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Governance Structures, Efficiency, and Firm Profitability

A combined DEA and panel data regression approach

Erik Lehmann *, Susanne Warning ** and Jürgen Weigand ***

Abstract

Using a panel data set of 361 German corporations for the period 1991 to 1996 we test the hypothesis that firms with more efficient governance structures have higher profitability. To determine efficiency we compare firms with respect to ownership concentration, the identity of owners, capital structure, investment and firm growth by a multi-input/multi-output Data Envelopment Analysis (DEA). This non-parametric linear programming technique considers both multiple in- and outputs. Based on the concept of pareto efficiency, it computes an efficiency score where the associated weights of the inputs and outputs are determined endogenously. The DEA efficiency scores are then used as explanatory variables in panel data regressions of profitability. Our main finding is that the efficiency scores indeed contribute significantly to explaining profitability differences between firms, even after controlling for industry effects and unobserved systematic firm effects.

JEL classification: G3, L1

Key words: firm performance, ownership concentration, owner identity, managerial discretion

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1. Introduction

What explains differences in firm profitability? In the standard textbook model of neoclassical firms and markets, differences in firm profitability cannot persist in the long run but are eliminated over time through competitive entry. In reality however, profitability differences seem to exist for very long periods of time (see Mueller 1986). Recent theories of the firm suggest that, due to asymmetric information and incomplete contracting, internal factors, such as the organization of firms and their governance structures, are important drivers of firm efficiency and profitability.[1] Agency problems, transaction costs and relationship-specific investments can all be invoked to make a case for why internal organization and governance structures may matter for corporate performance. For example, in the agency view of the firm, a link between investment, profitability and finance results from principal-agent problems of unobservable managerial effort. The manager's effort cannot be made part of an enforceable contract because it is only observed by the manager not by his principal. This informational asymmetry gives the manager discretion for opportunistic behavior. Management may pursue their own goals, divert funds for their own benefit, invest and finance inefficiently so that profitability is lowered. Owners can reduce the adverse effects of managerial discretion by monitoring managers or offering them incentive-compatible contracts. Both options incur costs. The costs and benefits of monitoring are subject to the size of owners' stakes in the firm. Small shareholdings give rise to the well-known free-rider problem. As they have more to lose, large block holders have the incentive to monitor and in diverting managers (see Shleifer and Vishny, 1997). Therefore, a

reintegration of ownership and control may foster productive investments and enhance profitability.

In this paper we assume that a firm's governance structure is well characterized by its ownership structure and capital structure, as proposed by Jensen and Meckling (1976) among others. Thus, we focus more or less on organizational aspects and treat market mechanisms like the market for corporate control, the managerial labour market or the product market as exogenous. Controlling for other systematic influences, the governance structure determines the firm's investment and growth behaviour and, eventually, profitability. Using a panel data set of 361 German corporations for the period 1991 to 1996 we test the hypothesis that firms which select more efficient governance structures have higher profitability.

A bulk of empirical studies has already looked into the potential link between corporate governance and corporate performance (see Thomsen/Pedersen 2000, Short 1994, or Frick/Lehmann 2004 for surveys). Although this paper is in line with previous empirical research in testing the effect of corporate governance mechanisms on firm performance, it differs from those studies. First, most studies apply reduced form regressions and investigate the impact of governance variables, such as ownership concentration, on profitability while taking capital structure or investment as given. This approach can be defended on the grounds that estimating a full-fledged simultaneous equations model of firm decision making requires a lot of specification effort, good data, and good instruments for system identification. The reduced form approach comes at a price: the empirical evidence of whether differences in governance

[1] The industrial organization literature explains profitability differences by factors external to the firm, such as the demand and technology characteristics of the product market. See e.g. Church and Ware (2000).

regimes help explain differences in corporate performance remains ambiguous (see Short, 1994, for a survey or Thomson/Pederson 2000). Thus, we follow a different road in this paper and incorporate the link between governance structures, investment and firm growth explicitly into profitability regressions by exploiting the advantages of Data Envelopment Analysis (DEA). We will introduce this method to provide more robust results in analyzing the relationship between governance structures and firm profitability.

The basic idea of DEA is to generate an efficiency score by estimating a best-practice production function. As a nonparametric technique, DEA does not require the explicit specification of the underlying input-output relationship. DEA first defines a production frontier on which all pareto-optimal firms are located. This frontier envelops all other firm observations which are subsequently called inefficient. Firms not lying on the frontier are thus dominated by at least another firm or a combination of firms that define the frontier. However, one drawback of an isolated DEA approach is the assumption that there is no measurement error in constructing the frontier. However, this deterministic drawback turns to be an advantage since now the scores can be used in regression analysis.

In particular, we assume that firms which operate on a high efficiency level are associated with higher profitability. In particular, we assume that ownership concentration, the firm's capital structure and its capital intensity are inputs to generate two outputs: growth and investment. Both outputs are one of the major driving forces of future returns of a firm. In this vein, we follow Grandori (1991) that organizations are characterized by multi-actor multi-objective choices of organization. The various shareholders and groups of shareholders could then be interpreted as "Multi-actors"

with different goals or "multi-objective choices" (Grandori 1991, 321): firm growth and investments. Thus, firms producing both outputs efficiently[2] should be associated with higher returns on assets.

Thus, our study also differs from others, which implicitly rely on a specific production function and a specific relationship between governance variables and performance.[3] This paper tries to fit into recent work, analyzing the complex structure and relationship between corporate governance mechanisms and performance (see Böhren and Ödegaard 2003 for such a discussion). However, it lacks from sufficient theoretical work, explaining those relationship.

Only few papers have focused on the relationship between ownership and firm efficiency. Elyasiani and Mehdian (1992) found significant efficiency differentials between minority-owned banks and non-minority owned banks. Lauterbach and Vaninsky (1999) show that owner-managed firms are less efficient in generating net income than firms managed by professional managers.

Although the latter study is the closest to our approach, it differs in various ways. First, Lauterbach and Vaninsky use only one output variable. Thus, there is no real advantage over standard regression analysis. The principle advantage of DEA in fact lies in its capacity to link multiple inputs with multiple outputs. Second, in contrast to Lauterbach and Vaninsky (1999), we adopt a two-step approach and use the efficiency scores as (weakly) exogenous variables to explain profitability. Third, we use a panel data set that allows us to control for time variation and unobserved systematic effects, and stochastic errors.

[2] Grandori (1991) offers a survey of different efficiency concepts.

Our empirical analysis proceeds in two steps. First, we use DEA to link ownership structure and capital structure as the firm's inputs to investment and turnover growth as the firm's output. The analysis generates firm-specific efficiency scores which measure for any sample firm in any year the distance from the technically efficient frontier. In the second step, the DEA efficiency scores are used as explanatory variables in a panel regression analysis of firm profitability. Our main finding is that the efficiency scores indeed contribute significantly to explaining profitability differences between firms, even after controlling for industry effects and unobserved systematic firm effects.

