

Coworker Complementarity and the Stability of Top-Management Teams

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We analyze changes in the composition of top management teams when a key member of the team (the chief executive officer [CEO]) departs. We find that the probability of non-CEO top manager turnover increases markedly around times of CEO turnover. Further, the magnitude of this increase depends on the relations between the tenure of the manager and tenures of the departing and incoming CEOs. Departure of a long-tenured CEO has a larger effect on turnover probability for a long-tenured non-CEO manager than for a short-tenured manager. Succession of a long-tenured manager as CEO has a larger effect on turnover probability for a short-tenured non-CEO manager than for a long-tenured manager. We argue that these findings are at least partially the result of complementarities across these groups of coworkers that affect the value of employment relationships between senior executives and firms.

1. Introduction

People do not work in isolation. Most employees create value by combining their efforts and talents with those of other individuals at the firm. Doing so is most valuable if individuals work with others who complement them.

In this paper, we explore the implications of coworker complementarity for the stability of work groups in firms. We first show that when one of a complementary pair of employees leaves the firm, the probability that the other leaves the firm increases. That is, complementarity implies contemporaneous

We are grateful to the American Compensation Association's Emerging Scholars Program and the General Motors Center for Strategy Research at Kellogg for support. Thanks to Charles Himmelberg, Kevin Hallock, three referees, and various seminar participants for comments, and to Kevin Hallock for generously sharing his data on layoff announcements by Fortune 500 firms. This work was completed while Hayes and Schaefer were at the University of Chicago Graduate School of Business and the Kellogg School of Management at Northwestern University, respectively. We thank those institutions for their support.

The Journal of Law, Economics, & Organization, Vol. 22, No. 1,
doi:10.1093/jleo/ewj002

Advance Access publication November 2, 2005

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association in employee turnover. We then show that the magnitude of this change in the probability of turnover depends on the strength of complementarities with the departing and incoming employees. Specifically, when one employee leaves, the resulting change in the probability that another employee leaves increases in the strength of the complementarity between them. Further, this change in probability is decreasing in the strength of the complementarity between the employee and the departing employee's replacement.

We examine these implications empirically using data on teams of top managers. Our analysis centers on relationships between firms' chief executive officers (CEOs) and other members of top management teams. To motivate this exercise, we offer the following simple facts: The unconditional likelihood of non-CEO managerial turnover is 13.8%, which rises to 17.7% in years when there is contemporaneous CEO turnover, and to 24.4% when the incoming CEO has been employed by the firm for five years or less.¹ We perform a detailed empirical analysis of the relationship between CEO turnover and departures of other senior executives. We consider how various theoretical models may relate to the empirical patterns, including the hypothesis that coworker complementarity affects the value of managers' employment relationships.

Our main empirical strategy is to estimate a series of logit models that allow the probability of a manager leaving the firm to depend on characteristics of the firm, the manager, and the firm's CEO. We present three main empirical findings. First, the probability of non-CEO turnover rises markedly around times of CEO turnover. Second, this increase in non-CEO turnover around times of CEO turnover—a quantity we refer to as the **CEO/manager turnover association (CMTA)**—depends on the relation between the tenures of the manager and the departing CEO. Specifically, we find that the departure of a long-tenured CEO has a larger effect on turnover probability for a long-tenured non-CEO manager than for a short-tenured manager. Third, the CMTA depends on the relation between the tenures of the manager and the incoming CEO, but in the reverse direction. Succession of a long-tenured manager as CEO has a larger effect on turnover probability for a short-tenured non-CEO manager than for a long-tenured manager. We argue that these results are largely consistent with the hypothesis of complementarities across individuals within top management teams.

Coworker complementarity is not the only theory that can predict contemporaneous turnover among members of top management teams. Other explanations include learning models, where corporate boards use correlated signals to update beliefs regarding executives' abilities; tournaments; and models where executives' skills complement a particular strategy or set of business practices. These are all potentially important, and we offer some evidence of their empirical relevance. We do not find strong evidence in favor of the learning-model or tournament hypotheses, and conclude that these models

1. Throughout the paper, we refer to employees who do not hold the position of Chief Executive Officer as "managers" and employees who do hold the chief executive officer position as "CEOs." We reserve the term "executive" to refer to members of both groups.

cannot easily explain all the empirical patterns unless one also allows for complementarities across coworkers. The last class of models (strategy-specific skills) differs from coworker complementarity in subtle ways, making it somewhat difficult to distinguish the two models empirically. We do, however, discuss some additional implications of the strategy-specific skills hypothesis, and find that these are not supported by the data.

We conclude that patterns in top-management turnover seem to be consistent with coworker complementarity, but that other factors may play a role as well.

We highlight several potential contributions of this work. First, we believe our paper to be the first to quantify the effects of complementarities across specific individuals within firms.

Numerous previous studies have documented the value of having employees share information and work together. Gant et al. (2002), for example, study the sharing of information across jobs within a production process but do not consider whether the identities of specific employees within those jobs affect group productivity. Second, while there is a large body of work on the implications of firm-specific human capital, relatively little has been done to identify the actual sources of firm-specific aspects of individual productivity. Our results suggest that some firm specificity may derive from complementarities with the firm's other employees. Third, while the large literature on CEO turnover has documented significant links between firm performance and the likelihood of CEO departure (Warner et al., 1988; Barro and Barro, 1990) and between board composition and CEO departure (Weisbach, 1988), research in this field has not, to date, carefully examined employment outcomes among a firm's top non-CEO managers.² Fourth, more recent work in corporate finance shows that various forms of organizational change are more common after changes in the CEO position (see, e.g., Weisbach, 1995; Denis and Denis, 1995; and Mulherin and Poulsen, 1998). Our results suggest that managerial turnover is yet another dimension on which organizational changes are associated with CEO changes, and that implementation of organizational changes stemming from CEO turnover may require changes in the incumbent top-management team. Like this earlier work on the relation between CEO changes and other organizational changes, our analysis leaves the question of causality unresolved; that is, we establish only that CEO and non-CEO turnover are associated, but we do not empirically identify whether CEO turnover causes non-CEO turnover or vice versa. Given our hypothesis of complementarity, causality could run in either direction.

