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Bennedsen, Morten; Kongsted, H.C. ; Meisner Nielsen, Kasper

Document Version
Final published version

Publication date:
2007

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Citation for published version (APA):
Bennedsen, M., Kongsted, H. C., & Meisner Nielsen, K. (2007). *The Causal Effect of Board Size in the Performance of Closely Held Corporations*. Copenhagen Business School, CBS. Working Paper / Department of Economics. Copenhagen Business School No. 14-2007

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Copenhagen
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Department of Economics

Copenhagen Business School

Working paper 14-2007

THE CAUSAL EFFECT OF BOARD SIZE IN THE PERFORMANCE OF CLOSELY HELD CORPORATIONS.

Morten Bennedsen
Hans Christian Kongsted **Kasper Meisner Nielsen**

The Causal Effect of Board Size in the Performance of Closely Held Corporations*

by

Morten Bennedsen[ac]

Hans Christian Kongsted[bc]

Kasper Meisner Nielsen[ac].

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 smaller closely held firms is less clear; we argue that existing work has been incomplete in analyzing the causal relationship due to weak identification strategies. Using a rich data set of almost 6,000 small and medium-sized closely held corporations we provide a causal analysis of board size effects on firm performance using a novel instrument given by the number of children of the founders of the firms. First, we find no empirical evidence of adverse board size effects when the size of the board lies in the typical range for closely held corporations of three to six directors. Second, we find a significantly negative board size effect for the minority of closely held firms that are characterized by having comparatively large boards of seven or more members and non-complex operations.

*This project has been supported by CEBR (www.cebr.dk) and the Danish Social Science Research Foundation under the research project GOCOW. Kongsted and Nielsen would also like to thank Centre for Applied Microeconometrics (www.econ.ku.dk/cam). We thank Randall Morck and the participants in seminars at the FMA 2005 Meeting and the Centre for Applied Econometrics for useful comments. The activities of CAM are financed by a grant from the Danish National Research Foundation.

Corresponding author: Kasper Meisner Nielsen, Copenhagen Business School, Department of Finance, Solhoej Plads 3, DK-2000 Frederiksberg, Denmark, Phone: (+45) 3815 3629, Email: kmn.fi@cbs.dk

[a]Copenhagen Business School

[b]Centre for Applied Microeconometrics, University of Copenhagen

[c]Centre for Economic and Business Research

The Causal Effect of Board Size in the Performance of Closely Held Corporations

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 smaller closely held firms is less clear; we argue that existing work has been incomplete in analyzing the causal relationship due to weak identification strategies. Using a rich data set of almost 6,000 small and medium-sized closely held corporations we provide a causal analysis of board size effects on firm performance using a novel instrument given by the number of children of the founders of the firms. First, we find no empirical evidence of adverse board size effects when the size of the board lies in the typical range for closely held corporations of three to six directors. Second, we find a significantly negative board size effect for the minority of closely held firms that are characterized by having comparatively large boards of seven or more members and non-complex operations.

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

[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.

analysis of board size effects in close corporations 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 number of founders' 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 5,830 small and medium-sized closely held Danish corporations. We obtained the name and social security number of everyone who has founded a firm in Denmark and those of all close family members. The core instrument used for board size is the number of founders' children over the age of thirty. It is shown that this instrument correlates with board size. In addition, we discuss in detail the claim that the founders' 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 closely held corporations in firms where the board consists of the typical range of three to six directors. Second, there is a significantly negative board size effect in a minority of firms which have comparatively large boards of seven 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, the final results show that the negative board size effect of seven or more directors disappears 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 founders' family relations. 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

[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."*

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 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 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 percent 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 kicks in at a relatively large number of directors.

In the following, the negative board size effect in small and medium-sized closely held corporations is questioned and two methodological weaknesses in the single existing study of performance effects in small and medium-sized firms, Eisenberg *et al.*, are pointed out. 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

[3]This tendency was confirmed by tracking papers and articles that discuss board size effects using GOOGLE SCHOLAR. More than 50 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 firms.

treated as an endogenous regressor in order to estimate its 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.[4] They do not take ownership variables into account. 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.

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

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

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.[5]

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 closely held corporations can be derived from the close family ties that characterize the majority of these firms. In comparison to the system analyses 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.

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

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

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 14,103 in 1999, are considered.

The standard selection criteria for performance evaluations is adhered to while regulated industries and financial intermediaries are excluded from the analysis, thereby reducing the number of firms to 7,960.[6] A number of extremely small firms (primarily firms that were recently established) and firms that have changed industry or reporting standards are also excluded. These criteria are described in the appendix. As a result, 5,830 firms represent the population for this analysis.

