselbank ("Hypo-Guide") *Wegweiser durch deutsche Aktiengesellschaften (*Guide of German Stock Corporations, annual issues 1988–1996), and Hoppenstedt's *Börsenführer* (Stock Guide, annual issues, 1988–1998).

Following Nickell et al. (1992) we apply a standard Cobb-Douglas production function approach to investigate the discussed links. The empirical model

$$y_{it} = a_i + \lambda_t + b_1 k_{it} + b_2 l_{it} + b_3 O_{it} + b_4 IC_{it} + b_5 SC_{it} + \varepsilon_{it}$$

relates the log of turnover (deflated by the 1991 GDP deflator), *y*, to the log of total assets (deflated by industry-specific 1991 price deflators), *k*, as a proxy for the firm's capital stock, the log of total employment, *l*, as well as a set of variables implied by the above discussion. These explanatory variables are ownership concentration *O* (Herfindahl index of shares outstanding), the interest-coverage ratio (interest payments/cash flow) *IC*, and supplier concentration *SC* (Herfindahl index at the two-digit industry level). We include firm- and time-specific effects, *a* and *l*, to control for systematic influences on productivity not captured by the explanatory variables, most notably capacity utilization. The subscript *i* identifies individual firms and the subscript *t* denotes time periods; *e* is the regression error.

To consider the identity of owners we define six mutually exclusive groups of owners: families or individuals (FAMILY), financial institutions (FININST), another industrial firm (INDFIRM), a mix of different large shareholders (MIX), foreign owners (FOREIGN), and changing owners (CHANGE). We then interact these 1/0-variables with ownership concentration to test for differences in the impact of ownership concentration on productivity across groups of owners.[8]

As data on firm-specific sunk costs, such as advertising, R&D expenditures, or expenditures for leasing or renting assets are not available at the company-level, we employ industry-level data for R&D as well as leasing expenditures. We split the sample of firms as belonging to industries above and below the median values of the industry-level variables. Low tangible sunk costs then refer to above median leasing expenditures (and vice versa), since in general highly specific assets cannot be leased. A firm with a high share of leasing expenditures is thus supposed to produce with less specific assets and, consequently, lower sunk costs. On the contrary, above median R&D expenditures indicate high intangible sunk costs (and vice versa) since R&D expenditures are assumed to be highly specific. If there are differences between potentially high and low sunk costs industries, they should be reflected in differences in the regression coefficients across the two sub-samples. Table 1 provides summary statistics of the variables for the full and split samples of firms.

We use the Herfindahl index of supplier concentration as an indicator of the average degree of market power in an industry. If there is a disciplining effect of competition on managers, this would imply a negative relationship between Herfindahl index and productivity. Moreover, if sunk costs raise barriers to competition, the effect is predicted to have a lower (productivity-enhancing) impact in high sunk costs industries. By contrast, if market power improves managerial performance, the influence of supplier concentration on productivity performance should be positive and more pronounced in high sunk costs industries.

The interest-coverage ratio is included to test for the "discipline-of-debt" effect. The higher the ratio of interest payments to cash flow the more the firm is under pressure to improve performance. Thus, we would expect a positive impact of debt on productivity. The discipline-of-debt effect should be less pronounced in high sunk costs industries, since the amount of highly specific assets has been found to be negatively related to leverage (Bradley et al., 1984).

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[7] The remaining firms are limited liability corporations.

[8] See Lehmann and Weigand (2000) for a detailed description of firms' ownership structures and respective descriptive statistics.

Table 1

Summary statistics of selected variables:
Low tangible vs. low intangible sunk-cost firms

Variables	Low tangible sunk-cost industries (high leasing)		Low intangible sunk-cost industries (low R&D)	
	Mean	Std. Dev.	Mean	Std. Dev.
Total assets (in mill. DM)	1,726	6,554	1,031	2,211
Employment	8,731	31,709	5,471	11,753
Supplier concentration (Herfindahl index, 0–10,000)	517	758	488	719
Interest coverage ratio	0.087	1.646	0.274	3.497
Ownership concentration (Herfindahl index, 0–10,000)	6,894	3,42	6,634	3,374
Number of firms	172		161	

If ownership concentration indeed reflects tighter monitoring and control by the owners, and owners curb inefficient investments by intervening early (see Fluck, 1999, and Boot et al., 2001, on this), productivity performance should be affected positively. With asset specificity impeding effective monitoring, high sunk costs can reduce this positive effect. By contrast, for dominant shareholders high potential sunk costs might be an incentive to pay even more attention to performance since they expose themselves to a higher business risk.