The three studies most comparable to ours are Helmich and Brown (1972), Wruck and Wruck (2002), and Fee and Hadlock (2004). Helmich and Brown studied 208 changes in the president position for evidence of associated turnover among other executives. They find an association between outside

2. Most existing work on employment outcomes for non-CEO managers use this form of turnover as simply a broader indicator of change at the top of the organization. See Furtado and Rozeff (1987), Warner et al. (1988), Kaplan (1994a,b), Denis and Denis (1995), and Mikkelsen and Partch (1997).

succession and turnover among other executives but make no comparison between firms experiencing turnover in the president position and firms experiencing no turnover in this position. Wruck and Wruck (2002) studied the formation of multiple groups of top managers from within a single firm after a part of that firm has been spun off. They show that a top operating manager from the part of the firm that has been spun off is often teamed with an executive with “governance expertise” from the rest of the firm. This suggests a complementarity across operational and governance skills within top-management teams.

In a contemporaneous paper, Fee and Hadlock (2004) also show that managerial turnover is significantly higher near the time of CEO change. They interpret their results as consistent with both a “team-specific human capital” model and a model in which signals of managerial performance are correlated. Our study (which makes use of a broader sample) leads us to conclude that the correlated-signals model does not appear to be an important driver of the relationship between CEO and managerial change. Our analysis also differs from theirs in that we examine the characteristics of managers who join and depart top management teams, and explore the interactions among those characteristics for evidence consistent with coworker complementarity. Fee and Hadlock instead emphasize how departure from a top-management team affects an executive’s subsequent career. Thus, we view their paper as a study of labor market outcomes for non-CEO executives, and ours as an analysis of factors affecting the composition of productive groups within organizations.

Finally, we note that our analysis is similar in spirit to that found in the large literature on the dynamics of job changes in labor markets. There, matching and specific-skill acquisition offer potential explanations for the fact that the probability of job change is inversely related to the employee’s tenure with the firm. While the empirical patterns are largely consistent with this explanation, the literature has not, to date, offered convincing direct evidence in favor of these hypotheses (Farber, 1999). Our analysis, which relies on matching or specific-skill acquisition to predict a positive CMTA, suffers from a similar limitation. While we argue that the patterns in the data appear consistent with coworker complementarity, the difficulty of directly measuring such complementarities precludes a sharper test.

The remainder of our paper proceeds as follows: In Section 2, we develop a simple model of coworker complementarity and use it to generate empirical predictions. We describe our data and present our empirical analysis in Section 3. In Section 4, we discuss other theories that can predict a positive CMTA and consider how well these models explain the empirical patterns. We conclude in Section 5.

2. Coworker Complementarity and Turnover

In this section, we use a stylized model to derive implications of coworker complementarity for managerial turnover. In the model, two managers are complementary because they generate more value when working together than

when they work separately. We take a broad view of this complementarity and note that it could arise from a number of sources, including (but not limited to) the following:

- Executives may be endowed with skills that are complemented by those of another executive. For example, an executive with operational skills may be well matched with another whose talents lie in setting strategic direction.
- Executives may be endowed with personality traits or management philosophies that are compatible and facilitate productive interactions. For example, an executive who prefers to delegate important tasks to subordinates might have difficulty working with another who prefers centralizing all authority. Executives may be most productive when working with others who have similar styles.
- Executives may learn to work with each other over time, developing a stock of human capital that is specific to coworkers.³ As an illustration of these effects from the management literature, Vancil (1987:119) emphasizes the importance of “cohesion” among a members of a top-management team. As the team members “work together, discussion becomes more efficient, a common database and shared jargon evolve, and biases become clear. Managers who have been through many wars together can handle a heavy agenda because they need not waste a lot of time trying to understand each other.”
- Executives may enjoy working with their friends. This on-the-job consumption increases the surplus in the relationship between a group of executives and the firm that employs them.

To develop the implications of co-worker complementarity, we consider a firm that must employ two executives. Let $f: M \times M \rightarrow R$ be a function mapping the identities of the firm’s executives to the surplus (gross of wages) generated through their joint efforts. We interpret the surplus f as including both profits and any nonpecuniary benefits accruing to the executives themselves.⁴ Executives $m_1, m_2 \in M$ complement each other if the marginal productivity of executive m_2 increases when he is paired with executive m_1 (and vice versa). Let executives $m_i, m_j \in M$ be the best alternatives to executives m_1 and m_2 , respectively. Then, m_1 and m_2 strictly complement each other if

$$f(m_1, m_2) - f(m_1, m_j) > f(m_1, m_2) - f(m_i, m_j). \quad (1)$$

3. Parrino (1997) analyzes how career outcomes for top managers are affected by accumulation of specific human capital.

4. Note that the question of who captures this surplus directly—the firm through higher profits or the employees through on-the-job consumption—is irrelevant for consideration of which employment relationships are efficient. Wages can presumably adjust to reflect bargaining over the quasi-rents arising from the complementarities.

In words, this inequality states that the change in surplus associated with the replacement of executive m_j with executive m_2 is greater when m_2 is paired with m_1 .

