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Corporate Capital Budgeting and CEO Turnover

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ABSTRACT

When a firm has minimal agency and informational asymmetry problems, it should make efficient capital budgeting decisions. Many firms over-invest prior to CEO turnover, halt investments in the period surrounding the turnover, and then greatly increase their level of expenditures. Empirical analysis of the cross-sectional and inter-temporal variation in the quality of firms' corporate capital budgeting decision reveals that the impact of CEO turnover is asymmetric between under- and over-investing firms, and this complements the larger literature using average firm-wide performance measures. Firms are more likely to have forced turnovers when there is more over-investment prior to the turnover, and these firms make more efficient investment decisions subsequently. Board influence is largely insignificant prior to a CEO turnover but is consistently associated with higher levels of investment subsequently.

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1. INTRODUCTION

Managers, and CEOs in particular, can significantly influence corporate behavior and performance. In pioneering research, Bertrand and Schoar (2003) provide evidence of managerial "style," whereby managers that transition across firms have a direct, measurable impact on firm performance and a wide range of corporate policies. Many studies have found strong complementary evidence that the quality of a firm's performance varies markedly before and after a CEO turnover (e.g., Jenter and Kanaan, 2010; Huson et al., 2001; Huson et al., 2004; etc.). Huson et al. (2004) find that firms experience higher operating returns on assets in the three years following CEO turnovers, with these returns increasing more for firms with higher levels of institutional ownership and more independent boards of directors. Studies such as these generally use as dependent variables average firm-wide performance measures such as average Tobin's Q or operating returns on asset. These measures are useful top-down perspectives on the overall aggregated quality of a firm's investments, but do not shed light on the marginal investment decisions undertaken by the firm.

When a firm has good managers who are properly incentivized and monitored, agency problems should be minimized and a firm should use resources as effectively as possible. Corporate capital budgeting decisions should be most efficient when agency and informational asymmetry problems are minimized (Jensen, 1986; Shleifer and Vishny, 1989; Greene et al., 2009), which is often when a firm has particularly strong internal communication channels (Hornstein and Zhao, 2011). CEO turnover may reflect the presence of agency or informational asymmetry problems, and thus be associated with discrete changes in the functioning of internal communication channels. Intensified agency and informational asymmetry problems may cause a CEO to anticipate their departure is imminent, and thus induce a myopic bias that leads to the

CEO attaching a higher weight to short-term firm performance. This might cause the quality of corporate capital budgeting decisions to be less effective as the CEO's departure approaches.

We examine patterns in the efficiency of corporate capital budgeting in the years surrounding CEO turnover. This complements and extends earlier research (e.g., Huson et al., 2004) by exploring how the capital allocation process changes at firms given the firm's prior tendencies to under- or over-invest. Moreover, this empirical framework permits exploration of whether under- and over-investing firms should be examined jointly, as is commonly done, or separately.

If a firm makes efficient capital budgeting decisions, it should invest in all positive-NPV opportunities and bypass all negative-NPV opportunities. Assuming firms always invest in the highest value-added projects first, then there should be a marginal investment project which has an incremental value-added exactly offset by the incremental cost and this would be the optimal final project for a firm to undertake.[1] In this scenario, a firm would have an estimated marginal *q* that deviates little, if at all, from the appropriate tax-adjusted benchmark value. This approach to evaluating capital budgeting was developed by Durnev et al. (2004), refined in Greene et al. (2009), and adopted by Ferreira and Laux (2007) and Siegel et al. (2011), among others.

CEO actions could influence the level and quality of corporate investments and capital budgeting decisions due to idiosyncratic concerns of the individual. For example, the CEO may invest in a wider range of opportunities to maximize shareholder wealth or due to agency problems such as empire building (Jensen, 1986), hubris (Roll, 1986) or overconfidence

[1] Firms routinely make investment decisions that directly impact the value of total firm assets and that should have a related impact on their market valuation. In practice it is not always easy for a firm to identify the true NPV of an investment, and firms often make multiple investment decisions in short time periods. When the capital markets are efficient and well-informed, the changes in firm assets and valuation should occur contemporaneously as soon as the change in firm assets is disclosed.

(Malmendier and Tate, 2008). Alternatively, the CEO may decline investment opportunities again out of a belief that it is best for shareholder wealth maximization or due to other agency problems such as reputational concerns (e.g., Hirshleifer and Thakor, 1992) or shirking (e.g., Hirshleifer and Suh, 1992; Holmstrom and Weiss, 1985). There are competing explanations for why the quality of a firm's capital budgeting decisions may vary around the time of CEO turnover. These theories are tested empirically in this paper.

The univariate data indicate that on average firms appear to invest more heavily in the CEO's earlier years and slow down investments in the years leading up to the CEO turnover before beginning a slow, steady increase in investments. This yields inter-temporal variation in estimated marginal *q*. The empirical analysis of the quality of a firm's capital budgeting decisions reveals that firms have sharply improved asset allocation when agency problems are minimized. For example, agency problems are lower after a forced departure and when an entrenched manager is replaced.

The results reveal that under- and over-investing firms should be analyzed separately as the impact of firm characteristics and board governance is not constant across the groups. The inter-temporal analysis reveals that boards take time to effect change, and that CEO turnover often trails the periods of less efficient capital budgeting decisions by several years, consistent with Jenter and Lewellen (2010).

Section 2 presents the model and empirical methodology. The data and variables are discussed in Section 3. Empirical results are analyzed in Section 4. Finally, Section 5 concludes.

2. MODEL AND EMPIRICAL METHODOLOGY

The value of a firm's marginal investment can be assessed using marginal *q*, which is the ratio of the unanticipated incremental change in firm market value divided by the contemporaneous marginal investment. Thus, an optimal capital budgeting process would be one where a firm invests until the last investment generates a marginal *q* of 1.0. A positive (negative) deviation of estimated marginal *q* from 1.0 would thus reflect under- (over-) investment. Exogenous factors such as taxes, however, may affect the capital budgeting process and cause the optimal benchmark marginal *q* to differ systematically from the theoretical benchmark of 1.0.[2]

2.1 Marginal q *estimation*

The empirical approach for estimating marginal *q* was developed by Durnev et al. (2004) and extended by Greene et al. (2009) to use random coefficients.[3] If the marginal investor in a firm faces capital gains and dividend taxes of T_{CG} and T_D then firm *i*'s marginal *q* is defined as the tax-adjusted ratio of unanticipated change in firm value to the contemporaneous unanticipated change in firm assets, or:

$$\dot{q}_i = \frac{(1-T_{CG})(V_{i,t} - E_{t-1}V_{i,t})}{(1-T_D)(A_{i,t} - E_{t-1}A_{i,t})} = \frac{(1-T_{CG})\left[V_{i,t} - V_{i,t-1}\left(1+\hat{r}_{i,t} - \hat{d}_{i,t}\right)\right]}{(1-T_D)\left[A_{i,t} - A_{i,t-1}\left(1+\hat{g}_{i,t} - \hat{\delta}_{i,t}\right)\right]}. \qquad [1]$$

$V_{i,t}$ is the market value of firm *i* at time *t*, and $A_{i,t}$ is the total assets of firm *i* at time *t*. E_{t-1} is the expectations operator, which uses all information available to the firm at time *t-1*. We substitute

[2] Marginal *q* is distinct from average Tobin's Q, which reflects market perceptions of firm value. Average Q is the ratio of firm market value to the replacement value of firm assets. If firms have no agency problems then marginal and average Q may yield different interpretations of the impact of corporate leadership. For example, a manager may over-invest as part of empire building, leading to a marginal *q* that is less than the appropriate benchmark. However, if the market does not yet recognize that this was a duplicative or superfluous investment, then the market may reward the firm with a higher stock price and thus an increased average Q.

[3] The efficiency gains of the Greene et al. (2009) approach are outlined in Greene and Hornstein (2012).

for the expectations operator using $\hat{r}_{i,t}$, the expected return from owning the firm and disbursements to investors; $\hat{d}_{i,t}$, the expected level of disbursements from the firm (dividends, share repurchases, and interest expenses); $\hat{g}_{i,t}$, the rate of expected expenditures on capital goods; and $\hat{\delta}_{j,t}$, the expected rate of depreciation of the firm's assets. The firm's value (*V*) and assets (*A*) are estimated as per Durnev et al. (2004).

When [1] is rearranged so that marginal *q* is expressed as a coefficient, the empirical specification becomes:

$$\frac{\Delta V_{i,t}}{A_{i,t-1}} = \beta_{0,i} + \beta_{1,i}\frac{\Delta A_{i,t}}{A_{i,t-1}} + \beta_{2,i}\frac{V_{i,t-1}}{A_{i,t-1}} + \beta_{3,i}\frac{D_{i,t-1}}{A_{i,t-1}} + \delta_t P_t + u_{i,t} \qquad [2]$$

where $D_{i,t-1}$ (or $d_{i,t}V_{i,t-1}$) is disbursements to investors, including dividends, share repurchases, and interest expenses. A series of year fixed effects, P_t, are also included to reflect macroeconomic factors that may affect all firms or cause marginal *q* to be estimated less accurately in some years.[4] All four coefficients in [2] may reflect firm heterogeneity and are estimated in the random coefficient model as $\hat{\beta}_j = \beta + \nu_{i,j}$, where *j* denotes the coefficient number (0…3). This yields an estimate and variance for each coefficient, $\hat{\beta}_j$, and a series of firm-specific estimates of each coefficient, $\hat{\beta}_{i,j}$. The coefficient $\hat{\beta}_{1,i}$ is firm *i*'s marginal *q* times the relevant tax factors or $\dot{q}_i \cdot \left(\frac{1-T_D}{1-T_{CG}}\right)$. The estimated values of marginal *q* are then used to form the dependent variables for the second-round testing.

[4] For example, Jenter and Kanaan (2010) find that CEOs are more likely to be dismissed from their jobs after poor industry or market performance.

Using representative tax rates from the 1990s, the personal tax on disbursements, T_D, is approximately 33%; and the effective personal gains tax rate, T_{CG}, is about 14% (or half of the statutory rate of 28%, assuming that the marginal investor is tax-exempt half the time). This implies that the estimated marginal *q* should be approximately 0.78 times the theoretical optimal value of 1.0. Durnev et al. (2004) used a non-linear technique to estimate the benchmark marginal *q* to be in the range 0.755-0.780, consistent with the estimated benchmark based on representative tax rates used herein. The deviation of a firm's estimated marginal *q* from this benchmark value is used as an indicator of the efficiency of the firm's capital budgeting decisions. More generally, during this period the marginal investor would have faced higher effective tax rates on dividends than on capital gains, and the upper bounds on T_D and T_{CG} were 33% and 28%, respectively. A reasonable range of the tax-adjusted benchmark marginal *q* is therefore 0.78 to 1.00. Accordingly, all empirical tests are conducted using both estimated benchmark marginal *q*'s, 0.78 and 1.00, which are denoted herein as *h*.

2.2 Marginal q *analysis*

To motivate our analysis of how the quality of a firm's corporate capital budgeting decisions might vary across time, we begin by exploring three representative scenarios of how agency and informational asymmetry problems could result in systematic changes in the quality of the firm's corporate capital budgeting decisions.

First, managerial tenure may serve to entrench an individual and thus insulate that individual from the ramifications of poor investment decisions. If this is the case, then the quality of a firm's corporate capital budgeting decisions should markedly change as soon as this individual's departure can be reasonably anticipated. This would manifest itself as a higher

estimated marginal q but not necessarily as a reduced deviation of marginal q from the appropriate benchmark. In related work Dezsö (2007) finds that the increase in operating returns on assets post-turnover reflects improved management and is not an artifact of mean reversion, and that this largely stems from forced turnovers as opposed to voluntary CEO departures such as retirements. We inject nuance into the interpretation of Dezsö (2007) by showing that the impact of improved management is asymmetric across the under- and over-investing samples.