No formal theory is available to predict how the identity of owners may affect productivity. If we believe in the corporate plundering argument (Berle, Means, 1932), we may expect that firms with large "active" (Jensen, 1993), "inside" (Mayer, 1992) shareholders are more productive at any level of ownership concentration than firms with self-controlling managers. Managerial entrenchment by investing in specific but less productive assets may then be harder. Smaller firms frequently have individuals or families as dominating owners, since they started or inherited the company. Therefore, they may have a particular interest in the firm being successful, not necessarily in terms of high returns on equity but rather by maintaining the status quo of personal influence. Such an influence can be positive if the owner motivates managers and employees to more commitment and determination so that productivity is enhanced. However, infighting among family members or incompetent owners trying to "guide" managers can have the opposite effect on productivity. If banks or financial institutes are more efficient monitors (Diamond, 1984, 1991) who reduce agency costs effectively, corporate performance should be improved, but governing industrial firms is not the core business of banks. They monitor to protect their own investments (e.g. loans) and will only intervene in case of the borrower's

default. If productivity enhancing firm projects are risky, the probability of default rises which is not in the best interest of the bank as a creditor since she shares in the downside risk but not in the upside gain. The governance effort of financial institutions and the respective impact on corporate performance is thus ambiguous. Firms owned by other industrial companies (INDFIRM) are in many cases subsidiaries of larger (traded) corporations. Recalling that subsidiaries often operate as "profit centers", there is at least one layer of hired managers between the subsidiary and the management of the ultimate owners. This might encourage managerial slack by delegating responsibility to the subsidiary. Moreover, a mix of different large shareholders (MIX) presumably harms productivity performance because a clear-cut business strategy might be lacking in presence of several strong investors with potentially different objectives. Firms dominated by a foreign shareholder (FOREIGN) are often subsidiaries of foreign parent companies. Therefore, they might pursue other objectives than productivity performance, for example building up a platform abroad, and productivity could be negatively affected. We suspect changing ownership (CHANGE) to affect productivity positively since a new owner might be especially motivated to brush up company performance.

4. Results

Tables 2 and 3 present the coefficient estimates for the full and split samples of firms. As specification tests indicated significant fixed firm- and time specific effects as well as the presence of first-order serial correlation in the standard Within-OLS errors, the regression equation was estimated by a GLS panel estimator described in Hsiao

Table 2

Full sample estimates

Dependent variable: Log (turnover) Independent variables	Tangible sunk costs (leasing)	Intangible sunk costs (R&D)
Log (total assets)	0.3567 (8.86)**	0.3633 (9.25)**
Log (employment)	0.4669 (9.62)**	0.4618 (9.81)**
Supplier concentration	1.1833 (3.87)**	1.1800 (3.85)**
Interest-coverage ratio	0.0040 (4.07)**	0.0040 (4.09)**
Ownership concentration	0.0003 (0.40)	−0.0002 (0.32)
Adj. R squared	0.53	0.53

Log (turnover) is the natural log of firm turnover deflated by the 1991 GDP deflator. Log (total assets) is the natural log of firm total assets deflated by industry-specific 1991 price deflators. Ownership concentration is measured by the Herfindahl index of shares outstanding (see Lehmann and Weigand, 2001, for details). The interest-coverage ratio is defined as interest payments over cash flow. Supplier concentration is the Herfindahl index at the two-digit industry level (source: Statistisches Bundesamt).

The reported three-step GLS estimates are robust to heteroskedasticity (White, 1980) and first-order serial correlation. The Within-OLS estimator, accounting for fixed firm- and time-specific effects, was used to generate consistent first-step estimates. Absolute t-values in brackets behind the regression coefficients.

* Significant at the 0.05 error level. — ** Significant at the 0.01 error level.

Table 3a

Split sample estimates

Dependent variable: Log (turnover)	Tangible sunk costs (leasing)	Intangible sunk costs (R&D)
High sunk-cost industries (low leasing ratios, high R&D intensities)		
Log (total assets)	0.3815 (9.25)**	0.3405 (6.78)**
Log (employment)	0.4392 (7.37)**	0.5095 (10.30)**
Supplier concentration	1.7329 (3.44)**	1.1311 (3.33)**
Interest-coverage ratio	0.0041 (4.30)**	0.0058 (3.37)**
Ownership concentration	−0.00006 (−0.08)	0.0005 (0.06)
Differences to low sunk-cost industries (high leasing ratios, low R&D intensities)		
Log (total assets)	0.0663 (1.44)	0.0344 (0.51)
Log (employment)	0.0760 (1.50)	−0.0849 (1.06)
Supplier concentration	−1.033 (2.83)**	−0.6873 (1.19)
Interest-coverage ratio	−0.0002 (0.08)	0.0027 (1.48)
Ownership concentration	0.0005 (0.42)	−0.00009 (0.08)
Adj. R squared	0.59	0.58

The reported three-step GLS estimates are robust to heteroskedasticity (White, 1980) and first-order serial correlation. The Within-OLS estimator, accounting for fixed firm- and time-specific effects, was used to generate consistent first-step estimates.
Absolute t-values in brackets behind the regression coefficients.