Now consider the effect of this complementarity on executive turnover. It is efficient for the firm to employ an executive if the surplus generated by the employment match exceeds that of any other employment match.⁵ Thus, conditional on employing executive m_1 , it is efficient for the firm to employ executive m_2 if

$$f(m_1, m_2) - u_2 > f(m_1, m_j) - u_j,$$

where u_i denotes the outside utility for executive m_i . If the firm employs executive m_i instead of m_1 , then it is efficient for the firm to employ executive m_2 if

$$f(m_i, m_2) - u_2 > f(m_i, m_j) - u_j.$$

To derive an empirical model from these relations, let u_2 be a random variable with cumulative distribution function G . Suppose further that the firm employs executives m_1 and m_2 in period t . Conditional on employing executive m_1 in period $t + 1$, the probability of turnover from t to $t + 1$ for executive m_2 is given by

$$1 - G[f(m_1, m_2) - f(m_1, m_j) + u_j].$$

In words, executive m_2 will leave the firm if the value of his outside opportunity increases sufficiently so that the period t employment match is no longer efficient.⁶ If executive m_1 is not employed in period t , then the probability of turnover from t to $t + 1$ for executive m_2 is given by

$$1 - G[f(m_i, m_2) - f(m_i, m_j) + u_j].$$

Thus, the change in the probability of executive m_2 's departure when executive m_1 departs is

$$G[f(m_1, m_2) - f(m_1, m_j) + u_j] - G[f(m_i, m_2) - f(m_i, m_j) + u_j]. \quad (2)$$

If G is strictly increasing, it is straightforward to show that if m_1 and m_2 are complements, then the probability of executive m_2 's departure is strictly higher when executive m_1 departs. The intuition for this result is this: Executive m_2 should be employed by the firm if this employment match is efficient. If executive m_1 departs, then the value created by executive m_2 when employed by this firm falls because of the lost complementarity between the two executives. This increases the likelihood that the match between the firm and executive

5. Note that simple switching costs and information asymmetries associated with search can lead to complementarities between matched executives. The surplus function f should be interpreted as reflecting these costs.

6. This outside opportunity can be interpreted as leisure rather than work. It is efficient for an employment relationship to end in a "retirement" when the value of the employee's leisure time is sufficiently high.

m_2 is no longer surplus maximizing, and hence increases the likelihood of turnover. This relation holds in the reverse direction as well; departure of executive m_2 leads to an increased likelihood of executive m_1 's departure. This framework therefore predicts contemporaneous association in turnover among complementary executives. Interpreting m_2 as a non-CEO manager and m_1 as a CEO, our discussion suggests that the change in the probability of non-CEO/manager turnover around times of CEO turnover—a quantity we define as the turnover association (CTMA)—should be positive.⁷ This observation forms our first testable hypothesis.⁸

We develop our second and third hypotheses by refocusing on the inequality in (1). The left-hand side of this inequality is the change in surplus when matching executive m_2 rather than executive m_j with executive m_1 . Economically, it can be interpreted as the effect of executive m_2 's presence on executive m_1 's productivity; this term therefore represents the quality of the match between executive m_2 and executive m_1 . It immediately follows that the CMTA, that is, the expression in (2), increases in $f(m_1, m_2) - f(m_1, m_j)$. This comparative static leads to our second hypothesis: Holding all else fixed, the CMTA should increase in the strength of the complementarity between the manager and the departing CEO.

The right-hand side of the inequality in (1) is the increase in surplus when matching executive m_2 rather than executive m_j with executive m_i . It is the effect of executive m_2 's presence on executive m_i 's productivity, and represents the quality of the match between these two executives. The CMTA decreases in $f(m_i, m_2) - f(m_i, m_j)$, leading to our third hypothesis. Holding other factors constant, the CMTA should decrease in proportion to the complementarity between the manager and the incoming CEO.

To put our second and third hypotheses to the data, we need a means for assessing the strength of the complementarity between executives. Here, we reference the search-theoretic literature on job changes in labor markets. The key implication of such models is that match quality should be positively related to job tenure. Jovanovich (1979b), for example, studies a model in which match quality is uncertain *ex ante*. Workers and firms search for good matches, and both parties learn over time about match quality. Bad matches are dissolved, while good matches persist. Hence, match quality is positively related to job tenure. Parsons (1972) and Jovanovich (1979a) study models in which workers invest in firm-specific skills. These investments increase the

7. Note that if we could identify instances of exogenous CEO turnover, then we could directly estimate the quantity in (2), i.e., the increase in the probability of a non-CEO's departure caused by the departure of a CEO. However, because of the potential for reverse causality, it is not appropriate to interpret our CEO/manager turnover association as measuring a causal relation. We did experiment with an instrumental variables strategy; see Section 4.1.

8. Focusing on complementarities between CEOs and non-CEO managers seems natural given most firms' hierarchical reporting structures. While the relationship between the CEO and each individual non-CEO would seem to be important, it is less clear that each manager-to-manager relationship is important. Our reasoning, however, can apply equally well to any two employees of a firm. We do briefly examine manager-to-manager complementarity in Section 3.3.

quality of the match between workers and firms (because they raise the employee's productivity inside the relationship but not outside) and therefore offer another reason why match quality should be positively related to job tenure. A large literature, summarized by Farber (1999), documents that the probability of job changes is inversely related to tenure, consistent with the hypothesis that match quality increases in observed tenure.

Applying this reasoning to our context, we argue that the quality of a match between two executives should increase depending on the amount of time the two managers have worked together. This effect could arise either from search with *ex ante* uncertain match quality or from investments in coworker-specific human capital. Suppose, for example, that executives start off uncertain as to whether their skills will complement each other, whether their management styles are compatible, or whether they enjoy working together. If they learn over time about the strength of these complementarities, then good matches will persist, while bad matches will not. Executives could also find that their joint productivity grows as they learn to work together; this also suggests that manager-to-manager complementarity should be positively related to time spent working with each other.

