The Causal Effect of Board Size in the Performance of Small and Medium-Sized Firms*

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Abstract: Boards are endogenously chosen institutions determined by observable and unobservable firm characteristics. Empirical studies of large publicly traded firms have successfully controlled for observable determinants of board size and shown a robust negative relationship between board size and firm performance. The evidence on small and medium-sized firms is less clear; we show that existing work has been incomplete in analyzing the causal relationship due to weak identification strategies. Using a rich data set of almost 7,000 small and medium-sized closely held corporations we provide a causal analysis of board size effects on firm performance: We use a novel instrument firmly grounded in the institutional setting surrounding most small and medium-sized firms given by the number of children of the chief executive officer of the firms. First, we find a strong positive correlation between family and board size and that the correlation is driven by firms where the CEO's relatives serve on the board. Second, we find empirical evidence of a small adverse board size effects driven by the minority of small and medium-sized firms that are characterized by having comparatively large boards of six or more members.

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1 Introduction

The structure and size of corporate boards have received much attention in the media and in the business community recently, fuelled by the prominent business failures of large companies such as Enron, Worldcom and Parmalat. The general view that board characteristics matter is reflected by an abundance of national and international guidelines for good corporate governance. A survey of the codes of conduct reveals that without exemption, a substantial amount of space is devoted to the specific organization of the corporate board.[1] Nine of the fifty-one codes in the survey even go as far as to recommend specific size limitations on the number of directors. These size recommendations find their support in recent empirical research, which has established a negative relationship between board size and firm performance.

Corporate boards are endogenously determined institutions and board size depends on a number of observable firm characteristics e.g. firm size, ownership distribution, level of diversification, etc. Board size is also likely to depend on a number of unobserved factors, including factors that are potentially correlated with firm performance. This makes a causal interpretation of the observed correlation between board size and performance highly contestable even when it is possible to control for observable determinants of board size. The contribution of the present paper is to provide a causal analysis of board size effects in small and medium-sized firms by proposing an instrumental variable (IV) approach. Importantly, the great scope and level of detail of our data will allow us to define an instrument for board size, the CEO's number of children. The use of this instrument is firmly grounded in the institutional setting surrounding most closely held corporations.

The empirical analysis is based on a representative sample of 6,850 small and medium-sized closely held Danish corporations. We obtained the name and social security number of the CEO and the CEO's nuclear family members. The core instrument used for board size is the CEO's number of children over the legal age of eighteen (the age at which you are allowed to serve as a board member). We find a strong positive correlation between the instrument and board size,

[1] All codes of conduct for good corporate governance that were available on the homepage of the European Corporate Governance Institute (www.ecgi.org) in January 2005 were collected and analyzed for discussions of the structure and role of the corporate board. The most recently issued code by either a governmental body or the local stock exchange was picked for each country, providing a sample of 51 codes.

which is driven by the sub sample of firms where CEO relatives serve on the board. In addition, we discuss in detail the claim that the CEO's family relations are unrelated to firm performance when we control for observable determinants of performance.

Our empirical findings suggest that once we include a rich set of controls available in our data, observed correlations between board size and performance can indeed be given a causal interpretation. This in turn allows us to analyze the relationship between board size and performance in a less restrictive framework than that applied in previous studies, generating new insights into the relationship between the number of directors and performance in small and medium-sized firms. First, there is no evidence of an adverse board size effect for small and medium-sized firms when the board consists of the typical range of three to five directors. Second, there is a significantly negative board size effect in the minority of firms which have comparatively large boards of six or more members.

The analysis of board size effects is then extended to the issue of complexity of operations. In general, it should be expected that complex firms have larger boards, because there is a greater need for advice and strategic input from the directors. Accordingly, we find evidence which suggests that the negative board size effect of six or more directors is weaker for firms that are characterized by having complex operations.

The rest of the paper is organized as follows: In the next subsection we provide a brief survey on board size literature focusing on the methodological problems involved in giving a causal interpretation to the board size-performance relationship. Section 2 describes the dataset. Section 3 establishes in detail the source of exogenous variation in board size, which we derive from the CEOs' family characteristics. In Section 4 a standard OLS based approach is used, the instrumental variable is introduced and finally a more flexible model specification is estimated to show that no evidence exists of a board size effect for small boards in closely held corporations. Section 5 analyzes the relationship between firm complexity and optimal board size. We conclude and discuss our findings in Section 6.

1.1 A Brief Overview of the Board Size Literature with a Focus on Causality

Theoretically, based on Mancur Olson's arguments from his study on the problems of collective actions, Jensen (1993) and Lipton and Lorsch (1992) have argued that large corporate boards may be less efficient due to difficulties in solving the agency problem among the members of

the board. These authors conclude that large boards create less value than small boards.[2] This conclusion is summarized in the recent survey by Hermalin and Weisbach (2003 - p. 13, their emphasis):

> 'The idea is that when boards become *too* big, agency problems (such as director free-riding) increase within the board and the board becomes more symbolic and less a part of the management process.'

The survey by Hermalin and Weisbach also emphasizes that the corporate board should be considered an endogeneously determined institution and its organization (e.g. board size) depends on a number of firm characteristics. A number of studies have analyzed the observable determinants of board organization (see Boone, Field, Karpoff and Raheja 2005; Lehn, Patro and Zhao 2004; Linck, Netter and Yang 2005 and Raheja 2005) although these papers have little to say about the link between board size and performance.

The first empirical study of board size effects on performance was done by Yermack (1996) who analyzes a panel of 452 large US firms in the period from 1984 to 1991. Using a fixed effects approach, he shows that there is a negative and significant board size effect on Tobin's Q and that smaller boards fire CEOs more frequently. The negative board size effect on performance has been confirmed in a number of studies on large publicly traded US firms. Other studies of large US firms provide evidence that the board size effect depends on the organizational form; Adams and Mehran (2002) find a positive board size effect for US banking firms whereas Coles, Daniel and Naveen (2004) show that the negative board size effects does not hold for firms with complex operations.

There are several studies which show that the negative board size effect also exists for publicly traded firms in other countries, for example: Conyon and Peck (1998) in a sample of publicly traded firms in the UK, France, the Netherlands, Denmark and Italy; Mak and Kusnadi (2001) in Malaysia and Singapore; Lodrer and Peyer (2002) in Switzerland; and de Andres, Azofra and Lopez (2005) in a sample of firms from ten OECD countries. In contrast, Jong, DeJong, Mertens and Wasley (2000) report insignificant board size effects in Dutch firms while Black, Jang and

[2] In fact Jensen (1993, p. 865) writes *"When boards get beyond seven or eight people they are less likely to function effectively and are easier for the CEO to control."*

Kim (2003) do so in Korean firms. Kiel and Nicholson (2003) find positive board size effects in Australia. Thus with few exceptions, the negative board size effect is well established for large publicly held corporations across countries.

In a frequently cited study, Eisenberg *et al.* (1998) extended the analysis of board size effects to include small and medium-sized closely held corporations. The sample used consisted of almost 900 small and medium-sized closely held corporations in Finland, where most of the firms had from three to seven directors on the board. It was found that even for these small closely held corporations a significant negative board size effect existed. The estimated effect on performance was large. For instance, according to their most conservative estimates, an increase in board size, e.g. from 3 to 4 directors, would on average lower the returns on assets by approximately 11 percentage points at the sample mean of 13 percent.