* Significant at the 0.05 error level. — ** Significant at the 0.01 error level.

(1986, pp. 55) which is robust to heteroskedasticity and first-order serial correlation of the regression residuals.[9]

Inspecting the full sample results in Table 2 first, capital stock and employment have the expected positive and highly significant coefficients with respect to the level of productivity. The size of the coefficients implies decreasing returns to scale. Supplier concentration affects productivity performance significantly positively. Thus, there is some empirical evidence for the hypothesis that market power enhances productivity at least in the short run. There is also evidence supporting the discipline-of-debt-hypothesis: A high interest-coverage ratio puts considerable pressure on managers and consequently forces them to improve productivity performance. The impact of ownership concentration on productivity is positive but not statistically significantly so.

Splitting the full sample into sub-samples reflecting low and high sunk costs industries (Table 3a) leads only to one significant coefficient difference. The positive impact of supplier concentration is more pronounced for firms in industries with low expenditures for leasing or renting assets, and thus presumably high tangible sunk costs. This might reflect tangible sunk costs constituting barriers to entry and exit and therefore reinforcing the positive impact of supplier concentration on productivity performance.

Considering the identity of owners, interacted with ownership concentration (Table 3b), as a determinant of productivity, we find some quite interesting results: Splitting the sample according to rental and leasing expenses yields a siginifcal negative impact of ownership concentration for firms which are owned by different large shareholders and operate in industries with lower than median leasing and higher than median R&D expenditures (potentially high sunk costs). The reason could be that a group of equally strong owners with different ideas and and objectives might have trouble to agree to a single business strategy. As Van Praag and Cools (2000) argue, it might be crucial for firm performance to provide only one single target in the incentive contract of a firm's management and employees. The coefficient difference to firms from presumably lower sunk cost industries is not statistically significant.

A significantly negative impact of ownership concentration on productivity also shows up for the high intangible sunk costs firms (R&D intensive industries) which experienced changes in owners during the observation period. This time the coefficient difference to firms in less R&D-intensive industries is significantly positive, implying that ownership concentration had a weakly positive effect on productivity in low intangible sunk costs firms. For our sample of firms, changing ownership refers in most cases to banks or other industrial firms taking over blockholdings from originally family-owned firms. In the course of the following restructuring process focusing on cost reduction,

assets have to be put into a more productive use. While low sunk costs firms should be quite successful in cost cutting, this cannot be done without substantial losses in the presence of asset specificity. Moreover, experience shows that highly skilled managers or employees as very specific human assets are often the first to leave a company in a restructuring process resulting in some kind of a "brain drain" for the firm. Therefore, low sunk costs firms have an advantage over high sunk costs firms when ownership changes.

Finally, we look at longer-term changes in productivity and use the (logarithmic) change rates of the variables included in the estimating regression from the base year 1991 to the end year 1996. This regression boils down to a standard cross-section of firms which can be consistently estimated by OLS, correcting for heteroscedasticity (White, 1980). The results for the split samples including the identity of owners are presented in Table 4.

In the sample split according to the ratio of leasing and rental expenses we find a significantly negative impact of ownership concentration on productivity growth for firms in low sunk cost industries controlled by financial institutions (FININST). In the long run, it seems, strong ties between banks and non-financial firms allow for substantial managerial slack in low sunk cost industries in which business risk is supposedly lower. Further, there is a significantly positive coefficient difference to the firms from high sunk cost industries. Consequently, financial institutions seem to have a notably stronger interest to monitor managerial action in high sunk costs industries. As suggested, the reason might be that highly specific assets cannot be used as collateral to satisfy claims in case of bankruptcy. Therefore, banks expose themselves to a considerably larger risk if they permit slack in high sunk costs industries.