In addition to the gross sample, a sub sample of family-owned firms is

[6] *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.

examined. We use the definition of family businesses set up by Bennedsen *et al.* (2004) based on current ownership characteristics. They define a company as a family firm if members of a single family hold 50 percent or more of the equity, which means that more than two-thirds of the firms in the sample are family firms.

The main strategy used in identifying the causal effect of board size on firm performance is based on information related to the founders of the firms. Personal founder information is available for approximately one-third of the firms in the gross sample of 5,830 firms.[7] The additional 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.

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.[8] The name and CPR number (the Danish equivalent to a social security number) of each founder was collected and submitted to the CPR Agency in the Ministry of Interior, the government department responsible for administrating social security numbers.

[7]The sample contains an almost equal representation of family firms (with a coverage rate of 34.0 percent) and non-family firms (30.8 percent).

[8]This excludes less than .4 per cent of the firms with available founder information.

The agency then provided the family relations, including names and CPR numbers of all nuclear family members.

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. Some firms, which have existed in another form before their incorporation date (e.g. as ApS firms), may have a registered firm age in the annual report which pre-dates 1986.[9] The requirement of a maximum of ten founders and a registered firm age of 25 years or less (motivated by the instrumental variables approach adopted in Section 3) leaves a sample of 1,930 observations with the necessary founder information of which 1,320 firms are family-owned.

The gross sample of 5,830 firms can be compared to the sample of 879 Finnish firms analyzed by Eisenberg et al. (1998).[10] With an average board size of 3.7 and median assets of DKK 7,636,000, figures for the Danish firms are comparable to the corresponding figures of 3.7 and 5,498,000 (converted to 1999-DKK) for the Finnish firms. The mean age of 19.5 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 founder samples and their

[9]This is true for approximately 8 percent of the firms with available founder information.

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

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 of the firm and to the number of owners of the firm. Indeed, most firms have highly concentrated ownership, with an average of approximately two owners.

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, 5 or 6 directors. Firms with seven or more board members have on average lower RoAs, although it should be noted that the latter category is quite thin. In conclusion, Table 1 illustrates that there is no apparent pattern of increased board size associated with lower returns on assets among firms with small boards in the raw Danish data.

3 Family Relationships as Exogenous Variation in Board Size

It has now been established that most closely held corporations are small, have few owners, and are family controlled. In the following, it is argued that exactly the fact that many closely held corporations 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.

Specifically, the information on the family relationships of the founders of the firm will be used when establishing valid instrumental variables 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 number of founders' children.

Two conditions must be satisfied for the instrumental variable estimation strategy to work. First, a systematic relationship should be established between the founder-related instrumental variable and the current size of the corporate board; and second, the founder-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, when claiming the number of founders' children as an exogenous source of variation, the argument is that the size of the relevant 'pool' of director candidates increases with the number of founders' children at or above a certain age, in this case, 30 years of age.[11] 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 founders' family size over and above variations that are due to differences in the number of founders and owners.

[11] Although people between the ages of 18 and 29 are legally eligible to be board members, we consider the thirty-year age limit to be more relevant in practical terms. Furthermore, out of the 21,547 board members in firms in the gross sample of 5,830 firms, only 5.1 percent are between the ages of 18 and 29. Section 5.1 checks the robustness of results to the assumed age limit.

Table 2 shows the mean number of founders and founders' children in firms with different board sizes. Evidence is provided for firms with founder information in the gross sample and for the sample of family-owned firms. The table indicates a general tendency toward a positive relationship between board size and the number of founders' children in both samples, although less pronounced for comparatively large boards of six or seven members in family firms. It should be noted that the data are comparatively thin for the latter categories. To assess the significance of differences between board sizes in the number of founders' children we report two tests for each sample. One is a test of equal means of the individual board size categories whereas the other test compares means between boards of three members and four 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 two-stage least squares estimation procedure applied in the next section. Since it is mainly in family-related concerns that such a correlation is expected to be produced, our prior is that the relationship is statistically significant in family-owned firms, but less so in non-family owned firms.

Second, we need to establish that founder-related information is 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 number of founders' children, and unobservables affecting current firm performance. This claim rules out the possibility of founders 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. A time lag is imposed between fertility decisions affecting founder-related information and the earliest foundation date of any firm in the sample in order to limit the relevance of such "reverse causality" considerations. Specifically, an upper 25-year limit on firm age and a lower 30-year age limit for founders' children ensure a separation of at least five years between fertility decisions determining founders' family size (the people included were born before 1970 and the firms were founded 1975 at the earliest).[12][13]

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 number of founders' children on current performance. This exclusion restriction is of course contestable. Even without any direct causal link between fertility and the foundation of firms, a non-zero correlation could exist between a founder's fertility and current unobservables in the performance of the firm. Innate ability in managing a firm and fertility could be related (most likely positively). On the other hand, there is a trade-off

[12]Because only founder data on firms registered as joint stock companies in 1986 or later could be obtained, most of the firms included were established in 1986 or later. Thus, for the majority of the firms, the time lag between fertility decisions and establishing the firm is more than 15 years.