The paper is organized as follows. In the next section we briefly summarize the literature in the context auf our empirical study. Then, we introduce DEA in Section 3. In Section 4 we present the Data. The empirical results are provided and discussed in Section 5. Section 6 concludes.

2. Large-block holders, Efficiency and Firm Performance

Large-block ownership can be motivated at least by two factors: the shared benefits of control and the private benefits of control. However, the two are not mutually exclusive, as the mixed empirical evidence shows (see Short 1994, Holderness 2003), and let us assume that both factors are typically at work. While the shared benefits of control arise from the substantial collection of control rights which enables large-block holders to monitor and discipline the management, also the private benefits increase with the accumulation of control rights. While shared benefits of control should have a positive impact on managerial behavior and thus firm performance, the private benefits

[3] There are some studies which explicitly test specific relationship between one corporate governance variable, like ownership, and performance (Morck et al. 1987, Bigelli et al.

of control could have a negative impact. Such benefits could either be pecuniary such as synergies in production or non-pecuniary or amenities that came from controlling corporations like sport clubs, newspapers and others. Following Bartelsman and Doms (2000), we argue that both – positive and negative effects of ownership concentration - are reflected by firm efficiency and firm performance. Productivity is mainly influenced by the ownership of a firm: Since firm's choice of technology, inputs, and production are made by management, and managers are controlled and selected by (large) shareholders, the latter also influences the productivity of a firm [4].

To estimate organizational efficiency of our sample firms, we take ownership concentration, the firm's capital structure and its capital intensity as inputs that generate the outputs firm growth and investment. We choose tangible investment and firm growth as outputs, since both are one of the major driving forces of future returns of a firm.[5] Furthermore, growth and investments can be directly controlled by managers. This, however, may also lead to adverse effects. As pointed out by Baumol (1959), Williamson (1964), or Marris (1964), a misuse of managerial discretion could be reflected in overinvestment in non-productive assets or firm growth. Also managers can increase growth rates by cutting prices or buying other firms. In this situation, the impact of the efficiency scores determined by an increase in the two outputs – growth and investments - on the ROA should be negative since increases in these outputs come only at the expense of reduced current-year profits.

(1998/1999), Himmelberg et al. 1999 among others).

[4] In the last two years, two big firms failed from the sample: the Holzmann AG and the Deutsche Babcock AG. Both firms were dominated by banks and insurance companies and showed a high dept-asset ratio.

To control for differences in capital endowments per employee across firms, we include the capital intensity as an input. An important strand of the corporate governance literature has focused on the role of debt as a disciplinary mechanism for managers (see Myers 2001). It has been argued that debt service reduces the cash flow available for spending at their discretion (Jensen 1986). Consequently, debt commits 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. 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 performs well. However, 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. (1997) as well as Dilling-Hansen et al. (1997) find a positive effect of debt levels on British and Danish firm productivity. Also Wald (1999) shows that profitability and productivity are the major determinants of dept/asset ratios in cross-sectional tests for the United States, United Kingdom, Germany, France and Japan.

[5] Although investments in R&D play a major role on the input side and are influenced by corporate governance variables (see Himmelberg et. al 1999), we are not able to add this variable since firms in Germany did not publish their spending in R&D.

Ownership concentration is frequently employed in the empirical literature to measure the extent of "governance" exercised by firm owners (Pederson/Thomsen 2003; Thomsen Pederson 2000, Lehmann/Weigand 2000). 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 that besets the incentive to monitor managers when shareholdings are widely dispersed is reduced, more concentrated firms should have more productive investments and more balanced growth. Furthermore, as Hermalin and Weisbach (1998) show, managers have a strong incentive to capture the board so as to ensure that they can keep their jobs and increase their benefits. The higher the ownership concentration of the largest shareholders, the lower is the influence of managers to select the board of directors by their self. In this vain, Bartelsman and Doms (2000) show that firm ownership determines the firm's choices on technology and inputs and thus is a major source of influencing productivity and growth.

Although the assumption that owners want the company to maximize profits is standard in economics, it is only an approximation of the more general idea that owners like managers may be expected to maximize their own utility. Thus the identity of owners may be an important factor with implications for productivity and performance (Pederson/Thomsen 2003). Especially in Germany large shareholders can be divided in two groups: Final owners like single individuals and families, or owners who act as intermediate agents (like financial companies, other industrial companies) for final owners. Thus, there is no clear cut answer why managers acting as "owners" of other companies want the owned company to maximize profits while they are assumed to

maximize their utility in their own company. Since markets are incomplete though that all risk is not diversifiable, even profit maximizing owners may disagree about corporate strategy and the choice and combination of inputs and outputs because of different preferences regarding the risk and the time profile of expected cash flows. Thus, we assume that shareholders may differ according to their costs (risk-bearing) and benefits of ownership.

Interpreting the firm as nexus of contracts (Alchian/Demsetz 1972) with different shareholders, the optimal ownership type ceteris paribus minimizes the costs of ownership and market contracting (Demsetz 1983). Ownership costs include the costs of monitoring and risk-bearing (Jensen/Meckling 1976) but also the cost of collective decision making in the case with large and heterogeneous shareholders as proposed by Hansmann (1988). The costs of market contracting include transaction costs associated with asset specifity, asymmetric information, or losses attributed to market power distortions like double marginalization. Benefits of ownership may result from dividends and other kinds of cash flows, private benefits from dominating the company (Fama/Jensen 1983), or access to input and output markets associated with lower costs or higher selling prices. Thus, we conjecture that each of the ownership categories have different objectives with implications for productivity and performance.[6] Financial institutions like banks and insurance companies may be interested in providing services and loans to the owned firms (see also Schneider 2000). Both may be adverse to downside risk and thus be reluctant for projects with higher expected returns and a higher risk. They may also be interested in increasing investments and growth which will usually mean more lending for them and more insurance services. Corporate

[6] The descriptive statistics of our sample underpin the assumptions.

owners may more be interested in maintaining a steady relationship with business partners. They could use their shares as a mechanism of power to appropriate rents from selling inputs or buying outputs from the dominated firms. Larger ownership share give them more influence to see that company managers respect their preferences (see Thomsen/Pedersen 2000; Pedersen/Thomsen, 2003). Family owners may be more concerned with growth and survival. Since an excessive share of their wealth is invested in the company, they may be relative risk-averse and thus favouring projects with a less risk and thus lower expected returns. They also are more likely to be credit constraint than other companies. Companies with more than one large shareholder may have higher costs of ownership bearing the costs of collective decision making (Hansmann 1988). This allows a lot of leeway to managers and thus may reduce productivity and performance. Also home country specific effects of the owner may influence the productivity of a company (de Jong 1995, Thomsen/Pedersen 2000). Finally, changes in the ownership structure of a firm may reflect changes in the costs and benefits of the ownership during the lifecycle of a firm (Demsetz 1983).

