Fallible Executives, Centralization of Decision-Making and Corporate Performance

Renée B. Adams[1] Heitor Almeida[2] Daniel Ferreira[3]

September 9, 2001

[1]Corresponding author. Federal Reserve Bank of New York. 33 Liberty Street, New York, NY 10045-0001. Telephone: (212) 720-5145. Fax: (212) 720-8363. e-mail: renee.adams@ny.frb.org. The views in this paper are my own and do not necessarily reflect the position of the Federal Reserve Bank of New York or the Federal Reserve System.

[2]Stern School of Business, New York University. 44 West 4th Street, room 9-190, New York NY 10012. Email: halmeida@stern.nyu.edu.

[3]Department of Economics, The University of Chicago. 1126 East 59th Street, 4th floor, Chicago IL 60637. Email: dsferrei@midway.uchicago.edu.

Fallible Executives, Centralization of Decision-Making and Corporate Performance

Abstract

In this paper we explore some possible consequences of fallibility in managerial decision-making for firm performance. Based on Sah and Stiglitz (1991), we develop the hypothesis that if managers are fallible, firm performance will be more variable as the number of managers participating in decision-making decreases, i.e. as the firm becomes more centralized. We use characteristics of the Executive Office to develop a proxy for the number of executives participating in top decision-making. For example, we argue that if the Chairman of the Board is not the CEO, decision-making in the firm will be more decentralized because the Chairman will also participate in decision-making. We test our hypothesis using this proxy (which we call the centralization index), and find that the evidence is consistent with our hypothesis. Firm performance (measured by Tobin's Q, stock returns and ROA) is significantly more variable for firms with greater values of our centralization index. The results are consistent across various tests designed to detect differences in variability.

Frictions in decision-making by top management have been the focus of a large number of papers in the corporate finance literature. Most of this work is based on agency theory, which emphasizes the possibility that the incentives of top managers and shareholders are not perfectly aligned, creating the potential for value-decreasing distortions in the corporate decision process (see for example the survey of corporate governance by Shleifer and Vishny, 1997). However, agency problems are not the only possible source of frictions in decision-making. Real world decisions will also be constrained by the decision-making ability of top managers. Even when they have the right incentives, managers may take wrong decisions due to human fallibility, that is, managers can make mistakes.

In this paper, we explore some possible consequences of fallibility for executive decision-making processes and consequently for firm value and firm performance. We develop a simple hypothesis about how fallibility will affect firm performance drawing upon the theoretical work of Sah and Stiglitz (1991). In Sah and Stiglitz (1991) managers can make good or bad decisions due to fallibility, and in addition they differ in their degree of fallibility. Sah and Stiglitz's (1991) key insight is that the impact of fallibility on firm performance will depend on the size of the decision-making group. In an organization in which only a small group of people is responsible for the most relevant decisions, the risk arising from human fallibility in decision-making is not well diversified. That is, the likelihood of either very good or very bad decisions is higher in what Sah and Stiglitz (1991) call a centralized organization (one in which only a small group of people make decisions) than in a decentralized organization (one in which many persons are involved in decision-making). Thus, our main prediction is that, as the degree of centralization increases, variability in firm value increases because decisions with extreme consequences are more likely to be taken.[1]

In order to test our hypothesis we develop an index of centralization in decision-making,

[1]Sah (1991) uses the same arguments to conjecture that autocracies should have more volatile economic growth than democracies. Almeida and Ferreira (2001) provide empirical evidence which is consistent with Sah's conjecture.

which is increasing in centralization. Our index uses the number of job titles of the CEO, the retention of the CEO title by the firm's founder, the CEO succession process and the overlap of the Executive Office with the Board to proxy for the number of people participating in decision-making. For example, we argue that if the Chairman of the Board is not the CEO, decision-making in the firm will be more decentralized because the Chairman will also participate in decision-making. Similarly, if the current CEO is the original founder of the firm, he is more likely to have the power to make decisions on his own, hence we consider such a firm to be more centralized.

Because our hypothesis concerns differences in variances, we apply three different heteroscedasticity tests to our data. The Goldfeld-Quandt test consists of comparing the variance of the performance variable (or the part of it not explained by an appropriate empirical model) between groups of centralized and decentralized firms. The Glejser test uses regressions which allow us to control for variables (other than centralization) which could also explain the variability of performance. Both these tests use either a cross-section or a panel of firms. We also use a third test which allows us to isolate the effect of centralization on the within-firm, over-time variability of performance. Using these three tests we show that Tobin's Q is more variable for firms with greater values of our centralization index. Furthermore, centralized firms show greater variability in stock returns and return on assets (ROA).

It is important to stress that our interpretation of these results does not depend on the existence of an agency problem. Even if managers are benevolent, there may still be frictions induced by human fallibility. There are concrete examples from recent business history that are consistent with this notion. For example, the CEO of AT&T (C. Michael Armstrong) was considered "one of Corporate America's best and brightest" when he started at AT&T (Business Week, February 5th, 2001, Wall Street Journal, October 26th, 2000). From 1997 to 1999, Armstrong pursued the strategy of trying to rebuild AT&T into a one-stop shopping Telecom mecca by a series of acquisitions. By the summer of 2000, this strategy

was clearly going wrong, leading to the current restructuring. Even though Armstrong pitches the restructuring as a sign of accomplishment, the market sees it as evidence that the "everything-under-one-roof" strategy was a failure.[2] Importantly, Armstrong's strategy was initially hailed by the market, which makes it hard to interpret the facts in the context of agency theory. One could argue that the acquisition strategy was the best one given the available information at the time, and thus it was not a mistake. However, based on the same information, AT&T's President (John Zeglis) disagreed that the acquisition strategy was the correct one (Wall Street Journal, October 26th, 2000). Subsequent events have proven that John Zeglis concerns were justified.

According to our hypothesis, decisions with extreme consequences (such as Armstrong's acquisition strategy) are less likely to be taken if decision-making is more decentralized. While our centralization index is only a proxy for the degree of centralization in decision-making, we believe it will be highly correlated with the ability of the CEO to follow the course of action which he thinks is the best one. We illustrate this point here using Toys "R" Us. In 1999 the CEO of Toys "R" Us Robert Nakasone stepped down, because of disagreements with the board which were believed to be heavily influenced by the founder, Charles Lazarus, and the ex-CEO, Michael Goldstein, who was Chairman of the Board. And the main concern about the new CEO John Eyler is that he may not have much room to make changes (Business Week, December 4th 2000). Our index captures the relative inability of the CEO to have a strong influence on decisions in this company. In fact, our centralization index for Toys "R" US in 1998 and 1999 takes on its lowest possible value, since the CEO, the Chairman and the founder are all different people, the CEO has no other

[2]For example, Brian Hayward, manager of Invesco Telecommunications Fund, sold his remaining shares in AT&T after Armstrong announced the bust up plan. His own words:

"They've been telling us up until now that bundled service is the way of the industry and now they are telling us that these companies are ready to be taken apart. It insulted my intelligence." (Wall Street Journal, October 26th 2000)

title, the positions of President and COO exist, and there is an insider on the board other than the CEO.

These two examples illustrate the notions that fallibility may be important, and that the allocation of titles and the other features of the Executive Office that we capture in our index might reflect the ability of the CEO to have an impact on decision-making. The formal evidence that centralization is positively correlated with the variability of performance is consistent with these ideas. However, one might still argue that this correlation could be explained by alternative arguments.

For example, Amihud and Lev (1981), Agrawal and Mandelker (1987) and Saunders, Strock and Travlos (1990) have argued that if managerial interests are not well aligned with those of shareholders, then managers might engage in self-interested risk-reduction activities such as conglomerate acquisitions. The authors thus predict a positive relationship between managerial ownership and risk (which they measure using variability in accounting measures of performance or stock returns). If managerial ownership is positively correlated with centralization, then our result could be explained by this agency argument. However, even though the correlation between ownership and variability is positive in our data, the effect of centralization on variability is positive even after we control for CEO ownership.

Similarly, one might argue that our measure of centralization is simply capturing other variables which could affect variability such as diversification, firm size, or firm age. Although these variables affect variability in performance in the expected ways in our data, we show that our index of centralization has an independent effect even after controlling for these other determinants of variability. The effect of centralization on the variability of performance is also economically significant, compared to the effect of these other variables. One less title for the CEO (a one-standard-deviation change in the centralization index) has an effect on variability which is equivalent to the addition of approximately one to two segments to the firm, to 15 to 20 additional years of firm age, or to a decrease of 2% to 6% in CEO ownership.

Our definition of centralization is based on the notion of centralization in Sah and Stiglitz

(1991). Other authors (such as Jensen and Meckling, 1992, Stein, 2000 and Zabojnik, 2000) have used this term in a different, although not unrelated way. In these papers centralization is about the level of the hierarchy at which decision-making is carried out, rather than the size of the decision-making group at a given level. For example, in Jensen and Meckling (1992) the allocation of decision rights to lower-level managers mitigates information problems but increases agency costs because lower level managers will have different goals than the CEO. Thus, the optimal degree of decentralization (delegation) will depend on factors that affect the relative importance of agency versus information costs, such as the size of the organization and the rate of change in the environment. One of their predictions is that an increase in variability increases the scope for managerial misbehavior (specifically, moral hazard), and hence decreases delegation.[3] If an increase in the potential for managerial misbehavior also increases our measure of centralization, then this could be an alternative explanation for the positive correlation between our measure of centralization and variability.

However, we believe it is unlikely that an increase in the scope for managerial misbehavior would lead to an increase in our measure of centralization. It is not obvious that as the potential for misbehavior increases, the size of the decision-making group at the top of the corporate hierarchy should decrease. For example, if the scope for agency problems increases it might be desirable to separate the positions of Chairman of the Board and CEO (Core, Holthausen and Larcker, 1999). Similarly, it might be desirable to have a CEO position occupied by someone other than the founder. Separating these positions decreases our index of centralization. Thus, we do not believe that the positive correlation between our proxy for the size of the decision-making group and variability is driven by this agency argument.