In sum, the negative board size effect has been confirmed by many studies on publicly traded firms and by a single study of closely held corporations. This has created a general view in the literature that board size is negatively related to performance for firms and boards of all sizes. Hermalin and Weisbach (2003) conclude: "The data therefore appear to reveal a fairly clear picture: board size and firm value are negatively correlated".[3] This is in contrast to the theoretical literature quoted above, which seems to imply that a negative board size effect only applies to firms with a relatively large number of directors.

In the following, we re-examine the board size effect in small and medium-sized firms. To the best of our knowledge this is the first paper that seeks to thoroughly identify the causal effect of board size on performance using an IV approach. We thereby address a general concern in the literature that board size could be correlated with the inherently unobservable determinants of firm performance, suggesting that board size should be treated as an endogenous regressor in order to estimate its causal effect on performance. Eisenberg *et al.* address this concern by using simultaneous equations, where the identification of board size effects in the performance relationship *a priori* hinges on a single restriction, namely the exclusion of the business group dummy from the relationship. Although this exclusion restriction is crucial for the causal interpretation of the estimated board size effect, its validity remains highly contestable. In fact, the

[3]This tendency was confirmed by tracking papers and articles that discuss board size effects using GOOGLE SCHOLAR. More than 100 articles state the existence of a negative board size effect on large *and* small firms using the Eisenberg *et al.* study as their only reference for the effect in small and medium-sized firms.

corporate finance literature has provided evidence of lower firm value and performance in business groups (see Classens et al. 2002 and Volpin 2002 a.o.). Thus, the validity of the Eisenberg *et al.* identifying assumption seems unfounded by the literature. Empirically, we show in the current paper that the results in Eisenberg *et al.* is likely to be driven by the above mentioned violation of the exclusion restriction, which erroneously attribute the negative effect of business group affiliation to board size.

Studies on publicly traded firms have used other exclusion restrictions, for example the implementation of anti-director rights, ownership concentration, ownership by banks and institutional investors, network between boards in financial and non-financial firms (Postma, van Ees and Sterken 2003); the degree of state ownership (Beiner, Drobetz, Schmid and Zimmermann 2003); CEO tenure, CEO age, firm age and the amount of free cash flow (Coles, Daniel and Naveen 2004); and the percentages of outside directors (de Andres *et al.* 2005). The validity of any of these seems questionable: It is difficult to argue that the variables do not have a direct effect on firm performance, as would be required for valid identification. In addition to Demsetz and Lehn (1985) and Morck, Shleifer and Vishny (1988), there are numerous studies showing the impact of ownership concentration on firm performance. The efficiency and performance of state owned enterprises have been a major concern in the expansive literature on privatization. The relationship between performance, good governance and the number of outside directors has been central in the debate over the last decade on how to improve the quality of governance in corporations.[4]

While acknowledging the difficulties inherent in a full system analysis of board size and firm performance, it is argued in this paper that valid identifying assumptions can be established. In particular, it is shown that identification of the causal effect going from board size variations to the performance of small and medium-sized firms can be derived from the close family ties that characterize the majority of these firms. In comparison to the system analysis found in the literature, our approach is focused upon the causal performance effect while the determinants of board size are treated as a reduced form.

[4]In our survey of 51 codes of conducts, 47 of them recommend that corporate boards should include a number of independent directors.

2 The Data

Our data include all closely held corporations with limited liability in Denmark in 1999. The data originate from the annual reports that closely held corporations are required to submit to the Danish Ministry of Economic and Business Affairs. The data include financial items from both the income statement and the balance sheet, ownership information, and the name and identity of the CEO and the board members.

Similar to most Western countries, Danish company law distinguishes between two types of closely held limited liability companies, a traditional joint stock company and a less regulated version. In Denmark the two types are denoted 'A/S' and 'ApS', respectively. The latter is the Danish equivalent of the American 'S-Corp' or the German 'GmbH'. The two company types differ substantially in terms of the regulations of boards, since 'A/S'-companies are obliged to have a corporate board with at least 3 members, whereas it is voluntary to establish a board for firms incorporated as 'ApS'. As a result, only the population of consolidated joint stock companies (A/S), totalling 14,909 in 1999, are considered.

The standard selection criteria for performance evaluations is adhered to by excluding regulated industries and financial intermediaries from the analysis, thereby reducing the number of firms to 8,225.[5] A number of extremely small firms (primarily firms that were recently established) and firms that have changed industry or reporting standards are also excluded. As a result, 7,496 firms represent the population for this analysis.

In addition to the gross sample, we use a sample of 6,850 firms where we can access the CEO's family characteristics through the official Danish Civil Registration System (CPR). [6] To access the family records in the CPR-agency, we have obtained the CEOs social security number (CPR number) from a database from the Danish Commerce and Companies Agency (Erhvervs- og Selskabsstyrelsen), at the Ministry of Economic and Business Affairs. This dataset reports both the names and CPR numbers of the founders, management and board members of all firms

[5] *Inter alia* Utilities, financial intermediaries, business services, community, social and personal service activities that are likely to be regulated industries are excluded. Our sample consists of firms with primary industry affiliation within NACE groups 10 through 36 and 45 through 63.

[6] We are not capable of tracking the family characteristics of foreign CEOs that have not become naturalized. As Danish nationality law prevents adults from holding multiple citizenships our sample will by construction exclude foreign CEOs.

with limited liability. [7]

The main strategy used in identifying the causal effect of board size on firm performance is the CEO's family characteristics. The name and CPR number of each CEO was collected and submitted to the official Danish Civil Registration System (CPR), the government department responsible for administrating social security numbers. The CPR-agency then provided the family relations, including names and CPR numbers of all nuclear family members. Thus, by combining the datasets obtained from these three sources, we obtain an unique dataset with both firm and CEO family characteristics.

The CEO family characteristics sample of 6,850 firms can be compared to the sample of 879 Finnish firms analyzed by Eisenberg et al. (1998).[8] With an average board size of 3.7 and median assets of DKr 6.9 million figures for the Danish firms are comparable to the corresponding figures of 3.7 and 5.5 million (converted to 1999-DKK) for the Finnish firms. The mean age of 18.1 years for the Danish firms, however, is well above the mean age of 10.8 reported by Eisenberg *et al.* for the Finnish firms. Our sample is not comparable to the samples used by Yermack (1996) and others to study board size effects in large publicly traded firms, where the firms and board sizes are much larger.

In Table 1, main variables in the gross and CEO family characteristics samples and their relationships to board size can be compared. It is clear from the table that small and medium-sized firms dominate both samples. The number of directors appears to be positively related to firm size as measured by the assets.

Table 1 also provides evidence on the raw relationship between performance and board size. For both samples, there are no noticeable differences between the average RoAs of firms with 3, 4 or 5 directors. Firms with six or more board members have on average lower RoAs. This pattern is confirmed when we industry adjust RoA on the two-digit NACE level (the European industry classification system). In conclusion, Table 1 illustrates that there is some evidence of increased board size associated with lower returns on assets, but only for firms with comparatively large boards.