[13]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.

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. The pool of within-family management talent is non-decreasing in family size. If the CEO is chosen within the family, then founders' family size should impact non-negatively on firm performance. On the other hand, the tendency to choose a family CEO and potentially neglect outside management talent also increases proportionally with family size, as evidenced by recent findings in Bennedsen *et al.* (2004). We control for direct performance effects of the presence of a family CEO by including a dummy for firms where a family relationship exists between the CEO and one or more of the owners or the CEO herself is an owner. Moreover, the firms in our sample are inherently fairly young, few of them having undergone any generational change in management. Again, the net impact, if any, on firm performance via a family CEO channel appears ambiguous.

As a result, we conclude in favor of the main exogeneity assumption: Any effect of founders' 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.

A potential alternative strategy would be to rely on the family relations of the *current* owners for identifying the board size/performance relationship. Indeed, 74 percent of the family-controlled firms in our 1999 sample are still owned by at least one of the original founders and most of the exogeneity arguments would apply equally well to the case of current owners. However, for firms in the sample with a change in ownership before 1999, the time

lapsed between decisions is inherently shorter. This introduces a further potential source of correlation since the decision to buy a particular firm may be guided by unobserved firm characteristics related both to performance and to the family relations of the new owners. In contrast, for the analysis based on founder information, the change in ownership merely weakens the relationship between the number of founders' children and current board size, but does not affect the exogeneity status of the former variable in the performance equation. Thus in the main analysis in Section 5, a conservative choice of instrument was chosen in terms of the number of founders' children. In view of the fact that many of the founders are still the current owners, the current owner alternative below will be considered briefly to determine whether concerns about exogeneity for this variable matter empirically.

4 The Link between Board Size and Firm Performance

This section reexamines the empirical relationship between board size and firm performance. To mirror the existing literature, the OLS relationship is estimated using standard controls for size, age, and the degree of diversification of the firm (a dummy for multiple business segments) as well as membership of a business group.[14] Ownership and founder variables available in the data set are added as additional controls. We proceed with the IV analysis using the number of founders' children as an exogenous source of variation in board size. Based on the conclusions from the IV analysis,

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

the performance equation with a more flexible specification of board size effects is reconsidered in the final subsection. Summary measurements of the variables included in the regressions are found in Table 3.

4.1 Basic Ordinary Least Squares 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 and 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 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. First a linear specification is used for the main analysis and then a more flexible specification of board size is explored.

The following standard set of controls for firm performance is employed throughout the empirical analysis: The number of employees (in logs) and its square as a measure of the size of the firm; the age of the firm; and a dummy for the firm being in a business group as well as a control variable dummy for whether the firm is diversified.[15]

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

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). As is evident from Table 2, most firms indeed have very few owners with a gross sample average of two. Ownership is represented by a set of dummy variables for two, three or four or more owners with single-owned firms as the reference category. An additional characteristic related to ownership is the presence of a family CEO. Bennedsen *et al.* (2004) point out that most closely held corporations are family-controlled, which they also associate with a tendency to select a member of the family as the CEO. In order to control for a potential negative performance effect when narrowing the pool of potential CEO candidates to the family, a dummy for firms with this characteristic was included.

The final set of regressors control for the number of founders of the firm. In Table 2, it is documented that the number of persons who founded the firm is clearly correlated with firm characteristics already included in the regression, in particular the size of the board. Other persistent determinants of performance, however, could well exist that are unobserved and correlated with the number of founders. In order to proxy for such effects, dummy variables for having two or three or more founders are thus included in the regression.

Table 4 reports the basic OLS regressions. The regression in column (1) includes only board size and the standard controls, (2) adds information on

ownership and the presence of a family CEO, and (3) has the founder dummy variables. (1) and (2) can be estimated for the gross sample of 5,830 firms, whereas the regression in (3) is reported only for the sample of 1,320 family-controlled firms. Most effects of the standard controls are consistent across the specifications.[16] Firm size has an increasing although concave effect on performance. More diversified firms have lower profits, whereas the business group dummy is insignificant. Older firms seem slightly less profitable than younger firms in the gross sample. The age effect is not significant in the sample of family-controlled firms, which is mainly due to a smaller sample size and the fact that firms in the latter sample have existed for 25 years or less.