We develop our theoretical hypothesis in section 1. In section 2, we describe our measure of centralization. In section 3 we describe our sample in detail. We test our empirical hypothesis in section 4. After establishing our result, we discuss possible implications and

[3]The idea that an increase in variability increases the scope for moral hazard has been explored in other papers such as Demsetz (1983) and Demsetz and Lehn (1985).

extensions in Section 5.

1 Theoretical Arguments and Empirical Implications

Our main goal in this paper is to test the hypothesis that centralization of decision-making at the firm level leads to more variability in firm performance. This hypothesis can be motivated using the theoretical arguments in Sah and Stiglitz (1991). In their model, decision-makers are fallible in the sense that they make mistakes, and they differ in the probability of making good and bad decisions (i.e., they differ in their degree of fallibility).

In the context of corporate decision-making, suppose a CEO makes all decisions alone. If she is of the good type, she will make good decisions more often than if she were of the bad type. Suppose that now the CEO and a second executive, say the Chairman of the Board, have to agree before a decision is implemented.[4] The Chairman again can be either of a good or of a bad type. If the quality of both the CEO and the Chairman are not perfectly correlated ex ante, the likelihood that a proposed good or bad decision is vetoed by one of the executives is higher than it was when only the CEO was responsible for decisions. In other words, there is more compromise in decision-making in the decentralized firm. Therefore, either less decisions would be taken, or the final decision taken would have to reflect the different opinions of both executives. Therefore, a less centralized firm will tend to exhibit less variability in decisions and thus in outcomes.

In Sah and Stiglitz (1991), there is no clear prediction for the relationship between the degree of centralization and the organization's average performance. In the example above, if the degree of fallibility of the CEO and the Chairman is the same, the average quality of

[4] Another possibility is that aggregate performance depends on the outcomes of several decisions, and the responsibilities are divided between the Chairman and the CEO when they are different people. This is actually closer in spirit to the situation described by Sah and Stiglitz (1991). However, the implications for variability would be identical.

decisions may not change. As Sah and Stiglitz (1991) discuss, the impact of decentralization on average performance will also depend on the concavity of the function linking performance and decisions. If this function is convex (concave), centralization (decentralization) should increase average performance. Since we have no prior for the differential abilities of the decision-makers or for the shape of the relationship between decisions and performance, we have no prior for the effect of centralization on average performance.

The main implication of this analysis is then as follows. More centralized firms should display higher variability in measures of firm performance such as Tobin's Q, stock returns and return on assets (ROA). This should hold both for cross-firm variability in performance, and for variability of performance within the same firm. More specifically, a sample of firms which are relatively centralized should have more extreme performances (and thus higher cross-sectional variability). Additionally, firms which are more centralized should display higher variability in performance over time. In our empirical tests we attempt to test both hypotheses jointly (by using a panel sample where both effects will be present), and also separately by isolating the cross-sectional differences in performance and the differences in performance over time for the same firm.

2 Measuring Centralization of Decision-Making

To test our hypothesis we develop a measure of centralization, which we call the decision-making centralization index (or DC index for short). Since our focus is on the number of decision-makers at a given level of the hierarchy, we examine decision-making in the Executive Office. By Executive Office, we mean the tip of the managerial hierarchy. The Executive Office has several features that we can use to estimate the number of participants in decision-making.

For example, if the CEO is not the Chairman of the Board, we expect the firm to be less centralized since the Chairman often has an important role in decision-making. The

Chairman is frequently an ex-CEO, who retains the title of Chairman during a probationary 'training' period for the new CEO. During this period the old CEO passes on relevant information to the new CEO. Brickley, Coles and Jarrell (1997) also point out that giving an ex-CEO the Chairman title eases his transition from active duty to retirement. This suggests that upon becoming Chairman the former CEO still participates in decision-making.[5]

We also expect the overlap of the Executive Office with the board and the frequent retention of the CEO title by the company's founder to influence the degree of centralization in decision-making. Since the board is legally responsible for the management of the corporation, we expect that if an inside[6] manager (other than the CEO) sits on the board, he is more likely to participate in top decision-making. Thus, we consider firms with more than one inside manager on the board to be less centralized.[7]

In addition, if the founder of the firm is not the CEO, the CEO might have to share decision-making. Firms whose founder is the CEO should therefore be more centralized than firms whose CEO is not the founder.

The CEO succession process of a firm also influences the degree of joint decision-making in the firm to the extent that the successor of the CEO is involved in CEO decision-making

[5] An example of how an ex-CEO who retains the title of chairman can still have substantial influence over the firm's management is documented in Lehn and Treml (2000). The founder of JLG industries, John L. Grove, was replaced in 1991 by L. David Black as the CEO of the company, but retained his position as Chairman. The board determined in 1992 that Grove should withdraw from day-to-day activities and concentrate on board activities, but he continued to have disagreements with the management team and openly expressed his concerns about the state of affairs in the firm. The leadership conflict culminated with the removal of Grove as chairman in 1993.

[6] As opposed to managers who are "outsiders" i.e. they do not work for the firm.

[7] One might argue that insiders just rubberstamp CEO decisions, and thus that this measure does not capture an increase in the number of decision-makers. We do not believe this to be true. For example, in the AT&T example we discuss in the introduction, the President and the CEO voiced different opinions about AT&T's diversification strategy. In any case, the presence of rubberstamping will make it harder for us to find our results.

prior to becoming CEO. The two most familiar types of succession processes (e.g. Vancil 1987, Brickley, Coles and Jarrell 1997, Naveen 2000) are horse races, in which the firm conducts a tournament among eligible candidates for the position of CEO, and passing the baton, in which the firm chooses a designated successor for the CEO.[8] In the latter case, a new CEO also has the title of President (or COO). Once he plans his succession, he hands the title of President or COO to the heir apparent. If the CEO has an heir apparent then there is a gain to grooming him by involving him in CEO level decision-making. There are many cases of firms in which the designated successor to the CEO voices his opinion on strategy as, for example, AT&T's President, John Zeglis, did about CEO C. Michael Armstrong's cable strategy (Wall Street Journal, October 26th 2000). Thus, if the CEO is not also the President (or COO), we expect decision-making to be less centralized.

It is plausible that the candidates for the CEO position will participate less in CEO decision-making in a horse race than when the CEO passes the baton. If the firm conducts a tournament for the CEO, then it may be difficult to involve all candidates fairly in CEO decision-making.[9] In addition, involving the candidates in CEO decision-making may have drawbacks since the losers of the tournament generally leave the firm.[10] Thus, we consider firms which are passing the baton to be less centralized than firms which conduct horse races for the CEO position.

[8] These are probably also the most common types of succession plans. Naveen (2000) finds in a sample of 691 successions of the firms in the 1991 Forbes compensation survey during 1987-1997 that the CEO was the former President 58% of the time. Canella and Lubatkin (1993) find that over two thirds of the CEOs in their sample were President of their firm at the time of their appointment.

[9] Jack Welch does not describe his own competition for the CEO position of GE as a very participatory experience: "I had to come to work for three years, and sit with seven other candidates in a dining room and stare at each other." (Hill, 2000)

[10] The case of General Electric illustrates this argument (Hill, 2000). There were three candidates for Jack Welch's position in 2001: James McNerney, Robert Nardelli, and Jeffrey Immelt. Once Immelt was named CEO-elect, McNerney and Nardelli were expected to leave the firm. Even while the tournament was being conducted Jack Welch was depicted as the primary decision-maker in the media.

The overlap of the Executive Office with the Board, the CEO succession process and the retention of the CEO title by the firm's founder are all interconnected. The heir apparent to the CEO is usually also appointed to the board (Hermalin and Weisbach 1988).[11] When the CEO is also the founder there is less likely to be a formal succession process. Thus both for simplicity and to obtain one measure we can use to perform some of our empirical tests in the next section,[12] we summarize the centralization-related aspects of the Executive Office in one measure that is increasing in centralization (DC index).

We define our centralization index DC as the sum of 7 indicator variables i_{chair}, i_{noiob}, i_{founder}, $i_{\mathsf{president}}$, i_{other}, i_{nopres}, and i_{nocoo}. i_{chair} is equal to 1 if the CEO is also the chairman, i_{noiob} is equal to 1 if there is no other insider on the board other than the CEO, i_{founder} is equal to 1 if the CEO is the founder of the company, $i_{\mathsf{president}}$ is equal to 1 if the CEO is also the president, i_{other} is equal to 1 if the CEO has any other title (such as COO), i_{nopres} is equal to 1 if the firm has no president, and i_{nocoo} is equal to 1 if the firm has no COO. We include i_{other} because the title of the CEO's heir apparent may vary across firms.

The two variables i_{nopres} and i_{nocoo} are proxies for the type of succession process in the firm.[13] If a firm's succession process typically consists of a horse race, then the candidates for the CEO position are more likely to be of equal rank and thus have titles such as Vice President or Executive Vice President (Naveen, 2000) or, as in the case of Jack Welch's succession (Hill, 2000), the candidates may have titles associated with different divisions. In this case the firm will be less likely to have a President or COO, thus the absence of a President or COO is a sign that decision-making is more centralized.[14]

[11] The number of candidates in a horse race may be too large to accommodate on the board. For example, the number of people competing in the horse race for the position of CEO of General Electric in 1980 was 7.

[12] For example, the Goldfeld-Quandt heteroscedasticity test requires that we rank the observations along a single dimension.

[13] This is similar to the argument in Naveen (2000) who classifies firms which have a President or COO distinct from the CEO as those with succession plans.