The second scenario begins with the premise that CEOs with high levels of general managerial skills may have greater levels of reputational capital and more promising outside employment opportunities. Such CEOs could thus exhibit less opportunistic behavior and encourage their firms to adopt more conservative investment practices (Hirshleifer and Thakor, 1992). Managerial myopia can lead to under-investment in activities that are difficult to observe, and could amplify the tendency towards conservatism (Stein, 2003). On the other hand, such CEOs might believe that their individual decisions are less easily observed, and that they must therefore undertake bigger investments in order to gain market credibility. This would lead the firm to undertake more investments, including possibly diversifying the firm into new sectors or locations (Amihud and Lev, 1981; Rose, 1992). The first argument suggests that generalist CEOs should run firms with higher estimated marginal q's while the second posits the reverse. This yields a composite hypothesis: CEOs with greater firm-specific knowledge may be associated with firms that have estimated marginal q's that deviate less from the appropriate benchmark. To the extent that firm-specific knowledge is gained through hands-on experience, CEO tenure at the firm can effectively proxy for their stock of firm-specific knowledge. We are therefore able to test empirically this hypothesis.

The final scenario is somewhat of a contingency perspective in that it might be observed only if a CEO is more powerful.[5] Powerful CEOs maintain more opaque information environments and their firms face higher cost of debt (Liu and Jiraporn, 2010) and have lower firm value (Bebchuk et al., 2009). More powerful CEOs may engage in larger mergers and acquisitions, which are viewed negatively by the stock market (Grinstein and Hribar, 2004). Adams and Ferreira (2007) find that more powerful CEOs have less need to compromise with other executives, leading to greater variability in firm outcomes. This suggests that firms with more powerful CEOs may have less efficient corporate capital budgeting decisions and that this would be due to over-investment.[6] In this scenario, the firm may then have a higher estimated marginal *q* post-turnover as the incoming CEO would presumably assume office with less political capital and might review, and possibly curtail, some investments begun by the predecessor.

Separate analyses are conducted on firms that under- and over-invest, depending on whether $(\hat{q}_i - h)$ is above or below zero; $(\hat{q}_i - h)^+$ and $(\hat{q}_i - h)^-$ are used as dependent variables in the two sub-samples, respectively. Thus, we examine the relation between the extent of under- or over-investment and the firm's characteristics using a truncated regression:

$$\left.\begin{matrix}(\hat{q}_i - h)^+ \\ (\hat{q}_i - h)^- \end{matrix}\right\} = \alpha + \lambda X_i + \eta C_i + \omega I_{SIC} + \varepsilon_i \qquad [3]$$

where ***X*** represents the various CEO characteristics, and ***C*** represents the firm-level control variables. I_{SIC} are industry fixed effects that capture each firm's primary two-digit SIC code.

[5] Bebchuk et al. (2011b) propose that the CEO pay slice, or the fraction of total compensation awarded the top-five executive team that goes to the CEO, can proxy for the relative power of the CEO vis-à-vis top colleagues.
[6] Siegel et al. (2011) report complementary evidence that firms engaging in acquisitions in countries with more egalitarian cultures markedly over-invest.

Finally, we assume that the disturbance term, ε_i, is normally distributed with zero mean and constant variance σ^2. All observations are weighted by the inverse of the standard error associated with the estimated marginal *q* as in Saxonhouse (1976) and Greene et al. (2009). Since the truncated variance is between 0 and 1, the marginal effect of each variable may be smaller than that of the corresponding coefficient (Greene, 2003). As *h* can assume either of two values, 0.78 or 1.00, [3] is estimated four times for each set of independent variables – i.e., for the under- and over-investing sub-samples defined relative to 0.78 and 1.00. Efficient capital budgeting will be associated with an estimated marginal *q* that converges to the level of the benchmark marginal q, either 0.78 or 1.00. Thus, the implicit comparison group in this study is the set of all firms in the market that are not explicitly included in the sample.

To identify the impact of CEO turnovers on corporate capital budgeting decisions either of two approaches could be employed. The first approach identifies inter-temporal variation in the influence of CEOs on the quality of a firm's capital budgeting decisions. For example, an entrenched CEO may have engaged in empire-building (Jensen, 1986) and thus led the firm to have a lower estimated marginal *q*. The newly appointed CEO may decide to review proposed investments that have not yet been fully funded, leading to a higher estimated marginal *q* for the firm. Then, after the new CEO has acclimated to the firm and gained a good working relationship with the board of directors, the firm may increase its investments and thus see marginal *q* decrease. Alternatively, an incumbent CEO who does not get along well with the board of directors may have trouble making investments. Thus, such a firm might have a lower level of spending prior to the CEO turnover. The new CEO may enjoy a more harmonious relationship with the board and be able to engage in numerous investments. This CEO would then see the company have a lower estimated marginal *q* immediately upon taking office. This approach

would require estimation of marginal *q* for different windows surrounding the time of the CEO departure. The second stage estimation would involve examination of the efficiency of the firm's capital budgeting decisions as explained by various firm characteristics. Variables that capture the nature of the CEO transition might not be included as independent variables in this analysis.

The second approach examines the nature of corporate capital budgeting decisions only during the period of the CEO turnover. The empirical model would include characteristics of the CEO's departure (e.g., voluntary vs. forced) as well as attributes of both the incumbent and successor CEO. This would permit identification of which characteristics of the CEOs have an impact on the firm's capital budgeting decisions. This approach requires estimation of a marginal *q* centered on the turnover year. In the second stage we could examine how the deviations of this estimated marginal *q* from the appropriate benchmark are affected by inclusion of variables that capture the CEO turnover and characteristics of the incumbent or successor CEO. This approach would allow identification of the immediate impact of the turnover.

Both approaches have merit, and so both rounds of analysis are conducted and reported herein. They should yield complementary evidence regarding the relationship between corporate capital budgeting decisions and CEO turnover. The empirical analysis used herein allows identification of whether the efficiency of a firm's capital budgeting is associated with specific firm and CEO characteristics but does not identify the precise causal channel. On the other hand, by employing the sliding ruler approach, examining trends in estimated coefficients across periods may shed light on whether the nature of this relationship changes in the years surrounding a CEO turnover. If there are such changes, they could be loosely interpreted as causal.

3. DATA AND VARIABLES

The sample, data sources, marginal q estimation procedure, and dataset construction are discussed in this section.

The period of CEO turnovers is 1992-2002. Thus, the firm-level variables are estimated using data that begins in 1989 so that the first window would begin three years before the first CEO turnover. Since the last CEO turnover is in 2002, the dataset ends in 2005 to allow the last window to end three years after the turnover. The marginal q estimates, which form the basis of the dependent variable in the second-stage regressions, are obtained using data from 1989-2005; and the independent variables in the second-stage regression, firm and CEO characteristics, use data for the years 1989-2004. The dataset consists of those firm-year observations that could be matched across the CRSP/Compustat Merged Database (Compustat), CRSP Daily Stocks Database (CRSP), and the CEO turnover dataset compiled by Jenter and Kanaan (2010) and subsequently merged with that of Peters and Wagner (2010). The Jenter and Kanaan (2010) and Peters and Wagner (2010) dataset includes 1,294 turnovers from 1992-2002 and we retain 766 of these after cleansing the Compustat data and then matching that data to the turnover sample.

The construction of the CEO dataset is described in detail by Jenter and Kanaan (2010), and the classification of forced turnovers where the incumbent CEO's departure is not voluntary follows the Parrino (1997) process. Observations are excluded if the CEO turnover stemmed from a corporate takeover or merger, involved a subsidiary of another firm, or if there were co-CEOs. In instances where there was clearly an interim CEO, the second turnover is discarded from the dataset as the first turnover reflects the corporate transition that we are interested in

examining. We define as interim CEOs those CEOs who hold their position for no more than two years.[7]

Marginal *q* estimation requires reliable estimates of a firm's market value and assets. To ensure that the corporate accounting data used to estimate and analyze marginal *q* are stable, and that noisy or extreme values are excluded, several sample filters are employed. First, only firms that are not in finance, insurance and real estate (i.e., SIC codes 6000-6999) and have tangible assets of at least $1 million are included. Second, when Compustat reports a value as 'insignificant' it is reset to be zero. Third, entries for preferred stock, class B stock, and the like are discarded by excluding entries whose CRSP CUSIP issue number begins with numbers other than 10 or 11. Next, we exclude all firm-year observations when a firm's estimated average Tobin's Q was below 0.0 or above 5.0. Also excluded are firm-year observations in which the firm's value, total assets, or tangible assets changed by more than 300% in absolute value.

Our dataset is larger than that of Gao et al. (2012) who started with the same CEO turnover dataset and ended up with a sample of 388 CEO turnovers and is nearly half the size of the dataset collected by Hazarika et al. (2012). Despite the vast differences in dataset sizes, the dataset used herein appears to be qualitatively similar to the datasets used in Gao et al. (2012) and Hazarika et al. (2012) which are both contemporaneous with this paper.

3.1 The quality of corporate capital budgeting

Since marginal *q* is estimated using year-on-year changes in firm value and firm assets, a minimum of two observations per firm are needed to obtain an estimate of marginal *q* as

[7] Dezsö (2007) and Huson et al. (2001) define interim as one year as their key variables are measured in levels and thus they need a minimum of one year's worth of data for their empirical analysis. As marginal *q* estimation requires data be measured in changes, a minimum of two years of data are needed. Thus, an interim CEO is defined herein as a CEO who held the position for less than two years.

Equation [2] is estimated using random coefficients.[8] It is appropriate to evaluate the efficiency of a firm's average capital budgeting decisions through the use of a single estimated marginal *q* for a period of time as the true marginal capital budgeting decision cannot be identified (Durnev et al., 2004; Greene et al., 2009; Hornstein and Zhao, 2011). Thus, the question is what is the minimum number of observations that needs to be used to estimate marginal *q*. There is an intrinsic tradeoff between period length and precision of the marginal *q* estimation such that when fewer years of data are used to estimate marginal *q* in order to increase the breadth of our data sample, then the marginal *q* estimates have a larger standard error. However, the second stage estimation is more precise when we use the noisier estimates of marginal *q*.

In the baseline results presented herein, each period contains two consecutive years. As the results are qualitatively similar with windows of 3-5 years, we report herein the results using the two year windows in order to maximize sample size and use longer windows in the robustness tests. This supports the goal of identifying inter-temporal variation in the quality and determinants of corporate capital allocations. Moreover, using multiple overlapping two year windows enables easier comparison of this analysis of corporate capital budgeting decisions in the years surrounding CEO turnovers with the more mature literature on operating returns surrounding CEO turnovers (e.g., Huson et al., 2004) which typically use windows of up to three years. In addition, by studying the seven year period starting three years before CEO turnover and ending three years afterwards, we are examining a total period of time, seven years, that is consistent in length with the finding that the average CEO tenure is now just over six years (Kaplan and Minton, 2011).

[8] Durnev et al. (2004) estimated Equation [2] using OLS and 3-digit industry level data. They required a minimum of 5 observations per industry to obtain estimates of industry marginal *q* with one degree of freedom. They had a maximum of 10 observations per 3-digit SIC code. Greene et al. (2009) and Hornstein and Zhao (2011) required a minimum of 5 observations per firm for use with random parameters estimation of firm's marginal *q* with a very large degrees of freedom.

To examine the impact on the efficiency of a firm's capital budgeting decisions of CEO turnovers, various windows of the firm's history are examined. We explore several overlapping periods that are prior to, concurrent with, and subsequent to the CEO transition. In this way we can identify patterns in corporate capital budgeting where the only change is the time period under consideration. Just as a stock market event study would examine a window (e.g., a five day window of t-2 to t+2), and operating returns on assets are analyzed over a multi-year period (e.g., three years in Huson et al., 2004), we can examine a window surrounding a CEO turnover where our window would be measured in years. We examine six different windows ending in years t-2, t-1, t, t+1, t+2, and t+3, where the CEO turnover occurs in year t, to allow for the possibility that the CEO turnover may be predictable and that related changes may have begun in advance of the turnover. We use a "sliding ruler" to partition each firm's time series into overlapping periods.