3. Empirical Analysis

3.1 Data

To conduct our empirical analysis, we augment the standard data source used in studies of top-management compensation with a number of hand-collected data items. Compustat's ExecuComp is a panel data set consisting of detailed information on executive compensation for a broad cross-section of firms from 1994 to 2000. Throughout our sample period, publicly traded firms in the United States were required to disclose (in their proxy statements) the identity and pay of (1) all individuals serving as CEOs for any part of the year, (2) the next four most highly paid executive employees if their pay exceeded \$100,000, and (3) up to two other individuals for whom disclosure would have been provided had the individual been an employee of the firm at the end of the fiscal year. Consequently, these disclosures provide a snapshot of the identities and pay levels of each firm's top executives at a given point in time. To facilitate interfirm comparability, we select the executive listed by ExecuComp as CEO and the next four most highly paid executives and refer to this set of executives as the firm's group of "proxy-named executives."⁹

9. ExecuComp makes a practice of "filling in" pay information for managers who did not appear in firms' proxy statements in a given year. If, for example, a manager appears in a firm's year t proxy statement and the firm reports pay information retroactively for years $t - 1$ and $t - 2$, then this manager will often be included by ExecuComp in the list of $t - 1$ and $t - 2$ managers for that firm. Using the entire ExecuComp sample (which includes these filled-in executives) would bias our results, because a manager can be filled in for year $t - 1$ only if he or she does not leave the firm from year $t - 1$ to t . Restricting attention to only the CEO and the four highest-paid managers omits these cases.

We augment this data by hand-collecting information regarding each executive's age and employment history from firms' annual reports. The Securities and Exchange Commission (SEC) requires firms to identify executive officers and certain other "significant" employees annually. We refer to the list of executives and other significant employees disclosed in a given year as the firm's "executive officer group," and we note that SEC rules require the group of proxy-named executives to be a subset of the executive officer group. For each employee in the executive officer group, we can observe whether that employee has been with the firm for at least five years, and if not, how long the employee has been with the firm. We define a variable *Tenure* < 5 years, where a value of 1 is assigned if the executive has been an employee of the firm for less than five years, and a value of 0 otherwise.¹⁰

In addition to collecting age and experience information, we use the executive officer group to devise a measure of executive turnover. Constructing a turnover measure using only the list of proxy-named executives is problematic because of the pay-rank criteria for inclusion in the proxy. The criteria for inclusion in a firm's executive officer group are, however, unrelated to pay levels.¹¹ While it is possible that an employee could be present in a firm's executive officer group in year t and remain an employee of the firm but drop out of the executive officer group in year $t + 1$, this can happen only if there is a substantial change in the functions performed by that employee.¹² For each executive i listed in firm j 's year- t group of proxy-named executives, we define turnover as follows:

$$\text{Non-CEO Manager Turnover}_{it} = \begin{cases} 0 & \text{if executive } i \text{ is listed in firm } j\text{'s} \\ & \text{year } t + 1 \text{ executive officer group} \\ 1 & \text{otherwise.} \end{cases}$$

We apply a different definition for CEO turnover, because an executive can leave the CEO position but still remain a member of the executive officer group. For each firm j and year t , we define CEO turnover as follows:¹³

10. In defining this variable, we take the length of time since the employee first became an employee of the firm. If, for example, an executive joined a firm as an employee in 1983, retired as an employee in 1994, but remained on the firm's board of directors, and then became an employee again in 1996, then we would record this employee's 1996 tenure as 13 years.

11. The group of executive officers, as defined in Rule 405 of the Securities Act of 1933, refers to employees who are "in charge" of a unit, division, or function, or perform a "policy making function." In our data, there are 6149 cases where a manager leaves a firm's group of proxy-named executives. In 4111 of these, the manager also left the firm's executive officer group.

12. There are cases where a manager leaves the executive officer group but remains a nonemployee director of the firm. There are no cases where a manager is present in the executive officer group in year t and $t + 2$, but not year $t + 1$.

13. Because ExecuComp occasionally lists a CEO who left during year t as the year- t CEO, we hand-checked each CEO departure to ensure matching the departure to the correct fiscal year.

Table 1. Executive-Level Summary Statistics

	CEOs	Non-CEO Managers
Executive-years	8,122	29,784
Annual rate of turnover	10.3%	13.8%
Annual rate of turnover conditional on contemporaneous CEO turnover		17.7%
Annual rate of turnover conditional on incoming CEO tenure < 5 years		24.4%
Age		
Mean	55.5	50.6
Median	55	51
SD	7.49	7.54
Tenure < 5 years		
Mean	0.17	0.31
Salary + bonus (\$000)		
Mean	1,180	554
Median	850	405
SD	1,797	630
Shares owned as a fraction of total shares outstanding (%)		
Mean	3.15	0.43
Median	0.40	0.04
SD	6.97	2.13

CEO = chief executive officer.

$$\text{CEO Turnover}_t = \begin{cases} 0 & \text{if the executive listed as firm } j \\ & \text{CEO at the end of year } t \text{ is still} \\ & \text{listed as CEO at the end of year } t + 1 \\ 1 & \text{otherwise.} \end{cases}$$

Our final sample consists of 8122 firm-years and 37,906 executive-years.¹⁴ We present summary statistics for employee-level variables in Table 1 and for firm-level variables in Table 2. Notably, the raw data on managerial turnover appear to offer strong support for our first hypothesis. Table 1 reports that while the unconditional rate of non-CEO managerial turnover is 13.8%, this rate jumps by nearly a third, to 17.7%, in years where there is also CEO turnover. If the incoming CEO has been with the firm for less than five years, this rate jumps to 24.4%. We turn next to assessing this CMTA using regression analysis.

3.2 The CEO/Manager Turnover Association

We begin by documenting factors that are related to the probability of executive turnover. In Table 3, we present results from estimating a series of logit

14. We were able to hand-collect complete age and employment history information for more than 96% of the executive-years in the original ExecuComp sample. Missing age and experience data are due primarily to missing annual reports on the SEC or 10kwizard web sites. Also, to limit the potential effect of outliers in our data, we drop the lowest and highest 1% of market and accounting returns. Inclusion of these firms in our analysis has no qualitative effect on our findings. We also drop firm-years where there is CEO turnover as a result of a merger or spinoff.