The performance effect of the board size in the gross sample is negative, although small and insignificant. Adding ownership information and information on the number of founders does not change that conclusion. The ownership and CEO dummies are jointly significant when added in column (2) (p-value 0.018), whereas the founder dummies are only marginally significant (p-value 0.102) in column (3), based on the family-controlled sample.

The consistency of the above results and their *ceteris paribus* interpretation clearly rely on the exogeneity of all regressors in the performance equation, including the board size variable. The next section examines the empirical validity of this assumption.

[16]This is indeed the case throughout most of the empirical analysis and will only be noted when exceptions occur.

4.2 Instrumental Variables Estimation Results

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 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 number of founders' children, is employed as a source of exogenous variation in board size.[17]

Table 5 reports instrumental variables estimation results based on the extended specification of the structural performance equation. Firms included in this table are family-controlled firms with valid founder information founded no more than 25 years ago. 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. The second-stage regression includes the predicted value of board size from the first-stage regression along with the exogenous determinants of performance. Table 5 contains two sets of results. Column (1) uses the exclusion of the number of founders' children from the

[17]As discussed intensively in Section 4, our main identifying argument is that once we have controlled for a rich set of potential performance determinants, including ownership variables and the number of founders, then the variations in the number of founders' children is unrelated to unobserved firm characteristics.

performance equation to exactly identify the performance relationship while column (2) adds its square as an additional instrument. This yields a testable overidentifying restriction.

The signs of most effects in column (1) are unchanged compared to the extended OLS results in Table 4. Some effects have increased in magnitude, which is also true for their standard errors. The effect of board size is negative and larger in numerical value than in the OLS regression, but remains 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 overidentified case in column (2) shows somewhat reduced standard errors, but the board size effect remains insignificant.

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 is provided by the test of identification reported on the bottom of Table 5. This is a test of a significant relationship between the potentially endogenous regressor, board size, and the instrumental variable, the number of founders' 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. The number of founders' children qualify as a valid instrument based on this criterion with an F-test of identification of 8.00 and a very low p-value.

Having established a significant correlation between the proposed source of exogenous variation 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 5 reports the Hausman test[18] of the significance of the differences between the OLS estimates in Table 4 (which are consistent and efficient if board size turns out exogenous) and the IV results in column (1) in Table 5 (which are consistent in any case). Based on the founders' children instrument there is no evidence that the OLS estimates are significantly biased, as the Hausman test has a $p-$value of 57 percent. Thus, the OLS results are preferable on the grounds of efficiency.

The robustness of this conclusion is checked in column (2) by adding the number of founders' children squared to the set of instruments. This adds flexibility to the reduced-form relationship and the test of excluding both instruments from the first-stage regression is again very significant. The conclusion that OLS estimates are not significantly biased remains unaltered. Moreover, having two instruments and one potentially endogenous variable, one overidentifying restriction, which easily passes the Sargan test provided in Table 5, can be tested, adding credibility to the core of the identifying argument made in Section 4.

In conclusion, the number of founders' children has been established as a valid instrument for the performance equation. Both the OLS and IV estimates of the effect of board size on firm performance are negative, al-

[18]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.

though insignificant. Their orders of magnitude are significantly less than the estimates of the existing study by Eisenberg *et al.* (1998).

4.3 Flexible Ordinary Least Squares Results

The above findings allow OLS estimation and thus more flexibility regarding the functional form of board size effects.[19] 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 (six or fewer members) and large boards (seven or more members). The re-specifications of the board size variables are combined with the extended OLS specification from Table 4, column (2). The effects of other performance determinants are largely unaltered by introducing a flexible board size specification. They are therefore not reported in Table 6.

The unrestricted dummy variable specification in column (1) suggests no effects of boards of three to six members. Boards with seven or more members are associated with a significantly lower RoA. The F-test of excluding dummies for small boards of six or less members is easily accepted. The restricted specification reported in column (2) shows a strongly significant effect of large boards.

[19] 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.

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 at six is suggested by the unconditional RoAs reported for each board size in Table 1 and by the theoretical considerations discussed in Section 2. 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 seven or more members.

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. On the other hand, our results are contrary to the findings of Eisenberg *et al.* (1998) on two accounts. First, no evidence of negative board size effects in small boards was found. Secondly, the magnitude of the board size effect in boards of seven or more members is much smaller than that estimated by Eisenberg *et al.* The estimates reported in Table 6, column (4) predict that increasing the size of the board e.g. from six to seven members would lower the RoA by somewhat less than half a percentage point. The Eisenberg *et al.* study estimates an effect of five percentage points for a similar change.