[7] Under Danish corporate law firms are required to file with the Ministry any change in CEO or board positions within two weeks of the actual date of occurrence.

[8] Approximately 80 percent of the Finnish firms are classified as active in manufacturing and trade.

3 Family Size as Exogenous Variation in Board Size

In the following, it is argued that exactly the fact that many small and medium-sized firms have strong family ties provides a valuable source of variation in their governance characteristics, which can be claimed as exogenous in terms of corporate performance. In particular, Bennedsen, Nielsen and Wolfenzon estimate using a 50 percent threshold that between 80 and 90 percent of all small and medium-sized firms in Denmark are controlled by families.

Specifically, the information on the family relationships of the CEO of the firm will be used to establish a valid instrument for the relationship between corporate performance and corporate board size. Board size is treated as being endogenous in the performance relationship and we control for a rich set of observable determinants of current performance. The candidate source of exogenous variation in board size is the CEO's number of children.

Two conditions must be satisfied for the instrumental variable estimation strategy to work. First, a systematic relationship should be established between the CEO-related instrumental variable and the current size of the corporate board; and second, the CEO-related information in itself should not be related to the current performance of the firm given the set of observable determinants of performance controlled for. Each condition is considered in turn and evidence is provided to substantiate our claims.

First, due to the significant overlap between ownership and control in small and medium-sized firms the bulk of CEOs are controlling owners. In fact, more than 75 percent of the CEOs are also owners of the corporation. Second, CEO's number of children is an exogenous source of variation, since the size of the relevant 'pool' of director candidates increases with the CEO's number of children at or above the age of eighteen, which is the age at which people are legally eligible to be board members. Moreover, if one family member is admitted to the corporate board then—due to "equal treatment" considerations—it is likely that further family members will be added, creating a tendency for corporate board size to vary according to the CEO's family size. Since it is mainly in family-related businesses that such a correlation is expected to be produced, our prior is that the relationship is statistically significant in firms where the CEO relatives serve on the board, but less so in firms without family-board relations.

Table 2 shows the mean of the CEO's number of all children and children aged eighteen or above in firms with different board sizes. Evidence is provided for the CEO family characteristics

sample and for the sub sample of firms where CEO relatives serve on the board. The table indicates a general tendency toward a positive relationship between board size and CEO family size: In firms with a board size of three the CEO has 1.29 children aged 18 or above on average compared to 1.81 for firms with seven or more board members. In accordance with our argument outlined above, this pattern is even more pronounced in the sub sample of firms where CEO relatives serve on the board. In 50 percent of all small and medium-sized firms CEO relatives hold at least one directorship. Among these firms the CEO has 1.44 and 2.34 children aged 18 or above when the board size is three and seven or more, respectively. Thus, we find evidence of a positive correlation between board size and CEO family size consistent with our identification argument.

To further validate our claim that the CEO's children provide a valuable source of variation in the board size across firms, Table 3 reports the identity of board members. We report the number of directors that are: CEO, CEO relatives, other owners, other owners' relatives and outsiders (the residual). We define CEO relatives such that we only count relatives that are not owners of the firm. Likewise we define other owners' relatives as people related to other owners but unrelated to the CEO. Finally, Outsiders is the residual group of directors that are neither CEO, Owners or their immediate family.[9]

From Table 3 it is evident that 32.4 percent of all board members are CEOs, whereas CEO relatives occupies 19.5 percent of all board seats. Thus, in total the CEO and relatives account for 50 percent of all directorships. Other owners and relatives account for 14 percent, whereas outsiders occupies the remaining 34 percent of the board seats.

Among the CEO relatives the children account for 31.8 percent of the family board seats, which corresponds to 6.2 percent of all board seats. Finally, in firms with CEO relatives on the board, the CEO and relatives account for almost two-thirds of the total board seats. In sum, we provide evidence consistent with our identification strategy: CEOs and their relatives are frequently appointed as board members of small and medium-sized firms. This evidence adds credibility to the core of our identification argument.

To assess the significance of differences between board sizes in the CEO's number of children we report two tests for each sample. One is a test of equal means of the individual board size

[9]We define relatives as nuclear family members. Thus, Table 3 provides a lower bound on the estimated family influence on boards of small and medium-sized firms.

categories whereas the other test compares means between boards of three members and seven or more members. Both tests show very significant differences between the categories. Whether a significant overall correlation can be established when controlling for other determinants of board size, will be shown in the results from the first-stage of the 2SLS-IV procedure.

Table 4 reports the first stage regression, where we control for an array of firm characteristics.[10] We find a strong positive effect of the CEO's number of children aged eighteen or above on board size. On average the board size increases with 0.08 members for each adult child, an effect which is significant at the one-percent level. The effect is robust towards controlling for ownership characteristics in Column II. Further, in Column III we condition on whether CEO relatives are serving on the board. Consistent with our identification strategy we find a larger effect of CEO children on board size in the sub sample of firms where our story predicts the strongest effect.

Second, we need to establish that CEO family characteristics are indeed exogenous in a performance relationship. That is, based conditionally on the observable determinants of current performance, no correlation should exist between the instrumental variable, the CEO's number of children, and unobservables affecting current firm performance. This claim rules out the possibility of CEOs making fertility decisions based on characteristics of the firm they founded or plan to found, other than the variables already included in the performance relationship.

The exogeneity claim is also supported by the fact that it is possible to control for a very rich set of current firm characteristics in the data. Our claim is that once we control for this set of observables that includes information on the distribution of ownership, there will be no further direct or indirect effects of the CEO's number of children on current performance. This exclusion restriction is of course contestable. Innate ability in managing a firm and fertility could be related (most likely positively). On the other hand, there is a trade-off between time invested in child-bearing and in acquiring managerial skills, thus a priori no definite sign for such a correlation is apparent.

Another potential source of correlation could be derived from the process of CEO choice in family firms. In particular, Bennedsen, Nielsen, $Pérez-González and Wolfenzon (2006) show that the departing C$ $succession performance. However, in the current paper we measure the family size of the current CEO. Thus, any$

[10] We will introduce each of the control variables in Section 4. Summary measurements of the variables included in the regressions are found in Table 5.

As a result, we conclude in favor of the main exogeneity assumption: Any effect of CEO's family relationships on current performance runs via the size of the corporate board and not through current but unobserved aspects of the management of the firm. We further use a alternative specification using the number of founders' children as instrument for board size as a robustness check.

4 The Link between Board Size and Firm Performance

This section reexamines the empirical relationship between board size and firm performance. In addition to the IV-results we estimate the OLS relationship to facilitate a comparison. In all regressions we use an array of control variables: firm size (log. to assets), firm age, industry diversification (an indicator variable equal to one if the firm operates in multiple business segments) and a dummy for business group affiliation.[11] Ownership variables available in the data set are added as additional controls.

We proceed by reporting the OLS and the second stage of the IV analysis using the CEO's number of children as an exogenous source of variation in board size. We then show how the difference between our results and the results in Eisenberg et al. most likely can be attributed to their identification strategy. Based on the conclusions from the IV analysis, the performance equation with a more flexible specification of board size effects is reconsidered before we in the final subsection provide a robustness checks to our identification strategy by using the number of founders' children as instrument for board size.