Leech and Leahy (1983) suggest that the location of control rights, i.e. the identity of owners, is a more useful indicator of the degree of governance exerted by the owners than ownership concentration (see also Schneider 2000, Pedersen/Thomsen 2003). 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. Lehmann and Weigand (2000) find that the identity of the ultimate owner matters for the effect of ownership concentration on corporate performance. We therefore take specific account of the location of control rights and run the DEA for each owner group separately for every year 1992 to 1996. Given the six different owner groups over five years we run the above program 30 times with the same input-output specification.

3 Efficiency measurement with DEA

Recently, Jensen argued that it is logically impossible to maximize in more than one dimension at the same time unless the dimensions are monotonic transformations of one another (see Jensen 2001). Otherwise, he argues, economic value and social welfare is created whenever a firm produces a set of outputs valued by customers at a rate more than the value of the inputs that the firm consumes to produce those outputs. This is the well known concept of technical efficiency (see Caves 1992, Green/Mayes 1991). However, since not all inputs like the governance structure are technical, we instead use the term of organizational efficiency, as discussed in Grandori (1991). Thus, firm value as expressed by measurement of return on assets, is the market value of the expected stream of benefits generated by an efficient production of outputs. However, estimating efficiency in the case of multiple outputs and inputs is associated with many problems such as the weighting of different outputs, measurement of inputs without market prices and the transformation from inputs to outputs without the knowledge of the specific kind of production function.

One technical solution is the concept of Data Envelopment Analysis (DEA). This is a non-parametric linear programming technique that considers multiple inputs and multiple outputs in the absence of generally accepted weightings for the multiple factors. DEA computes an efficiency score where the associated weights of the inputs and outputs are determined endogenously by linear programming. DEA first defines a production frontier on which all pareto optimal firms are located. This frontier envelops all other firm observations which are subsequently called inefficient. Consequently, firms not lying on the frontier are dominated by at least another firm or a combination of firms that define the frontier. In a second step the distance of every inefficient firm to its reference firm on the frontier is determined, using a radial measure. This distance indicates the level of inefficiency of the firm.

DEA is based on linear programming techniques.[7] Let there be j=1,...,n firms consuming i=1,...,m inputs x_{ij} to produce r=1,...,s outputs y_{rj}. The assigned weight to output r is u_r and the weight assigned to input i is v_i. Taking the observed inputs and outputs as exogenous the weights of the inputs and outputs are calculated by applying linear programming techniques. The objective is to maximize the relative efficiency score h_k for each firm individually subject to the constraint that no other firm attaching the same weight has a higher score than one. So, the efficiency scores are normalized to the interval from 0 to 1. The non-negativity constraint holds for all weights as well as for all inputs and outputs. The intuition for calculating the efficiency score h_k for firm k is as follows:

[7] Introductions to DEA are provided by e.g. Seiford and Thrall (1990) or Cooper, Seiford and Tone (2000).

$$\max_{\mathbf{u},\mathbf{v}} h_k = \frac{\sum_{r=1}^{s} y_{rk} u_r}{\sum_{i=1}^{m} x_{ik} v_i}$$

(1)
$$\text{subject to } \frac{\sum_{r=1}^{s} y_{rj} u_r}{\sum_{i=1}^{m} x_{ij} v_i} \leq 1 \qquad (j = 1, 2, ..., n)$$

$$u_r > 0 \qquad (r = 1, 2, ..., s)$$

$$v_i > 0 \qquad (i = 1, 2, ..., m)$$

The sum of an aggregated output and the sum of an aggregated input ratio is maximized which is known as fractional program. Following Charnes et al (1978) this fractional program is transformed into a linear program. Maximizing the fraction from (1) can be achieved by minimizing the denominator of the fraction and normalizing the nominator to 1 to make the solution clear.

$$\min_{\mu,\upsilon} \sum_{i=1}^{m} x_{ik} \upsilon_i$$

$$\text{subject to} \quad \sum_{r=1}^{s} y_{rk} \mu_r = 1$$

(2)
$$-\sum_{r=1}^{s} y_{rj} \mu_r + \sum_{i=1}^{m} x_{ij} \upsilon_i \geq 0 \qquad (j = 1, 2, ..., n)$$

$$\mu_r > 0 \qquad (r = 1, 2, ..., s)$$

$$\upsilon_i > 0 \qquad (i = 1, 2, ..., m)$$

The duality theory from linear programming implies that there is a dual program for each primal linear program and the solutions are always equal. The formulation applied

for the estimation procedure determines the position of a firm *k* relative to the frontier by the solution of the following dual program of (2):

$$
\begin{aligned}
&\max_{\theta,\lambda} \theta_k \\
&\text{subject to } \theta_k y_{rk} - \sum_{j=1}^{n} y_{rj}\lambda_j \le 0 && (r = 1, 2, ..., s) \\
&x_{ik} - \sum_{i=1}^{m} x_{ij}\lambda_j \ge 0 && (i = 1, 2, ..., m) \\
&\lambda_j \ge 0 && (j = 1, 2, ..., n)
\end{aligned} \tag{3}
$$

The dual program shows that the firm's relative efficiency is maximized, subject to the condition that the underlying production function is monotone increasing and concave, and envelops all firms. In this way the relative efficiency of each firm is maximized separately.

The above linear program has to be solved for all *n* firms. Formally, this means that the index *k* takes values from 1 to *n* and *n* programs have to be solved. By identifying the efficient reference firm for each firm separately, the DEA model in fact identifies an empirical production frontier. A firm is called technically efficient if the efficiency score θ_k equals one. Otherwise, the firm is called inefficient and the score indicates the level of inefficiency. In this case, the firm could improve its efficiency by either reducing its input levels or increasing its output levels over which management has control.

The variable θ_k is called the efficiency score and indicates the proportion by which all outputs of firm *k* are augmented so that firm *k* is efficient. Therefore, every output of firm *k* must be increased proportionally by θ_k to reach the reference firm on the

efficiency frontier. The efficiency frontier is formed as piecewise linear and connects the set of best practice observations, yielding a convex production possibilities set. The reference firm is a hypothetical firm, generated as linear combination of fractions of one or more observed input-output- combinations of firms on the facet. The variable λ_j gives the proportion of the *j*th firm in the reference set of firm *k*. Thus, for each firm *k* in the sample, DEA determines whether it is technically efficient and lies on the frontier or not. From this starting point the DEA-model can be extended in various ways. So we have been dealing with a model of constant returns to scale until this point. The DEA model applied in our study bases on the assumption of variable returns to scale to allow for inputs and outputs in percentages. Therefore we add the further constraint $\sum_{j=1}^{n} \lambda_j = 1$ that can be interpreted as convexity condition (Banker/Charnes/Cooper 1984).