4.4 Robustness Checks

This section summarizes analyses on the robustness of the results of the main analysis. Two robustness checks are performed regarding the validity

of the identification strategy. The core identification argument relied on family characteristics to instrument board size in family-run firms, thereby establishing whether board size is endogenous or not. The robustness of this argument to the particular age limit imposed on founders' children in defining the instrumental variable is addressed first. As an alternative age criterion, the legal age limit of 18 is considered. Secondly, the number of children of *current* owners as an alternative instrument is examined. This variable is available for a large proportion of firms in the gross sample, thus allowing more precise inference.

4.4.1 Instrument Defined by the Legal Age Limit

In the main analysis, the number of founders' children aged 30 or above as the instrument for board size. A less restrictive age limit will now be used and all founders' children aged 18, the legal minimum age for members of a corporate board in Denmark, or above, in 1999 will be considered.

The thirty-year age limit in the main analysis was chosen under the assumption that people below this age are less likely potential board member candidates. If this argument is valid, a weaker relationship would be expected between board size and founders' children above the legal age limit of 18 than in the main analysis. On the other hand, an argument for including young adults between the ages of 18 and 29 in the analysis is that even though it was shown that this group only constitutes a small part of the aggregate number of board members, family-related board members are probably overrepresented in the group.

The sample of firms in the founder sample (a total of 1,320 firms) remains

unchanged in this analysis, whereas the values of the instrumental variable for some firms will change because all children above the legal minimum age of 18 are now counted. Redefining the instrumental variable means that a time separation of at least five years between fertility and foundation decisions is no longer imposed.[20]

The results are reported in column (1) of Table 7. Using the number of founders' children aged 18 or above as the instrument for board size yields the same basic conclusions as in the main analysis: The estimated impact of board size on firm performance is negative, but insignificant, and OLS estimates of board size effects would not be significantly biased. Consistent with the view maintained in the main analysis that the age limit of 30 is more relevant in practical terms, identification weakens when the age limit is lowered. However, the test of identification is still well above the Staiger and Stock (1997) criterion and the redefined instrument cannot be classified as weak.

In conclusion, identification of the relationship weakens, but the main results from the IV analysis are robust with regard to the particular age limit used for the founders' children when defining the pool of candidate board members.

[20]The results are essentially unaltered if the five-year separation is restored by excluding firms founded before 1986 (the children included in the analysis are born in 1981 or earlier).

4.4.2 Current Owners' Children as Exogenous Variation in Board Size

The instrumental variable estimation strategy focuses on founders' children as the relevant pool of candidate board members rather than current owners' children. Essentially, it is necessary for the instrumental variable not to correlate with current performance, given the observable performance determinants included in the model. As argued in Section 4, the founder-based strategy is considered conservative in terms of the critical *a priori* argument of exogeneity of the instrumental variable. This argument seems less compelling, however, for the case of owners' children.

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 number of current owners' children, is expected to show a higher correlation with current board size and is available for a larger proportion of the firms in the gross sample. Thus, in this section, IV results that employ the owner-based instrumental variable will be presented.

The only firms included were those where social security numbers and family information for all owners were available. The number of firms satisfying this criterion was 2,578, almost doubling the size of the sample. Column (2) in Table 7 reports the results from the IV estimates using current owners' children more than 30 years of age as the instrument for board size.

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 current owners' children is a

stronger instrument for board size, whereas the test for whether board size is endogenous remains insignificant.[21]

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*

[21]The case reported in Table 7 is precisely identified which means that the exogeneity of the instrument cannot be tested. If the squared number of owners' children is added as an additional instrument, the implied overidentifying restriction with a p-value of 72.3 percent cannot be rejected. This lends credibility to the exogeneity assumption, also for the case of current owners.

(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)[22], 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 8, these models have been extended by interacting the two proxies with the following flexible board size specification: A linear effect and an interaction of the linear effect with a dummy for firms having more than six board members.

From Table 8, it is evident that the negative effect of large boards disappears in complex firms. When complexity is measured by the firm being

[22]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.

part of a business group as in column (1), the significantly negative effect of boards of seven or more members (LB) is seen to be counterbalanced, almost one-to-one, by a significant interaction term for firms with large boards and complex operations (CLB). The net effect of large boards in firms with complex operations is estimated to $-0.0065 + 0.0071 = 0.0006$. Indeed, a test of LB and CLB 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 79 percent). The interactions between the two board variables and the complexity measure are jointly significant at a one percent level. Similarly, the joint test of the two linear board size terms, BS and CBS, cannot reject the null hypothesis with a $p-$value of 81 percent.