[14] The reason we use two separate dummy variables is to ensure that a firm in which the CEO is the

In general it would be difficult to construct such a measure of centralization at a level of the organization below that of the Executive Office. While decision-making within a certain division could be characterized as centralized or decentralized it would be unclear how to account for the allocation of responsibility across divisions. However since decision-making in the Executive Office, and more specifically CEO decision-making, will arguably have the most pronounced impact on performance, we consider our measure to be the most relevant proxy for our notion of centralization.

3 Data Description

Our sample consists of data on publicly traded firms in the 1998 Fortune 500 during 1992-1999. We restrict our sample to exclude financial firms and utilities because, as Saunders, Strock and Travlos (1990) point out, the presence of a regulator may affect decision-making in regulated firms (in their paper specifically: risk-taking in banks). We further restrict our sample to the set of firms for which data is available on ExecuComp (2000). From Standard and Poor's ExecuComp (2000) we obtain information on all executives mentioned in the firms' executive compensation table as well as financial information. We obtain monthly stock returns for the sample firms as well as value-weighted market returns from CRSP. We gather the remaining financial information from Compustat and the date of the firm's incorporation from Moody's Industrial Manuals (1999), proxy statements and annual reports for fiscal 1998. Our final sample consists of 2,633 firm-years of data and 34,158 monthly stock returns for 336 firms during the 1992-1999 time period.

The data we gather on executives from ExecuComp (2000) consists of 16,022 executive-

President and the Chairman is equally centralized as a firm which conducts a horse race and in which the CEO is also the Chairman. If the succession generally occurs through the President title then it is not likely that the firm has a COO (in our sample, in only 811 out of 15978 firm-years there is both a President and a COO). Thus, for such a firm, disregarding the other dummy variables, $\mathsf{DC} = 3$, which is the same value as that of a firm which conducts a horse race and in which the CEO is also the Chairman.

years of data for our 336 sample firms during the 1992-1999 time period. This data contains information on whether the named executive sits on the board and the title of each executive. If the named executive is the CEO we also obtain the year in which he became CEO and his ownership in the firm.[15] We use the data on executives to construct a data set of firm-years containing CEO ownership, CEO tenure as CEO and the first 6 indicator variables necessary to construct our DC index, $i_{\mathsf{noiob}}, i_{\mathsf{nopres}}, i_{\mathsf{nocoo}}, i_{\mathsf{president}}, i_{\mathsf{other}}, i_{\mathsf{chair}}$. We define i_{noiob} in a given year to be equal to 1 if no executive mentioned in the firm's executive compensation table except the CEO sits on the board in that year. Similarly we define i_{nopres} (i_{nocoo}) to be equal to 1 in a given year if the firm has no president (COO) amongst the executives mentioned in the compensation table for that year. According to Regulation S-K of the Securities Act of 1933, the executives described in a firm's compensation table must include the 4 highest paid executives in the firm other than the CEO. While it is feasible that other insiders sit on the board or that the president (COO) is not amongst the top 4 executives in terms of salary, we consider it unlikely. We use the title of the CEO in a given year to set $i_{\mathsf{president}}$ ($i_{\mathsf{other}}/i_{\mathsf{chair}}$) equal to 1 if the CEO is also the president (has any other title/is also the chairman) in that year.

Since ExecuComp (2000) does not contain information on whether the CEO is also the founder, we define i_{founder} in a given year to be 0 if the firm was incorporated at least 64 years prior to the current year or if the current CEO joined the company at least 4 years after the date of the firm's incorporation.[16] For the remaining firm-years we checked whether the

[15] In Execucomp the data item containing the proportional ownership of the CEO is often missing if ownership is less than 5%. We therefore calculate it as the ratio of the number of shares owned by the CEO to total shares outstanding after adjusting the number of shares owned by the CEO for stock splits. While Execucomp adjusts the total shares outstanding for stock splits it may not adjust CEO ownership (as can be seen in the case of CEO Bill Gates of Microsoft), however it does include an adjustment factor (Access item: AJEX) that can be used to adjust ownership.

[16] The longest period of time a CEO has been working for his firm in our sample is 59 years. We use 64 years as a cutoff to account for missing data on CEO firm tenure. Since most firms are founded several

current CEO was the founder in a variety of sources consisting of proxy statements, annual reports and the internet.[17] We set i_{founder} in a given year equal to 1 if any source explicitly named the current CEO as a founder or the main executive at the time the company began (including when it was spun-off).

In addition to constructing the centralization index, we construct two performance measures for our sample firms, Tobin's Q (Q) and return on assets (ROA). Our measure of Tobin's Q is the ratio of the firm's market value to its book value. The firm's market value is calculated as book value of assets minus the book value of equity plus the market value of equity. We define ROA as the ratio of net income before extraordinary items and discontinued operations to its book value of assets. In Table 1 we present summary statistics concerning select financial variables, CEO characteristics and our centralization measure DC index. In most firm-years another insider other than the CEO sits on the board (70%). Likewise in most firm-years firms have a President (74%). They are less likely to have a COO (35%). Consequently CEOs are also less likely to have a title other than President (27%) or Chair (86%). In 9% of firm-years the CEO is also the founder. Table 2 shows that our compilation of this information into DC index is fairly evenly distributed with DC index taking on the values 0, 1 and 2 approximately 50% of the time and 3, 4, and 5 the other 50% of the time with a resulting mean of 2.42 for the entire sample.

years prior to the date of incorporation this procedure ensures that we check more CEOs than are likely to be founders.

[17] When we could find the name of a firm's original founder this procedure was straightforward. However, very few proxies, annual reports or company websites disclosed the name of the original founder. We were most successful doing a search with the name of the executive and the word founder using the Google search engine.

4 Empirical Tests

In this section we test whether our decision-making centralization (DC) index increases the variability of performance measures. In order to do this we apply several heteroscedasticity tests to our data, and use different measures of performance such as Q,stock returns and ROA. We focus initially on Q, and in section 4.4 we consider stock returns and ROA.

Our hypothesis has implications both for the variability of performance across firms (since more centralized firms should have more extreme performances), and for within-firm variability of performance (since a more centralized firm should have higher variability in performance over time). Thus we perform our tests using a panel of firms (where both effects should be present), and we also try to isolate the cross-firm and within firm effects. We do the former by replicating the same tests we perform for the panel using the averages of all variables from 1992 to 1999. We do the latter (in section 4.5) by regressing the standard deviation of the performance measures over 1992-1999 on the centralization index and controls.

4.1 Empirical Model for Tobin's Q

Our heteroscedasticity tests require us to specify a model for Tobin's Q. We estimate a similar model as Morck, Shleifer and Vishny (1988), Yermack (1996), and Himmelberg, Hubbard and Palia (1999). The main difference is that we include the DC index because centralization may affect average performance (even though we have no prior for the direction of this relationship, as discussed in section 1).

We regress Q on DC, current and one-year lagged return on assets, CEO ownership and its square, log of assets (a proxy for firm size), firm growth (measured by capital expenditures over sales), firm age (measured by the number of years since the date of incorporation), industry dummies (two digit SIC code dummies) and year dummies (in our panel regressions).

Table 3 shows the output of two different regressions. The first one is a is a panel

regression in which every firm-year is counted as one observation. The second one is a cross-sectional regression with the variables averaged over the 1992-99 period. The coefficients on all variables are broadly consistent with the ones estimated in previous literature. As evidenced by the low t-statistics, the coefficients on the DC index are not significantly different from zero. This does not mean that centralization should be completely unrelated to firm performance. As we argued in section 1, decision-making centralization should affect the variance of firms' market valuation. Figure 1 presents some descriptive evidence which is consistent with our hypothesis. We plot the Tobin's Q residuals from the cross-sectional regressions for the firms with the highest 20% and the lowest 20% values of the centralization index. The visual evidence in Figure 1 is consistent with our main hypothesis, since cross-sectional variability is clearly higher in the more centralized sample. We now turn to formal tests of this hypothesis using some standard heteroscedasticity tests.

4.2 Goldfeld-Quandt Heteroscedasticity Tests

In this section, we apply the Goldfeld-Quandt (1965) heteroscedasticity test to our data.[18] This requires us to divide our sample into centralized and decentralized firms, and to apply the "true" empirical model for Tobin's Q to each sub-sample separately. We focus first on the model we specified in the previous section, but we also perform the test using the raw Q variable. The reason for this is to check that the result is not too dependent on our specification of the model for Q. In the latter case, the Goldfeld-Quandt test collapses into a standard test of comparing variances between two different samples.

Since the median of the DC index is 2, we define the decentralized sub-sample in our panel sample as the one containing observations with DC indices of 0 to 2 and the centralized sub-sample as the one with DC indices ranging from 3 to 5. In our cross-sectional sample, DC indices are averages over 8 years, therefore they are not necessarily integer values. In

[18] For more details on this test see Greene (1993).

that case, we use median DC value of 2.5 as the cut-off point.

Using the residuals from the two separate regressions, we compute the sum of the squares of the residuals (RSS) for each group. Under the assumption of normality of these residuals, the ratio of the RSS of the first group to the RSS of the second group should follow an $F-$distribution with $n_1 - k$ and $n_2 - k$ degrees of freedom of the numerator and the denominator, respectively, where n_i is the number of observations in group i, $i = 1, 2$, and k is the number of regressors. Therefore, to test the null hypothesis of homoscedasticity against the alternative that more centralized firms have greater variance in their market valuations than decentralized ones, we create an $F-$statistic by dividing the RSS for the centralized group by the RSS of the decentralized group and compare it with critical values from F-tables with the appropriate degrees of freedom. An $F-$statistic greater than 1 is evidence against the null and in favor of the hypothesis of greater variance under centralization.