To illustrate the estimation procedure two outputs and one input is used (see figure 1). The efficiency frontier is built by firm A, B, and C that are technically relatively efficient. All other observations are enveloped by this frontier. The level of inefficiency for firm D can be calculated as the ratio of the distances OD to OD*. Thereby D* is the hypothetical reference firm of firm D, generated as radial extension of amount of outputs 1 and 2 of firm D. The efficiency score for firm D is OD/OD* and indicates the level of inefficiency. Hence, all firms on the frontier have a score equal to one and are therefore called efficient. The smaller the value of the score the higher is the level of inefficiency, at least the score is zero.

However, one drawback of an isolated DEA approach is the assumption that there is no measurement error in constructing the frontier. That temporarily gives a decision making unit better performance one year relative to other years. Also, there are no inaccuracies created by accounting rules that would make measured outputs and inputs deviate from economic outputs and inputs. Any of these errors that appear in an inefficient unit's data may be reflected as a change in its measured efficiency. But this deterministic approach turns to be an advantage later in our study.

Lacking of distributional assumptions, the generated DEA scores can be used in regression analysis (Lovell 1993) and has several advantages for this study. First, DEA requires very little structure to be placed upon the function relating inputs to outputs. Second, it allows investigating multiple outputs simultaneously. Importantly, it does not require that the relationship between multiple outputs is specified. This would be necessary for a simultaneous equations regression model. Third, it calculates a relative efficiency score for each firm separately subject to the entire set of firms under evaluation. The weights attached to the inputs and outputs are determined endogenously for each firm.

Since the seminal contribution of Charnes et al. (1978), a number of different DEA models and their corresponding applications have appeared in the literature. Originally, DEA was designed to measure the relative efficiency within non-profit organizations where market prices are not available (see Thursby 2000 for universities). However, by its ability to model multi-input/multi-output production functions without assuming a functional form *a priori*, DEA has been widely applied in the profit sector. Examples are Zhu (2000) for the Forbes 500 firms or Brockett et al. (1998) for insurance companies. Others have used DEA to look into differences in technical efficiency

between small and large firms (Patibandla 1998) and innovation efficiency (Grupp 1997). Probably most often DEA has been employed to analyze the banking sector (see Berger and Humphrey 2000 for a detailed survey of more then 130 studies that apply frontier efficiency analysis).

4 The Data

4.1 Data and sources

We employ a data set of 361 firms from the German mining and manufacturing sector. The panel runs from 1991 to 1996 and is characterized by the pressure to restructure corporate activities as a consequence of the European single-market program and the German reunification. Financial statement data for the sample 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 majority of the sample firms are stock corporations (300 companies). The remaining firms are limited liability corporations. 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).

4.2 Variable definitions

We assume corporate performance to have three dimensions: investment, firm growth, and profitability. We measure firm profitability by the return on total assets (ROA), defined as gross profits (calculated as turnover minus expenses for personnel and materials) over total assets. ROA thus measures current accounting profitability more than expected future earnings.[8] Investment is defined as the annual expenditures for tangible assets scaled by total assets. Firm growth is calculated as the log change in annual turnover.

Governance structures are reflected by ownership concentration, the identity of owners, and capital structure. We measure ownership concentration by the Herfindahl index of outstanding voting stock. For capital structure we use the ratio of total debt to total assets. We define a large shareholder as controlling at least 5 per cent of 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. 2. FAMILY is defined as firms having (pools of) individuals or families as largest shareholders. 3. FININST is defined as firms having banks, insurance companies, or associated investment companies as largest shareholders, or, having widely dispersed shareholdings, but banks controlled at least 75% of the voting capital through proxy voting rights. 4. MIX is defined as firms having different independent

[8] Other performance measures in the empirical literature are market-to-book value and the return on investments. The first is only available for companies with quoted shares. This would reduce our sample towards only the quoted firms and thus increase the selection bias of our analysis. The ROI is rather sensitive towards changes in the interest rates and more biased towards leverage effects. Interest rates however varied on a large intend during the time period of the sample caused and influenced by the German reunification.

large shareholders. 5. FOREIGN is defined as firms having foreign companies as largest shareholders. 6. CHANGE is defined as firms which experienced a change in the identity of block holders through turnovers of blocks from one of the owner categories 1-5 to another. Capital structure is measured by the share of debt in total capital.

Further variables to be employed are capital intensity, defined as total assets per employee, absolute firm size, defined as log of total assets, and market concentration. We take market concentration as a summary measure of industry characteristics, reflecting current production technologies (potential scale economies), demand (price elasticity) as well as the intensity of competition. We use the Herfindahl index at the two-digit industry level.

4.3 Descriptive sample statistics

Table 1 contains summary statistics of the firm variables for the groups of firms as classified by the identity of their largest owner. Nearly one third of all firms in the sample can be identified as family owned or controlled firms. They have the second highest ROA and investment ratios compared to all other groups. Family owned firms also grow faster on average and have the highest gearing. They also have the lowest dept ratio which indicates the policy of those firms by restricting the influence of third parties like banks. The second largest group with 81 observations is controlled by another independent large shareholder like other firms (INDFIRM). Interestingly, this group shows the lowest rates of returns, investment ratios and growth rates than any other group. This could be explained by the fact that firms and holdings as large shareholders try to increase their own returns chargeable to the dominated firms. This

also explains why the ownership concentration is the highest in this group: to ensure that they could pursue their own economic interests. The group with the highest return on assets is the one controlled by foreign companies (FOREIGN).[9] One explanation may be a selection effect that foreign firms only invest in high profitable firms – but why should this not even hold for German institutional investors, especially banks or firms with more information? Otherwise foreign investors may have more disciplining influence on the managers of a firm or select other types of managers in Germany. The high ownership concentration also indicates the incentive to influence the firm policy directly instead of a portfolio investment. About 15% of the firms in the sample have multiple large shareholders (MIX). These firms may be associated with higher coordination costs and free riding problems by the different groups of shareholders, which may increase the freedom of action by the management (see Hermalin/Weisbach 1998). This group represents the "average" firm group, since employment, returns on assets, growth rates or capital structure is similar to the average of the whole sample. Also the group with a change in the ownership structure (CHANGE) does not vary from the overall mean and median. The smallest group in the sample with only 20 observations are firms controlled by financial and investment companies. They control the firms directly by their ownership shares and indirectly by proxy votes. This gives banks power to control those firms in their own interest without bearing the risk of investing capital. Therefore, ownership concentration is the lowest in all groups. The investment decisions of financial institutions in those firms could rather be explained by exercising power in the "Deutschland AG" than by economic performance. On the one hand, those firms exceed the mean and median size of the other firms by the factor

[9] The finding that foreign large shareholders have a significant positive effect on firm performance is also found in other studies (see Claessens/Djankov 1999).

of five and are by far the largest firms in the sample. On the other hand, the return on assets is lower than the average. They also show the highest dept ratio of all groups. However, the relationship between size, capital structure, returns and investments is much more complicated as expressed by those simple descriptive statistics.