The results in column (1), therefore, show that the negative performance effect of large boards is dominant only in firms with non-complex operations. There is no 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 (2) of Table 8, which employs a dummy for multiple business segments as the measure of complex operations and confirms the main finding of a countervailing effect in firms with complex operations, although less significantly. The complexity measures are found to be jointly significant at the ten percent level. The net effect of large boards in complex firms is estimated at -0.0022 ($= -0.0053+0.0032$) and is not statistically different from zero. Using the multiple business segment dummy as a proxy for complex operations, no evidence was found of a negative board size effect of small boards in general and no effect of large boards in firms that operate in more than one business segment was found.

In conclusion, and in accordance with the theoretical predictions, the negative performance effect of large boards is found to be relevant only 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.

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 yet insignificant 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 closely held corporations. Second, a significantly negative effect was found when increasing the size of boards with seven or more members and 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 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 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 six 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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Appendix

This appendix describes the criteria used in the data selection. The total population of closely held corporations (only 'A/S' firms are included, see section 2) in Denmark totalled 14,103 firms in 1999. The exclusion criteria consist of three steps. First, the analysis is focused upon firms operating in non-regulated industries. Second, firms that are newly established, have gone through bankruptcy procedures or are under restructuring are removed. Third, very small firms and firms with missing observations are excluded. All of the above selection criteria are imposed to avoid any major changes in valuation principles due to firms under restructuring, firms with extreme growth due to recent establishment, etc. While some of the adjustments could potentially be related to the current performance of the firm, none of the conclusions reported in this paper are altered by these selection criteria. The implications of the three steps in the selection procedure on the sample size are described below.

Step 1: Exclude regulated industries. A total of 6,143 firms operating in regulated industries are excluded; as well as utilities (25), financial intermediation, business services and community, social and personal service activities (6,118). A further 345 firms that did not report their industry classification are also excluded. The number of firms is thereby reduced to 7,615.

Step 2: Exclude newly established firms and firms undergoing bankruptcy or restructuring. A total of 1,604 firms, inactive at some point from 1996 to 1998 were eliminated. The majority of these firms are newly established. A further 358 firms experiencing structural changes from 1998 to 1999 were eliminated: a change in business group affiliation (34), a change in industry

code (80), reporting of extraordinary profits (210) and financial distress due to bankruptcy (31). The number of firms is thereby reduced to 5,998.

Step 3: Exclude extremely small firms and firms with missing information. There were 66 firms that did not report the number of employees. Finally, 102 extremely small firms that reported primo assets of less than 1 million DKK (approximately 170K USD using the 1999 exchange rate) were excluded, leaving 5,830 firms for the population of this analysis.

Table 1: Descriptive statistics on ownership, assets and returns on assets for different board size categories

This table reports the mean and median number of *owners*, the book value of *assets* and the return on assets (*RoA*) for board size categories ranging from 3 to 7+. Medians are reported in parentheses. *Gross Sample* is the full sample of firms used in the analysis (see Section 2), whereas *Founder Information* is the sub-sample of firms for which we were able to obtain information on the founder of the firm (see Section 2 for further details).

	Gross Sample				**Founder Information**			
Board Size	N	Owners	Assets	RoA	n	Owners	Assets	RoA
3	3,503	1.70 (1.00)	11,161 (6,098)	0.0782 (0.0708)	1,307	1.63 (1.00)	7,817 (4,809)	0.0924 (0.0885)
4	1,253	2.21 (2.00)	33,160 (8,124)	0.0783 (0.0762)	390	2.15 (2.00)	54,430 (6,155)	0.0899 (0.0860)
5	696	2.72 (2.00)	29,587 (13,609)	0.0783 (0.0769)	161	2.68 (2.00)	23,590 (9,216)	0.0944 (0.0970)
6	236	3.09 (3.00)	150,382 (25,855)	0.0765 (0.0706)	47	3.23 (3.00)	43,972 (19,018)	0.0913 (0.0970)
7+	142	3.82 (3.00)	292,656 (61,441)	0.0377 (0.0535)	25	3.45 (3.00)	125,644 (16,839)	0.0558 (0.0607)
Total	5,830	2.04 (2.00)	30,582 (7,636)	0.0771 (0.0719)	1,930	1.88 (2.00)	20,757 (5,503)	0.0916 (0.0888)

Table 2: The link between founder family characteristics and board size

This table reports the mean number of founders and mean number of founders' children aged 30 or above for board size categories ranging from 3 to 7+. *Gross Sample* is the full sample of firms used in the analysis (see Section 3), whereas *Family Controlled* is the sub-sample of family firms where a single family holds a majority of the equity. *Founder Information* is the sub-sample of firms for which we were able to obtain information on the founder of the firm (see Section 3 for further details). 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 more than three directors. Numbers in brackets are p-values, whereas *** denotes significance at 1 percent level.