The estimates of marginal *q* suggest that most firms are investing at a level that is consistent with theory across time but with some variation in particular periods. The average estimated marginal *q* rises substantially as the firm nears the turnover year, peaks shortly after the turnover and then slowly stabilizes. The average estimated marginal q's range from -3.79 to 6.03 with the most extreme high and low values observed in the period t to t+1. The other recent studies that have also used marginal *q* to measure efficiency of corporate capital budgeting have generally found similar ranges of estimated values for marginal *q* and that more firms over-invested than under-invested (Durnev et al., 2004; Ferreira and Laux, 2007; Greene et al., 2009; Hornstein and Zhao, 2011; Siegel et al., 2011; Faccio et al., 2011). We constrained the data to be centered around a major change of corporate control whereas none of the other studies included such a restriction.

As shown in Table 1, the average estimated marginal *q* rose from 0.89 (standard deviation of 0.43) in the years t-3 to t-2 to peak at 1.13 (s.d., 0.64) in the years t+1 to t+2, and then fell to roughly 0.86 (s.d., of 0.66) in the years t+2 to t+3. These swings show that most firms invest less as the CEO turnover nears and then invest more subsequently. The types of firms that under- and over-invest are fairly similar, as shown in Table 2 Panel A, which suggests that the inter-temporal variation in the level of investment is consistent with rising informational asymmetry problems that make it hard for decision-makers to evaluate properly potential investments, and diminish the efficacy of internal communication channels that would allow decision-makers to obtain relevant information.

[INSERT TABLE 1 HERE]

[INSERT TABLE 2 HERE]

While the extreme estimates of marginal *q* are very different from the theoretical benchmark value of 1.0 and thus more difficult to understand economically, they are included in the sample analysis nonetheless. In the years prior to the turnover the outliers are evenly split between the under- and over-investing samples while the outliers are primarily under-investing firms post-turnover. This suggests that firms with the most inefficient capital budgeting decisions after the CEO turnover are those where corporate investments stalled.

A total of 667 firms with 766 turnovers were present for one or more of the six overlapping time windows, with 414 firms that had 507 turnovers present in all six windows.[9] Of the 766 turnovers, 30 were always classified as under-investing relative to the benchmark estimated marginal *q* value of 1.0 (and 160, or 21%, vs. the benchmark of 0.78) while 102, or 13%, were

[9] All results are robust to use of the balanced panel dataset.

always classified as over-investing relative to the same benchmark value of 1.0 (and 24 vs. the benchmark of 0.78). An additional 27 turnovers are associated with the firms always over-investing in the years prior to the CEO turnover and always under-investing in years t onwards relative to the value of 1.0 (and there were 18 such events if we use the alternative benchmark value of 0.78). Meanwhile 26 turnovers were always associated with firms' under-investing prior to the CEO turnover and always over-investing thereafter relative to the critical values of 1.0 (and there were 20 such turnovers vs. the value of 0.78).

The univariate estimates of marginal *q* reveal two clear trends. First, on average the level of corporate investment is curtailed in the run-up to a CEO transition and then the pace gradually picks up. Second, even among firms that invest more heavily after a CEO turnover, the level is often considerably less than pre-turnover. Accordingly, more of the firms are or become under-investors than the reverse. This suggests that corporate capital budgeting decisions may vary markedly in quality over time, and that agency and information asymmetry problems may be more pronounced in the periods surrounding CEO turnovers when coordination costs may be exacerbated. Firms thus curtail their scope of activity during this period as they wait for leaders to set a clear agenda.

The second trend is the increased dispersion of estimated marginal *q*'s in the years immediately preceding and contemporaneous with the CEO turnover. This suggests that there may be considerable inter-firm variation in planning and managing CEO transitions. To the extent that some firms may "groom" successor CEOs by hiring from within and providing plum assignments to expose the executive to different areas of the firm, we would therefore expect insider CEOs to preside over firms with more efficient capital budgeting allocations. On the other hand, outsiders might arrive at a firm with a fresh set of eyes and with the board's

permission to thoroughly reposition the firm. That would suggest that outsider CEOs might help firms use capital more effectively. The univariate data present a mixed view of this hypothesis. As shown in Panel B of Table 2, the firms that appoint outsider CEOs have estimated marginal *q*'s that do not appear to be markedly different from the firms that appoint insider CEOs. This further motivates our multivariate analysis to ascertain how the CEO impacts decision-making within the firm.

We concede that it is unclear a priori why there is a greater dispersion of estimated marginal *q* from year t onwards but that this dispersion may be of economic importance. A t-test of the estimated marginal *q*'s across periods reveals that each estimated marginal *q* is statistically significantly different from all other estimated marginal *q*'s at the one percent level. Similarly, a t-test of the standard deviation of the estimated marginal *q*'s across periods again reveals that each period's estimate is statistically significantly different from all other estimates at the one percent level. These two rounds of t-tests confirm that there is statistically and economically significant variation in the quality of corporate capital budgeting across time.

[INSERT FIGURE 1 HERE]

3.2 Determinants of corporate capital budgeting

In the second stage analysis, the estimated values of marginal *q* are used to form a dependent variable which captures the quality of a firm's capital budgeting decisions. Three types of independent variables are used in this analysis to identify the determinants of the quality of a firm's corporate capital budgeting decisions. First, there are characteristics of the CEO, second, characteristics of the firm, and, third, the nature of the firm's corporate governance.

A CEO's tenure at the firm may be interpreted in opposing ways. On the one hand, longer tenure could imply that the firm has high levels of firm-specific managerial skills (e.g., Bertrand and Schoar, 2003). However, if a manager acquires too high a level of firm-specific managerial skills, he may have too low a level of general managerial skills and try to entrench himself for labor market security (Aivazian et al., 2010). Antia et al. (2010) propose that CEOs with longer expected tenures have fewer agency problems, which suggests that agency problems are likely to minimized in the year of a CEO's appointment when their expected tenure is longer.

Of the 766 CEO turnover events analyzed, in 22% outsiders are the successors, and 14% of turnovers are forced, of which 5%, or 43% of the forced turnovers, are ones where outsiders took control in forced turnovers. The estimated marginal *q*'s are higher for outsider and forced turnovers in the earliest period, lower in the turnover period, and higher subsequently (Table 2, Panel B). This alone suggests that there may be greater discontinuity of policy and operating culture when a CEO is forced to leave. Moreover, given that the overwhelming majority of turnovers involve insiders, a firm may hire an outsider CEO when the firm is prepared to change directions, which often involves large scale investments. That is consistent with the average estimated marginal *q* being more variable for the firms with outsider CEOs and forced turnovers.

Incumbent CEOs have served an average of 11.1 years at the firm by the time of their departure while successor CEOs have served an average of 9.6 years at the firm at the time of appointment. At those firms that appoint CEOs from within, both the incumbent and successor CEO have served an average of 11.8 and 11.9 years at the firm prior to the turnover, respectively. Thus, firms that hire or promote from within may well attach different weights to particular attributes in their CEO. We therefore include in our empirical analysis CEO

characteristics such as whether the incoming CEO is an outsider, if the turnover is forced, and length of both the incumbent and incoming CEOs' tenure at the firm.

Firm size may greatly impact the ability of a firm to identify promising new investment opportunities as larger firms are more likely to have already invested in profitable opportunities and are therefore more inclined to over-invest (Jensen, 1986). On the other hand, larger firms may have greater internal capital markets and thus face fewer financial constraints that could block the firm from pursuing new, value-added investment opportunities (Lamont, 1997). Larger firms are more likely to have more layers of management, which would suggest more potential for informational asymmetry problems, and that larger firms might have less efficient capital budgeting decisions. However, firms that are larger often develop greater internal communication networks that could mitigate such problems, and these are associated with more effective capital budgeting decisions (Hornstein and Zhao, 2011). The univariate data from Table 2 Panel A show that under-investing firms are generally larger. Firm size is measured as the log of average property, plant and equipment (PPE).

Whether a firm has valuable growth opportunities may influence the timing and the scale of new investments. The presence of such growth opportunities can be proxied by market perceptions of the firm, as embodied in average Tobin's Q. Average Tobin's Q is consistently higher among the under-investing firms (Table 2 Panel A), which suggests that agency problems may be more pervasive at firms that have higher levels of investment. Firms also have higher growth prospects when they appoint an outsider as CEO (Table 2 Panel B), suggesting that the market prices in the possibility of the firm undertaking strategic changes (e.g., Pan and Wang, 2012). Average Q is measured as the ratio of firm value to firm assets as per the definitions from Durnev et al. (2004).

A firm can carry out new investments if and only if it has strong financing capabilities. Firms that have low cash flow or liquidity may need to conserve resources for future usage (Himmelberg et al., 2002). Firms with high cash flow may be more likely to over-invest (Jensen, 1986), which is consistent with the sample of firms analyzed herein (Table 2 Panel A). Cash flow is measured as the ratio of the sum of income before extraordinary items and depreciation and amortization to tangible assets, and liquidity is measured as the ratio of net working capital (current assets less current liabilities) divided by tangible assets.

Firms may also obtain money from creditors and thus be levered. Highly levered firms may face greater financing constraints due to bankruptcy concerns (Myers, 1977; Modigliani and Miller, 1958). At the same time, firms with high levels of debt may be subject to greater monitoring and may have debt covenants that restrict their ability to invest. As a result, such firms may make more value-enhancing investments (Jensen, 1986). Leverage is measured as the ratio of the sum of long-term debt and current liabilities to total assets.

Two measures of intangible assets, research and development (R&D) and advertising, are included separately as firms that rely more heavily on intangible assets may have more information asymmetry between managers and investors. This might cause the firm to face more severe liquidity constraints or it may make it more difficult for the firm to forecast accurately future cash flows, and thus lead to greater variability in the quality of corporate capital budgeting decisions. Moreover, CEOs tend to decrease R&D spending during their final years of office but this is not associated with lower levels of investment spending (Dechow and Sloan, 1991). The ratios of R&D expenditure to tangible assets and advertising expenditures to tangible assets are used to proxy for this aspect of firm-specific information asymmetry.

If agency or informational asymmetry problems are the primary obstacles to a firm routinely making efficient capital allocations, then institutions that could prevent the emergence of such problems or mitigate existing problems should be associated with more efficient investment decisions. Moreover, when corporate governance is effective we should see better monitoring associated with higher (lower) levels of investment among under- (over-) investing firms. The measures of corporate governance that we examine are characteristics of the board of directors and the firm's bylaws measures that would enable managerial entrenchment.

Publicly traded firms are required to have a board of directors to advise and monitor top management of the firm. When a board is particularly effective it should have reliable, open channels of communication to various top executives at the firm, and board members should not feel constrained to offer objective advice. To that end, it may be better for a firm to have more unaffiliated or independent directors on their board. We therefore include a control for the total size of the board, which averages just about 11 members over the periods, with the range being 5-21, and board independence, which averages 71-77% across time. The optimal board size and composition may reflect characteristics of the individual firm and its directors (Raheja, 2005), and cross-sectional variation in board size and composition may reflect economic considerations and idiosyncratic firm characteristics (Boone et al., 2007). However, firms with larger boards have less variable corporate performance (Cheng, 2008).

Senior management may prize board stability or wish to make hostile take-overs more difficult to carry out, which suggests there is an intrinsic tension with regards to how often members of the board should stand for election (Bebchuk et al., 2002). A firm may therefore choose to adopt a staggered or classified board whereby directors serve overlapping terms (usually for three years) with a fraction of members up for election each year. Staggered boards

are strongly associated with lower firm value (Bebchuk and Cohen, 2005; Bebchuk et al., 2011a) and fewer takeover battles (Daines and Klausner, 2001). Roughly 63% of the firms in the dataset have classified boards.[10]

The corporate governance data are as reported by the IRRC, and are thus available for only a subset of the turnovers analyzed herein. Accordingly, this vector of variables is included only in the final round of empirical analysis.