5 Empirical results

5.1 Results from DEA Analysis

Table 2 presents distributional information on the computed efficiency scores from the 30 estimations. Although the number of efficient units is determined by the size of the sample, their number varies across the different owner groups and over time. For example, in the INDFIRM group in 1996 13 of 81 firms operated on the efficiency frontier, yielding an efficiency score of 1. The remaining firms had chosen their input-output combinations inefficiently relative to the firms on the efficiency frontier. The lowest efficiency scores, i.e. the "most inefficient" firms, are found in the groups of firms owned by other firms or by foreigners. However, standard deviations are the highest for these groups, indicating that the firms are rather heterogeneous in their technical efficiency. The highest share of technical efficient firms is found for the group of firms controlled by banks or other financial institutions. This group also has the lowest standard deviations. We also run the DEA scores for different years independently from the different ownership structures. The results are depicted in figure 2 and 3. Figure 2 shows the distribution of the efficiency scores from 1991 until 1996. Figure 3 provides kernel density estimations for the 6 years on basis of the DEA scores. Both figures exhibit that the DEA scores are not stable within the time period and thus should have enough variation to explain variations of the ROA. Figure 3 also

shows that there might be a bimodal distribution of the efficiency scores among the included firms. This artifact could be seen for all years. Unfortunately, we could not find a logically explanation for this finding.

4.2 Regression analysis

As the DEA efficiency scores are deterministic, we can use them as regressors in a regression analysis of firm profitability. We hypothesize that more efficient firms (that is, those with higher efficiency scores) have higher profitability. We thus follow Jensen's (2001) argument that managers should have one performance measurement. In line with most empirical studies of firm performance, we also use the ROA as a measure of the market value from the production of the outputs.

The model to be estimated is

$$ROA_{it} = \sum_{j=1}^{6} b_j E_{it}^{j} + b_7 SIZE_{it} + b_8 CONC_{it} + u_{it}, \qquad u_{it} = a_i + a_j + \lambda_t + \varepsilon_{it},$$

in which *ROA* is the return on total assets and *E* denotes the DEA efficiency scores of firms according to their owner groups $j = 1,\ldots,6$. The subscripts $i = 1,\ldots,361$ and $t = 1992,\ldots,1996$ identify firms and time periods respectively. The regression disturbance u_{it} can be decomposed into firm-, industry- and time-specific effects, a_i, a_j, λ_t respectively, and a classical white noise regression disturbance ε_{it}. We take these

effects as random. We add firm size and market concentration which have been widely used in industrial organization studies on the determinants of profitability.

If scale or scope economies are important we would expect a positive effect of absolute firm size on profitability (e.g. Baumol 1959, Klette 1999) while a negative effect could again point at organizational inefficiencies (X-inefficiency, Leibenstein 1966). However, as larger firms tend to be more diversified, lower risk premiums could render the effect negative as well. Oligopoly theory suggests that market concentration is positively correlated with profitability. This prediction is supported by a vast empirical literature. We therefore expect the coefficient on market concentration to be positive. However, it is often argued that product market competition may also align managers' goals with the aim of efficient production (Allen/Gale 2000). Therefore an increase in the market concentration as a measure of lower product market competition should increase managerial slack and therefore decrease a firm's performance (Hart 1983). A lot of empirical work provides evidence of this point of view (Caves 1992, Nickel et al. 1997).

Table 3 summarizes the regressions results. The four regressions vary in their specification and could thus be interpreted as a robustness check of the findings. With one exception the efficiency scores are highly significant for all owner groups, irrespective of the estimation method and also show the same sign. Since the specification tests suggest that the model with fixed firm effects (firm-specific intercepts) in column (3) is appropriate, we will pool our interpretation based on this estimation.

Column 1 presents the cross-section OLS results with the regression variables averaged over the observation period (361 observations). Column 2 gives the pooled (cross-

section time-series) OLS estimates (1805 pooled observations). Column (3) shows the pooled (Within-)OLS estimates based on the assumption of fixed (constant) firm-specific effects (361 firm-specific intercepts). Column (4) assumes random firm-specific effects (i.e., a common intercept from which individual firms may deviate randomly). Regressions (2) to (4) include fixed time dummies to pick up time-specific effects common to all firms (e.g. business cycle effects). All estimates shown are robust to heteroskedasticity (White).

The underlying assumption that efficiency is a major source of ROA could clearly be stated by the results. Although the descriptive statistics provide a great variation of the efficiency scores within the different groups, the results are clear and robust among the different estimation techniques. The results also hold if we compute the DEA scores per year and not per shareholder group.

If, as often argued, managers would misuse their discretion and over invest in non-productive assets or firm growth – and thus increase the efficiency scores – one should expect a negative influence of the scores on the ROA. Otherwise, the results show that higher efficiency scores are associated with higher returns on assets and vice versa. Thus, the misuse of managers could be reduced by large shareholders, independently whether they are banks, other firms or families. This results supports the theoretical arguments about the disciplining role of large shareholders (see Shleifer/Vishney 1997). The findings also confirm the arguments by Bartelsman and Doms (2000) that productivity is mainly influenced by the ownership of a firm: Since firm's choice of technology, inputs, and production are made by management, and managers are

controlled and selected by (large) shareholders, the latter also influences the productivity of a firm. [10]

Interestingly, especially the group dominated by financial institutions differs from all others. Although the sign of the coefficient shows the positive impact on ROA, it still remains insignificant in column 3. This emphasizes our assumptions derived from the descriptive statistics, that banks and insurance companies like the Deutsche Bank AG and the Allianz AG (the two largest shareholders of German firms and the guarantees for the so called "Deutschland AG" – which describes the interconnections of firms in Germany) are more interested in increasing their influence in big firms than in productivity and higher returns. They may also profit from their investments by selling their products or providing dept at costs which may be more in their economic self interest. Thus, the costs of large shareholding on firms with lower returns may be lower than the benefits for banks and insurance companies. Thus, the private benefits for those firms may be higher than their impact on monitoring managers.[11]