	Gross Sample & Founder Information			**Family Controlled & Founder Information**		
Board Size	n	Founders	Children (Age 30+)	n	Founders	Children (Age 30+)
3	1,307	2.24	0.92	1,001	2.21	0.91
4	390	2.36	1.10	223	2.29	1.25
5	161	2.57	1.33	78	2.65	1.54
6	47	2.47	1.40	11	2.36	0.90
7+	25	2.92	1.68	7	3.29	3.57
Total	1,930	2.30	1.01	1,320	2.26	1.02
Difference between groups			5.05^{***} [0.000]			6.63^{***} [0.000]
Difference between 3 and 4+			18.7^{***} [0.000]			28.7^{***} [0.000]

Table 3: 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 *Family Controlled with Founder Information* sample. *Gross Sample* is the full sample of firms used in the analysis (see Section 3), whereas *Family Controlled with Founder Information* is the sub-sample of family firms where a single family holds a majority of the equity for which we were able to obtain information on the founder of the firm (see Section 3 for further details).

	Mean	**Median**	**Std. Dev.**	**Minimum**	**Maximum**
Panel A: Gross Sample (n=5,830)					
Return on Assets	0.0770	0.0719	0.120	-0.8401	1.4078
Board Size	3.70	3	1.106	3	15
Employees	37.2	12	304.00	1	18,270
Firm Age	19.5	15	17.04	1	344
Multiple Business Segments	0.475	0	0.499	0	1
Business Group	0.062	0	0.241	0	1
Number of Owners	2.042	2	1.262	1	16
Family CEO	0.635	1	0.481	0	1
Panel B: Family Controlled with Founder Information (n=1,320)					
Return on Assets	0.0904	0.0858	0.114	-0.8069	0.5666
Board Size	3.34	3	0.716	3	10
Employees	14.2	9	30.47	1	763
Firm Age	9.5	9	3.823	1	25
Multiple Business Segments	0.403	0	0.491	0	1
Business Group	0.018	0	0.134	0	1
Number of Owners	1.493	1	0.795	1	9
Family CEO	0.957	1	0.203	0	1
Number of Founders	2.255	3	1.065	1	9

Table 4: OLS estimates of the board size-firm performance relationship
The dependent variable is the return on assets (RoA). 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.

	(1)	(2)	(3)
Estimation Method	OLS	OLS	OLS
A. Board Variables			
Board Size	-0.0023	-0.0027	-0.0041
	(-1.49)	(-1.61)	(-0.98)
B. Controls			
Employees (log)	0.0146***	0.0138***	0.0277***
	(3.92)	(3.67)	(2.61)
Employees (log, squared)	-0.0021***	-0.002***	-0.0058**
	(-3.47)	(-3.34)	(-2.49)
Firm Age	-0.0006***	-0.0006***	-0.0003
	(-6.43)	(-6.43)	(-0.38)
Multiple Business Segments	-0.0071**	-0.0071**	-0.006
	(-2.20)	(-2.20)	(-0.87)
Business Group	0.0056	0.0067	0.0442
	(0.90)	(1.07)	(1.51)
C. Ownership			
Two Owners		0.012***	0.0124*
		(3.17)	(1.64)
Three Owners		0.0001	-0.008
		(0.02)	(-0.49)
Four or More Owners		0.0076	-0.0152
		(1.30)	(-0.84)
Family CEO		0.0031	0.0165
		(0.78)	(1.13)
D. Founders			
Two Founders			-0.0051
			(-0.44)
Three or More Founders			0.012*
			(1.80)
N	5830	5830	1320
R-squared	0.03	0.03	0.08

Table 5: IV estimates of the board size-firm performance relationship

The dependent variable is the return on assets (RoA). We use *Number of founders' children aged 30 or above* as the instrument for board size (see Section 4 for a motivation of the instrument). The table reports the second stage from the two-stage-least-squares estimation. *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. *Overidentifying Restrictions* is the Sargan test of the overidentifying restrictions implied by additional instruments. 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.