4.1 OLS and Instrumental Variable Results

The dependent variable in the performance equation is the return on assets (RoA) of the firm in 1999. This performance measure is known to be quite noisy, although few good alternatives exist when analyzing the performance of closely held firms. The variable of main interest the number of board members are entered linearly in the basic specification. Other studies have imposed a log transformation, e.g. Yermack (1996), or even used a twice log-transformed version, as in Eisenberg *et al.* (1998). It is noted that the range of variation in board size is narrow and, if anything, the unconditional relationship between board size and performance in Table 1

[11] Industry dummies at the two-digit NACE level are included throughout.

suggests smaller effects of absolute changes in board size in small boards than in comparatively large boards, not larger effects as would be implied by a log transformation.

The following standard set of controls for firm performance is employed throughout the empirical analysis: Firm size (log. to assets); the age of the firm; and a dummy for firms operating in multiple business segments as well as a dummy for being in a business group.[12] Summary measurements of the variables included in the regressions are found in Table 5.

Variables related to ownership are also available due to the richness of the data set, particularly information on the number of owners. Ownership distribution - and especially the number of owners - may have a direct impact on performance, since it is the main mechanism aligning the interest of controlling and non-controlling owners (Bennedsen and Wolfenzon 2000). We control for the ownership distribution by an indicator variable taking the value one when the firm has multiple owners, thereby using single-owned firms as the reference category. We further add a dummy for whether the CEO is an owner, to control for differences in performance between firms with a family CEO and firms with an outside CEO.

Table 6 reports the results from the OLS and IV-regressions. The regressions in Column I and II includes only board size and the standard controls, whereas Column III and IV add ownership variables. Most effects of the standard controls are consistent across the specifications. Firm size has an increasing although concave effect on performance. The multiple business segment dummy is insignificant, whereas firms with a business group affiliation have a significantly lower performance. Older firms seem slightly less profitable than younger firms.

The OLS performance effect of board size is negative and, although small, highly significant. Adding ownership information does not change that conclusion. The consistency of the OLS results and their *ceteris paribus* interpretation clearly rely on the exogeneity of all regressors in the performance equation, including the board size variable. The IV-regressions examine the empirical validity of this assumption.

The main issue is whether board size variations are endogenous in the performance equation and whether any resulting inconsistencies matter substantially for the estimated board size effect. As argued in the introduction, unobserved performance determinants may exist that are also related to board size. If so, the OLS results do not identify the causal effect of board size

[12]Both Yermack (1996) and Rajan, Servaes, and Zingales (2000) find evidence that more diversified firms are less profitable. See the survey by Stein (2003).

variations on performance. The fact that the above regressions include a rich set of controls is a partial remedy to this problem. To further investigate the exogeneity issue, the proposed instrumental variable, the CEO's number of children, is employed as a source of exogenous variation in board size.[13]

Column II and IV in Table 6 report instrumental variables estimation results based on the extended specification of the structural performance equation. The performance equation is estimated in a two-stage least squares procedure. The first stage is a reduced-form regression of board size on the instrumental variables and on all the other exogenous variables in the model.[14] The second-stage regression includes the predicted value of board size from the first-stage regression along with the exogenous determinants of performance.

The effect of board size is negative and larger in numerical value than in the OLS regression, but is insignificantly different from zero. On the other hand, even with the inflated standard errors we can safely reject any negative board size effects in the order of magnitude found by Eisenberg *et al.* (1998).

The relative precision of the instrumental variables estimates clearly rely on the strength of the instrument applied here. A test of the validity of the instrument can provided by a F-tests of significance. This is a test of a significant relationship between the potentially endogenous regressor, board size, and the instrumental variable, the CEO's number of children, conditional on the set of included exogenous regressors in the performance equation. In the case of no significance, a "weak instruments" problem exists. In order for an instrumental variable not to be weak, Staiger and Stock (1997) argue that F-tests of significance should be at least five and preferably ten. The CEO's number of children qualify as a valid instrument based on this criterion with a F-test of identification of 54.7 and 53.8 in Column II and IV, respectively. Thus, in both specifications our exogenous variation in board size, the CEO's number of children, does not suffer from a weak instrument problem.

Having established a significant correlation between the proposed source of exogenous vari-

[13] As discussed intensively in Section 3, our main identifying argument is that once we have controlled for a rich set of potential performance determinants, including ownership variables, then the variations in the CEO's number of children is unrelated to unobserved firm characteristics.

[14] The corresponding first-stage regressions of board size were reported in Column I and II in Table 4, respectively.

ation and the size of the board, the instrumental variable can thus be used to address the question if the board size effect estimated by a simple OLS regression is substantially biased or not. Table 6 reports the Hausman test[15] of the significance of the differences between the OLS estimates (which are consistent and efficient if board size turns out exogenous) and the IV results (which are consistent in any case). Based on the CEO's number of children instrument there is no evidence that the OLS estimates are significantly biased, as the Hausman test has a $p-$value of 51 percent. Thus, the OLS results are preferable on the grounds of efficiency. A similar conclusion emerge from Column IV where we have added ownership controls.

In conclusion, the CEO's number of children has been established as a valid instrument for the performance equation. Based on the Hausman test, OLS results are preferred to the IV-estimates. Thus, we find a small negative board size effect with a significantly lower orders of magnitude compared to the estimates of the existing study by Eisenberg *et al.* (1998). To explain this difference we proceed by replicating the Eisenberg *et al.* identification strategy in our sample of Danish small and medium-sized firms.

4.2 Replication of the Eisenberg *et al.* identification strategy

In this sub section we seek to reproduce the Eisenberg *et al.* identification strategy to shed light on the large difference in the magnitude and interpretation of the estimated board size effect. Our approach is based on the view that board size is determined by observed as well as unobserved firm characteristics. First, an important determinant of board size (often not included in the data) is the ownership structure of the firm. In particular, it is expected that the number of owners and the distribution of ownership do affect board size. Corporations with a single owner tend to have smaller boards than firms with multiple owners. Board members serve a distributional role as agents for individual owners (Bennedsen 2001). Eisenberg *et al.* recognize this relationship, but do not have data on ownership structures. Second, even if detailed information on ownership were available, a more general concern remains that board size could be correlated with the inherently unobservable determinants of firm performance, suggesting that board size should be treated as an endogenous regressor in order to estimate its

[15]The particular form of the test performed here is a residual-addition test, see e.g. Davidson and MacKinnon (1993). The test is based on adding the residual of the first stage regression to the structural performance equation and testing its significance.

causal effect on performance.

Eisenberg *et al.* address this concern by modelling board size as a function of performance, size, age and whether or not the firm belongs to a business group.[16] The performance equation, on the other hand, models the return on assets (RoA) as a function of board size, board member payment disturbances, the size and age of the firm, and the change of total assets as a measure of growth opportunities. The identification of board size effects in the performance relationship *a priori* hinges on a single restriction, namely the exclusion of the business group dummy from the relationship. Although this exclusion restriction is crucial for the causal interpretation of the estimated board size effect, its validity remains unsubstantiated. In fact, the corporate finance literature has provided evidence of lower firm value and performance in business groups (see Classens et al. 2002 and Volpin 2002 a.o.). Thus, the validity of the Eisenberg *et al.* identifying assumption seems unfounded by the literature.