The same pattern as for the FININST-firms emerges for firms owned by another industrial firm (INDFIRM). In

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[9] The procedure uses Within-OLS to obtain consistent first-step estimates. From the first-step residuals the serial correlation coefficient is estimated. The regression is then transformed to eliminate serial correlation and is re-estimated by GLS, applying White's (1980) procedure to obtain standard errors that are robust to heteroskedasticity. Standard specification tests for panel data regressions have been employed to test for the presence of fixed effects ("Hausman test", Hausman, 1977), heteroskedasticity (Lagrange multiplier test, Breusch, Pagan, 1980), and first-order serial correlation (modified Durbin-Watson test, see Bhargava et al., 1982). Detailed regression results and test statistics are available from the authors on request. As our time series is rather short, we did not employ a dynamic panel regression estimator as in Nickell et al. who instrument the right-hand side regressors of the first-differenced regression equation (to removed firm-specific fixed effects) by the levels of the respective variables lagged at least two periods. In this way, errors-in-variables problems such as the endogeneity of the right-hand side variables can be mitigated.

Table 3b

Split sample estimates, considering the identity of owners

Dependent variable: Log (turnover)	Tangible sunk costs (leasing)	Intangible sunk costs (R&D)
High sunk-cost industries (low leasing ratios, high R&D intensities)		
Log (total assets)	0.3873 (9.39)**	0.3385 (6.69)**
Log (employment)	0.4355 (7.43)**	0.5089 (10.03)**
Supplier concentration	1.7384 (3.46)**	1.1355 (3.28)**
Interest-coverage ratio	0.0041 (4.59)**	0.0055 (3.48)**
Ownership concentration INDFIRM	0.0004 (0.30)	0.0022 (1.43)
Ownership concentration difference to FAMILY	−0.0007 (0.49)	−0.0021 (1.32)
Ownership concentration difference to FININST	0.0005 (0.29)	−0.1736 (0.89)
Ownership concentration difference to MIX	−0.0699 (3.33)**	−0.0791 (2.89)**
Ownership concentration difference to FOREIGN	−0.0003 (0.12)	−0.0034 (1.59)
Ownership concentration difference to CHANGE	−0.0020 (0.39)	−0.0101 (2.00)*
Differences to low sunk-cost industries (high leasing ratios, low R&D intensities)		
Log (total assets)	0.0727 (1.57)	0.0373 (0.55)
Log (employment)	0.0802 (1.59)	−0.0838 (1.04)
Supplier concentration	−1.0653 (1.94)*	−0.7329 (1.25)
Interest-coverage ratio	−0.0015 (0.62)	−0.0024 (1.42)
Ownership concentration INDFIRM	0.0016 (0.67)	−0.0025 (0.99)
Ownership concentration difference to FAMILY	−0.0004 (0.15)	0.0031 (1.20)
Ownership concentration difference to FININST	0.0003 (0.09)	0.0006 (0.18)
Ownership concentration difference to MIX	0.0185 (0.59)	−0.0030 (0.08)
Ownership concentration difference to FOREIGN	−0.0052 (1.51)	0.0046 (1.50)
Ownership concentration difference to CHANGE	0.0018 (0.18)	0.0146 (2.05)**
Adj. R squared	0.55	0.57

For definitions of variables see Table 2.

We define a large shareholder as controlling at least 5% cent of a corporation's voting capital and distinguish six identities of large shareholders: (1) INDFIRM is defined as firms having another independent industrial firm or a holding company as largest shareholder (e.g. Thyssen Guss AG, subsidiary of Thyssen concern). — (2) FAMILY is defined as firms having (pools of) individuals or families as largest shareholders (e.g. Bausch AG, Bosch GmbH). — (3) FININST is defined as firms having banks, insurance companies, or associated investment companies as largest shareholders (e.g. Linde, larger stakes owned by Deutsche Bank and Commerzbank), or, having widely dispersed shareholdings, but banks control at least 75% of the voting capital through proxy voting rights (e.g. Bayer). — (4) MIX is defined as firms having different independent large shareholders (e.g. Bosch-Siemens Hausgeräte GmbH, owned equally by Bosch GmbH and Siemens AG). — (5) FOREIGN is defined as firms having foreign companies as largest shareholders (e.g. Opel AG, owned by GM). — (6) CHANGE is defined as firms which experienced a change in the identity of blockholders through turnovers of blocks from one of the owner categories 1–5 to another (e.g. Aqua Signal AG).
The reported three-step GLS estimates are robust to heteroskedasticity (White, 1980) and first-order serial correlation.
The Within-OLS estimator, accounting for fixed firm- and time-specific effects, was used to generate consistent first-step estimates. Absolute t-values in brackets behind the regression coefficients.

* Significant at the 0.05 error level. — ** Significant at the 0.01 error level.