Controlling for the identity of owners, for firm size as well as product market characteristics summarized by market concentration, we find that firms which are more efficient according to the DEA in selecting their governance structures, investment and growth strategies, have higher profitability. The coefficients on firm size and market concentration are significant and conform to the theoretical expectations. The negative effect of the firm size could point either on organizational slack or lower risk

[10] In the last two years, two big firms failed from the sample: the Holzmann AG and the Deutsche Babcock AG. Both firms were dominated by banks and insurance companies and showed a high dept-asset ratio.
As an example, DaimlerChrysler, where the Deutsche Bank is the largest shareholder is a prominent example for such a behavior. In the past decade more than 10 billions of Euros where invested in projects without any significant and positive effects on firm performance. The Deutsche Bank, however, is also the main bank of DaimlerChrysler, with own interests. The last CEOs of DaimlerChrysler are mainly placed and controlled by the Deutsche Bank.

premiums. The effect of the market concentration on ROA could also be interpreted in a different way. Taken the concentration ratio as an inverse measure of product market competition, it shows that a major explanation for the ROA is due to oligopoly power instead of managerial effort. However, it is difficult to access how much of a firms' profit is caused by oligopoly pricing and market power or from managerial effort. If a tough product market competition would force managers on high financial returns like the ROA, the concentration ratio should rather remain insignificant since the efforts and incentives may be captured by the efficiency scores. On the contrary, the coefficient indicates the highest absolute value compared to all coefficients.

Finally we also performed standard t-tests on the differences between the efficiency score coefficients. The differences across owner groups are not statistically significant at conventional levels of significance.

6 Summary

The purpose of this study is to incorporate explicitly the link between governance structures and organizational efficiency on firm profitability regressions. Most empirical studies apply reduced form regressions and investigate the impact of governance variables, mostly ownership concentration, on profitability, taking capital structure or investments as given. This approach could be defended that estimating full-fledged simultaneous equation models requires a lot of specification effort and good instruments for system identification (see Böhren/Ödegaard 2003, Himmelberg et al. 1999). Also the reduced form approach as widely used in the empirical literature (see Short 1994) has one crucial drawback: the empirical evidence of whether differences in governance regimes help explain differences in corporate performance remains

ambiguous. Thus, in contrast to previous research on governance-structure-performance studies (as summarized by Short 1994, Thomson/Pederson 2000, or Holderness 2003), our results are quit robust among different estimation techniques.

Our main finding is that profitability differences between firms can be significantly explained by the technical efficiency of firms, even after controlling for industry effects and unobserved systematic effects. The difference across owner groups is not statistically significant. In conclusion, it could be shown that not only the concentration and the location of ownership matters, as found by Pederson and Thomson (2003), but also the technical efficiency of firms.

To determine efficiency, we use a nonparametric approach (DEA) and thus link ownership structure and capital structure as a firms input to generate investment and turnover growth as outputs. In a second step the efficiency scores are included as explanatory variables in a panel regression analysis of firm profitability, measured by the ROA.

This study also displays that although managers have to pursue multiple tasks – firm growth and investments in this case – the success of those tasks can be measured by technical efficiency. The positive and significant impact on ROA also shows that this measurement incorporates those effects and thus may serve as an overall objective function as proposed by Jensen (2001). To get a more comprehensive picture of how technical efficiency is linked with governance structure, future research should be done to identify what is behind these effects.

The limitations of this study are mainly three aspects. Firstly, the endogeneity problem which is prevalent in empirical research (see Himmelberg et al. 1999; Bören/Odegaaard 2003 for a discussion). Such endogenous effects arise, since both, performance and corporate governance mechanisms are determined simultaneously. However, as shown in Lehmann and Weigand (2000) for this dataset, ownership is much more stable than in other corporate governance systems. Secondly, the problem of missing variables, like spending in R&D. Since firms in Germany are not forced to publish such data, they are not available for researchers. Limiting the study only towards those firms, which made their spending public, would lead to selection bias towards those firms. Since only a small part of those firms are listed on the stock market, other performance measures like market-to-book ratio or Tobins Q would restrict our analysis to only a small sub sample. However, those performance measures are also very noisy (see Himmelberg et al. 1999 or Morck et al. 1988 for a discussion). Finally, the selection of inputs and outputs in the DEA analysis. If available, other inputs like investments in R&D, personnel spending, or the number of patents could also be considered as additional inputs.

Nevertheless, the empirical results clearly indicate that firms operating pareto efficient in producing growth and investments, also have higher returns on assets. The organizational efficiency, however, is mainly driven by the ownership structure and the capital structure. Thus, we cannot conclude that large-block holders only share private benefits of control. Or, in other words, the superior monitoring of the management may force them to operate on a high efficient level which then results in higher firm performance. The negative impacts of large block-holders may then be outweighed by this effect. However, further research is necessary to confirm those findings.

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Figure 1: Model of DEA with 2 Outputs and one Input

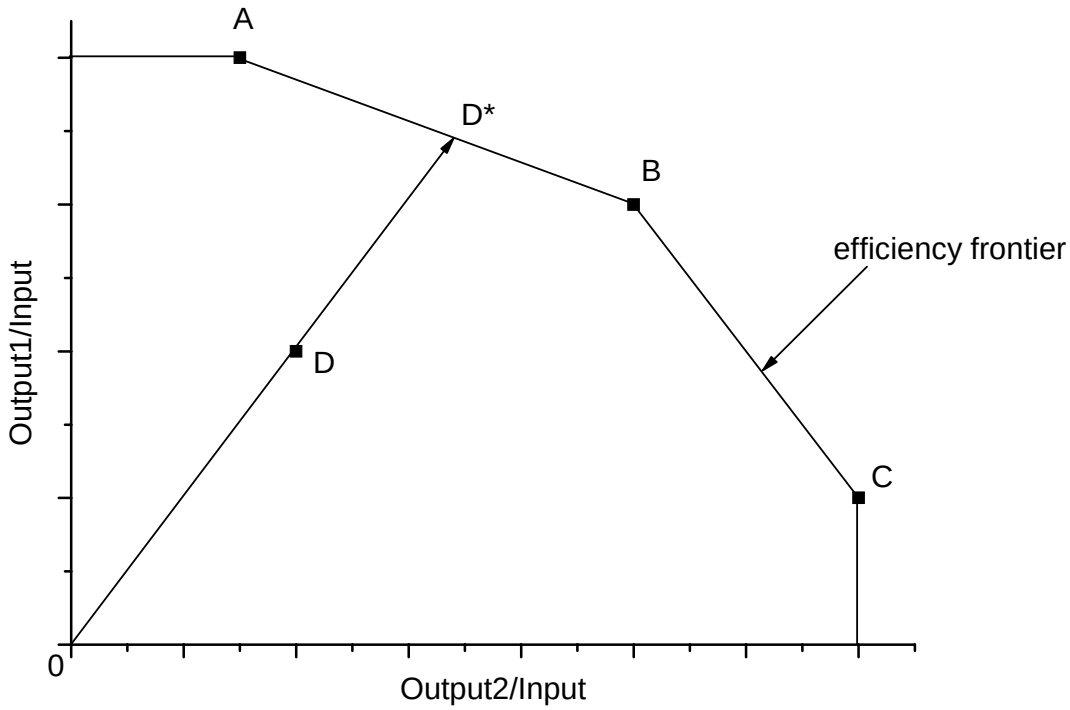

Table 1:

Summary statistics: sample of 361 German manufacturing firms, 1991-1996

		Location of control rights					
	ALL FIRMS	INDFIRM	FAMILY	FININST	MIX	FOREIGN	CHANGE
Number of firms	361	81	122	20	54	58	26
Return on total assets							
Mean	.2958	.2408	.3162	.2725	.2918	.3439	.2913
Median	.2875	.2253	.3120	.2536	.2999	.3129	.2844
Tangible investment ratio							
Mean	.0751	.0636	.0836	.0704	.0844	.0690	.0684
Median	.0634	.0532	.0706	.0644	.0744	.0550	.0602
Firm growth							
Mean	.0219	.0016	.0428	.0363	.0221	.0018	.0204
Median	.0220	.0074	.0378	.0256	.0191	.0076	.0082
Ownership concentration							
Mean	7,465	8,818	7,485	1,897	3,318	9,045	4,078
Median	10,000	10,000	9,900	3,420	3,322	10,000	3,563
Employment							
Mean	11,063	9,012	8,753	53,510	11,469	5,008	8,304
Median	2,094	2,746	1,354	14,329	3,987	1,641	1,747
Capital structure							
Mean	.5841	.5930	.5541	.6367	.5999	.6115	.5626
Median	.5974	.6019	.5666	.6673	.6068	.6264	.5464

Table 2

Summary statistics: DEA efficiency scores for 361 firms, 1992-1996

		1992	1993	1994	1995	1996
	No. eff. firms	14	11	10	12	13
	Mean	.514	.688	.510	.740	.722
INDFIRM	SD	.288	.183	.229	.164	.184
81 obs	Maximum	1.000	1.000	1.000	1.000	1.000
	Minimum	.093	.371	.112	.412	.071
	No. eff. firms	22	19	18	27	18
	Mean	.656	.694	.621	.790	.770
FAMILY	SD	.214	.188	.211	.161	.167
122 obs	Maximum	1.000	1.000	1.000	1.000	1.000
	Minimum	.308	.291	.278	.388	.139
	No. eff. firms	10	11	9	9	8
	Mean	.917	.906	.892	.862	.896
FININST	SD	.105	.134	.124	.140	.109
20 obs	Maximum	1.000	1.000	1.000	1.000	1.000
	Minimum	.665	.477	.627	.610	.681
	No. eff. firms	14	18	12	13	14
	Mean	.819	.899	.759	.835	.840
MIX	SD	.153	.114	.164	.118	.133
54 obs	Maximum	1.000	1.000	1.000	1.000	1.000
	Minimum	.539	.536	.380	.622	.482
	No. eff. firms	12	8	9	13	9
	Mean	.688	.490	.757	.619	0.645
FOREIGN	SD	.206	.252	.139	.252	0.212
58 obs	Maximum	1.000	1.000	1.000	1.000	1.000
	Minimum	.156	.187	.360	.134	0.221
	No. eff. firms	12	13	10	12	11
	Mean	.859	.856	.750	.937	0.909
CHANGE	SD	.152	.207	.246	.082	0.114
26 obs	Maximum	1.000	1.000	1.000	1.000	1.000
	Minimum	.577	.182	.279	.743	0.611