The results (reported in Table 4) are consistent with our hypothesis. For both the cross-section and panel samples, the $F-$statistic is greater than one and highly significant, with virtually zero p-values.

In columns III and IV of Table 4 we report the results using the raw Q variable, instead of the residuals from the model. The results are the same, with somewhat greater p-values. This suggests that results are robust to alternate specifications of the model for Q.

The difference in variances also appears to be economically significant. The implied ratio of variances goes from 1.05 to 2.20.[19] This implies that the standard deviation of Tobin's Q is higher in the centralized sample, by a factor varying from 3% to 50%.[20]

4.3 Tests Based on Regressions

One of the weaknesses of the tests in the previous subsection is that observations can only be ranked by one variable at a time. Therefore, we cannot test whether decision-making

[19] One estimate for the variance is just the residual sum of squares divided by the degrees of freedom.

[20] We will analyze economic significance in more detail using the results in Table 9.

centralization affects performance variability after controlling for other variables that might also affect variance.

For example, Amihud and Lev (1981) explain differences in the variability of performance by appealing to an agency argument. They argue that firms with disperse ownership (firms with more severe agency problems) engage in more conglomerate acquisitions in order to reduce risk, even when this is not optimal for shareholders. If the CEO has higher ownership, he will have less incentives to reduce risk (see also Agrawal and Mandelker, 1987, and Saunders, Strock and Travlos, 1990). This could induce a positive correlation between managerial ownership and variability in performance. To ensure that our measure of centralization is not capturing this agency effect, we need to be able to control for CEO ownership.

Another possibility is that our index simply reflects the degree of diversification. Firms with more segments may need more people making decisions, and thus appear less centralized. Such firms may also have less variability because of the effect of diversification. Thus, diversification could generate a spurious positive correlation between centralization and variability.

In order to control for these and other possible determinants of performance variability, we apply the Glejser and the modified Glejser tests to our sample.[21] To conduct the Glejser test, we regress the absolute value of the residuals $\hat{\varepsilon}_i$ from our empirical model for Tobin's Q (section 4.1), on the decision-making centralization index DC_i and on a vector of controls $\mathbf{z}_i$ which we hypothesize should be associated with the variability in firm performance:

$$|\hat{\varepsilon}_i| = \alpha + \beta DC_i + \boldsymbol{\theta}\mathbf{z}_i + e_i \tag{1}$$

The modified Glejser test uses the square of the residuals, instead of their absolute value:

$$\hat{\varepsilon}_i^2 = \alpha + \beta DC_i + \boldsymbol{\theta}\mathbf{z}_i + e_i \tag{2}$$

In both cases, an F-test of the hypothesis that all slopes equal zero is a test of the null hypothesis of homoscedasticity against the alternative that the variance of firm performance

[21] The terminology "modified Glejser" comes from Goldfeld and Quandt (1972).

is a function of (DC_i, z_i). Therefore, the two different specifications imply two different alternative hypotheses. To test whether decision-making centralization alone positively affects the variance of firm performance, we use a t-test for the null that the coefficient $\beta \leq 0$ against the alternative $\beta > 0$. High t-statistics are evidence that decision-making centralization is positively correlated with the variance of firm performance. In what follows, we use both the Glejser and the modified Glejser tests to ensure that the results are not sensitive to small changes in the alternative hypothesis.[22]

Our benchmark vector of controls z includes CEO ownership (to control for the agency argument described in Amihud and Lev, 1981), the degree of diversification (the number of different two-digit SIC segment codes), firm size (natural log of assets), firm age (number of years since date of incorporation), leverage (book value of long term debt divided by book assets), CEO tenure (the number of years since the CEO was appointed CEO) and its square, and one-digit-SIC industry dummies. We expect bigger and older firms to exhibit less variability in performance. We include leverage because of the evidence that leverage is negatively correlated with variability (see Harris and Raviv, 1991). We include the tenure variables to control for life-cycle learning effects (see May, 1995), and the industry dummies to control for the fact that some industries might be inherently more volatile than others.

In Table 5 we report the results of both regressions (1) and (2) for each type of sample, the panel and the cross-section. The panel regressions include time effects. We do not use firm fixed-effects in our panel specification, because our centralization index does not vary much over time for a given firm (the change in the index for the same firm, from one year to the next one is zero approximately 80% of the time).[23] In addition, we expect differences in

[22] Godfrey (1988) shows that the modified Glejser test can be viewed as a Lagrange Multiplier (LM) test, similar to the Breusch-Pagan/Godfrey test (see Greene, 1993), which includes the correction suggested by Koenker to make the test robust to non-normality.

[23] In the context of the ownership literature, Himmelberg, Hubbard and Palia (1999) argue for the use of firm fixed effects in regressions which relate ownership to firm performance. However, Zhou (2001) points out that if the explanatory variable changes slowly over time (as do ownership and centralization), firm

variability to be more systematically related to industry, which we control for.[24] We always use heteroscedasticity-corrected standard errors when calculating our t-statistics, since the residuals of these regressions are heteroscedastic by construction.[25]

The null of homoscedasticity is always easily rejected against the alternative that the variance of firm performance is a function of (DC_i, z_i), as evidenced by the large F-statistics (the corresponding $p-$values, which we do not report, are virtually zero). More importantly, in all four cases reported in Table 5 the coefficient on DC is positive, indicating that more centralization of decision-making is associated with greater variance in the market valuation of firms. The t-statistics are higher in the cross-sectional sample than in the panel sample, but even the panel results are significant for the absolute value specification (t-statistics are generally higher in the Glejser's tests than in the "modified Glejser" tests which use the square of the residuals).

In Table 6, we augment the set of control variables to include all remaining variables (the square of ownership, ROA, lagged ROA and Capex/Sales) of the empirical model for the level of Tobin's Q, which we specified in section 4.1. The reason for this is that any variable which has an effect on the average Tobin's Q could potentially have an effect on the higher moments of Q as well. The results are consistent with those of Table 5. One difference is that the coefficient on DC has a higher t-statistic. Thus, the use of this larger set of controls makes it easier for us to accept the hypothesis that centralization is positively correlated

fixed-effect regressions may fail to detect relationships in the data even when they exist.

[24] An indirect way to control for firm-specific effects is to use fixed effects in the empirical model for Tobin's Q. This addresses the possibility that the difference in variances is driven by the fact that centralized firms are intrinsically more diverse as a group (and thus the Tobin's Q model has less explanatory power for centralized firms). While we do not report these tests here, the results are similar to the ones we report.

[25] The residuals (e_i) of these regression have the following three features: (1) they have non-zero expected value, (2) they are autocorrelated and (3) they are heteroscedastic. Amemiya (1977) shows that, asymptotically, the first two problems vanish (see also Amemiya, 1985). To correct for heteroscedasticity, Greene (1993) suggests using the asymptotically corrected covariance matrix of White.

with variability. However, since we have no economic reason for including these additional variables, we use the benchmark model in Table 5 for the remaining of the paper.

In general, the results of these tests corroborates our previous findings that DC positively affects the variance of firm performance, both cross-sectionally and in the panel sample. In addition, the tests performed in this section allow us to control for other possible determinants of variance in firm performance. For example, even after controlling for CEO ownership, decision-making centralization still affects the variance of firm value. This implies that the centralization index is not simply capturing the particular agency problem emphasized in Amihud and Lev (1981), Agrawal and Mandelker (1987), and Saunders, Strock and Travlos (1990). Similarly, the correlation between the DC index and variability does not seem to be driven by diversification and other firm characteristics such as age and size.

The economic significance of the coefficient in centralization also appears to be large, as compared to the coefficients on these other variables. The coefficient on the centralization index indicates that one less title for the CEO is equivalent to an increase of 11 to 49 years of firm age, 0.6 to 3.2 additional segments, or to a decrease in ownership of 1% to 8%, depending on the specification.

4.4 Alternate Performance Measures

In this section, we check the robustness of the results to changes in the variable measuring performance. Following previous literature, we also use stock returns and return on assets (ROA hereinafter) as alternate measures of performance. We replicate all our previous tests using these measures, but in the interest of brevity we discuss only the Glejser tests below.

4.4.1 Empirical Model for Stock Returns

To perform the Glejser test using stock returns we use the residual returns from the market model with the market return (value-weighted market return from CRSP) as the single

factor.[26] We use monthly stock returns to estimate our betas and residuals for the period 1992-1999.

As in the tests with Q, we use both a cross-sectional and a panel sample of residuals. To perform the panel tests we construct the residuals for each firm-month as the difference between the stock return for the firm in that month, and the market return multiplied by the firm's beta. Thus, the firm's residual return is the component of performance which cannot be explained by the market model (abnormal performance). Our hypothesis is that the variability in abnormal performance increases with centralization. Since we use monthly data for stock returns and annual data for the controls, we adjust the t-statistics for non-independence within firm-year.

To perform the cross-sectional tests we calculate the residual as the difference between the firm's average stock return in the time period, and the average market return multiplied by the firm's beta.

4.4.2 Empirical Model for ROA

To perform the Glejser test using ROA we use the residuals from the following empirical model:[27]

$$\begin{aligned} ROA \;=\; & b_0 + b_1 DC \text{ index} + b_2 \text{CEO ownership} + b_3 (\text{CEO ownership})^2 + b_4 \ln(\text{assets}) \\ & + b_5 \frac{\text{Capex}}{\text{Sales}} + b_6 \text{Firm age} + b_7 \text{number of segments} + u \end{aligned}$$

The regression also includes industry dummies and year dummies (in the panel sample). This is the same empirical model we specified for Tobin's Q in section 4.1, except now we do not use ROA and its lag as regressors.

[26] We also used total stock returns instead of the residuals and the results were similar.

[27] We do not report the output of these regressions.