Again, we will focus on the reduced form and use the exclusion restriction, business group affiliation, from the Eisenberg *et al.* study to instrument board size. In Table 7 we report the outcome of this identification strategy together with OLS results to facilitate a comparison with our results. The OLS results show a small negative board size effect comparable to the results we obtained in Table 7 where business group affiliation was included as a control. The IV-results contrasts the OLS results dramatically as we find a negative board size effect of 11 percentage points. Thus, when replicating the Eisenberg *et al.* identification strategy we obtain results on the same magnitude as their results: Increasing the board size with 1 director leads to 11 percentage points lower return on assets compared to the 13 percentage points estimate in Eisenberg *et al.* when increasing the board size from 3 to 4 members.

Having replicated their identification strategy we now argue that the extremely large board size effect is an artifact of the Eisenberg *et al.* identification strategy. From Table 4 it is evident that business group affiliation is positively and significantly correlated with board size. Thus, the business group dummy meets the first out of the two necessary conditions for a valid instrument. On the contrary there appears to be a strong and significantly negative direct effect of business group affiliation on performance as shown in Table 6. Thus, the proposed instrument violates the exclusion restriction, due to the well-documented negative effect of business group affiliation on

[16] See Table 3 of Eisenberg *et al.*

performance (see Classens et al. 2002 and Volpin 2002 a.o.). We thereby erroneously attribute the negative effect of business group affiliation to board size due to the direct effect of business group affiliation on operating performance. Having accessed the source of the difference in the results we provide additional insights on the small negative board size effect we obtained in the OLS regressions.

4.3 Additional Insights on the Negative Board Size Effect using a Flexible OLS Specification

The above findings allow OLS estimation and thus more flexibility regarding the functional form of board size effects.[17] Two different approaches are applied. The first approach uses the fact that board size is an integer to construct dummy variables for boards of four, five, six and seven (or more) members, while the second approach uses a piecewise linear approach similar to that applied by Morck, Shleifer, and Vishny (1988). It specifies a linear relationship between board size and RoA, but allows for different slopes in small (five or fewer members) and large boards (six or more members). The effects of other performance determinants are largely unaltered by introducing a flexible board size specification. They are therefore not reported in Table 8.

The unrestricted dummy variable specification in Column I suggests no effects of boards of three to five members. Boards with six and seven or more members are associated with a significantly lower RoA. The F-test of excluding dummies for small boards of five or less members is easily accepted. The restricted specification reported in Column II shows a strongly significant effect of large boards. Boards with six members have a 1.87 percentage point lower RoA, wheres boards with 7 or more members have a 3.29 percentage points lower RoA than firms with small boards. This suggests that the small negative board size effect we encountered in the previous section is an average of no effect for board sizes of five or lower and a larger negative effect for larger boards. Interestingly, this finding is consistent with both the theoretical literature (Jensen 1993 and Lipton and Lorsch 1992) and the empirical literature finding a negative board size effect for larger boards.

In Column II of Table 8 we cannot reject the null of a identical effect of six and seven or more

[17] See Davidson and MacKinnon (1993, section 7.6) for a discussion of potential problems with the IV estimation when the endogenous regressor enters non-linearly in the structural equation.

members. In Column III we therefore estimate the joint effect of six of more board members. Finally in Coloum IV we use a piecewise linear specification. For the piecewise linear approach, a change in the slope of the board size-performance relationship at six board members is allowed for. The breakpoint between five and six is suggested by the unconditional RoAs reported for each board size in Table 1 and by the results in Column I and II. Again, the effect is found to be insignificant in small boards. Increasing the board size only appears to be associated with a significantly lower RoA in comparatively large boards with six or more members.

In summary, the results of the flexible models are thus supportive of the prediction by Jensen (1993) and Lipton and Lorsch (1992) that negative board size effects due to agency problems become relevant in boards with seven or more members. The findings in this paper are also consistent with Yermack's (1996) finding of a negative board size effect in boards of seven or more members.

4.4 Robustness Check: Number of Founders' Children as Exogenous Variation in Board Size

This section analyses the robustness of the results of the main analysis. In particular, we focus on the robustness regarding the validity of the identification strategy. The core identification argument relied on CEO family characteristics to instrument board size utilizing that the vast majority of small and medium-sized firms are family controlled, thereby establishing whether board size is endogenous or not.

Essentially, it is necessary for the instrumental variable not to correlate with current performance, given the observable performance determinants included in the model. As a robustness check we now consider an alternative strategy using the family relations of the *founders* of the firm to identifying the board size-performance relationship. A founder-based strategy is considered conservative in terms of the critical *a priori* argument of exogeneity of the instrumental variable.

Nonetheless, the added credibility of the founder-based instrument comes at a potential cost in terms of the precision of the estimates because the alternative, the current CEO's number of children, is expected to show a higher correlation with current board size and is available for a larger proportion of the firms.

Personal founder information is available for around one-third of the firms in the CEO family

characteristics sample of 6,850 firms. The data on founders is from the Danish Commerce and Companies Agency, which handles the registration of all Danish firms. The founders of a firm are defined as the one or more individuals who filed the forms and officially registered the firm with the Danish Commerce and Companies Agency. In most cases the founders are one or more of the original owners. In any case, the founders can be held liable for the firm's activities until the company is formally incorporated.

There is a substantial reduction in the number of observations due to the fact that founder information is available only for firms incorporated in 1986 or later. Similarly, the information is not available on firms registered by other corporations, law firms, etc. The requirement of a maximum of ten founders combined with the requirement that all founders are individuals leave a sample of 2,087 observations with the necessary founder information.[18]

The construction of the sample explicitly imposes a time lag between fertility decisions affecting founder-related information and the earliest establishment date of any firm in the sample, which thereby limits the relevance of "reverse causality" considerations. Specifically, because the founder data only include firms established in 1986 or later, the fertility decision was taken at least 5 years before the firm was established as we only count children aged 18 or above 1999 (i.e. children born in 1981 or before).[19]

We thereby rule out the possibility of founders making fertility decisions based on characteristics of the firm as the firm has not been founded, yet.

Column II in Table 7 reports the results from the IV estimates using current owners' children aged 18 or above as the instrument for board size. In addition controls used throughout the paper, we control for the number of founders of the firm, since the number of persons who founded the firm is correlated with firm characteristics already included in the regression, in particular the size of the board.

[18] Approximately one third of the firms with personal founders have a single founder and approximately 90 percent of the firms have three or less founders. Firms with ten or less founders only are considered in order to limit the importance of special ownership arrangements with a very large number of individual owners or founders. This excludes less than .4 per cent of the firms with available founder information.

[19] The time lag also solves any potential identification problems arising from board organization being "sticky", i.e. the fact that changes in board organization are rare. The presence of stickiness implies that current board organization may be related to lagged determinants. However, due to the lag between fertility decisions and firm establishment any lagged variable affecting current board size will be subsequent to our choice of instrument.

Again, the basic insights from the main analysis are confirmed. Board size has a negative, although insignificant effect on performance. The test of identification reveals that the number of founders' children is not a weak instrument for board size, whereas the test for whether board size is endogenous remains insignificant. Thus, our results remain unchanged when we apply a more conservative instrument in terms of fulfilling the exclusion restriction.