Finally, industry-specific characteristics may cause firms in particular industries to systematically make more or less efficient capital budgeting decisions. Such industry characteristics may also already be manifested in a firm's size or financing capabilities as, for example, firms in some industries may enjoy different levels of economies of scale or scope. Two-digit industry fixed effects, S_{SIC}, are therefore included in the analyses of corporate capital budgeting decisions when possible. These fixed effects are not included in all regressions with corporate governance as the truncated regression model is estimated using maximum likelihood estimation. This process requires the unobserved heterogeneity, which would be partially captured by industry fixed effects, to be integrated out of the likelihood function using maximum simulated likelihood (Gourieroux and Monfort, 1996; Train, 2003) and a series of Halton draws (Bhat, 2001; Greene, 2001; Train, 2003). If the model contains too much heterogeneity, as may

[10] More broadly, a firm's corporate bylaws on investor protection can give investors more power to monitor and discipline managers, and better align the interests of the managers and the firm. Gompers et al. (2003) derived a governance index that consists of the sum of 24 different measures. Firms that have lower (higher) scores are considered to be more democratic (dictatorial) and have higher (lower) firm value (Gompers et al., 2003). Ferreira and Laux (2007) find that the antitakeover provisions embedded in the governance index are associated with reduced under-investment. This finding suggests that decreased information sharing, as is implied by the presence of the takeover protections, can give managers the breathing room to pursue higher levels of investment without soliciting advice from monitors. This data is available for approximately 8% of the firms in the dataset, and these firms average a score of roughly 9.7-10.1 depending on the time window. The Gompers index generally is insignificantly higher in the years following the CEO turnover but the range of values is constant across all the periods (5 to 15). Due to the minimal inter-temporal variation in this variable and the fact it was available for so few firms, we do not report the results from including this variable. That said, the key results remained intact.

occur when there are few degrees of freedom, then it cannot be estimated with the fixed effects included. Fixed effects for industry are thus included whenever possible.

4. RESULTS

In this section the results of three rounds of analysis are reported. These rounds of analysis differ based on which independent variables are included. First, only firm characteristics are included in order to identify the inter-temporal variation in how firm characteristics influence the quality of a firm's corporate capital budgeting decisions. Second, we include characteristics of the incumbent and newly appointed CEOs during the years they were in charge of the firm. In the final round, corporate governance variables are also included to capture the possibility that a firm's governance and firm performance may induce subsequent changes in either or both characteristics.

Each round of testing is conducted twice using different values for the "optimal" threshold benchmark value of marginal *q*. First, 1.00 is used as the appropriate benchmark value as theory suggests this is the correct value in the absence of taxes and other distortions. Second, 0.78 is used as the appropriate benchmark value as per the back-of-the-envelope experiment described in Section 2. In this way the first round of analysis may under-state (over-state) the extent to which firms under- (over-) invest while the second round of analysis may have the opposite bias.

When a variable has the same signs in both the under- and over-investing groups then we interpret the variable as having a consistent impact on the level of investment. However, the interpretation changes when a variable has different signs in the two groups as such a variable has asymmetric effects upon the aggregate level of corporate investment. When the variable's

sign depends on use of a particular threshold value of marginal q – either 1.00 or 0.78, the results depend critically on the intermediate firms (i.e., those with estimated marginal q's of 0.78-1.00) and thus we can comment on the actions of the firms that are always under- or over-investing (i.e., have estimated marginal q's above 1.00 or below 0.78) versus those firms in the middle.

4.1 Baseline results

In the baseline model, which is reported in Tables 3a and 3b, we regress the quality of a firm's corporate capital budgeting decisions, measured as the deviation of estimated marginal q from the appropriate benchmark value, upon seven firm characteristics and industry fixed effects. Four results stand out from this round of testing.

[INSERT TABLE 3A HERE]

[INSERT TABLE 3B HERE]

First, average Tobin's Q, which captures equity market perceptions of corporate growth opportunities, is positive and highly significant for under-investing firms in almost all time windows in both rounds of testing. This suggests that these firms may be restraining their level of investment in anticipation of larger future expenditures. On the other hand, this same variable is negative and significant in seven of the twelve specifications involving over-investing firms, and statistically insignificant in the other five specifications. This juxtaposition suggests that growth firms may face a lumpier investment schedule, which manifests itself as a greater deviation of estimated marginal q from the optimal capital budgeting thresholds in both samples. An alternative explanation is that the perceived growth opportunities are greater for the firms with more effective capital budgeting decisions. In other words, firms that are already investing more effectively, and have thus minimized agency problems, are poised for the highest growth.

Second, larger firms consistently make more efficient corporate capital budgeting decisions in the years pre-turnover, irrespective of whether they are under- or over-investing. This size advantage is completely gone post-turnover, which suggests that the possible disruption of a new CEO's appointment may be mitigated or offset by the continued, smooth functioning of internal communication channels, thus leading to a non-relationship between capital budgeting and firm size.

Next, corporate diversification is weakly associated with lower levels of investment among the under-investing samples versus both values of the benchmark marginal *q*. This suggests that firms present in more industries may face higher levels of fixed asset expenditure. This set of results suggests that diversification is associated with better capital budgeting decisions among the under-investing firms, and that the diversified firms may have more robust information sharing mechanisms that support better decision-making (Alcácer and Zhao, 2012)

Finally, there is weak evidence that research and development spending is associated with worse capital budgeting decisions among both under- and over-investing firms. Greene et al. (2009) and Hornstein and Zhao (2011) have found this effect is persistent while the results presented herein suggest that there may be inter-temporal variation that tempers the magnitude of this effect. The inter-temporal variation in the impact of R&D is consistent with Bereskin and Hsu's (2011) finding that CEO turnover is associated with significant changes in the quantity and quality of corporate innovation.

Finally, no other variables were consistently statistically significant across the specifications.

4.2 CEO characteristics

Three characteristics of the CEO are included in this round of analysis: CEO tenure, whether the CEO is replaced by an outsider, and whether the CEO turnover was forced. These results are reported in Tables 4a and 4b. The original set of independent variables retained their sign, significance and interpretation in this round of analysis. If the CEO is indeed an important contributor to corporate planning, and executive suite turmoil can have a profound impact on corporate expenditures, then characteristics of the CEO and the succession should be associated with the efficacy of corporate capital budgeting decisions. This would be consistent with the evidence that suggests boards often replace CEOs based on longer term patterns of behavior and not based on single years of bad results (Jenter and Lewellen, 2010).

[INSERT TABLE 4A HERE]

[INSERT TABLE 4B HERE]

First, despite the earlier finding that the range of estimated marginal q's was wider among firms that appointed outsider CEOs (Table 2 Panel B), the multivariate analysis reveals that when an outsider CEO is hired there is no impact on the quality of a firm's corporate capital budgeting decisions. This is consistent with the general finding that firms tend to promote internal candidates to be CEO. And yet, this is at odds with the stylized belief that outsider CEOs are appointed to induce change (e.g., Pan and Wang, 2012). This distinction may highlight the benefit of separate examinations of the marginal decisions of sub-groups of the population. Our result adds nuance to this stylized fact by showing that the appointment of an insider or outsider does not hinge on whether the firm under- or over-invests after controlling for other characteristics of the firm. That is, internal promotion is favored by all types of firms.

There is limited evidence that the CEO's departure is forced by the board when the firm has engaged in high levels of over-investment in the year prior to the turnover. This appears to contradict Jenter and Lewellen (2010)'s finding that boards are generally not firing CEOs based on financial performance or operations in a single calendar year.[11] Denis and Denis (1995) report that firms sharply curtail their scale of operations following forced turnovers whereas we find no evidence to support this relationship among either sub-sample of the data. The Denis and Denis (1995) sample included 353 CEO turnovers of which 131 could be classified as forced or voluntary while the subsample of the Jenter and Kanaan (2010) and Peters and Wagner (2010) dataset used herein is more than twice as big with 100% of the turnovers classified as forced or voluntary. Thus, the finding that forced turnover has no effect on post-turnover capital budgeting efficiency may reflect the 1985-1988 period studied by Denis and Denis (1995).

Entrenched CEOs, i.e., those with longer tenure, do not appear to routinely make less efficient capital budgeting decisions. We now examine when entrenchment undermines the quality of decision-making as the incumbent CEO's tenure is highly statistically significant in three of eight specifications in the under-investing sample. Thus, there is some evidence that more entrenched managers invest less in the years immediately preceding their departure, with the impact concentrated among the firms that most under-invest (i.e., are under-investors in both samples). When the firm massively under-invests in year t-2, the more entrenched managers are more likely to be forcibly replaced. Thus, when the CEO has made particularly poor capital budgeting decisions, primarily on the under-investing side, this CEO is more likely to be

[11] It is possible that the relationship between efficient capital budgeting decisions and the independent variables varies systematically for the sub-sample of firms that have forced turnovers. However, we are unable to explore this hypothesis due to the small sample size.

carefully monitored by the board and subsequently forced out of office. It would appear that in these situations, the firm is trying to make a clean break from the past.

The new CEO's tenure at the firm is statistically insignificant in all regression specifications. This result suggests that the board treats a newly appointed CEO as having a clean slate even if the individual is not new to the firm itself. When the new CEO's tenure is interacted with outsider status, this variable is strongly positive and negative in one of the six specifications for over-investing firms. Thus, firms that appoint outsider CEOs appear to be giving their incoming CEO guidance and oversight to prevent the new CEO from engaging in massive spending in their early years.

4.3 Corporate governance model

One result stands out in this round of analysis: the quality of a firm's corporate capital budgeting decisions is strongly affected by the characteristics of its board of directors, and this impact is not consistent across the under- and over-investing samples (see Tables 5a and 5b). All of the results in this section reflect a subset of the turnovers analyzed in the earlier rounds. When the earlier analyses were replicated on this subset of turnovers, all earlier results remained qualitatively unchanged, and so this set of results appears to reflect meaningful differences in how boards operate over time.

[INSERT TABLE 5A HERE]

[INSERT TABLE 5B HERE]

First, board size appears to have an impact on the firms that are either extreme under-investors (i.e., have an estimated marginal q greater than 1.00) or the intermediate firms (those

with estimated marginal *q*'s in between 0.78 and 1.00). Thus, when a firm over-invests it is due entirely to the impact of other firm characteristics, as discussed in Section 4.1, or the nature of the CEO's appointment and tenure, as discussed in Section 4.2. There is some evidence that under-investing firms greatly under-invest two years prior to the CEO turnover if they have a larger board. This result may reflect a stalemate among board members that leads the board to sit on the CEO's proposed corporate investments. This is consistent with the idea that board monitoring alone is insufficient to overcome internal informational asymmetries with the CEO (Inderst and Mueller, 2010). After the CEO turnover occurs, larger boards are associated with higher levels of investment among all firms only when the benchmark marginal *q* is assumed to be 1.00. This suggests that while firms with larger boards may invest more money in these periods, this is only occurring among those firms that are already investing less than their peers.

Second, classified or staggered boards are associated with lower firm valuations (Bebchuk and Cohen, 2005), which could be consistent with these firms making less effective corporate capital budgeting decisions. When the benchmark marginal *q* is assumed to be 1.0, firms with classified boards make more investments, and thus classified boards have a negative estimated coefficient among both the under- and over-investing samples. This relationship is statistically significant in just three of the ten models, and reverses entirely in one period.[12] By contrast, when the benchmark marginal *q* is adjusted for taxes, we find stronger evidence suggesting that firms make more effective capital budgeting decisions when their boards are classified. These sub-sample results jointly imply that there is a detrimental effect on capital budgeting of such boards when a firm is already investing less (i.e., has an estimated marginal *q*

[12] The variable is not included in two sub-sample analyses due to the lack of variation in this variable in those groups.

closer to 1.0) but that this effect is muted when one places a heavier weight on firms with estimated marginal *q*'s closer to the tax-adjusted benchmark value.

Finally, board independence is associated with lower levels of investment in five of the twelve periods prior to the CEO turnover, including four of the six samples in the analysis using the tax-adjusted benchmark marginal *q*. This suggests that more independent directors may be more emboldened to halt or modify proposed investment activity. There is some evidence that firms with higher estimated marginal *q*'s, in the range of 0.78-1.00, will make fewer investments in the years subsequent to the CEO turnover when they have more independent boards (Table 5a). This suggests that board independence may be associated with greater CEO-board friction which eventually leads to stalled investment activity and the eventual appointment of a new CEO who gains more cooperation from the board.

One earlier result needs to be revisited at this juncture: the relationship between corporate capital budgeting and forced CEO turnovers. After we control for the firm's corporate governance the earlier result that CEOs are forced from office following higher over-investment in year t-2 remains. Moreover, we now obtain strong evidence that firms with forced CEO turnover experience swings in the quality of their capital budgeting post-turnover, with this effect generally beneficial.