4.4.3 Results of Glejser Tests using Stock Returns and ROA

In Tables 7 and 8, we show the results of the heteroscedasticity tests, using the following specification:

$$f(\hat{u}) = a_0 + a_1 DC \text{ index} + a_2 \text{CEO ownership} + a_3 \text{CEO tenure} + a_4 (\text{CEO tenure})^2 + a_5 \text{leverage} + a_6 \ln(\text{assets}) + a_7 \text{Firm age} + a_8 \text{number of segments} + \epsilon \quad (3)$$

where $\hat{u}$ are the estimated residuals for stock returns or ROA, and $f(.)$ is either the absolute value function or the square function. This is the same specification we used in the Glejser tests for Tobin's Q. All specifications include industry dummies and year dummies (in the panel sample).

The results are again consistent with the previous ones. In particular, the coefficient on the DC index is positive in all specifications. However, $t-$statistics are higher for the stock return tests. The main difference between the Q results and the stock return and ROA results is that, in the latter tests, the coefficient on DC has higher $t-$statistics in the panel sample than in the cross-sectional sample, which is exactly the opposite pattern than in the Q tests. This indicates that within-firm variability is more important for stock returns and ROA, while the Q results are driven mostly by greater dispersion in performance across more centralized firms. To further investigate this hypothesis, we develop a test that only takes into account the within-firm over-time variability of performance measures in the next section.

4.5 Centralization and Variability Over Time

In this section we estimate the effect of centralization on the within-firm variability of performance. For all firms in which the performance measures are available for all years from 1993-1999, we compute the sample standard deviation of Q, ROA and stock returns, using their yearly values from 1993 to 1999. We also use the standard deviation of the firm-specific

stock returns (the residuals from the market model) as a dependent variable, as in Saunders, Strock and Travlos (1990). Then, we regress the standard deviations on the possible determinants of variability.[28] We use the same set of controls as in equation 3. The data for the regressors is either an average over the whole period (1992-1999), or the value for the year 1993. We use 1993 as our base year because ExecuComp started in 1992 and thus the 1993 data is more complete.

Table 9 shows the results. In the Q regressions (columns I and II), DC enters positively, but is not significantly different from zero at the conventional levels. The effect of centralization on ROA and stock returns, however, is positive and significant for all specifications. This is consistent with the idea that stock returns and ROA are more volatile over time than Q, and that this volatility is positively affected by decision-making centralization. The other coefficients also have the expected signs. Larger, older and more diversified firms tend to have lower variability in performance. Furthermore, higher CEO ownership is positively correlated with variability.

Table 9 allows us to easily evaluate the economic significance of the effect of centralization on variability. For example, one additional title for the CEO (an increase of one in our index, which is about a one-standard-deviation-change according to Table 1) increases the standard deviation of residual stock returns by an amount which ranges from 0.002 to 0.004. This has an effect equivalent to the decrease of two to four segments (more than one standard deviation in diversification) to the firm. It is also equivalent to 10 to 20 less years of firm age (the coefficient on age is -0.002, and age is multiplied by 10). We can also compare it with the effect of ownership. One additional title has an equivalent effect to an increase of approximately 4.4% in CEO ownership. This indicates that the effect of centralization is significant, compared to other variables which previous literature has argued can affect the variability of performance.[29]

[28] For an example of this approach in a somewhat different context, see Rodrik (2000).

[29] Similar results hold when we use ROA instead, or Tobin's Q (even though the effect on the latter is

5 Conclusion

In this paper we test the theoretical hypothesis that firm performance will be more variable as the number of managers participating in decision-making decreases, i.e. as the firm becomes more centralized. This is an implication of Sah and Stiglitz's (1991) model, in which the impact of fallibility on firm performance depends on the structure of decision-making.

We use characteristics of the Executive Office to develop a proxy for the number of executives participating in decision-making at a given hierarchical level. We test our hypothesis using this proxy (which we call the centralization index), and find that the evidence is consistent with Sah and Stiglitz's theory. The results are consistent across performance measures, and across various tests designed to detect differences in variance. The results hold both across firms and within firms. We believe that these results are important for the following reasons.

First, our results have implications for the evaluation of managers. Martin (2000) argues that it is difficult to evaluate managers and that the quality of management is observable only with hindsight. Our results point out that the quality of a manager should be judged in the context of the impact he has on decision-making. Good (or bad) performance is less indicative of CEO ability in centralized firms than in decentralized firms given that all CEOs are fallible. This argument is analogous to a signal extraction framework in which one should give more weight to priors when signals are noisy. Here centralization makes signals noisier, so they should be of less value.

A natural question that arises is whether centralization is good. The governance literature argues that is it not and advocates the separation of the CEO and Chairman of the Board positions.[30] Our results highlight that centralized firms can be those with the worst as well

not statistically significant). For example, the coefficient on our index is consistently at least as large as the coefficient on the number of segments.

[30] The governance literature is more concerned with entrenchment than decision-making, although the two concepts may sometimes be difficult to disentangle.

as the best performances. Thus any policy recommendations should not be based on the consideration of isolated cases. In addition our results point out one cost of decentralization: performance is less variable but the probability of spectacular performance is also lower.

Third, as Campbell, Lettau, Malkiel and Xu (2001) point out, there is very little empirical research on volatility at the firm level. They discuss several reasons why this could be important, such as the fact that arbitrageurs face risks related to idiosyncratic volatility, and the lack of diversification in many investors' portfolios. Our paper suggests that managerial fallibility and organizational structure may be important for understanding differences in volatility at the firm level.

Volatility is not only important for outside investors, but also for "insiders" such as managers whose compensation needs to be tied to performance, as the standard principal-agent model suggests. When firm performance is more volatile, it is more expensive to provide incentives to risk-averse agents. Thus, our results may have implications for the structure of compensation packages, an issue we plan to investigate in future research.

However, it is important to stress that our hypothesis does not depend on the existence of an agency problem. Even if managers are benevolent, there can still be frictions induced by human fallibility. Our evidence suggests that fallibility itself could be an important avenue for future research.

References

[1] Agrawal, A. and G. Mandelker, 1987, "Managerial Incentives, Corporate Investment and Financing Decisions", Journal of Finance, 42, 823-837.

[2] Almeida, H. and D. Ferreira, 2001, "Democracy and the Variability of Economic Performance", mimeo.

[3] Amemiya, T., 1985, Advanced Econometrics, Harvard University Press, Cambridge, Massachusetts.

[4] Amemiya, T., 1977, "A Note on a Heteroscedastic Model", Journal of Econometrics, 6, 365-370.

[5] Amihud, Y. and B. Lev, 1981, "Risk Reduction as a Managerial Motive for Conglomerate Mergers", Bell Journal of Economics, 12, 605-617.

[6] Brickley, J., J. Coles, and G. Jarrell, 1997, "Leadership Structure: Separating the CEO and Chairman of the Board", Journal of Corporate Finance, 3, 189-220.

[7] Business Week, 2001, Armstrong's Last Stand (Special Report), February 5th.

[8] Business Week, 2000, Clubby Boardrooms"R"Us, December 4th.

[9] Canella, A. and M. Lubatkin, "Succession as a Sociopolitical Process: Internal Impediments to Outsider Selection", Academy of Management Journal, 36, 763-793.

[10] Campbell, J., M. Lettau, B. Malkiel and Y. Xu, 2001, "Have Individual Stocks Become More Volatile? An Empirical Exploration of Idiosyncratic Risk", Journal of Finance, 56, 1-43.

[11] Core, J., R. Holthausen and D. Larcker, 1999, "Corporate Governance, Chief Executive Officer Compensation, and Firm Performance", Journal of Financial Economics, 51, 371-406.

[12] Demsetz, H., 1983, "The Structure of Ownership and the Theory of the Firm", Journal of Law and Economics, 26, 375-90.

[13] Demsetz, H. and K. Lehn, 1985, "The Structure of Corporate Ownership: Causes and Consequences", Journal of Political Economy, 93, 1155-77.

[14] Demsetz, H. and B. Villalonga, 2001, "Ownership Structure and Corporate Performance", mimeo.

[15] Goldfeld, S., and R. Quandt, 1965, "Some Tests for Homoscedasticity", Journal of the American Statistical Association, 60, 539-547.

[16] Goldfeld, S., and R. Quandt, 1972, Nonlinear Methods in Econometrics, Amsterdam: North-Holland Publishing.

[17] Godfrey, L., 1988, Misspecification Tests in Econometrics, Cambridge University Press.

[18] Greene, W., 1993, Econometric Analysis, McMillan, New York.

[19] Harris, M. and A. Raviv, 1991, "The Theory of Capital Structure", Journal of Finance 46, 297-355.

[20] Hermalin, H. and M. Weisbach, 1988, "The Determinants of Board Composition", Rand Journal of Economics, 19, 589-606.

[21] Hill, A., 2000, "Welch's Last Great Challenge", www.ft.com, People in Focus, October 24.

[22] Himmelberg, C., G. Hubbard and D. Palia, 1999, "Understanding the Determinants of Managerial Ownership and the Link between Ownership and Performance", Journal of Financial Economics, 53, 353-84.

[23] Jensen, M. and W. Meckling, 1992, "Specific and General Knowledge, and Organizational Structure", in Contract Economics, Werin, L. and H. Wijkander (ed.), Blackwell, Cambridge MA.

[24] Lehn, K. and H. Treml, 2000, "Decentralization, Incentives and Value Creation", Journal of Applied Corporate Finance, 15, 60-71.

[25] May, D., 1995, "Do Managerial Motives Influence Firm Risk Reduction Strategies?", Journal of Finance, 50, 1291-1308.

[26] Martin, P., 2000, "The Value of a Boss", Financial Times, October 28th.