Table 4

Productivity growth, 1991–1996

Dependent variable: change in Log turnover	Tangible sunk costs (Leasing)	Intangible sunk costs (R&D)
Low sunk-cost industries (high leasing ratios, low R&D intensities)		
Change in log (total assets)	0.4507 (5.72)**	0.4908 (4.03)**
Change in log (employment)	0.3823 (5.07)**	0.3572 (6.21)**
Supplier concentration	0.1688 (1.92)	0.0977 (0.70)
Interest-coverage ratio	−0.0008 (0.16)	−0.0049 (0.58)
Ownership concentration INDFIRM	−0.0023 (0.08)	−0.1026 (2.39)**
Ownership concentration difference to FAMILY	−0.0185 (0.62)	−0.0707 (0.54)
Ownership concentration difference to FININST	−0.2959 (2.20)*	−0.3302 (0.86)
Ownership concentration difference to MIX	0.0083 (0.13)	0.0303 (0.37)
Ownership concentration difference to FOREIGN	−0.0416 (1.41)	0.0589 (1.33)
Ownership concentration difference to CHANGE	−0.0181 (0.54)	0.0702 (1.69)
Differences to high sunk-cost industries (low leasing ratios, high R&D intensities)		
Change in log (total assets)	−0.1197 (1.09)	−0.1118 (1.19)
Change in log (employment)	0.1873 (1.80)	0.1556 (1.78)
Supplier concentration	0.1477 (0.46)	0.1080 (0.42)
Interest-coverage ratio	0.0004 (0.09)	0.0047 (1.50)
Ownership concentration INDFIRM	0.0529 (1.24)	0.1221 (2.60)**
Ownership concentration difference to FAMILY	0.0956 (0.51)	0.0313 (0.23)
Ownership concentration difference to FININST	0.3749 (2.01)*	0.2814 (0.71)
Ownership concentration difference to MIX	−0.1138 (1.11)	−0.0940 (0.96)
Ownership concentration difference to FOREIGN	−0.0484 (0.97)	−0.1323 (2.42)*
Ownership concentration difference to CHANGE	−0.0038 (0.80)	−0.0907 (1.72)
Adj. R squared	0.68	0.68

For definitions of variables see table 2.

The change in log (turnover) is the difference of log (turnover in 1996) and log (turnover in 1991).
The analogous definition applies to the changes in log (total assets) and log (employment). Supplier concentration, interest-coverage ratio and ownership concentration are the respective period time means.
The reported OLS estimates are robust to heteroskedasticity (White, 1980). Absolute t-values in brackets behind the regression coefficients.

* Significant at the 0.05 error level. — ** Significant at the 0.01 error level.

industries with low intangible sunk costs concentrated firm ownership affects productivity significantly negatively whereas this relationship is inverted in high intangible sunk cost industries. Again, in the long term the presence of high sunk costs might serve as an incentive to monitoring managers of the subsidiaries more closely.

5. Conclusion

The paper has explored the empirical links between competition, corporate governance, sunk costs, and productivity. Using a standard production function approach to relate firm output to input factors as well as variables describing governance structures, our panel data regression estimates show significant positive effects of both the interest coverage ratio as a measure of financial pressure (discipline-of-debt effect), and supplier concentration as an indicator of product market structure. Additionally, we find some evidence that ownership structures and sunk costs affect firm productivity on a year-to-year basis. A mix of different large shareholders significantly harms firm efficiency in high tangible and intangible sunk costs industries.

This result may point to difficulties in agreeing on a unique performance target when multiple larger block-holders are present. Changing ownership has a positive impact on productivity performance in low intangible sunk costs firms whereas a negative relationship prevails in high sunk costs firms. As a change in ownership is often followed by a restructuring and cost cutting process, sunk costs become relevant at this very moment because specific assets cannot be put into another productive use without substantial losses. In combination with a "brain drain effect" this might harm productivity in high sunk costs firms. By contrast, in low intangible sunk cost firms a cost reduction process might be successful.

When taking a longer-run perspective by focussing on productivity growth over the whole observation period an interesting result turns up with respect to firms having financial institutions or another industrial firm as largest shareholders. In both cases, high sunk costs seem to imply a higher monitoring effort of the dominant shareholders. This suggests that the potential business risk involved when operating with highly specific assets induces financial institutions and other firms in a dominating shareholder position to be less tolerant of managerial slack. In sum, there is some evidence suggesting that a combined effect of competition, corporate governance, and the sunkness of investment on the potential for managerial entrenchment and firm productivity does exist.

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