	(1)	(2)
Estimation Method	IV	IV
A. Board Variables		
Board Size	-0.0216	-0.0115
	(-0.71)	(-0.64)
B. Controls		
Employees (log)	0.0250**	0.0266**
	(2.15)	(2.40)
Employees (log, squared)	-0.0045	-0.0053*
	(-1.40)	(-1.92)
Firm Age	-0.0002	-0.0002
	(-0.20)	(-0.30)
Multiple Business Segments	-0.0065	-0.0062
	(-0.93)	(-0.89)
Business Group	0.0453	0.0447
	(1.56)	(1.53)
C. Ownership		
Two Owners	0.0139*	0.0131*
	(1.74)	(1.68)
Three Owners	-0.0029	-0.0058
	(-0.15)	(-0.35)
Four or More Owners	-0.0007	-0.0090
	(-0.02)	(-0.36)
Family CEO	0.0125	0.0148
	(0.75)	(0.96)
D. Founders		
Two Founders	-0.0038	-0.0045
	(-0.31)	(-0.38)
Three or More Founders	0.0127*	0.0123*
	(1.88)	(1.84)
Identification	8.00***	6.01***
	[0.005]	[0.003]
Hausman	0.33	0.15
	[0.566]	[0.694]
Overidentifying Restriction		0.26
		[0.607]
N	1,320	1,320
Root Mean Squared Error	0.11	0.11

Table 6: 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 as specified in column (2) of Table 4 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.

	(1)	(2)	(3)	(4)
Estimation Method	OLS	OLS	OLS	OLS
A. Board Variables				
Dummy for Board Size = 4 (BS4)	-0.0015 (-0.37)			
Dummy for Board Size = 5 (BS5)	-0.0002 (-0.04)			
Dummy for Board Size = 6 (BS6)	0.0002 (0.03)			
Dummy for Board Size ≥ 7	-0.0315*** (-2.88)	-0.0311*** (-3.01)		
Board Size			-3.4E-05 (-0.02)	
Board size * Dummy for Board Size ≥ 7			-0.0037*** (-2.47)	-0.0038*** (-3.09)
Joint F-test, exclude BS4, BS5 and BS6	0.05 [0.985]			
B. Controls	*YES*	*YES*	*YES*	*YES*
C. Ownership	*YES*	*YES*	*YES*	*YES*
N	5830	5830	5830	5830
R-squared	0.04	0.04	0.04	0.04

Table 7: Robustness of IV estimates of the board size-firm performance relationship
The dependent variable is the return on assets (RoA). Columns (1) and (2) use the number of *Founders' Children(Age 18+)* and number of current *Owners' Children* (Age 30+) as the instrument for board size, respectively. The table reports the second stage from the two-stage-least-squares estimation. *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.

	(1)	(2)
Estimation Method	IV	IV
Instrument	Founders' Children (Age 18+)	Owner's Children (Age 30+)
A. Board Variables		
Board Size	-0.0185	-0.0221
	(-0.41)	(-1.02)
B. Controls		
Employees (log)	0.0255**	0.0171**
	(2.04)	(1.99)
Employees (log, squared)	-0.0048	-0.0022
	(-1.18)	(-1.01)
Firm Age	-0.0002	-0.0016***
	(-0.22)	(-3.97)
Multiple Business Segments	-0.0064	-0.0094*
	(-0.93)	(-1.95)
Business Group	0.0451	0.0108
	(1.55)	(0.86)
C. Ownership		
Two Owners	0.0137*	0.0142**
	(1.65)	(2.22)
Three Owners	-0.0038	-0.0021
	(-0.17)	(-0.14)
Four or More Owners	-0.0033	0.0381*
	(-0.08)	(1.69)
Family CEO	0.0132	-0.0007
	(0.71)	(-0.05)
D. Founders		
Two Founders	-0.0040	
	(-0.31)	
Three or More Founders	0.0126*	
	(1.85)	
Identification	6.34**	14.7***
	[0.012]	[0.002]
Hausman	0.10	1.21
	[0.750]	[0.271]
N	1,320	2,578
Root Mean Squared Error	0.111	0.111

Table 8: 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 specified as in column (2) of Table 4 even though they are not reported. 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		
Board Size	0.0002	-0.0012
(BS)	(0.07)	(-0.39)
Board Size * Dummy for Board Size ≥ 7	-0.0065***	-0.0053**
(LB)	(-3.27)	(-2.34)
Interacted with Dummy for Complex Operations		
Board Size	0.0007	0.0023
(CBS)	(0.14)	(0.64)
Board Size * Dummy for Board size ≥ 7	0.0071**	0.0032
(CLB)	(2.29)	(1.06)
B. Controls	*YES*	*YES*
C. Ownership	*YES*	*YES*
Joint F-test, exclude CBS and CLB	6.42***	2.36*
	[0.002]	[0.095]
Joint F-test, exclude BS and CBS	0.21	0.02
	[0.811]	[0.980]
F-test, LB and CLB, same effects,	0.07	1.24
opposite signs	[0.793]	[0.266]
N	5830	5830
R-squared	0.04	0.04