[27] Morck, R., A. Shleifer, and R. Vishny, 1988, "Management Ownership and Market Valuation", Journal of Financial Economics, 20, 293-315.

[28] Naveen, L., 2000, "Management Turnover and Succession Planning in Firms", mimeo.

[29] Rodrik, D., 2000, "Participatory Politics, Social Cooperation, and Economic Stability", American Economic Review, 90, 2, 140-144.

[30] Saunders, A., E. Strock and N. Travlos, 1990, "Ownership Structure, Deregulation, and Bank Risk Taking", Journal of Finance, 45, 643-654

[31] Sah, R., 1991, "Fallibility in Human Organizations and Political Systems", Journal of Economic Perspectives, 5, 67-88.

[32] Sah, R., and J. Stiglitz, 1991, "The Quality of Managers in Centralized versus Decentralized Organizations", Quarterly Journal of Economics, 106, 289-295.

[33] Shleifer, A. and R. Vishny, 1997, "A Survey of Corporate Governance", Journal of Finance, 52, 737-783.

[34] Stein, J., 2000, "Information Production and Capital Allocation: Decentralized Versus Hierarchical Firms", NBER Working Paper 7705.

[35] Vancil, R., 1987, Passing the Baton: Managing the Process of CEO Succession, Harvard Business School Press, Boston.

[36] Wall Street Journal, 2000, "With Breakup Armstrong's Bet on Cable is Lost", October 26th.

[37] Yermack, D., 1996, "Higher Market Valuation of Companies with a Small Board of Directors", Journal of Financial Economics, 40, 185-211.

[38] Zabojnik, J., 2000, "Centralized and Decentralized Decision-Making in Organizations", forthcoming, Journal of Labor Economics.

[39] Zhou, X., 2001, "Understanding the Determination of Managerial Ownership and its Relationship to Firm Performance", forthcoming, Journal of Financial Economics.

Table 1: Summary of select financial variables, CEO characteristics and our centralization measure

Sample consists of monthly stock returns and 2,633 firm-years of data for 336 publicly traded, non-regulated firms from the 1998 Fortune 500 that were available on Execucomp (2000) during the years 1992-1999. Data on titles is constructed from 16,022 executive-years of data for these 336 firms during the years 1992-1999. Most financial data, all title data and CEO tenure is from Execucomp (2000). Monthly stock return data (variable name = RET) and market returns (variable name = VWRETD) are from CRSP. Remaining financial data and segment data is from Compustat. Firm age is collected from Moody's Manuals (1999), proxy statements and 10-Ks for fiscal 1998. Founder data is collected from a variety of sources consisting of proxy statements, annual reports and the internet Observations vary because of missing data. Our proxy for Tobin's Q is = (book value of assets-book value of equity+market value of equity)/book value of assets. ROA = net income before extraordinary items and discontinued operations/book value of assets. Leverage=long-term debt/assets. Firm age = #years since first date of incorporation. # of segments is equal to the number of different 2-digit SIC code industries the firm operates in. CEO tenure is the number of years since the CEO was appointed CEO. CEO ownership is defined as the ratio of the number of shares owned by the CEO after adjusting for stock splits to total shares outstanding. We define DC index to be the sum of $i_{noiob}, i_{nopres}, i_{nocoo}$, $i_{president}, i_{other}, i_{chair}, i_{founder}$ where i_{noiob} in a given year is equal to 1 if no executive mentioned in the firm's executive compensation table except the CEO sits on the board in that year, i_{nopres} (i_{nocoo}) is equal to 1 in a given year if the firm has no president (COO) amongst the executives mentioned in the compensation table for that year, $i_{president}$ (i_{other} / i_{chair}) is equal to 1 if the CEO is also the president (has any other title/is also the chairman) in that year and $i_{founder}$ is equal to 1 if the current CEO is the founder of the firm.

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Financial variables and CEO characteristics					
Tobin's Q	2595	2.01	1.38	0.81	19.15
Return on assets (ROA)	2633	5.42	5.80	-48.19	48.15
Stock returns	34158	0.02	0.11	-0.82	2.93
Value-weighted market returns	34160	0.02	0.04	-0.1	0.08
Leverage	2598	0.21	0.13	0.00	1.04
Assets in billions	2633	11.08	26.23	0.02	405.200
Capital expenditures/Sales	2556	0.07	0.06	0.00	1.28
# of segments	2540	2.75	1.70	1.00	13.00
Firm age	2622	55.43	34.53	0.00	147.00
Firm-years in which insiders other than the CEO sit on the board	2593	0.70	0.46	0.00	1.00
Firm-years in which firm has a President	2593	0.74	0.44	0.00	1.00
Firm-years in which firm has a COO	2593	0.35	0.48	0.00	1.00
CEO tenure as CEO	2257	7.37	7.22	0.00	47.00
CEO=President dummy	2349	0.27	0.44	0.00	1.00
CEO=Chair dummy	2349	0.86	0.34	0.00	1.00
CEO has other title dummy	2349	0.01	0.12	0.00	1.00
CEO=founder dummy	2413	0.09	0.29	0.00	1.00
CEO ownership	2304	0.02	0.05	0.00	0.46
Centralization measure					
Decision-making centralization (DC) index	2349	2.42	1.05	0.00	5.00

Table 2: Frequency distribution of Decision-making centralization (*DC*) index

Table 2 shows frequency distribution of DC index. Sample consists of 2,633 firm-years of data for 336 publicly traded, non-regulated firms from the 1998 Fortune 500 that were available on Execucomp (2000) during the years 1992-1999. Data on titles is constructed from 16,022 executive-years of data for these 336 firms during the years 1992-1999. All title data is from Execucomp (2000). Founder data is collected from a variety of sources consisting of proxy statements, annual reports and the internet. Observations vary because of missing data. We define DC index to be the sum of $i_{noiob}, i_{nopres}, i_{nocoo}, i_{president}, i_{other}, i_{chair}, i_{founder}$ where i_{noiob} in a given year is equal to 1 if no executive mentioned in the firm's executive compensation table except the CEO sits on the board in that year, i_{nopres} (i_{nocoo}) is equal to 1 in a given year if the firm has no president (COO) amongst the executives mentioned in the compensation table for that year, $i_{president}$ (i_{other} / i_{chair}) is equal to 1 if the CEO is also the president (has any other title/is also the chairman) in that year and $i_{founder}$ is equal to 1 if the current CEO is the founder of the firm.

	Frequency in sample	Percent of sample	Cumulative percent of sample
DC index=0	10	0.43	0.43
DC index=1	552	23.5	23.93
DC index=2	642	27.33	51.26
DC index=3	747	31.8	83.06
DC index=4	383	16.3	99.36
DC index=5	15	0.64	100.00
Total	2349	100.00	

Table 3: Regression of Tobin's *Q* on decision-making centralization (*DC*) index and control variables

Table 3 shows OLS regressions of Tobin's *Q* levels on *DC* index plus controls. Sample consists of 2,633 firm-years of data for 336 publicly traded, non-regulated firms from the 1998 Fortune 500 that were available on Execucomp (2000) during the years 1992-1999. Most financial data is from Execucomp (2000). Remaining financial data is from Compustat. Firm age is collected from Moody's Manuals (1999), proxy statements and 10-Ks for fiscal 1998. Our proxy for Tobin's *Q* = (book value of assets-book value of equity + market value of equity)/book value of assets.

Table 1 describes the construction of *DC* index. Control variables: CEO ownership is defined as the ratio of the number of shares owned by the CEO after adjusting for stock splits to total shares outstanding. *ROA* =net income before extraordinary items and discontinued operations/book value of assets. Firm age=#years since first date of incorporation. # of segments=# of 2-digit SIC code segments the firm operates in. Regressions vary by sample type. Column I shows a cross-sectional regression estimated on the mean of each variable over the period 1992-1999 for each firm. Column II uses the full panel of observations and includes year dummies. The regressions in both Columns include 1-digit SIC code dummies. Robust t-statistics shown in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable: Tobin's *Q*	
	I	II
DC index	0.003	0.027
	(0.107)	(0.642)
CEO ownership	4.692**	6.395**
	(2.358)	(2.044)
CEO ownership squared	-12.973**	-21.943**
	(-2.191)	(-2.566)
ROA	0.092***	0.209***
	(7.297)	(10.172)
Lagged *ROA*	0.080***	.
	(6.918)	.
Ln(assets)	0.120***	0.042
	(4.302)	(0.945)
Capex/Sales	-0.005	1.071
	(-0.009)	(1.033)
Firm age	-0.002***	-0.002
	(-2.778)	(-1.401)
# segments	-0.079***	-0.060**
	(-5.865)	(-2.335)
Constant	0.008	0.248
	(0.022)	(0.506)
Sample Type	Panel	Cross-section
Year dummies included?	Yes	No
Number of observations	2028	331
R^2	0.468	0.671
F-Statistic	22.070	12.930

Table 4: Heteroscedasticity Tests (Goldfeld-Quandt) for Tobin's Q as a function of DC index and control variables

Table 4 shows the results of using the Goldfeld-Quandt heteroscedasticity test to test whether the variance in performance in centralized firms is greater than in decentralized firms. We test the null hypothesis that the variance in centralized firms is smaller than in decentralized firms against the alternative that it is bigger. We use DC index to partition the sample into centralized and decentralized firms. Table 1 describes the sample and the construction of the variables. For the panel sample we define a firm to be centralized if DC index>2. For the cross-sectional sample we define a firm to be centralized if DC index>2.5. Columns vary by type of model used to construct residuals of Q and by sample type. The full model used to construct residuals is displayed in Table 3: $Q = b_0 + b_1\ DC$ index + b_2 CEO ownership+ b_3 CEO ownership squared+ $b_4\ ROA + b_5$ ln(assets)+ b_6 Capex/sales+ b_7 Firm age+ b_8 # of segments +1-digit SIC code dummies (+ b_9 one period lagged ROA +Year dummies in panel sample). The cross-sectional regression is estimated on the mean of each variable over the period 1992-1999 for each firm.