Table 2. Firm-Level Summary Statistics

	Mean	SD	Median	Minimum	Maximum	<i>N</i>
Total assets (millions)	\$8,550	\$32,361	\$1,253	\$14	\$717B	8,122
Return on assets (%)	4.85	6.79	4.62	-40.00	24.00	
Shareholder return (%)	18.1	43.5	12.2	-65.9	250.0	
Size of proxy-named executive group	4.88	0.44	5	2	5	

models where the dependent variable is a measure of executive turnover. In column (1), we use our indicator for CEO turnover as the dependent variable. In columns (2) through (4), we use non-CEO managerial turnover as the dependent variable.

We include characteristics of both the firm and the individual executive as independent variables. Firm-level variables include log assets, indicator variables for industry at the two-digit Standard Industrial Classification (SIC) code level, year indicators, indicators for the number of employees in the firm's group of proxy-named executives, and measures of industry-adjusted firm performance. To construct our measures of IAFP, we begin with the firm's shareholder return (RET) and return on assets (ROA) (which ExecuComp defines as net income before extraordinary items and discontinued operations divided by total assets) in year t . We adjust for industry effects by subtracting the median values of stock return and ROA, respectively, in that two-digit SIC industry in that year, dropping industry-years for which we have fewer than five firms.¹⁵ We then construct indicator variables based on percentiles of industry-adjusted firm performance. For ease of presentation, we present regressions that include indicator variables for quintiles of industry-adjusted firm performance.¹⁶

Executive-level variables include the fraction of the firm's common stock owned by the executive, indicators for the executive's rank (first through fifth) in salary and bonus compensation among the firm's group of proxy-named executives, an indicator for firm tenure less than five years, and indicators for four age categories: below 55, 55 to 63, 64 to 66, and over 66.¹⁷ Coefficients estimated by logit models are difficult to interpret economically, so we instead present the derivative of the probability of CEO turnover with respect to each independent variable.¹⁸ For indicator variables, we present the predicted change in the probability that the dependent variable changes from

15. All results are robust to using means, rather than medians, in computing industry adjustments.

16. An alternative would be to include industry-adjusted stock return and return on assets linearly in our regression. Our approach estimates a more exible relationship between firm performance and the likelihood of executive turnover. Our qualitative findings are invariant to this specification choice. Results are also robust to using deciles of firm performance.

17. We allow the ages 64 through 66 to be a separate category because many executives retire at around age 65. We experimented with various ways of defining age categories but found similar effects.

18. Probability derivatives are calculated at the median executive and firm characteristics and modal year and the SIC code. For example, median manager age is 51 years, so we compute probability derivatives (for variables other than the age category indicators) by setting the indicator for the under-55 age category equal to 1, and indicators for the 55-to-63 and over-66 66 categories to 0.

Table 3. Determinants of Executive Turnover

	CEO Turnover		Non-CEO Managerial Turnover	
	(1)	(2)	(3)	(4)
First ROA quintile	0.030 (2.13)	0.024 (4.24)	0.022 (4.11)	0.017 (2.76)
First RET quintile	0.065 (3.91)	0.022 (4.29)	0.019 (3.92)	0.020 (3.36)
Age less than 55	-0.290 (7.03)	-0.277 (9.44)	-0.267 (9.16)	-0.209 (6.78)
Age between 55 and 63	-0.243 (6.75)	-0.215 (7.95)	-0.208 (7.74)	-0.153 (5.45)
Age greater than 66	-0.139 (3.93)	-0.149 (4.64)	-0.145 (4.56)	-0.110 (3.36)
Fraction ownership	-0.004 (3.85)	-0.008 (4.69)	-0.007 (4.63)	-0.007 (3.60)
CEO tenure < 5 years	-0.005 (0.54)	0.042 (5.60)	0.040 (5.55)	0.031 (3.87)
Manager tenure < 5 years		0.009 (0.42)	0.007 (0.35)	0.029 (0.79)
(Manager tenure < 5 years) × (Age less than 55)		0.006 (0.10)	-0.001 (0.02)	-0.051 (0.53)
(Manager tenure < 5 years) × (Age between 55 and 63)		0.042 (0.63)	-0.035 (0.53)	-0.086 (0.89)
(Manager tenure < 5 years) × (Age greater than 66)		0.116 (1.45)	-0.110 (1.41)	-0.120 (1.07)
CEO age less than 55		0.028 (4.74)	0.031 (5.43)	0.022 (3.24)
CEO age between 55 and 63		0.017 (3.08)	0.019 (3.71)	0.012 (1.87)
CEO age greater than 66		-0.004 (0.57)	-0.002 (0.30)	-0.006 (0.79)
(Manager tenure < 5 years) × (CEO tenure < 5 years)		-0.042 (4.64)	-0.041 (4.69)	-0.035 (2.88)
CEO turnover			0.044 (6.44)	0.046 (6.45)
<i>N</i>	8,122	29,784	29,784	17,428

CEO = chief executive officer; ROA = return on assets; RET = shareholder return.

The column (1) dependent variable is an indicator for whether the CEO leaves the CEO position from year t to year $t + 1$. The columns (2) through (4) dependent variables are indicators for whether the manager leaves the firm's list of executive officers from year t to year $t + 1$. Parameters are probability derivatives. Robust asymptotic t -statistics, adjusted for within-firm correlation, are in parentheses. Regressions include log assets, indicators for the executive's compensation rank, the number of executives listed in the firm's proxy statement, year, two-digit SIC industry, and the second, fourth, and fifth quintiles of industry-adjusted firm performance. Columns (3) and (4) include indicators for whether the manager became CEO in year $t + 1$. "CEO turnover" in column (3) indicates contemporaneous CEO turnover, while in column (4) it indicates contemporaneous or prior-year turnover.