5 Complexity of Operations and the Impact of Board Size on Performance

The results reported for the flexible OLS specifications in Table 6 support the prediction from the theoretical literature that negative board size effects occur in comparatively large boards. In this section, whether or not the effects are dependent on the complexity of firms' operations are investigated.

As argued in the introduction, boards serve many different roles in a corporation, members contributing a number of different competencies. Fama and Jensen (1983) point out that firm organization depends on the scope and complexity of its operations. Firms with complex operations are characterized by a more decentralized decision making and information structure in which the '*benefits from better decision making can be achieved by delegating decision functions to agents at all levels of the organization who have specific knowledge... Control of the agency problems in such diffuse decision systems is achieved by separating the ratifying and monitoring of decisions (decision control) from the initiation and implementation (decision management)*', Fama and Jensen (1983, p. 322).

Thus, it follows that the monitoring role and information requirements of the board increases with the complexity of the operations; hence, complex operations induce a larger board. When board size of these firms is changed, there is a trade off between the positive effects of adding competencies and improving monitoring and the negative effect of increasing the free-rider problem among directors. This implies that firms with complex operations should *ceteris paribus* have larger boards and that any negative effects of having large boards become dominant only with a higher number of board members, or perhaps not at all.

Following the idea proposed by Fama and Jensen (1983)[20], we test whether or not the negative board size effect persists for firms with complex operations. We proxy the complexity of firms' operations by two variables: a dummy for the firm being in a business group and a dummy for the firm operating in more than one business segment. All models considered in the main analysis included controls for the performance effects of these complexity measures. In Table 10, these models have been extended by interacting the two proxies with the piecewise linear board size specification

Table 10 provides evidence that the negative effect of large boards is smaller in complex firms. When complexity is measured by the firm being part of a business group as in Column I, the significantly negative effect of boards of six or more members (LBS) is seen to be counterbalanced by a (insignificant) interaction term for firms with large boards and complex operations (CLBS). The net effect of large boards in firms with complex operations is estimated to $-0.0036+0.0016 = -0.002$. Indeed, a test of LBS and CLBS having equal effects with opposite signs cannot be rejected by a wide margin (the test of a zero net effect yields a $p-$value of 25 percent). The results in Column I, therefore, show that the negative performance effect of large boards predominant in firms with non-complex operations. There is little evidence of negative performance effects of small boards regardless of whether the firms are in a business group or not.

The second set of results is reported in Column II of Table 10, which employs a dummy for multiple business segments seem to contradict the previous finding of a countervailing effect in firms with complex operations. The net effect of large boards in complex firms is estimated at -0.0017 $(= -0.0019 + 0.0011)$, which is statistically different from zero at the ten-percent level. Using the multiple business segment dummy as a proxy for complex operations, we find no evidence of a negative board size effect of small boards in general and a slightly smaller negative effect of large boards in firms that operate in more than one business segment.

In conclusion, we find some evidence in accordance with the theoretical predictions, that the negative performance effect of large boards should be more prevalent in non-complex firms. This finding adds further credibility to the main conclusion that the negative board size effect only occurs in comparatively large boards.

[20]In a recent paper Coles *et al.* (2004) show that the negative board size effect for large publicly held firms disappears for firms with complex operations.

6 Discussion

A primary contribution of this paper is to produce estimates of the effect of board size on performance that can be given a causal interpretation. Moreover, we find that standard OLS results provide valid and precisely estimated small negative board size effects.

Based on these findings, a flexible model specification was then analyzed. First, no performance effects were found when varying the board size at levels below six directors, the typical range of board size in small and medium sized firms. Second, a significantly negative effect was found when increasing the size of boards with six or more members, an effect that was found to be predominant in firms with non-complex operations. This is consistent with the findings in Yermack (1996) on listed US corporations and shows that a negative board size extends to small and medium-sized closely held firms, but only to the minority of firms with comparatively large boards and a non-complex firm structure. The performance of the great majority of closely held firms shows no signs of being adversely affected by small increases in the size of their boards.

Overall, our analysis challenges the existence of a large negative board size effect for small boards in closely held corporations. As theory suggests, there are good reasons not always to choose the minimum board size. Given that board organization and the optimal number of directors occupy such a prominent place in many guidelines for good corporate governance and are discussed intensively in the business media and within many corporations, we believe our analysis, together with the well-established negative board size effect in large publicly traded firms, contains a clear policy message: Finding the right number of directors is a trade off between the benefits of having sufficient competencies represented and the cost arising from increased free riding among board members. Each firm must find the best trade off, and for most small and medium-sized firms this will be anything from three to five board members. Firms that are characterized by having a complex structure of operation through membership in business groups or that operate in multiple business segments may indeed prefer to exceed this range and add one or slightly more directors.

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Table 1: Board Size and Return on Assets

This table reports the mean and median number of the book value of *assets*, return on assets (*RoA*) and *industry adjusted RoA* for board size categories ranging from 3 to 7+. Medians are reported in parentheses. *All firms* is the gross sample of firms, whereas *CEO Family Characteristics Sample* is the sample of firms for which we were able to obtain information on the CEO's family characteristics (see Section 2 for further details).

	All firms				**CEO Family Characteristics Sample**			
Board Size	N	Assets	RoA	Industry adjusted RoA	N	Assets	RoA	Industry adjusted RoA
3	4,542	10.8 (5.8)	0.067 (0.063)	0.004 (0.000)	4,191	10.6 (5.8)	0.067 (0.063)	0.004 (0.000)
4	1,614	20.6 (7.8)	0.061 (0.061)	-0.001 (0.000)	1,459	18.5 (7.5)	0.063 (0.061)	0.001 (0.001)
5	871	27.4 (12.5)	0.065 (0.066)	0.003 (0.004)	794	26.3 (11.8)	0.066 (0.065)	0.004 (0.004)
6	288	108.9 (25.6)	0.046 (0.050)	-0.016 (-0.011)	251	95.0 (23.7)	0.052 (0.051)	-0.011 (-0.013)
7+	181	183.5 (42.0)	0.035 (0.040)	-0.025 (-0.012)	155	171.3 (39.7)	0.036 (0.041)	-0.023 (-0.008)
All	7,496	22.8 (7.1)	0.064 (0.062)	0.002 (0.000)	6,850	20.9 (6.9)	0.065 (0.062)	0.002 (0.000)

Table 2: Board Size and CEO Family Size

This table reports the average CEO's number of children and children aged 18 or above for board size categories ranging from 3 to 7+. *CEO Family Characteristics Sample* is the sample of firms for which we were able to obtain information on the CEO's family characteristics (see Section 2), whereas the *Sub sample of firms w/ CEO-relatives on board* is the sub-sample of firms where at least one CEO-relative serves on the board. The rows labelled *Difference between …* denote two tests of the equality of means between firms of board sizes: The first test is between all five board size categories. The second test is between firms with three directors and firms with seven or more directors. Numbers in brackets are p-values, whereas *** denotes significance at 1 percent level.