Sub-sample type	Test Statistic	I	II	III	IV
Centralized	Residual sum of squares of Q	88.42	1288.24	246.06	2704.7
	Degrees of freedom	136	962	171	1394
Decentralized	Residual sum of squares of Q	47.30	859.62	188.25	2229.05
	Degrees of freedom	160	1017	163	1199
F-statistic		1.87	1.50	1.31	1.21
P-value		7.47E-05	1.08E-10	0.04	2.71E-04
Type of model used to create residuals		Full	Full	None	None
Sample Type		Cross-section	Panel	Cross-section	Panel

Table 5: Heteroscedasticity Tests (Glejser and modified Glejser) for Tobin's Q as a function of DC index and control variables, benchmark model.

Table 5 shows the results of using the Glejser and modified Glejser heteroscedasticity tests to test whether the variance in performance in centralized firms is greater than in decentralized firms. Using both the cross-section and the panel we construct residuals $\hat{u}_i$ from the following regression in Table 3: $Q = b_0 +$ b_1 DC index + b_2 CEO ownership + b_3 CEO ownership squared + b_4 ROA + b_5 ln(assets)+ b_6 Capex/sales+ b_7 Firm age+ b_8 # of segments +1-digit SIC code dummies (+ b_9 one period lagged ROA +Year dummies in panel sample). We regress the absolute value and the squares of the residuals from this regression on DC index and controls including CEO ownership, measured by the ratio of the number of shares owned by the CEO after adjusting for stock splits to total shares outstanding, CEO tenure (the number of years since the CEO was appointed CEO) and its square, leverage (long-term debt/assets), firm size (natural log of assets), firm age (# years since first date of incorporation), and # segments (2-digit SIC segments the firm operates in). Table 1 further describes the sample and the construction of the main explanatory variables. Columns vary by functional form for the residuals and sample type. The cross-sectional regression is estimated on the mean of each variable over the period 1992-1999 for each firm. All regressions include 1-digit SIC code industry dummies. All coefficients on CEO tenure, CEO tenure squared and ln(assets) are multiplied by factors of 100, 1000 and 100, respectively. Robust t-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable: $\lvert\hat{u}_i\rvert$	Dependent variable: $\hat{u}_i^2$	Dependent variable: $\lvert\hat{u}_i\rvert$	Dependent variable: $\hat{u}_i^2$
	I	II	III	IV
DC index	0.034*	0.242	0.068***	0.126**
	(1.806)	(1.176)	(2.628)	(2.435)
CEO ownership	1.716**	9.447	0.905	2.604
	(2.594)	(1.589)	(0.813)	(0.959)
CEO tenure	0.150	4.112	0.213	-0.561
	(0.248)	(0.831)	(0.185)	(-0.201)
CEO ten.sq.	-0.031	-1.486	0.113	0.395
	(-0.162)	(-0.918)	(0.278)	(0.424)
Leverage	-0.985***	-4.768***	-0.830***	-2.151**
	(-5.445)	(-4.007)	(-2.724)	(-2.186)
Ln(assets)	4.287**	31.774**	-0.008	3.288
	(2.305)	(2.22)	(-0.003)	(0.530)
Firm age	-0.003***	-0.016***	-0.002**	-0.004*
	(-4.062)	(-2.812)	(-2.192)	(-1.707)
# segments	-0.062***	-0.256***	-0.048***	-0.086**
	(-5.925)	(-3.561)	(-2.751)	(-2.251)
Constant	0.786***	0.896	0.500	1.006
	(3.041)	(0.39)	(0.307)	(0.635)
Sample Type	Panel	Panel	Cross-section	Cross-section
Year Dummies?	Yes	Yes	No	No
# Observations	1953	1953	320	320
R^2	0.157	0.057	0.193	0.124
F-Statistic	7.49	2.63	9.86	3.76

Table 6: Heteroscedasticity Tests (Glejser and modified Glejser) for Tobin's Q as a function of DC index and control variables, full model.

Table 5 shows the results of using the Glejser and modified Glejser heteroscedasticity tests to test whether the variance in performance in centralized firms is greater than in decentralized firms. Using both the cross-section and the panel we construct residuals $\hat{u}_i$ from the following regression in Table 3: $Q = b_0 +$ b_1 DC index + b_2 CEO ownership + b_3 CEO ownership squared + b_4 ROA + b_5 ln(assets)+ b_6 Capex/sales+ b_7 Firm age+ b_8 # of segments +1-digit SIC code dummies (+ b_9 one period lagged ROA +Year dummies in panel sample). We regress the absolute value and the squares of the residuals from this regression on DC index and controls including CEO ownership (the ratio of the number of shares owned by the CEO after adjusting for stock splits to total shares outstanding) and its square, CEO tenure (the number of years since the CEO was appointed CEO) and its square, leverage (long-term debt/assets), ROA (net income before extraordinary items and discontinued operations/book value of assets) and its first lag, firm age (#years since first date of incorporation), # of segments (the number of 2-digit SIC segments the firm operates in), and Capex/Sales (capital expenditures divided by sales) . Table 1 further describes the sample and the construction of the main explanatory variables. Columns vary by functional form for the residuals and sample type.The cross-sectional regression is estimated on the mean of each variable over the period 1992-1999 for each firm. All regressions include 1-digit SIC code industry dummies. All coefficients on CEO tenure, CEO tenure squared and ln(assets) are multiplied by factors of 100, 1000 and 100, respectively. Robust t-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable: $\lvert\hat{u}_i\rvert$	Dependent variable: $\hat{u}_i^2$	Dependent variable: $\lvert\hat{u}_i\rvert$	Dependent variable: $\hat{u}_i^2$
	I	II	III	IV
DC index	0.041**	0.289	0.147***	0.072***
	(2.148)	(1.317)	(2.633)	(2.914)
CEO ownership	6.124***	38.702*	15.105***	6.827***
	(3.299)	(1.648)	(4.016)	(4.315)
CEO tenure	-0.428	0.470	-2.916	-0.858
	(-0.788)	(0.131)	(-0.977)	(-0.797)
CEO ten.sq.	0.024	-1.199	0.587	0.216
	(0.138)	(-0.795)	(0.692)	(0.612)
Leverage	-0.584***	-2.045*	-0.722	-0.393
	(-3.225)	(-1.830)	(-1.026)	(-1.217)
Ln(assets)	4.259**	35.282**	1.567	-0.706
	(2.161)	(2.055)	(0.222)	(-0.259)
Firm age	-0.002***	-0.013***	-0.003	-0.002*
	(-3.534)	(-2.654)	(-1.535)	(-1.833)
# segments	-0.052***	-0.184***	-0.046	-0.035*
	(-4.598)	(-3.052)	(-1.208)	(-1.853)
CEO own.sq.	-17.628***	-116.916	-48.033	-22.047***
	(-3.161)	(-1.641)	(-3.648)	(-4.907)
ROA	0.005	0.023	0.064	0.043
	(0.435)	(0.334)	(0.646)	(0.872)
Lagged ROA	0.020	0.145**	0.027	-0.014
	(2.087)**	(2.292)	(0.199)	(-0.262)
Capex/Sales	0.089	-2.560	0.559	0.551
	(0.251)	(-0.962)	(0.369)	(0.831)
Constant	0.386	-1.947	-0.770	0.023
	(1.155)	(-0.546)	(0.796)	(0.325)
Sample Type	Panel	Panel	Cross-section	Cross-section
Year Dummies?	Yes	Yes	No	No
# Observations	1953	1953	320	320
R^2	0.183	0.077	0.201	0.274
F-Statistic	6.97	2.40	1.62	5.86

Table 7: Heteroscedasticity Tests (Glesjer and modified Glejser) for monthly stock returns as a function of DC index and controls

Table 7 shows the results of using the Glejser and modified Glejser heteroscedasticity tests to test whether the variance in performance (as measured by monthly stock returns (SR)) in centralized firms is greater than in decentralized firms. We use both a panel and a cross-sectional samples. To perform the panel tests we construct the residuals $\hat{u}_i$ from the market model: $SR_{it} = \beta_i MR_t + u_{it}$, where SR denotes monthly stock returns, MR denotes the value-weighted market return and t ranges from 1992-1999. To perform the cross-section tests we construct the residuals for each firm as the difference between the average stock return for the firm in the period, and the average market return multiplied by the firm's beta: $u_i = \overline{SR_i} - \beta_i \overline{MR}$. We regress the absolute value and the squares of the residuals u_{it} in the panel, and u_i in the cross-section on DC index and controls that may explain variation in firm performance. Control variables: CEO ownership is defined as the ratio of the number of shares owned by the CEO after adjusting for stock splits to total shares outstanding, CEO tenure is the number of years since the CEO was appointed CEO. Leverage=long-term debt/assets. Firm age=#years since first date of incorporation, # of segments=the number of 2-digit SIC segments the firm operates in. Table 1 further describes the sample and the construction of the main explanatory variables. Columns vary by functional form for the residuals. All regressions include 1-digit SIC code industry dummies and year dummies. All coefficients on DC index, CEO ownership, CEO tenure, CEO tenure squared, leverage, ln(assets), firm age, # of segments and the constant are multiplied by factors of 100, 100, 1000, 10000, 100, 100, 1000, 100 and 100, respectively. Since all control variables are measured yearly, we adjust the variance estimates for non-independence within firm-year in the panel regressions. Robust t-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable: $\hat{u}_i^2$		Dependent Variable: $\lvert\hat{u}_i\rvert$	
	I	II	III	IV
DC index	0.053***	0.003	0.183***	0.105**
	(3.347)	(1.534)	(3.679)	(2.104)
CEO ownership	1.079***	0.095*	6.055***	2.098
	(2.738)	(1.842)	(4.490)	(1.499)
CEO tenure	0.039	0.002	0.110	-0.022
	(0.621)	(0.280)	(0.610)	(-0.113)
CEO tenure squared	-0.035*	-0.002	-0.116**	-0.028
	(-1.957)	(-1.082)	(-2.102)	(-0.492)
Leverage	0.275**	-0.010	1.163***	-0.381
	(2.031)	(-0.942)	(2.616)	(-1.037)
Ln(assets)	-0.130***	-0.002*	-0.485***	-0.066
	(-8.493)	(-1.893)	(-9.188)	(-1.631)
Firm age	-0.042***	-0.002***	-0.155***	-0.050***
	(-6.309)	(-3.431)	(-8.187)	(-3.495)
# segments	-0.020*	-0.001	-0.148***	-0.027
	(-1.724)	(-1.342)	(-4.698)	(-1.018)
Constant	2.394***	0.028*	12.474***	1.611***
	(9.984)	(1.926)	(15.170)	(3.669)
Sample Type	Panel	Cross-Section	Panel	Cross-Section
Year Dummies Included?	Yes	No	Yes	No
Number of Observations	24936	321	24936	321
R^2	0.057	0.194	0.089	0.181
F-Statistic	20.600	2.050	41.490	2.960