4.4 Intertemporal variation

First, there is substantial variation in the quality of corporate capital budgeting decisions across time. Huson et al. (2004) find that productivity increases after turnover, and if markets are efficient this would translate into the firm's market value increasing faster than the book value of firm assets, yielding a higher estimated marginal *q* post-turnover. As was discussed in

Section 3.1 and illustrated in Figure 1, the range of estimated marginal *q*'s varies substantially across the six windows examined herein with the mean estimated value peaking just after the turnover while the standard deviation and range of values are largest at the time of the turnover. Figure 1 illustrates the range of estimated marginal *q*'s observed in each period, and shows that the impact of outliers is also most pronounced in the turnover period.

Similarly, of the 766 turnovers analyzed herein, just 132, or 17%, can be consistently classified as under- or over-investing firms versus the benchmark marginal *q* of 1.0, and 184, or 24%, versus the tax-adjusted threshold marginal *q* of 0.78. Thus, the vast majority of firms cannot be consistently labeled as an under- or over-investing firm across time. This is both consistent with the fact that many firms may face a lumpy investment schedule due to both investment needs and the presence of inter-temporal agency problems within the firm, such as is modeled by Roper and Ruckes (2012). Many firms may thus end up with an estimated marginal *q* that is higher or lower than the benchmark marginal *q* and rarely have an estimated marginal *q* that is at the benchmark value. In related empirical work, Doms and Dunne (1998) report that 25-40% of an average plant's total investments over a seventeen year cycle occurs in just one focal year.

Second, if a firm had a consistent approach towards investment, then the impact of firm, CEO or corporate governance characteristics would be similar across time. That is, the sign, magnitude and statistical significance of estimated coefficients would be relatively similar across time. However, the only variables for which the estimated coefficients were consistent across time were those that were always statistically insignificant (e.g., outsider CEO). Thus, it is evident that each firm is making its corporate capital budgeting decisions based on current period characteristics and projections of the external environment, and not based on a time-invariant

corporate culture. The dynamism embodied in this corporate environment is beneficial as it allows the firms to adapt quickly.

Third, if changes in corporate characteristics or investment practices in one period had a lasting impact on the firm's behavior in subsequent periods, then there would be considerable changes in the raw, univariate statistics between periods. However, while the nature of marginal *q* changes substantially across time, we do not observe any meaningful changes in any other variable across time. In the balanced sample dataset, not reported herein, the univariate statistics showed little change from t-3 to t+3. Thus, the slight variation reported in Table 2 appears to reflect the changing nature of the sample across estimation windows.

4.5 Robustness tests

The first round of robustness tests began with adjusting the number of years of data used per firm in marginal *q* estimation. Instead of using two consecutive observations in the first stage estimation of marginal *q* (e.g., years t to t+1) and then one observation to create the second stage independent variables (e.g., year t), the number of observations was increased by one to three, two to four, or three to five. In these rounds of estimates, the range of values of estimated marginal *q* narrowed slightly while the average value changed little. The first stage estimation was slightly more precise while the second stage estimation became slightly less significant. However, all results reported herein remained qualitatively intact.

In the second round of robustness tests, CEO turnovers were excluded if the turnover announcement was 12 or more months before the turnover actually occurred. This was done to ensure that the fiscal year labeled as the turnover year contained all news of the turnover. Just

eight turnovers were announced 13 or more months ahead of time. Excluding these observations from the analysis did not change the results analyzed herein.

The third round of robustness tests used alternative measures of control variables such as market leverage in lieu of book leverage.

5. CONCLUSION

This paper makes three substantial contributions to the literatures on corporate capital budgeting and the role of the CEO. First, this analysis looks at both cross-sectional and time series explanations for variation in the quality of firms' corporate capital budgeting decisions. All results reported in this paper are consistent with the cross-sectional evidence regarding efficiency of corporate capital budgeting decisions reported in Durnev et al. (2004), Greene et al. (2009) and Hornstein and Zhao (2011), and greatly extend the limited time series analysis presented in Greene et al. (2009). Thus, the inter-temporal variation in corporate capital budgeting decisions identified in this paper represents a contribution to the corporate capital budgeting literature.

Second, the empirical analysis clearly reveals that firms have forced turnovers when there is marked over-investment and CEOs are more entrenched in years prior to the turnover. This is strongly consistent with Jenter and Kanaan (2010)'s finding that CEOs are evaluated based on a weighted combination of current and prior years' performance as the CEOs are not replaced immediately. Turmoil in the executive suite – as exemplified by CEO turnovers – may thus signal the existence of agency problems within the firm or informational asymmetries between key players, within or across firm boundaries. Accordingly, the quality of a firm's capital budgeting decisions may vary markedly in the period surrounding a CEO transition.

Third, there are clear and sustained differences between firms that under- and over-invest. This clearly illustrates that an average estimated effect in a population may reflect two offsetting impacts in sub-samples. Thus, important heterogeneity in the quality of firm's corporate capital budgeting decisions may have been masked in some prior work on the impact of CEO turnovers on firm performance.

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Table 1. Descriptive statistics.
In this table we report the mean and standard deviation of each variable by window in order to illustrate the inter-temporal variation in corporate characteristics.

	t-3 to t-2			t-2 to t-1			t-1 to t			t to t+1			t+1 to t+2			t+2 to t+3		
Variable	**Mean**	**S.D.**	**N**	**Mean**	**S.D.**	**N**	**Mean**	**S.D.**	**N**	**Mean**	**S.D.**	**N**	**Mean**	**S.D.**	**N**	**Mean**	**S.D.**	**N**
Marginal *q*	0.888	0.433	579	0.885	0.792	623	0.923	0.736	666	1.028	0.818	672	1.127	0.683	619	0.860	0.663	559
Average Q	1.181	0.919	579	1.245	0.988	623	1.214	0.977	666	1.138	0.937	672	1.151	0.896	619	1.177	0.895	559
Diversification	1.560	0.927	579	1.531	0.881	623	1.518	0.905	666	1.478	0.865	672	1.407	0.818	619	1.360	0.765	559
PPE	6.152	1.805	579	6.162	1.807	623	6.187	1.772	666	6.274	1.739	672	6.399	1.708	619	6.514	1.682	559
Liquidity	0.738	1.030	579	0.803	1.206	623	0.870	1.637	666	0.814	1.263	672	0.725	0.901	619	0.671	0.808	559
Leverage	0.242	0.154	579	0.241	0.154	623	0.240	0.156	666	0.245	0.160	672	0.248	0.159	619	0.253	0.160	559
Advertising	0.023	0.082	579	0.024	0.078	623	0.022	0.076	666	0.021	0.072	672	0.020	0.069	619	0.018	0.058	559
R&D	0.063	0.182	579	0.071	0.188	623	0.075	0.195	666	0.075	0.202	672	0.068	0.184	619	0.060	0.176	559
Board size	11.215	2.612	121	11.270	2.682	126	11.233	2.696	133	11.428	2.728	138	11.084	2.418	131	11.107	2.502	122
Classified board	0.627	0.486	110	0.625	0.486	120	0.639	0.482	122	0.627	0.486	126	0.636	0.483	121	0.628	0.485	113
Board independence	0.767	0.128	121	0.732	0.161	126	0.726	0.159	133	0.710	0.157	138	0.709	0.149	131	0.723	0.149	122
Tenure old CEO	9.140	8.250	515	9.567	8.226	571	10.205	8.405	615	11.111	8.424	622						
Tenure new CEO										9.619	10.502	646	10.817	10.541	600	11.916	10.780	553
Outsider successor	0.217	0.395	578	0.216	0.396	622	0.222	0.401	665	0.224	0.402	671	0.221	0.399	618	0.221	0.397	558
Forced turnover	0.135	0.325	579	0.135	0.327	623	0.140	0.333	666	0.140	0.333	672	0.134	0.326	619	0.133	0.322	559

Table 2. Sub-group analysis
In this table we report the mean and standard deviation of each variable by window for key sub-groups.

Panel A.1: Under-investors using h = 0. 78

	t-3 to t-2			t-2 to t-1			t-1 to t			t to t+1			t+1 to t+2			t+2 to t+3		
Variable	**Mean**	**S.D.**	**N**	**Mean**	**S.D.**	**N**	**Mean**	**S.D.**	**N**	**Mean**	**S.D.**	**N**	**Mean**	**S.D.**	**N**	**Mean**	**S.D.**	**N**
Marginal *q*	1.051	0.346	416	1.310	0.712	358	1.284	0.625	417	1.359	0.647	475	1.348	0.555	482	1.200	0.596	320
Average Q	1.254	0.906	416	1.427	1.017	358	1.354	1.020	417	1.196	0.946	475	1.212	0.888	482	1.320	0.934	320
Diversification	1.572	0.947	416	1.559	0.941	358	1.484	0.863	417	1.472	0.837	475	1.394	0.812	482	1.306	0.717	320
PPE	6.386	1.823	416	6.439	1.840	358	6.357	1.808	417	6.461	1.745	475	6.513	1.723	482	6.618	1.716	320
Liquidity	0.606	0.886	416	0.669	1.042	358	0.731	1.211	417	0.740	1.320	475	0.675	0.913	482	0.597	0.767	320
Leverage	0.248	0.150	416	0.250	0.153	358	0.246	0.154	417	0.247	0.157	475	0.250	0.156	482	0.255	0.161	320
Advertising	0.022	0.071	416	0.022	0.076	358	0.023	0.084	417	0.020	0.067	475	0.020	0.064	482	0.021	0.061	320
R&D	0.052	0.172	416	0.064	0.171	358	0.065	0.166	417	0.073	0.208	475	0.071	0.198	482	0.055	0.121	320
Board size	11.319	2.666	91	11.342	2.939	79	11.319	2.760	91	11.505	2.771	109	11.157	2.307	102	11.394	2.441	71
Classified board	0.627	0.487	83	0.628	0.486	78	0.679	0.470	81	0.634	0.484	101	0.629	0.486	97	0.582	0.497	67
Board independence	0.762	0.131	91	0.719	0.164	79	0.729	0.165	91	0.704	0.160	109	0.717	0.143	102	0.735	0.135	71
Tenure old CEO	8.869	7.895	374	9.520	7.642	327	10.404	8.256	391	11.076	8.269	439						
Tenure new CEO										9.766	10.681	461	10.482	10.486	468	11.646	10.735	315
Outsider successor	0.206	0.387	415	0.175	0.366	357	0.183	0.373	416	0.216	0.397	474	0.221	0.400	481	0.214	0.394	320
Forced turnover	0.129	0.320	416	0.113	0.307	358	0.124	0.319	417	0.128	0.322	475	0.121	0.313	482	0.141	0.337	320

Panel A.2: Over-investors using h = 0. 78

	t-3 to t-2			t-2 to t-1			t-1 to t			t to t+1			t+1 to t+2			t+2 to t+3		
Variable	**Mean**	**S.D.**	**N**	**Mean**	**S.D.**	**N**	**Mean**	**S.D.**	**N**	**Mean**	**S.D.**	**N**	**Mean**	**S.D.**	**N**	**Mean**	**S.D.**	**N**
Marginal *q*	0.473	0.345	163	0.310	0.465	265	0.317	0.455	249	0.229	0.611	197	0.350	0.496	137	0.404	0.436	239
Average Q	0.995	0.928	163	0.998	0.892	265	0.979	0.852	249	0.999	0.902	197	0.938	0.896	137	0.984	0.803	239
Diversification	1.528	0.877	163	1.494	0.794	265	1.574	0.969	249	1.492	0.929	197	1.453	0.840	137	1.431	0.821	239
PPE	5.555	1.614	163	5.787	1.695	265	5.901	1.674	249	5.822	1.643	197	5.998	1.593	137	6.377	1.628	239
Liquidity	1.074	1.272	163	0.985	1.377	265	1.103	2.153	249	0.993	1.096	197	0.899	0.838	137	0.770	0.850	239