Figure 2: Distribution of Efficiency Scores from 1991 – 1996

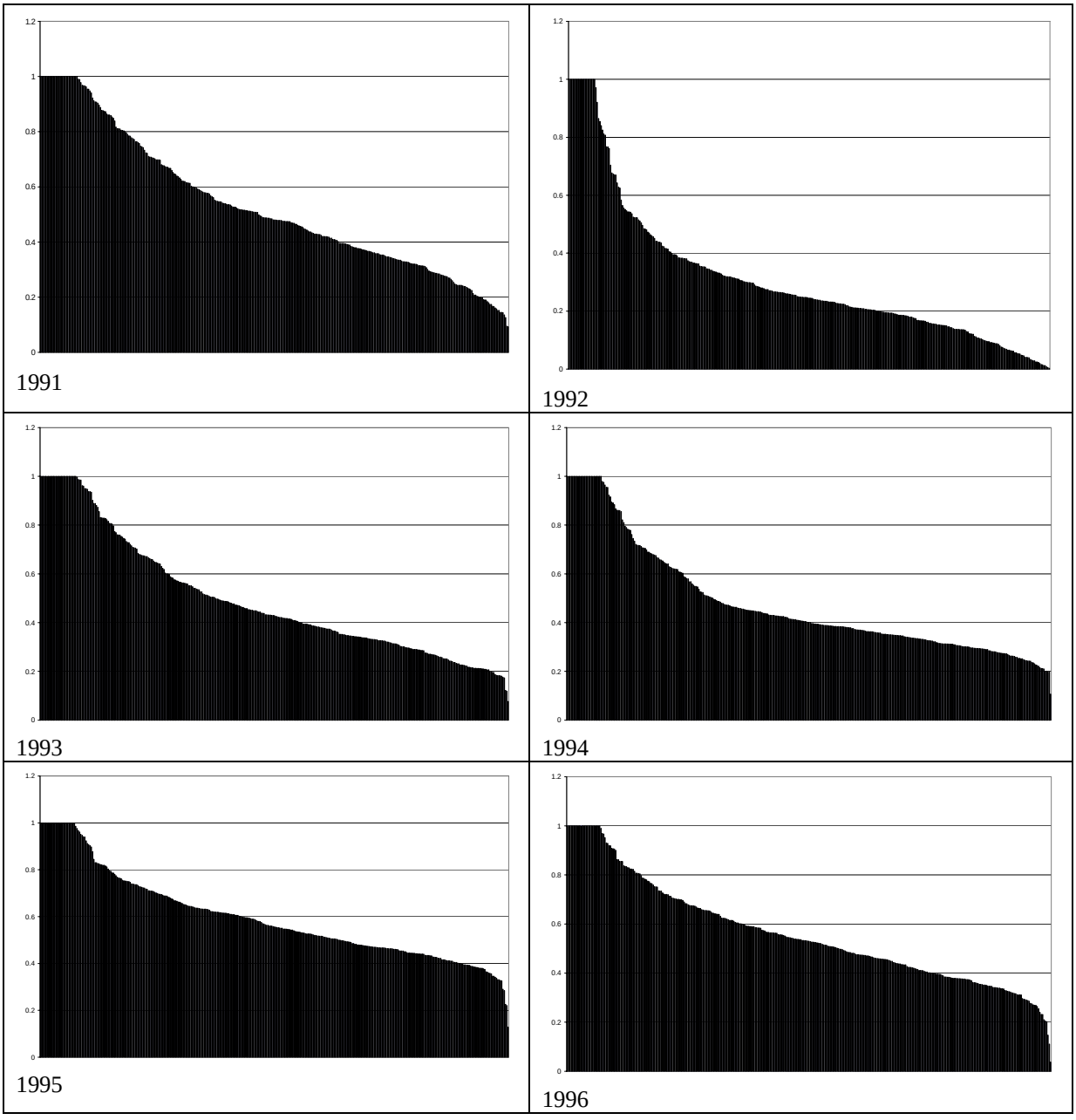

Figure 3:
Kernel density estimates for the DEA Scores (1991-1996)

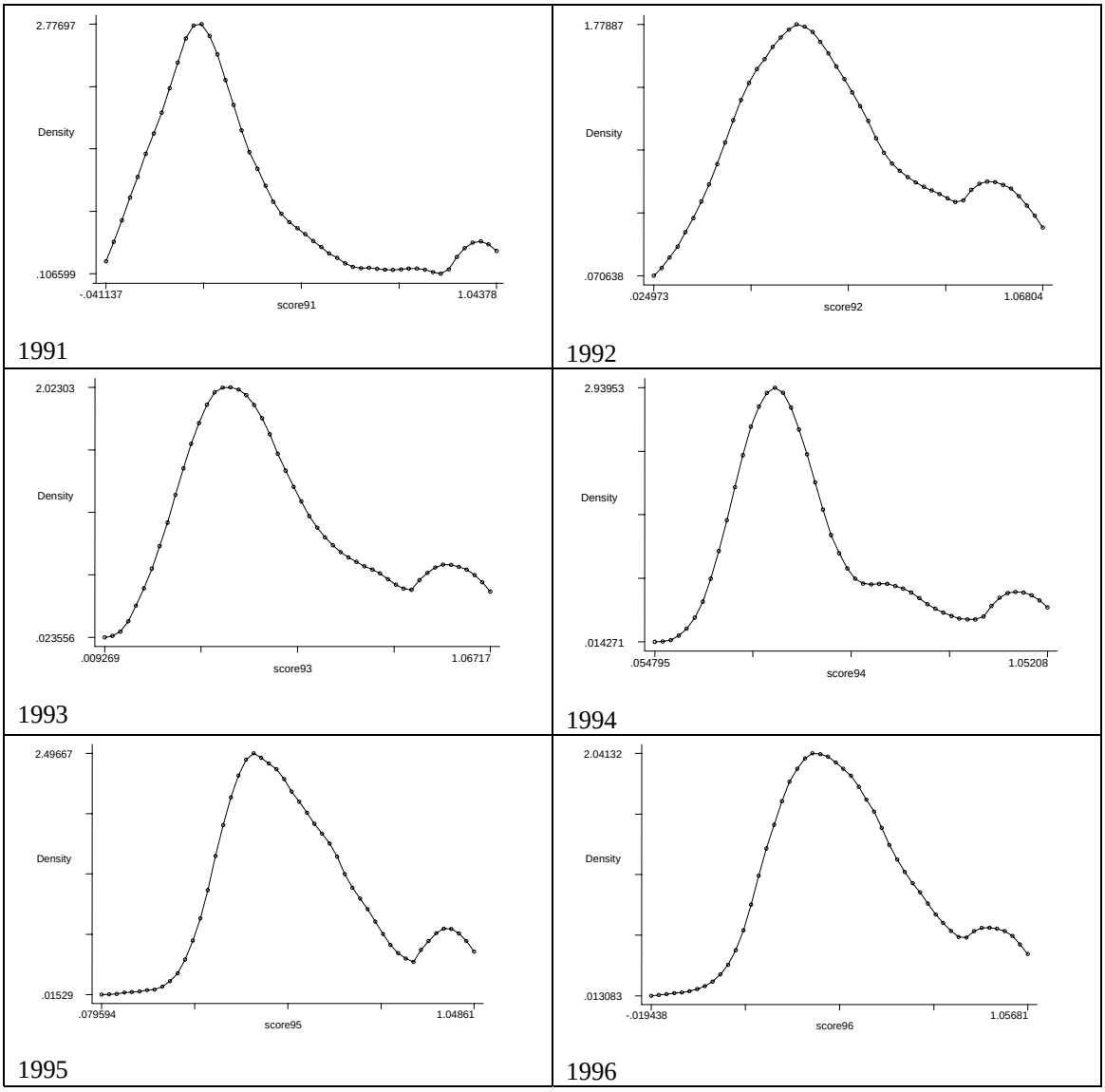

Table 3 Panel regression estimates (1992-1996)

Dependent variable: ROA	Regression coefficient (absolute t-statistic)			
Explanatory variables	(1) Cross-section OLS	(2) Pooled OLS common intercept fixed time effects	(3) Pooled OLS fixed firm & time effects	(4) Pooled GLS random firm effects fixed time effects
E_INDFIRM	.2298 (3.68) **	.1426 (5.43) **	.1050 (2.69) **	.0887 (4.28) **
E_FAMILY	.3025 (5.32) **	.2176 (9.47) **	.1215 (3.38) **	.1301 (6.59) **
E_FININST	.1973 (3.59) **	.1403 (6.18) **	.1825 (1.52)	.1240 (3.35) **
E_MIX	.2360 (4.57) **	.1678 (8.38) **	.1448 (2.62) **	.1184 (4.68) **
E_FOREIGN	.3701 (5.71) **	.2744 (10.31) **	.1373 (3.61) **	.1737 (7.53) **
E_CHANGE	.2241 (3.95) **	.1563 (7.04) **	.1792 (3.82) **	.1151 (3.79) **
Absolute firm size	–.0026 (.53)	–.0058 (2.16)**	–.1039 (6.56) **	–.0203 (4.71) **
Market concentration	.1033 (.94)	.1124 (2.05) *	.3836 (2.91) **	.2084 (2.20) *
R sq. adj.	.0881	.0918	.7533	.0673

Specification tests:
F test of common intercept F(360, 1431)=14.34 **
Hausman test of fixed vs. random firm effects: Chi-Sq (6)=223.83 **
The time effects (not reported separately) are jointly significant at the .01 level in columns (2) to (4).

** / * significant at the .01 / .05 error level respectively.