0 to 1 as the indicator changes from 0 to 1. Reported z -statistics apply to the computed probability derivative, not to the logit coefficient itself.¹⁹

19. As Ai and Norton (2003) point out, it is important to take care in assessing the magnitude and statistical significance of interaction terms in logit models. Signs and significance of logit coefficients can differ markedly from those of the implied probability derivatives due to the non-linearity of the logit model.

From column (1), we see that age and firm performance are associated with CEO turnover. The omitted categories for our firm-performance variables are the third (middle) quintiles; thus, the positive and significant coefficients on “First ROA quintile” and “First RET quintile” indicate that CEO turnover is more likely when the firm performs poorly relative to other firms in its industry. CEO turnover is 3.0 (6.5) percentage points more likely when the firm’s ROA (RET) is in the first quintile as compared with the third. While we omit from the table the coefficients on the remaining quintile indicators, we find that firms in the second quintile of stock performance are more likely by 2.6 percentage points (p -value = 0.03) to experience CEO turnover. The coefficients on none of the other performance variables are statistically larger than 0. Our omitted age category is 64 to 66, so results indicate that CEOs become more likely to turn over as they get older. As many authors have found, CEOs are most likely to turn over when around the standard retirement age. CEOs who hold smaller percentage ownership stakes in their firms are also more likely to turn over.²⁰

In column (2), we run a similar specification for non-CEO managers but add a number of independent variables pertaining to the firm’s CEO, including CEO age categories, a variable for whether the CEO’s tenure with the firm is less than five years, and a CEO/manager tenure interaction. We find that these managers are more likely by 2.4 and 2.2 percentage points to turn over when firm performance drops from the third to the first quintile of ROA and RET, respectively. Again, we find that turnover is significantly more likely when the firm is in the second stock return quintile compared with the third (by 0.8 percentage points; p -value = 0.07) and that none of the other firm-performance indicators are significantly positive. The age-category variables matter for these managers in much the same way they do for CEOs. The probability of managerial turnover is significantly higher when the firm’s CEO has been with the firm for less than five years. This effect, however, holds for only those managers who have been with the firm for more than five years. Specifically, a manager who has more than five years tenure with the firm is 4.2 percentage points more likely to turn over when the firm’s CEO has less than five years tenure compared with when the firm’s CEO has more than five years tenure. However, the probability of turnover for a manager with less than five years tenure with the firm is unrelated to the CEO’s tenure with the firm. (That is, we cannot reject the hypothesis that the coefficients on “Manager tenure < 5 years” and “(Manager tenure < 5 years) × (CEO tenure < 5 years)” sum to 0.) Column (2) also shows the probability of managerial turnover to be higher when the firm’s CEO is young.

20. We also tried including the value of restricted stock and unexercisable options held by an executive. Coefficients on these variables were not statistically distinguishable from zero, and our other inferences were unaffected by their inclusion. While such grants are presumably made to increase the cost to employees of leaving the firm, their obvious endogeneity complicates the interpretation of these regression coefficients.

In column (3), we add the CEO turnover variable. The coefficient on this variable is the increase in the probability of managerial turnover when there is CEO turnover, compared with the case of no CEO turnover. It is therefore the *ceteris paribus* calculation of the CMTA we defined above.²¹ We find that CEO turnover from year t to year $t + 1$ is associated with an increase of 4.4 percentage points in the likelihood of managerial turnover. This coefficient estimate is significantly different from zero at better than the 1% level. The unconditional likelihood of managerial turnover is 13.8%, so CEO turnover is associated with an increase by one-third in the likelihood of managerial turnover. We conclude that the contemporaneous CMTA is both economically and statistically significant.²²

Finally, in column (4) we broaden our definition of CEO turnover to take value 1 if the firm experienced CEO turnover from year $t - 1$ to t or from year t to year $t + 1$. In this regression, we also drop all managers who were new to the firm in year t . The coefficient on CEO turnover therefore reflects the increase in the likelihood of year t to $t + 1$ managerial turnover when there was contemporaneous or prior-year CEO turnover, conditional on the manager having been in the group of proxy-named executives at the start of the prior year. The coefficient on CEO turnover remains positive and significant at far better than the 1% level. Our estimates suggest that CEO turnover in the contemporaneous or prior year increases the likelihood of managerial turnover by 4.6 percentage points. We also estimated more flexible specifications that allow contemporaneous and prior-year CEO turnover to have different effects on managerial turnover. We were unable to reject the hypothesis that the effects of contemporaneous and prior-year CEO turnover are the same. These two effects do differ significantly from the effect of year $t - 2$ to $t - 1$ CEO turnover (as we found in unreported specifications). It appears, therefore, that the effect of CEO turnover on the likelihood of managerial turnover persists for a period of around two years.

We conclude that columns (3) and (4) of Table 3 offer strong support for our first hypothesis from Section 2—that CMTA is positive. In addition, we find that CMTA appears to have a duration of about two years and is both statistically and economically significant.

21. We also add an indicator for whether the manager takes over as CEO. This indicator perfectly predicts the dependent variable (remaining in the executive officer group), so inclusion of this variable has the effect of dropping those executive-years where the manager becomes the firm's CEO the following year. Hence, the correct interpretation of the coefficient on CEO turnover is the following: Conditional on the manager not being selected as the new CEO, how much does the likelihood of turnover increase when there is CEO turnover?

22. This, and all our main results, are robust to a number of alternative specifications. In an earlier version of this paper, we took the firm (rather than the individual manager) as the unit of analysis and estimated a series of ordered logit models where the dependent variable was the number of managers who turned over in a given year. Also, we estimated a model with firm fixed-effects (see Chamberlain, 1980) to verify that our results are not driven by firm-level heterogeneity in rates of managerial turnover.