	CEO Family Characteristics Sample			**Sub sample of firms w/ CEO-relatives on board**		
Board Size	N	Children	Children (Aged 18+)	N	Children	Children (Aged 18+)
3	4,192	2.10	1.29	2,209	2.21	1.44
4	1,459	2.17	1.46	730	2.24	1.61
5	793	2.77	1.68	384	3.09	2.02
6	251	2.78	1.95	76	3.24	2.12
7+	155	2.78	1.81	44	3.57	2.34
All	6,850	2.23	1.41	3,443	2.36	1.57
Difference between groups			5.91*** [0.000]			5.17*** [0.000]
Difference between 3 and 7+			5.12*** [0.000]			4.74*** [0.000]

Table 3: Board Member Identity and CEO Relatives

This table reports the identity of *All board members* in the CEO family characteristics sample and for *Board members in the sub sample of firms with CEO-relatives on the board*. We classify board members into: CEO, CEO-relatives, Other owners, Other owners' relatives and Outsiders (the residual). CEO-relatives are the relatives of the CEO who are not owners of the firm. We define Other owners' relatives as people related to other owners but unrelated to the CEO. Outsiders is the residual group of directors that are neither CEO, Owner or their immediate family members. Relatives are defined as nuclear family members. We further classify CEO-relatives into Spouses, Childen, Siblings and Parents.

	All board members		**Board members in sub sample of firms w/ CEO-relatives on board**		
Board member identity	N	%	N	%	% relatives
CEO	8,080	32.4	2,973	24.3	
CEO relatives					
- Spouse	2,755	11.0	2,755	22.5	56.1
- Child	1,560	6.2	1,560	12.8	31.8
- Sibling	34	0.1	34	0.3	0.7
- Parent	560	2.2	560	4.6	11.4
			4,909	40.1	
Other owners	3,163	12.7	829	6.8	
Other owners' relatives	320	1.3	106	0.9	
Outsiders	8,498	34.0	3,410	27.9	
All	24,970	100.0	12,227	100.0	

Table 4: First Stage Regression of Board Size–Firm Performance Relationship

The dependent variable is Board Size. This table reports the first stage from the two-stage-least-squares estimation of board size–firm performance relationship using the CEO's number of children as instrument for board size. Column I and II is the CEO family characteristics sample, whereas Column III is the sub sample of firms with a CEO-relative on the board. Numbers in parentheses are t-statistics based on robust standard errors. Each equation also includes intercept and industry dummies on the two-digit NACE level. *, ** and *** denote significance at the 10, 5 and 1 percent levels in a two-sided test, respectively.

	(I)	(II)	(III)
Estimation Method	OLS	OLS	OLS
A. Identification			
CEO's Number of Children Aged 18+	0.0847***	0.0814***	0.0944***
	(7.31)	(7.22)	(6.78)
B. Controls			
Firm Size (log. Assets)	0.2635***	0.2191***	0.1747***
	(17.6)	(15.1)	(10.5)
Firm Age	0.0022***	0.0027***	0.0021*
	(2.75)	(3.27)	(1.91)
Multiple Business Segments	0.0309	0.0271	0.0633**
	(1.20)	(1.09)	(2.11)
Business Group	0.3453***	0.3088***	0.1079
	(4.19)	(3.87)	(0.98)
C. Ownership			
Multiple Owners		0.3933***	0.5171***
		(17.4)	(16.8)
CEO is Owner		-0.3459***	-0.217***
		(9.89)	(-4.83)
Industry Effects	YES	YES	YES
N	6,850	6,850	3,443
R-squared	0.16	0.21	0.21

Table 5: Descriptive Statistics on Regression Variables

This table summarizes the mean, median, standard deviation, minimum and maximum of the variables used in the regressions throughout the paper. Panel A shows the statistics for the *Gross Sample*, whereas Panel B shows the statistics for the *CEO family characteristics sample*.

	Mean	**Std. Dev.**	**P5**	**Median**	**P95**
Panel A: Gross Sample (N=7,496)					
Return on Assets	0.064	0.130	-0.123	0.062	0.258
Board Size	3.69	3	3	3	6
Firm Size (Assets)	22.8	138.6	1.3	7.1	62.6
Firm Age	18.3	17.5	2	14	43
Multiple Business Segments	0.437	0.496	0	0	1
Business Group	0.065	0.246	0	0	1
Multiple Owners	0.558	0.497	0	1	1
CEO is Owner	0.755	0.430	0	1	1
Panel B: CEO Family Characteristics (N=6,850)					
Return on Assets	0.065	0.128	-0.121	0.062	0.258
Board Size	3.67	3	3	3	6
Firm Size (Assets)	20.8	133.2	1.3	6.9	59.7
Firm Age	18.1	17.1	2	14	42
Multiple Business Segments	0.434	0.496	0	0	1
Business Group	0.060	0.238	0	0	1
Multiple Owners	0.557	0.497	0	1	1
CEO is Owner	0.762	0.426	0	1	1

Table6: OLS and IV Estimates of the Board Size-Firm Performance Relationship

The dependent variable is the return on assets (RoA). This table reports the second stage from the two-stage-least-squares estimation of the board size–firm performance relationship using the CEO's number of children as instrument for board size (see Section 4 for a motivation of the instrument and Table 4 for the first-stage regressions). *Identification* is an F-test of the significance of the instrument in the first-stage regression. *Hausman* is a test of significant bias in the corresponding OLS estimates. Numbers in parentheses are t-statistics, whereas numbers in brackets are p-values. Both are computed using robust standard errors. Each equation also includes intercept and industry dummies on the two-digit NACE level. *, ** and *** denote significance at the 10, 5 and 1 percent levels in a two-sided test, respectively.

	(I)	(II)	(II)	(III)
Estimation Method	OLS	IV	OLS	IV
A. Board Variables				
Board Size	-0.0068***	-0.0161	-0.0059***	-0.0178
	(-4.56)	(-1.12)	(-4.03)	(-1.27)
B. Controls				
Firm Size (log. Assets)	0.0145***	0.0170***	0.0148***	0.0178***
	(8.30)	(4.00)	(8.47)	(4.48)
Firm Age	-0.0005***	-0.0005***	-0.0006***	-0.0005***
	(-6.19)	(-5.62)	(6.40)	(-5.67)
Multiple Business Segments	-0.0011	-0.0008	-0.002	-0.0015
	(-0.35)	(-0.25)	0.63	(-0.47)
Business Group	-0.0324***	-0.0292***	-0.0323***	-0.0284***
	(-5.84)	(-4.00)	5.84	(-4.00)
C. Ownership				
Multiple Owners			0.0227	0.0252
			(1.37)	(1.51)
CEO is Owner			0.0124***	0.0079
			(2.94)	(1.15)
Industry Effects	YES	YES	YES	YES
Identification		54.7***		53.8***
		[0.000]		[0.000]
Hausman Test		0.53		0.72
		[0.514]		[0.395]
N	6,850	6,850	6,850	6,850
Root Mean Squared Error	0.13	0.13	0.13	0.13

Table 7: OLS and IV Estimates of the Board Size-Firm Performance Relationship Using the Eisenberg et al. (1998) Identification Strategy

The dependent variable is the return on assets (RoA). This table reports the second stage from the two-stage-least-squares estimation of the board size–firm performance relationship where we replicate the Eisenberg et al. identification strategy by using *Business Group Affiliation* as the instrument for board size. *Identification* is an F-test of the significance of the instrument in the first-stage regression. *Hausman* is a test of significant bias in the corresponding OLS estimates. Numbers in parentheses are t-statistics, whereas numbers in brackets are p-values. Both are computed using robust standard errors. Each equation also includes intercept and industry dummies on the two-digit NACE level. *, ** and *** denote significance at the 10, 5 and 1 percent levels in a two-sided test, respectively.