Table 8: Heteroscedasticity Tests (Glejser and modified Glejser) for *ROA* as a function of *DC* index and controls

Table 8 shows the results of using the Glejser and modified Glejser heteroscedasticity test to test whether the variance in performance in centralized firms is greater than in decentralized firms. Using both the cross-section and the panel we construct residuals $\hat{u}_i$ from the following regression: $ROA = b_0 + b_1\ DC$ index + b_2 CEO ownership+ b_3 CEO ownership squared+ b_4 ln(assets)+ b_5 Capex/sales+ b_6 Firm age+ b_7 # of segments +1-digit SIC code dummies (+Year dummies in panel sample). We regress the absolute value and the squares of the residuals from this regression on *DC* index and controls that may explain variation in firm performance. Control variables: CEO ownership is defined as the ratio of the number of shares owned by the CEO after adjusting for stock splits to total shares outstanding, CEO tenure is the number of years since the CEO was appointed CEO. Leverage=long-term debt/assets. Firm age=#years since first date of incorporation. Table 1 further describes the sample and the construction of the main explanatory variables. Columns vary by functional form for the residuals and sample type. The cross-sectional regression is estimated on the mean of each variable over the period 1992-1999 for each firm. All regressions include 1-digit SIC code industry dummies. All coefficients on CEO tenure are multiplied by a factor of 100. Robust t-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable: $\hat{u}_i^2$		Dependent Variable: $\lvert\hat{u}_i\rvert$	
	I	II	III	IV
DC index	2.460	0.573	0.056	0.049
	(1.512)	(0.347)	(0.730)	(0.313)
CEO ownership	93.663	75.731	7.387***	8.284
	(1.340)	(1.230)	(2.844)	(1.544)
CEO tenure	-0.296	-0.620	-0.023	-0.047
	(-0.315)	(-1.198)	(-0.731)	(-0.932)
CEO tenure squared	0.218	0.925	-0.006	0.073
	(0.069)	(0.659)	(-0.061)	(0.527)
Leverage	1.405	-57.487***	-2.418**	-3.465**
	(0.034)	(-2.656)	(-2.428)	(-2.186)
Ln(assets)	-4.330	2.288*	0.033	0.203
	(-1.310)	(1.687)	(0.358)	(1.602)
Firm age	-0.165**	-0.088	-0.010***	-0.008*
	(-2.333)	(-1.487)	(-3.504)	(-1.812)
# segments	-4.553***	-2.661***	-0.297***	-0.316***
	(-3.655)	(-2.888)	(-6.419)	(-3.420)
Constant	44.704*	48.265**	3.238***	6.615***
	(1.779)	(2.477)	(2.711)	(4.440)
Sample Type	Panel	Cross-Section	Panel	Cross-Section
Year Dummies Included?	Yes	No	Yes	No
Number of Observations	2089	320	2089	320
R^2	0.034	0.134	0.075	0.160
F-Statistic	5.600	11.180	7.880	12.520

Table 9: Cross-sectional regression of standard deviations of Tobin's Q, Monthly Raw and Residual Stock Returns (SR) and ROA over the 1993-1999 period on decision-making centralization (DC) index and control variables in 1993 and averaged over the 1992-1999 period

Table 9 shows cross-sectional OLS regressions of the standard deviation in performance measures computed for each firm over 1993-1999 period on DC index plus controls measured in 1993 as well as on DC index plus controls averaged over the 1992-1999 period.Table 1 describes the sample and the construction of DC index. Our proxy for Tobin's Q is (book value of assets-book value of equity + market value of equity)/book value of assets. ROA=net income before extraordinary items and discontinued operations/book value of assets. Control variables: CEO ownership is defined as the ratio of the number of shares owned by the CEO after adjusting for stock splits to total shares outstanding. CEO tenure is the number of years since the CEO was appointed CEO. Leverage=long-term debt/assets. Firm age=#years since first date of incorporation, # of segments=the number of 2-digit SIC segments the firm operates in. Regressions vary by dependent variable, regressors and sample type. In Columns I-II the dependent variable is the standard deviation of Tobin's Q over 1993-1999. In Columns III and IV the dependent variable is the standard deviation of ROA over 1993-1999. In Columns V-VI (VII-VIII) the dependent variable is the standard deviation of raw (residual) monthly stock returns (SR) over 1993-1999. We construct the residual stock returns $\hat{u}_i$ from the market model: $SR_{it} = \beta_i MR_t + u_{it}$, where SR denotes monthly stock returns, MR denotes the value-weighted market return and t ranges from 1992-1999. Cross-sectional ('Average') regressions are estimated on the mean of each independent variable over 1992-1999. In the regressions for 1993, all independent variables are measured in 1993. The regressions in all Columns include 1-digit SIC code dummies. All coefficients on CEO tenure, CEO tenure squared and firm age are multiplied by factors of 100, 1000 and 10, respectively. Robust t-statistics are shown in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Dep. Var.: $sd(Q)$		Dep. Var.: $sd(ROA)$		Dep. Var.: $sd(SR)$ (raw)		Dep. Var.: $sd(SR)$ (resid.)	
	I	II	III	IV	V	VI	VII	VIII
DC index	0.056	0.064	0.607***	0.321**	0.004**	0.003*	0.004**	0.002*
	(1.082)	(1.454)	(3.274)	(2.307)	(2.512)	(1.861)	(2.533)	(1.766)
CEO ownership	2.650*	4.329	3.029	5.151	0.088**	0.044	0.090**	0.045
	(1.706)	(1.499)	(0.734)	(0.893)	(2.416)	(1.232)	(2.551)	(1.341)
CEO tenure	2.397*	1.339	-6.326	1.510	-0.006	-0.015	-0.037	-0.037
	(1.617)	(0.985)	(-0.968)	(0.328)	(-0.084)	(-0.318)	(-0.500)	(-0.864)
CEO ten.squared	-0.866*	-0.726	1.289	-0.555	-0.019	-0.003	-0.011	0.004
	-(1.759)	-(1.627)	(0.554)	(-0.393)	(-1.053)	(-0.234)	(-0.650)	(0.279)
Leverage	-1.732***	-1.018***	-1.275	-1.784*	0.005	0.012	0.008	0.010
	(-5.259)	(-2.619)	(-0.991)	(-1.654)	(0.383)	(1.222)	(0.592)	(1.064)
Ln(assets)	0.052*	0.005	-0.358**	-0.103	-0.010***	-0.007***	-0.011***	-0.007***
	(1.820)	(0.127)	(-2.103)	(-0.719)	(-6.048)	(-5.364)	(-6.339)	(-5.472)
Firm age	-0.032***	-0.029**	0.005***	-0.014	-0.002***	-0.002***	-0.002***	-0.002***
	(-2.899)	(-2.030)	(0.080)	(-0.220)	(-4.566)	(-3.462)	(-4.443)	(3.299)
# segments	-0.065***	-0.060***	-0.318***	-0.203**	-0.001	-0.001	-0.001	-0.001*
	(-3.207)	(-3.564)	(-2.927)	(-2.373)	(-0.609)	(1.103)	(-0.724)	(-1.708)
Constant	0.485	0.160	6.054***	3.365	0.155***	0.148***	0.156***	0.147***
	(1.172)	(0.199)	(3.735)	(1.572)	(8.226)	(8.581)	(8.494)	(8.921)
Sample Type	Averaged	1993	Averaged	1993	Averaged	1993	Averaged	1993
# Observations	321	258	321	258	321	258	321	258
R^2	0.248	0.29	0.149	0.115	0.421	0.412	0.432	0.420
F-Statistic	3.640	3.23	2.04	2.71	13.570	12.590	13.600	14.860

Figure 1: Best and worst performances and centralization

Figure 1 shows plot of residuals $\hat{u}_i$ for centralized and decentralized firms. Residuals $\hat{u}_i$ are obtained from the following regression in Table 3: $Q = b_0 + b_1\ DC$ index + b_2 CEO ownership+ b_3 CEO ownership squared+ $b_4\ ROA + b_5$ ln(assets)+ b_6 Capex/sales+ b_7 Firm age+ b_8 # of segments +1-digit SIC code dummies, where all variables are averaged over the 1992-1999 time period. We categorize firms as centralized if DC index is in the 5th quintile. We categorize firms as decentralized if DC index is in the 1st quintile.