Table 4. Executive Characteristics and the CEO/Manager Turnover Association

	Contemporaneous CEO Turnover			Contemporaneous & Prior-Year CEO Turnover		
	(1)	(2)	(3)	(4)	(5)	(6)
CEO turnover	0.044 (5.47)	0.043 (5.94)	0.023 (3.24)	0.047 (5.93)	0.044 (6.12)	0.029 (4.40)
(CEO turnover) × (Manager tenure < 5 years)	0.017 (1.14)			0.012 (0.86)		
(CEO turnover) × (Departing CEO tenure < 5 years)		0.027 (1.30)			0.031 (1.71)	
(CEO turnover) × (Incoming CEO tenure < 5 years)			0.051 (4.23)			0.049 (3.83)
<i>N</i>	29,784	29,784	29,784	17,428	17,428	17,428

CEO = chief executive officer.

Dependent variables are indicators for whether the manager leaves the firm's list of executive officers from year t to year $t + 1$. Reported parameters are probability derivatives. Robust asymptotic t -statistics, adjusted for within-firm correlation, are in parentheses. Firm-level variables included in each regression are log assets, CEO age, and indicators for quintiles of industry adjusted stock-market and accounting returns, two-digit SIC indicators, year, number of individuals in group of proxy-named executives, and year- t CEO tenure. Executive-level variables are fraction of ownership, compensation rank, age categories, indicators for tenure less than five years and whether the manager became the next CEO, and Age/Tenure, Manager Tenure/CEO Tenure interactions.

3.3 Effects of CEO and Manager Characteristics

Next, we explore our second and third hypotheses: that CMTA should increase in the complementarity between the manager and the departing CEO and decrease in the complementarity between the manager and incoming CEO. To do this, we rely extensively on our measures of executive tenure with the firm. Our reasoning here runs parallel to that used in the literature on job changes in labor markets. Models of matching of workers to firms with uncertain *ex ante* match quality (Jovanovich, 1979b) and accumulation of firm-specific human capital (Parsons, 1972; Jovanovich, 1979a) both predict that quality of matches between workers and firms should be positively related to tenure, and thus that the probability of job change should decrease with tenure. Here, we reason that uncertain *ex ante* coworker match quality or accumulation of coworker specific skills can lead to the same effect. That is, coworker complementarity should be positively related to the amount of time employees have worked together. Hence, to examine our second and third hypotheses, we look at how CMTA varies with interactions among the tenures of the departing CEO, the incoming CEO, and the manager.

First, though, we examine the direct effects of executive tenure on CMTA. In column (1) of Table 4, we interact an indicator for contemporaneous CEO turnover with our indicator for manager tenure less than five years. The point estimate on the interaction is 1.7 percentage points, which suggests that managers who have been with the firm for less than five years are more likely to depart around times of CEO turnover, compared with those with tenure longer than five years. This estimate, however, is not statistically distinguishable from zero. Similar magnitudes and significance apply in column (4), where we allow

for contemporaneous and prior-year CEO turnover. Thus, while CEO turnover leads to a substantial increase in the likelihood of managerial departure, the magnitude of this effect is not—in this specification—significantly related to manager tenure.

We use similar specifications in columns (2) and (5) for departing CEOs.²³ The point estimates suggest that departure of a short-tenured CEO leads to larger CMTA (by 2.7 and 3.1 percentage points), but the effect is significant ($p = 0.09$) only in the column (5) regression. The tenure of the incoming CEO is more strongly and consistently related to CMTA. As the column (3) and (6) regressions show, managers are roughly 5 percentage points more likely to turn over when the incoming CEO has been with the firm five years or less compared with when the incoming CEO has been with the firm for more than five years. This effect is significant at better than the 1% level. CMTA is not driven entirely by short-tenured incoming CEOs, however. The “CEO turnover” indicator remains significant ($p < 0.01$) as well, with the probability derivative implying that succession of a CEO with greater than five years tenure means a 2.3 (2.9 in column 6) percentage point increase in the likelihood of managerial turnover.

In unreported regressions, we investigated the relationship between CEO turnover and variables that more specifically identify the prior employment of the short-tenured incoming CEO. We divided incoming CEOs with less than five years tenure into three categories: those hired directly into the CEO position from outside the firm, those who were hired into another executive position and promoted to CEO in less than five years, and those who, at the time they were named CEO, were directors (but not employees). As we might expect given our complementarity hypothesis, our estimate of CMTA is highest for those hired from outside. However, the coefficients for all three types of short-tenured incoming CEOs are large and we could not reject the hypothesis that all three coefficients are identical.

To summarize, the main result arising from Table 4 is that managerial turnover is significantly higher when the incoming CEO has shorter tenure with the firm. This offers some indirect support for our third hypothesis. When the match between the incoming CEO and the manager is weaker (as captured by the incoming CEO having spent little time working at the firm), CMTA is larger.

As we noted above, however, our hypotheses can be most directly examined by looking at how the interactions between characteristics of the manager and the incoming or outgoing CEO affect CMTA. This suggests triple-interaction specifications, where we include interactions between each pair of the CEO turnover, manager tenure, and CEO tenure variables, as well as the triple interaction among all three. This specification allows us to determine whether the length of overlap between manager and departing and incoming CEO work

23. In columns (5) and (6), we use the characteristics of the contemporaneous departing and incoming CEO to define the interaction variables in cases where there was CEO turnover in both years.