Leverage	0.229	0.163	163	0.228	0.156	265	0.230	0.160	249	0.239	0.167	197	0.241	0.169	137	0.251	0.158	239
Advertising	0.024	0.105	163	0.025	0.080	265	0.020	0.060	249	0.023	0.082	197	0.021	0.085	137	0.014	0.054	239
R&D	0.089	0.204	163	0.080	0.208	265	0.091	0.236	249	0.082	0.189	197	0.058	0.122	137	0.068	0.230	239
Board size	10.900	2.454	30	11.149	2.207	47	11.048	2.575	42	11.138	2.587	29	10.828	2.804	29	10.706	2.556	51
Classified board	0.630	0.492	27	0.619	0.492	42	0.561	0.502	41	0.600	0.500	25	0.667	0.482	24	0.696	0.465	46
Board independence	0.780	0.119	30	0.754	0.154	47	0.719	0.146	42	0.730	0.142	29	0.682	0.169	29	0.705	0.166	51
Tenure old CEO	9.858	9.115	141	9.631	8.965	244	9.857	8.667	224	11.193	8.807	183						
Tenure new CEO										9.255	10.059	185	12.004	10.689	132	12.274	10.851	238
Outsider successor	0.245	0.413	163	0.272	0.426	265	0.287	0.436	249	0.244	0.415	197	0.219	0.397	137	0.231	0.402	238
Forced turnover	0.151	0.340	163	0.165	0.350	265	0.167	0.353	249	0.168	0.358	197	0.182	0.363	137	0.121	0.300	239

Panel B.1: Outsider successor appointed CEO

	t-3 to t-2			t-2 to t-1			t-1 to t			t to t+1			t+1 to t+2			t+2 to t+3		
Variable	**Mean**	**S.D.**	**N**	**Mean**	**S.D.**	**N**	**Mean**	**S.D.**	**N**	**Mean**	**S.D.**	**N**	**Mean**	**S.D.**	**N**	**Mean**	**S.D.**	**N**
Marginal *q*	0.915	0.564	109	0.905	0.967	118	0.870	0.924	131	1.002	1.008	134	1.168	0.741	120	0.823	0.733	107
Average Q	1.197	0.835	109	1.370	1.052	118	1.344	1.121	131	1.190	1.079	134	1.125	0.929	120	1.135	0.979	107
Diversification	1.450	0.799	109	1.390	0.717	118	1.359	0.724	131	1.343	0.662	134	1.233	0.546	120	1.196	0.504	107
PPE	5.657	1.845	109	5.677	1.848	118	5.706	1.846	131	5.826	1.826	134	5.901	1.822	120	6.028	1.765	107
Liquidity	1.112	1.506	109	1.152	1.508	118	1.212	1.718	131	1.100	1.393	134	1.004	1.156	120	0.917	0.980	107
Leverage	0.239	0.166	109	0.234	0.166	118	0.229	0.172	131	0.232	0.177	134	0.235	0.182	120	0.238	0.186	107
Advertising	0.025	0.067	109	0.027	0.075	118	0.034	0.105	131	0.031	0.100	134	0.023	0.076	120	0.020	0.048	107
R&D	0.134	0.329	109	0.146	0.303	118	0.155	0.310	131	0.149	0.297	134	0.141	0.269	120	0.124	0.212	107
Board size	11.211	2.394	19	11	2.160	19	10.364	2.258	22	10.783	2.645	23	10.6	2.088	20	10.579	2.269	19
Classified board	0.474	0.513	19	0.526	0.513	19	0.545	0.510	22	0.545	0.510	22	0.632	0.496	19	0.667	0.485	18
Board independence	0.781	0.119	19	0.697	0.216	19	0.721	0.200	22	0.687	0.196	23	0.692	0.172	20	0.676	0.164	19
Tenure old CEO	7.900	7.461	94	8.492	7.390	104	9.234	7.780	114	9.963	7.850	116						
Tenure new CEO										1.126	4.663	127	2.219	4.915	114	3.217	5.125	106
Forced turnover	0.254	0.424	109	0.268	0.433	118	0.272	0.436	131	0.274	0.437	134	0.264	0.431	120	0.268	0.432	107

Panel B.2: Insider successor appointed CEO

	t-3 to t-2			t-2 to t-1			t-1 to t			t to t+1			t+1 to t+2			t+2 to t+3		
Variable	**Mean**	**S.D.**	**N**	**Mean**	**S.D.**	**N**	**Mean**	**S.D.**	**N**	**Mean**	**S.D.**	**N**	**Mean**	**S.D.**	**N**	**Mean**	**S.D.**	**N**
Marginal *q*	0.881	0.390	436	0.887	0.725	471	0.942	0.687	501	1.036	0.772	504	1.121	0.672	465	0.869	0.652	418
Average Q	1.185	0.958	436	1.211	0.975	471	1.182	0.940	501	1.121	0.905	504	1.161	0.903	465	1.198	0.894	418
Diversification	1.594	0.970	436	1.573	0.924	471	1.549	0.919	501	1.500	0.878	504	1.441	0.836	465	1.388	0.806	418
PPE	6.283	1.770	436	6.285	1.776	471	6.309	1.732	501	6.390	1.701	504	6.526	1.658	465	6.639	1.644	418
Liquidity	0.647	0.856	436	0.725	1.124	471	0.794	1.637	501	0.749	1.238	504	0.666	0.833	465	0.620	0.768	418
Leverage	0.246	0.151	436	0.245	0.152	471	0.244	0.153	501	0.250	0.156	504	0.252	0.153	465	0.255	0.153	418
Advertising	0.022	0.087	436	0.023	0.081	471	0.020	0.068	501	0.019	0.064	504	0.020	0.069	465	0.016	0.055	418
R&D	0.047	0.122	436	0.054	0.146	471	0.056	0.153	501	0.058	0.171	504	0.050	0.154	465	0.046	0.168	418
Board size	11.383	2.664	94	11.404	2.788	99	11.466	2.782	103	11.636	2.772	107	11.176	2.550	102	11.266	2.608	94
Classified board	0.663	0.476	83	0.641	0.482	92	0.663	0.475	92	0.642	0.482	95	0.634	0.484	93	0.616	0.489	86
Board independence	0.759	0.134	94	0.732	0.152	99	0.719	0.153	103	0.706	0.149	107	0.707	0.149	102	0.724	0.149	94
Tenure old CEO	9.768	8.546	393	10.125	8.517	439	10.785	8.652	470	11.762	8.664	472						
Tenure new CEO										11.918	10.542	496	13.220	10.516	458	14.579	10.729	414
Forced turnover	0.095	0.287	436	0.092	0.283	471	0.097	0.290	501	0.096	0.289	504	0.091	0.2819	465	0.087	0.275	418

Table 3a. Baseline model with no taxes. The baseline model of [3] includes only firm level control variables. In this round of analysis the benchmark marginal *q*, *h*, is presumed to be 1.00, corresponding to an absence of capital gains and dividends taxes. Industry fixed effects are included when possible. Standard errors are reported in parentheses. * denotes statistical significance at the 10% level; **, 5% level; and ***, 1% level.

	t-3 – t-2		**t-2 – t-1**		**t-1 – t**		**t – t+1**		**t+1 – t+2**		**t+2 – t+3**	
	q > 1.00	q < 1.00	q > 1.00	q < 1.00	q > 1.00	q < 1.00	q > 1.00	q < 1.00	q > 1.00	q < 1.00	q > 1.00	q < 1.00
Average Q	0.290***	-0.042	0.708***	-0.119*	0.610***	-0.093	0.835***	-0.175	0.797***	-0.464*	0.472***	-0.199*
	(0.092)	(0.086)	(0.150)	(0.072)	(0.114)	(0.112)	(0.208)	(0.165)	(0.182)	(0.261)	(0.142)	(0.111)
Diversification	0.217*	0.057	-0.647**	0.039	-0.050	-0.087	-0.262	-0.168	-0.342*	-0.001	-0.154	-0.055
	(0.129)	(0.090)	(0.291)	(0.076)	(0.188)	(0.110)	(0.267)	(0.186)	(0.207)	(0.239)	(0.306)	(0.117)
PPE	-0.170***	0.257***	-0.329***	0.236***	-0.237***	0.388***	-0.266**	0.218*	-0.069	0.096	-0.040	0.039
	(0.064)	(0.091)	(0.108)	(0.057)	(0.067)	(0.111)	(0.119)	(0.116)	(0.0839)	(0.137)	(0.081)	(0.062)
Liquidity	0.085	0.011	0.094	0.028	-0.067	-0.023	-0.090	-0.296*	0.034	0.008	0.186	-0.531***
	(0.101)	(0.097)	(0.144)	(0.051)	(0.066)	(0.048)	(0.195)	(0.164)	(0.181)	(0.225)	(0.175)	(0.157)
Leverage	0.293	-1.046*	-0.600	-0.415	-1.025	0.366	-1.254	1.426	-0.384	-0.052	-1.573	-0.030
	(0.618)	(0.547)	(1.361)	(0.433)	(0.698)	(0.754)	(1.199)	(0.961)	(0.848)	(0.940)	(1.168)	(0.650)
Advertising	-2.527	-1.008*	-1.815	0.459	0.430	1.211	-3.413	2.758	-1.132	-0.332	-3.308	3.225
	(1.932)	(0.550)	(1.943)	(0.784)	(0.936)	(0.934)	(2.853)	(2.031)	(1.467)	(2.370)	(2.682)	(2.078)
R&D	-0.409	-0.795*	-0.480	-0.323	-0.014	-0.300	0.653	-0.928	0.859	-1.681	0.861	-0.380
	(0.393)	(0.472)	(0.883)	(0.324)	(0.439)	(0.383)	(0.960)	(0.835)	(0.566)	(1.520)	(1.032)	(0.364)
Intercept	-0.880	-0.374	-0.469	-3.154***	-0.906	4.856	0.676	-2.134**	-2.560	-0.497	1.757	2.291
	(0.780)	(1.175)	(1.327)	(0.878)	(0.931)	(15.00)	(1.798)	(1.032)	(1.988)	(1.854)	(1.153)	(1.540)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Log-likelihood	61.43	278.9	11.79	70.34	66.15	70.17	89.74	17.65	81.91	24.17	30.99	71.59
N	134	445	200	423	253	413	358	314	398	221	152	407

Table 3b. Baseline model with taxes. The baseline model of [3] includes only firm level control variables. In this round of analysis the benchmark marginal *q*, *h*, is presumed to be 0.78, corresponding to the presence of capital gains and dividends taxes at the rates explained in Section 2. Industry fixed effects are included when possible. Standard errors are reported in parentheses. * denotes statistical significance at the 10% level; **, 5% level; and ***, 1% level.

	t-3 – t-2		**t-2 – t-1**		**t-1 – t**		**t – t+1**		**t+1 – t+2**		**t+2 – t+3**	
	q > 0.78	q < 0.78	q > 0.78	q < 0.78	q > 0.78	q < 0.78	q > 0.78	q < 0.78	q > 0.78	q < 0.78	q > 0.78	q < 0.78
Average Q	0.523***	-0.193*	1.501***	-0.218**	0.461***	-0.186	0.463***	0.022	0.348***	-0.564*	0.737***	-0.669**
	(0.156)	(0.105)	(0.404)	(0.095)	(0.092)	(0.120)	(0.0705)	(0.143)	(0.048)	(0.342)	(0.179)	(0.311)
Diversification	-0.160	0.417*	-0.827*	-0.044	-0.206	-0.123	-0.069	-0.267	-0.120*	-0.114	-0.382	0.046
	(0.137)	(0.216)	(0.431)	(0.112)	(0.128)	(0.121)	(0.089)	(0.178)	(0.061)	(0.355)	(0.290)	(0.306)
PPE	-0.126*	0.351**	-0.380**	0.265***	-0.188***	0.320***	-0.060	0.143	0.023	0.409	-0.055	0.012
	(0.073)	(0.143)	(0.170)	(0.078)	(0.056)	(0.111)	(0.043)	(0.112)	(0.031)	(0.253)	(0.073)	(0.152)
Liquidity	-0.052	0.110	0.436*	0.122*	0.030	0.086	-0.082	-0.206	0.018	0.413	-0.007	-0.986**
	(0.136)	(0.117)	(0.238)	(0.071)	(0.064)	(0.069)	(0.076)	(0.149)	(0.071)	(0.371)	(0.185)	(0.408)
Leverage	0.007	-0.006	-1.209	-0.434	-0.462	0.567	-1.031**	0.922	-0.019	0.645	-1.824*	0.829
	(0.714)	(0.627)	(1.819)	(0.525)	(0.589)	(0.806)	(0.468)	(0.923)	(0.322)	(1.233)	(1.069)	(1.584)
Advertising	-1.921	-1.129**	-2.358	1.102	-1.243	-2.300	-1.770	2.506	-0.096	-0.804	-2.923	-1.861
	(1.810)	(0.550)	(2.822)	(1.100)	(0.776)	(1.421)	(1.090)	(2.199)	(0.591)	(2.863)	(2.536)	(3.054)
R&D	0.736	0.523	-2.751*	-0.659*	0.209	-0.354	0.627	-1.021	0.458*	-4.820*	2.057*	0.071
	(0.450)	(0.552)	(1.437)	(0.366)	(0.443)	(0.348)	(0.460)	(0.763)	(0.234)	(2.651)	(1.118)	(0.634)
Intercept	-1.002	-1.360	-3.099	-2.414***	-0.185	-3.563	0.607	-1.778**	-0.507	-1.583	-12.58	8.098
	(0.958)	(1.876)	(2.277)	(0.907)	(0.868)	(3.110)	(0.886)	(0.901)	(0.626)	(2.232)	(11.35)	(6.691)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Log-likelihood	257.7	99.20	45.34	38.19	54.89	40.33	-36.09	4.833	-67.42	35.16	114.1	81.56
N	416	163	358	265	417	249	475	197	482	137	320	239