	(I)	(II)	(II)	(III)
Estimation Method	OLS	IV	OLS	IV
A. Board Variables				
Board Size	-0.0079***	-0.1099***	-0.0071***	-0.1144***
	(-5.52)	(-4.34)	(-4.88)	(-3.87)
B. Controls				
Firm Size (log. Assets)	0.0118***	0.0443***	0.0127***	0.0449***
	(7.57)	(5.57)	(7.72)	(5.12)
Firm Age	-0.0005***	-0.0003**	-0.0006***	-0.0003*
	(-6.72)	(-2.27)	(-6.54)	(-1.74)
Multiple Business Segments	0.0001	0.0058	-0.0008	0.0065
	(0.02)	(1.43)	(-0.25)	(1.48)
C. Ownership				
Multiple Owners			0.0204	0.0352*
			(1.26)	(1.72)
CEO is Owner			0.0137***	-0.0324***
			(3.26)	(-2.51)
Industry Effects	YES	YES	YES	YES
Identification		34.1***		34.1***
		[0.000]		[0.000]
Hausman Test		34.1***		34.1***
		[0.000]		[0.000]
N	7,496	7,496	7,496	7,496
Root Mean Squared Error	0.13	0.13	0.13	0.13

Table 8: Flexible OLS Estimates of the Board Size-Firm Performance Relationship

The dependent variable is the return on assets (RoA). The models include control and ownership variables even though they are not reported. Each equation also includes intercept and industry dummies on the two-digit NACE level. Numbers in parentheses are t-statistics, whereas numbers in brackets are p-values. Both are computed using robust standard errors. *, ** and *** denote significance at the 10, 5 and 1 percent levels in a two-sided test, respectively.

	(I)	(II)	(III)	(IV)
Estimation Method	OLS	OLS	OLS	OLS
A. Dummy specification				
Dummy for Board Size = 4 (BS4)	-0.0046			
	(-1.16)			
Dummy for Board Size = 5 (BS5)	-0.0049			
	(-1.00)			
Dummy for Board Size = 6 (BS6)	-0.0209**	-0.0187*		
	(-2.14)	(-1.93)		
Dummy for Board Size ≥ 7 (BS7+)	-0.0354***	-0.0329***		
	(-3.61)	(-3.41)		
Dummy for Board Size ≥ 6 (BS6+)			-0.0239***	
			(-3.26)	
B. Piecewise linear specification				
Small Boards (SBS = Min[Board Size,5])				-0.0027
				(-1.20)
Large Boards (LBS = Board size * BS6+)				-0.0033***
				(-3.08)
Joint F-test, exclude BS4 and BS5	0.98			
	[0.375]			
F-test, BS6 = BS7+		1.20		
		[0.273]		
C. Controls	YES	YES	YES	YES
D. Ownership	YES	YES	YES	YES
Industry Effects	YES	YES	YES	YES
N	6,850	6,850	6,850	6,850
R-squared	0.04	0.04	0.04	0.04

Table 9: Robustness of IV Estimates of the Board Size-Firm Performance Relationship

The dependent variable is the return on assets (RoA). The dependent variable is the return on assets (RoA). This table reports the second stage from the two-stage-least-squares estimation of the board size–firm performance relationship using the number of founders' children as instrument for board size. *Identification* is an F-test of the significance of the instrument in the first-stage regression. *Hausman* is a test of significant bias in the corresponding OLS estimates. Numbers in parentheses are t-statistics, whereas numbers in brackets are p-values. Both are computed using robust standard errors. Each equation also includes intercept and industry dummies on the two-digit NACE level. *, ** and *** denote significance at the 10, 5 and 1 percent levels in a two-sided test, respectively.

	(I)	(II)	(III)	(IV)
Estimation Method	OLS	IV	OLS	IV
A. Board Variables				
Board Size	-0.0110***	-0.0131	0.0034	-0.0268
	(-3.26)	(-0.39)	(0.47)	(-0.39)
B. Controls				
Firm Size (log. Assets)	0.0171***	0.0174***	0.0261	0.0293
	(4.83)	(2.54)	(3.85)	2.92
Firm Age	-0.0001	-0.0001	-0.0005	-0.0003
	(-0.81)	(-0.80)	1.03	0.44
Multiple Business Segments	-0.002	-0.0021	-0.0172	-0.0177
	(-0.34)	(-0.35)	1.43	1.42
Business Group	-0.0336**	-0.0333**	-0.0633	-0.0684
	(-2.39)	(-2.32)	2.99	2.64
C. Ownership				
Multiple Owners	0.0007	0.0013	-0.0084	0.0044
	(0.11)	(0.11)	0.64	0.13
CEO is Owner	0.032***	0.0316***	0.0306	0.0267
	(3.39)	(2.57)	1.55	1.11
D. Founders				
Multiple founders	0.0153	0.0155	0.0359	0.0375
	(2.48)	(2.16)	2.99	2.9
Identification		14.5		4.16
		[0.000]		[0.042]
Hausman		0.57		2.95
		[0.210]		[0.087]
N	2,087	2,087	455	455
Root Mean Squared Error	0.13	0.13	0.11	0.11

Table 10: OLS Estimates of the Board Size-Firm Performance Relationship Controlling for Complexity of Operations

The dependent variable is the return on assets (RoA). The models include control and ownership variables. Each equation also includes intercept and industry dummies on the two-digit NACE level. *Board Variables* interact with two measures of complex operations: a dummy for the firm being a B*usiness Group* and a dummy for *Multiple Business Segments* defined as operations in more than one industry, respectively. Numbers in parentheses are t-statistics, whereas numbers in brackets are p-values. Both are computed using robust standard errors. *, ** and *** denote significance at the 10, 5 and 1 percent levels in a two-sided test, respectively.

	(1)	(2)
Estimation Method	OLS	OLS
Complexity Measure	Business Group	Multiple Business Segments
A. Board Variables		
Small Boards	-0.0024	-0.0013
(SBS = Min[Board Size, 5])	(-1.02)	(-0.40)
Large Boards	-0.0036***	-0.0039**
(LBS = Board size * BS6+)	(-2.72)	(-2.56)
Interacted with Dummy for Complex Operations		
Small Boards	-0.0039	-0.0029
(CSBS)	(-0.58)	(-0.68)
Large Boards	0.0016	0.0011
(CLBS)	(0.74	(0.53)
B. Controls	*YES*	*YES*
C. Ownership	*YES*	*YES*
Joint F-test, exclude SBS and CSBS	1.02	1.08
	[0.362]	[0.340]
F-test, LB and CLB, same effects,	1.31	3.54*
opposite signs	[0.252]	[0.060]
N	6,850	6,850
R-squared	0.04	0.04