Table 4a. CEO turnover characteristics model with no taxes. We now include characteristics of the CEO and nature of the turnover when estimating model [3]. In this round of analysis the benchmark marginal *q*, *h*, is presumed to be 1.00, corresponding to an absence of capital gains and dividends taxes. Industry fixed effects are included when possible. Standard errors are reported in parentheses. * denotes statistical significance at the 10% level; **, 5% level; and ***, 1% level.

	t-3 – t-2		**t-2 – t-1**		**t-1 – t**		**t – t+1**		**t+1 – t+2**		**t+2 – t+3**	
	q > 1.00	q < 1.00	q > 1.00	q < 1.00	q > 1.00	q < 1.00	q > 1.00	q < 1.00	q > 1.00	q < 1.00	q > 1.00	q < 1.00
Average Q	0.238***	-0.006	0.816***	-0.062	0.490***	-0.016	0.863***	-0.257*	0.773***	-0.452*	0.492***	-0.213*
	(0.092)	(0.079)	(0.162)	(0.062)	(0.099)	(0.110)	(0.225)	(0.154)	(0.178)	(0.248)	(0.146)	(0.113)
Diversification	0.303*	0.073	-0.638**	-0.018	-0.087	-0.063	-0.561*	-0.104	-0.387*	0.062	-0.002	-0.066
	(0.166)	(0.079)	(0.312)	(0.058)	(0.179)	(0.105)	(0.334)	(0.163)	(0.222)	(0.238)	(0.297)	(0.119)
PPE	-0.146**	0.188***	-0.269**	0.183***	-0.252***	0.295***	-0.238*	0.115	-0.073	0.060	-0.006	0.041
	(0.067)	(0.069)	(0.106)	(0.043)	(0.063)	(0.095)	(0.131)	(0.091)	(0.088)	(0.133)	(0.087)	(0.064)
Liquidity	0.146	0.022	0.219	0.012	-0.030	0.013	-0.091	-0.359*	-0.005	-0.061	0.214	-0.541***
	(0.122)	(0.0877)	(0.139)	(0.047)	(0.061)	(0.050)	(0.220)	(0.185)	(0.184)	(0.236)	(0.180)	(0.161)
Leverage	0.233	-1.137**	-0.407	-0.303	-0.857	0.412	-0.925	1.119	-0.375	-0.277	-1.722	0.088
	(0.723)	(0.493)	(1.271)	(0.356)	(0.627)	(0.727)	(1.250)	(0.845)	(0.859)	(0.922)	(1.162)	(0.655)
Advertising	-1.593	-0.927*	-0.512	0.701	-0.055	1.133	-2.036	2.056	-1.212	-0.042	-3.712	3.372
	(1.873)	(0.480)	(1.643)	(0.687)	(0.849)	(0.976)	(2.924)	(1.546)	(1.462)	(2.293)	(2.708)	(2.117)
R&D	-0.596	-0.803*	-0.886	-0.208	-0.068	-0.377	0.806	-0.639	0.920	-1.689	0.581	-0.328
	(0.426)	(0.429)	(0.838)	(0.269)	(0.391)	(0.382)	(1.036)	(0.824)	(0.567)	(1.543)	(1.046)	(0.369)
Outsider CEO	-0.116	0.176	0.010	-0.014	0.488	0.026	0.277	-0.891	-0.063	0.431	0.274	-0.148
	(0.377)	(0.227)	(0.677)	(0.173)	(0.363)	(0.355)	(0.805)	(0.701)	(0.365)	(0.570)	(0.532)	(0.276)
Forced turnover	-0.097	-0.034	-0.212	-0.452***	0.171	-0.228	-0.556	0.263	-0.597	-0.431	0.395	-0.247
	(0.238)	(0.196)	(0.417)	(0.144)	(0.247)	(0.266)	(0.562)	(0.376)	(0.436)	(0.505)	(0.424)	(0.268)
Tenure old CEO	0.003	-0.003	0.047**	-0.002	0.035***	0.009	0.0351	-0.003				
	(0.015)	(0.008)	(0.024)	(0.006)	(0.012)	(0.012)	(0.022)	(0.016)				

Outsider * tenure old CEO	0.015	-0.018	0.142**	-0.012	-0.029	-0.021	-0.114	0.061				
	(0.033)	(0.020)	(0.061)	(0.014)	(0.025)	(0.031)	(0.072)	(0.069)				
Tenure new CEO							-0.033	0.019	-0.008	0.001	-0.019	-0.008
							(0.022)	(0.016)	(0.013)	(0.022)	(0.019)	(0.010)
Outsider * tenure new CEO							0.177	-0.026	-0.116	-0.026	-0.037	0.011
							(0.180)	(0.043)	(0.099)	(0.066)	(0.116)	(0.032)
Intercept	-0.872	-1.161	-2.234	-2.787***	-0.928	4.347	0.256	-1.834*	-2.291	5.384	1.706	2.392
	(0.827)	(1.481)	(1.439)	(0.758)	(0.875)	(13.26)	(1.851)	(1.006)	(1.930)	(6.409)	(1.184)	(1.553)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Log-likelihood	59.88	260.2	26.28	82.60	68.19	73.33	87.83	33.37	84.52	25.57	32.78	72.25
N	117	397	182	388	237	377	317	278	388	211	150	402

Table 4b. CEO turnover characteristics model with taxes. We now include characteristics of the CEO and nature of the turnover when estimating model [3]. In this round of analysis the benchmark marginal *q*, *h*, is presumed to be 0.78, corresponding to the presence of capital gains and dividends taxes at the rates explained in Section 2. Industry fixed effects are included when possible. Standard errors are reported in parentheses. * denotes statistical significance at the 10% level; **, 5% level; and ***, 1% level.

	t-3 – t-2		**t-2 – t-1**		**t-1 – t**		**t – t+1**		**t+1 – t+2**		**t+2 – t+3**	
	q > 0.78	q < 0.78	q > 0.78	q < 0.78	q > 0.78	q < 0.78	q > 0.78	q < 0.78	q > 0.78	q < 0.78	q > 0.78	q < 0.78
Average Q	0.405***	-0.161**	1.363***	-0.114	0.529***	-0.068	0.443***	-0.078	0.338***	-0.551	0.763***	-0.692**
	(0.120)	(0.077)	(0.351)	(0.085)	(0.111)	(0.107)	(0.082)	(0.115)	(0.047)	(0.336)	(0.194)	(0.293)
Diversification	-0.215*	0.305**	-1.003**	-0.104	-0.207	0.028	-0.145	-0.192	-0.140**	0.026	-0.358	0.049
	(0.128)	(0.139)	(0.443)	(0.091)	(0.146)	(0.101)	(0.109)	(0.139)	(0.066)	(0.372)	(0.290)	(0.278)
PPE	-0.065	0.152**	-0.347**	0.241***	-0.206***	0.207***	-0.047	0.090	0.018	0.311	-0.037	-0.002
	(0.060)	(0.075)	(0.159)	(0.067)	(0.065)	(0.080)	(0.052)	(0.085)	(0.032)	(0.227)	(0.078)	(0.141)
Liquidity	0.024	0.052	0.397*	0.105	0.033	0.067	-0.101	-0.209	0.015	0.151	-0.063	-1.136***
	(0.128)	(0.081)	(0.223)	(0.066)	(0.072)	(0.057)	(0.091)	(0.142)	(0.071)	(0.389)	(0.202)	(0.415)
Leverage	0.108	-0.465	-1.557	-0.415	-0.423	0.588	-1.078**	0.474	-0.026	0.379	-2.062*	1.160
	(0.671)	(0.429)	(1.753)	(0.455)	(0.668)	(0.694)	(0.542)	(0.751)	(0.323)	(1.318)	(1.110)	(1.479)
Advertising	-1.143	-0.591	-2.529	1.269	-1.518*	-3.648**	-1.423	0.500	-0.102	-0.969	-3.275	-0.854
	(1.418)	(0.388)	(2.825)	(0.940)	(0.903)	(1.530)	(1.169)	(1.366)	(0.589)	(2.790)	(2.654)	(2.731)
R&D	0.501	0.580	-2.624*	-0.633**	0.037	-0.199	0.860	-0.760	0.457**	-3.890	2.337*	0.506
	(0.394)	(0.385)	(1.348)	(0.320)	(0.484)	(0.319)	(0.536)	(0.663)	(0.231)	(2.464)	(1.240)	(0.647)
Outsider CEO	-0.475	0.303	0.390	0.355	0.199	-0.103	-0.017	0.381	-0.120	0.645	-0.051	0.198
	(0.345)	(0.349)	(0.798)	(0.245)	(0.369)	(0.358)	(0.354)	(0.714)	(0.137)	(0.792)	(0.473)	(0.595)
Forced turnover	0.437	-0.224	0.060	-0.444**	0.045	-0.248	-0.329	0.241	-0.088	-0.479	0.481	-1.307**
	(0.278)	(0.199)	(0.653)	(0.187)	(0.262)	(0.254)	(0.248)	(0.326)	(0.149)	(0.655)	(0.401)	(0.662)
Tenure old CEO	0.003	0.009	0.028	0.005	0.024*	0.007	-0.0005	-0.004				
	(0.012)	(0.010)	(0.032)	(0.008)	(0.012)	(0.010)	(0.009)	(0.015)				

Outsider * tenure old CEO	0.039	-0.075*	0.096	-0.027	0.002	0.022	-0.020	-0.039				
	(0.029)	(0.043)	(0.062)	(0.020)	(0.026)	(0.033)	(0.025)	(0.075)				
Tenure new CEO							-0.010	0.017	-0.001	0.033	-0.006	-0.026
							(0.008)	(0.015)	(0.005)	(0.037)	(0.015)	(0.023)
Outsider * tenure new CEO							-0.014	-0.130**	-0.025	-0.053	-0.056	-0.027
							(0.046)	(0.057)	(0.027)	(0.086)	(0.082)	(0.069)
Intercept	-1.063	-0.760	-2.836	-2.386***	-0.830	-2.583*	0.602	-1.706**	-0.415	-1.068	-12.90	8.156
	(0.905)	(1.147)	(2.178)	(0.841)	(0.930)	(1.357)	(0.968)	(0.813)	(0.615)	(2.250)	(11.54)	(5.840)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Log-likelihood	246.6	96.44	44.69	51.15	55.34	47.56	-31.56	23.40	-63.47	37.70	113.3	85.17
N	373	141	326	244	390	224	424	171	467	132	315	237

Table 5a. Complete model with no taxes. Characteristics of the firm's corporate governance are now included in estimation of model [3]. In this round of analysis the benchmark marginal *q*, *h*, is presumed to be 1.00, corresponding to an absence of capital gains and dividends taxes. Industry fixed effects are included when possible. Standard errors are reported in parentheses. * denotes statistical significance at the 10% level; **, 5% level; and ***, 1% level.

	t-3 – t-2		**t-2 – t-1**		**t-1 – t**		**t – t+1**		**t+1 – t+2**		**t+2 – t+3**	
	q > 1.00	q < 1.00	q > 1.00	q < 1.00	q > 1.00	q < 1.00	q > 1.00	q < 1.00	q > 1.00	q < 1.00	q > 1.00	q < 1.00
Average Q	-0.049	0.005	-0.130	0.071	0.194*	-0.013	-0.223	-0.382*	0.459***	-0.412***	0.313***	-0.173
	(0.067)	(0.074)	(0.091)	(0.126)	(0.114)	(0.083)	(0.157)	(0.206)	(0.138)	(0.131)	(0.063)	(0.164)
Diversification	0.042	0.001	-1.057***	-0.195**	0.199	-0.070	-0.076	0.028	-0.277*	0.397***	-0.341***	0.057
	(0.128)	(0.053)	(0.227)	(0.079)	(0.247)	(0.044)	(0.160)	(0.178)	(0.166)	(0.0822)	(0.049)	(0.084)
PPE	-0.033	-0.032	-0.068	0.169**	-0.027	0.016	-0.121	-0.173	0.066	-0.903***	0.159***	-0.053
	(0.073)	(0.061)	(0.063)	(0.083)	(0.086)	(0.042)	(0.107)	(0.203)	(0.133)	(0.147)	(0.048)	(0.080)
Liquidity	-0.535*	-0.092	0.315	0.202	-0.345*	-0.016	-0.457	-0.807	-1.151**	-1.890***	-0.372***	-1.305***
	(0.308)	(0.187)	(0.282)	(0.215)	(0.203)	(0.118)	(0.375)	(0.825)	(0.458)	(0.375)	(0.136)	(0.287)
Leverage	0.726	0.367	-0.808	0.932	-3.243**	1.373***	-1.964	-0.801	-1.464	4.175***	1.698***	-0.522
	(0.786)	(0.423)	(0.602)	(0.648)	(1.576)	(0.373)	(1.520)	(1.363)	(1.456)	(1.217)	(0.376)	(0.806)
Advertising	1.482	0.396	-0.212	3.392*	1.511**	1.556	9.954***	3.356	-3.603	13.55***	4.340**	0.480
	(1.463)	(0.485)	(0.239)	(1.991)	(0.587)	(1.364)	(3.588)	(2.084)	(2.953)	(1.775)	(1.759)	(0.722)
R&D	-3.452**	-0.022	1.703*	-0.098	6.458**	-0.363	5.147**	-1.524	-0.581	19.50***	-5.184***	0.842
	(1.423)	(1.149)	(0.916)	(0.884)	(2.971)	(0.563)	(2.425)	(4.328)	(2.696)	(3.096)	(0.889)	(2.128)
Board size	0.241	-0.201	1.313**	-0.093	1.045	0.137	0.294	0.582	-0.699	-0.786***	-1.499***	-0.482*
	(0.894)	(0.196)	(0.665)	(0.198)	(1.754)	(0.161)	(0.986)	(0.654)	(0.579)	(0.235)	(0.243)	(0.270)
Classified board	-0.889*	-0.498		-0.952**	0.648	-0.082	1.252*	0.790	0.568	-2.517***		-0.007
	(0.496)	(0.361)		(0.484)	(0.961)	(0.277)	(0.760)	(1.270)	(0.979)	(0.724)		(0.355)

Board independence	-0.015	0.009	0.038	0.035	-0.046	0.047**	-0.012	0.034	-0.008	-0.397***	-0.291***	0.011
	(0.027)	(0.024)	(0.025)	(0.035)	(0.052)	(0.021)	(0.065)	(0.046)	(0.058)	(0.062)	(0.025)	(0.039)
Outsider CEO	0.311	-0.048	-0.027	-0.083	-0.476***	0.057	-0.296	0.366	-0.135	0.565***	-0.116*	-0.601***
	(0.236)	(0.091)	(0.129)	(0.111)	(0.166)	(0.089)	(0.258)	(0.249)	(0.223)	(0.150)	(0.064)	(0.189)
Forced turnover	-0.170	-0.100	0.566	-0.418	-0.313	0.443	0.655	1.267	0.780	1.907***	-6.375***	0.891*
	(0.417)	(0.495)	(0.518)	(0.464)	(1.584)	(0.302)	(1.052)	(1.120)	(1.105)	(0.655)	(0.626)	(0.505)
Tenure old CEO	0.014	-0.003	-0.030	0.017	-0.048**	0.002	0.104***	-0.002				
	(0.014)	(0.009)	(0.021)	(0.012)	(0.022)	(0.011)	(0.036)	(0.019)				
Outsider * tenure old CEO	0.157	0.023	0.131**	-0.023	-0.075	-0.007	-0.120	-0.012				
	(0.108)	(0.025)	(0.060)	(0.019)	(0.119)	(0.016)	(0.118)	(0.040)				
Tenure new CEO							0.030*	0.011	-0.016	-0.076***	-0.023***	-0.008
							(0.018)	(0.017)	(0.015)	(0.018)	(0.005)	(0.009)
Outsider * tenure new CEO							0.054	-0.046	-0.008	1.579***	0.179***	0.029
							(0.076)	(0.040)	(0.040)	(0.200)	(0.032)	(0.023)
Intercept	0.319	0.570	1.368	-0.889	2.078*	-1.848**	0.171	4.011	-0.586	-0.353	10.66***	1.433
	(0.799)	(1.181)	(0.984)	(1.188)	(1.140)	(0.727)	(1.383)	(4.415)	(1.744)	(0.935)	(1.007)	(1.061)
Industry FE	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Log-likelihood	20.95	70.72	70.67	37.22	49.14	47.79	49.58	49.76	35.38	38.99	57.86	36.62
N	22	78	43	65	41	72	61	54	80	38	34	78

Table 5b. Complete model with taxes. Characteristics of the firm's corporate governance are now included in estimation of model [3]. In this round of analysis the benchmark marginal *q*, *h*, is presumed to be 0.78, corresponding to the presence of capital gains and dividends taxes at the rates explained in Section 2. Industry fixed effects are included when possible. Standard errors are reported in parentheses. * denotes statistical significance at the 10% level; **, 5% level; and ***, 1% level.

	t-3 – t-2		**t-2 – t-1**		**t-1 – t**		**t – t+1**		**t+1 – t+2**		**t+2 – t+3**	
	q > 0.78	q < 0.78	q > 0.78	q < 0.78	q > 0.78	q < 0.78	q > 0.78	q < 0.78	q > 0.78	q < 0.78	q > 0.78	q < 0.78
Average Q	-0.072	0.025	0.339***	0.266	0.090	0.192**	0.345***	0.069	0.292***	-0.134	0.526***	-0.435
	(0.055)	(0.056)	(0.083)	(0.183)	(0.085)	(0.082)	(0.131)	(0.099)	(0.073)	(0.199)	(0.153)	(0.385)
Diversification	-0.149***	0.099	-0.146**	-0.260*	0.013	-0.034	0.057	-0.130**	-0.116*	-0.249	0.006	0.123
	(0.045)	(0.087)	(0.068)	(0.148)	(0.088)	(0.035)	(0.149)	(0.056)	(0.068)	(0.390)	(0.126)	(0.157)
PPE	0.091**	-0.340**	-0.157***	0.070	0.053	0.458***	-0.042	0.055	0.071	-0.368	-0.063	-0.249
	(0.040)	(0.164)	(0.049)	(0.150)	(0.059)	(0.087)	(0.092)	(0.067)	(0.062)	(0.418)	(0.120)	(0.218)
Liquidity	0.565***	-0.313	0.612***	-0.023	0.095	0.124	-0.084	0.783**	-0.542***	2.484	-0.135	-0.793
	(0.204)	(0.274)	(0.222)	(0.311)	(0.201)	(0.164)	(0.296)	(0.357)	(0.207)	(1.658)	(0.292)	(0.692)
Leverage	-0.096	0.202	1.937***	2.148**	-0.946	2.275***	-1.319	2.428***	-0.886	3.391	-0.527	6.215*
	(0.377)	(0.513)	(0.571)	(0.900)	(0.735)	(0.413)	(0.818)	(0.848)	(0.688)	(3.722)	(0.833)	(3.254)
Advertising	-1.030***	1.378	0.006	-0.279	1.098**	-2.245**	0.367	-1.549	-1.865	-4.284*	-5.635**	-0.560
	(0.304)	(1.501)	(0.349)	(2.501)	(0.434)	(1.128)	(1.087)	(1.151)	(1.426)	(2.461)	(2.722)	(1.809)
R&D	-1.034**	2.331	1.924	-0.488	4.441***	-1.591***	2.610	-6.413***	0.537	-16.46*	-1.105	1.546
	(0.497)	(1.449)	(1.192)	(1.674)	(1.717)	(0.406)	(2.105)	(1.808)	(1.449)	(8.607)	(2.330)	(5.275)
Board size	-0.016	0.079*	0.011	0.082	-0.036	-0.044***	0.018	0.071**	0.017	0.177	0.019	-0.028
	(0.018)	(0.042)	(0.022)	(0.069)	(0.030)	(0.017)	(0.044)	(0.036)	(0.029)	(0.173)	(0.044)	(0.084)
Classified board	0.332***	-0.037	-0.206**	0.432**	-0.044	0.242***	0.064	-0.254*	-0.061	2.084*	-0.210	-1.931**
	(0.085)	(0.119)	(0.096)	(0.174)	(0.098)	(0.059)	(0.198)	(0.155)	(0.118)	(1.143)	(0.166)	(0.789)

Board independence	0.806**	1.598**	0.334	0.408	1.243**	0.905***	0.966	-0.719	0.395	-1.500	0.795	1.195
	(0.366)	(0.711)	(0.434)	(0.597)	(0.567)	(0.253)	(0.779)	(0.499)	(0.502)	(2.296)	(0.928)	(1.190)
Outsider CEO	0.310	-0.232	-1.257***	-0.149	-0.569	0.362***	-0.476	1.550***	-0.297	1.511	0.269	0.080
	(0.189)	(0.274)	(0.330)	(0.240)	(0.474)	(0.135)	(0.564)	(0.539)	(0.225)	(2.925)	(0.444)	(0.961)
Forced turnover	0.989*	-0.159	-1.421	-1.520*	1.026**	0.112	0.529	-1.574**	0.094		0.837	3.991
	(0.544)	(0.244)	(2.319)	(0.836)	(0.460)	(0.340)	(0.560)	(0.672)	(0.428)		(1.266)	(2.599)
Tenure old CEO	0.016**	0.006	-0.015	-0.013	0.0004	0.027***	-0.010	-0.024*				
	(0.007)	(0.009)	(0.010)	(0.016)	(0.009)	(0.009)	(0.016)	(0.013)				
Outsider * tenure old CEO	-0.017	0.041	0.234***	0.020	0.030	-0.007	-0.047	-0.121***				
	(0.016)	(0.057)	(0.047)	(0.020)	(0.052)	(0.013)	(0.056)	(0.039)				
Tenure new CEO							-0.021*	-0.012*	-0.006	0.073*	0.004	-0.036
							(0.013)	(0.007)	(0.007)	(0.043)	(0.011)	(0.028)
Outsider * tenure new CEO							0.016	-0.001	-0.002	-1.276	0.009	-0.362
							(0.029)	(0.048)	(0.017)	(2.125)	(0.025)	(0.250)
Intercept	-1.189**	0.056	0.665	-1.382	-0.522	-3.939***	-0.579	-1.052	-0.585	-0.468	-2.910	-4.956
	(0.596)	(0.870)	(0.647)	(1.302)	(0.715)	(1.225)	(1.267)	(0.708)	(0.844)	(4.142)	(2.134)	(3.604)
Industry FE	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes
Log-likelihood	77.79	33.25	45.85	43.52	57.19	57.48	19.98	20.26	9.019	13.15	44.04	46.86
N	73	27	67	41	73	40	92	23	94	24	66	46

Figure 1. Distribution of estimated marginal *q*'s by window
This figure illustrates the dispersion of estimated marginal *q*'s across three-year time windows.