Table 5. Interactions Among Executives' Characteristics

	Contemporaneous CEO Turnover		Contemporaneous & Prior-Year CEO Turnover	
	(1)	(2)	(3)	(4)
CEO Turnover	0.050 (5.62)	0.020 (2.44)	0.049 (5.92)	0.029 (3.85)
(CEO Turnover) × (Manager Tenure < 5 years)	-0.020 (1.27)	0.014 (0.84)	-0.012 (0.60)	0.012 (0.53)
(CEO Turnover) × (Departing CEO Tenure < 5 years)	-0.031 (1.21)		-0.016 (0.68)	
(CEO Turnover) × (Manager Tenure < 5 years) × (Departing CEO Tenure < 5 years)	0.110 (2.21)		0.066 (0.91)	
(CEO Turnover) × (Incoming CEO Tenure < 5 years)		0.068 (4.34)		0.057 (3.76)
(CEO Turnover) × (Manager Tenure < 5 years) × (Incoming CEO Tenure < 5 years)		-0.044 (1.76)		-0.011 (0.37)
<i>N</i>	29,784	29,784	17,428	17,428

CEO = chief executive officer.

Dependent variables are indicators for whether the manager leaves the firm's executive officer group from year t to year $t + 1$. Reported parameters are probability derivatives. Robust asymptotic t -statistics, adjusted for within-firm correlation, are in parentheses. Firm-level variables included in each regression are log assets, CEO age, and indicators for quintiles of industry adjusted stock-market and accounting returns, two-digit SIC indicators, year, number of individuals in group of proxy-named executives, and year- t CEO tenure. Executive-level variables are fraction of ownership, compensation rank, age categories, an indicator for tenure less than five years, and Age/Tenure, Manager Tenure/CEO Tenure interactions.

histories is related to the probability of managerial turnover around times of CEO change. We estimate these specifications, and present results in Table 5.

We examine our second hypothesis—that CMTA should increase in the strength of the complementarity between the manager and the departing CEO—in column (1) of Table 5. There, we combine the specifications from columns (1) and (2) of Table 4 and add the triple interaction between CEO turnover, manager tenure, and departing CEO tenure indicators. We make three observations here. First, note that the sign on the CEO turnover/manager tenure indicator has reversed, as compared with column (1) of Table 4. To the extent that our Table 4 results suggested that short-tenured managers had higher CMTAs, this effect seems to be driven by cases where the departing CEO also has short tenure. Second, the sign on the CEO turnover/departing CEO tenure indicator has reversed, as compared with column (2) of Table 4. This again suggests that estimating the interaction among these effects is important. Third—and this is our key result—the triple interaction is positive and significant at better than the 3% level. In words, this implies that the marginal effect of manager tenure on CMTA increases with the tenure of the departing CEO. Thus, the match between the tenures of the manager and the departing CEO is a key determinant of CMTA.

Panel A: CEO/Manager Turnover Association as a Function of Manager and Departing CEO Tenure (From Table 5, Column 1)

	Departing CEO Tenure < 5 years	Departing CEO Tenure \geq 5 years
Manager Tenure < 5 years	0.092	0.030 ($p = 0.023$)
Manager Tenure \geq 5 years	0.019	0.050

\updownarrow ($p = 0.046$) \leftarrow

Panel B: CEO/Manager Turnover Association as a Function of Manager and Incoming CEO Tenure (From Table 5, Column 2)

	Incoming CEO Tenure < 5 years	Incoming CEO Tenure \geq 5 years
Manager Tenure < 5 years	0.058	0.033
Manager Tenure \geq 5 years	0.089	0.020 ($p < 0.01$)

\leftarrow ($p < 0.01$)

Figure 1. Number in each cell is the estimated CEO/manager turnover association (CMTA). Arrows indicate that the difference between the two estimates is statistically significant, with p -values in parentheses. Panel A and B associations can be computed directly from the regressions in columns (1) and (2), respectively, of Table 5.

Another way to interpret this regression is by constructing a simple chart. Panel A of Figure 1 displays a two-by-two matrix in which rows correspond to different levels of manager tenure and columns correspond to different levels of departing CEO tenure. In each cell, we enter the estimated CMTA for that manager-tenure/departing-CEO-tenure pair. To illustrate, the number in the lower-right cell (0.050) is our point estimate of the increase in the probability of long-tenured manager turnover when a long-tenured CEO departs compared with when there is no CEO turnover. The number in the lower-left cell (0.019) is the CMTA for the case of a long-tenured manager and a short-tenured departing CEO. Arrows between adjacent cells indicate that the turnover probabilities in the connected cells are statistically different from each other, with p -values in parentheses.

Note specifically in Panel A that the on-diagonal cells (those for which the CEO and non-CEO executives' firm tenures are the same) are highest in magnitude. If a CEO and a manager have both been with the firm for five years, then CEO departure is associated with an increase in the likelihood of manager departure of 5.0 percentage points. If the departing CEO has been with the firm for less than five years, then the increase in managerial turnover probability is

only 1.9 percentage points. If, on the other hand, the manager has been with the firm for less than five years but the departing CEO has been with the firm for more than five years, the increase in managerial turnover probability is 3.0 percentage points. The most striking result from the matrix is the very high CMTA (9.2 percentage points) for the case where both managers are short-tenured. This association is significantly larger than that for the case where only one is short-tenured at better than the 5% level. Within our framework, one could construct either a matching or a specific-capital explanation for this finding. One possibility is that short-tenured CEOs hire additional managers from outside only if they have strong reason to believe that those outsiders are good matches with themselves. Alternatively, it may be the case that the short-tenured departing CEO and the short-tenured manager accumulated specific skills by working together at another firm prior to joining the present employer. We present some evidence on this second explanation in Section 3.4.

To recap our main finding from column (1) of Table 5, it appears that the match between the tenures of the manager and the departing CEO plays an important role in determining how CEO turnover is related to turnover of other managers. This is established by the positive and significant triple interaction effect. This result is consistent with our hypothesis that CMTA should be larger when the complementarity between the two executives is stronger.

We now consider our third hypothesis, which predicts that CMTA will decrease in the strength of the complementarity between the manager and the incoming CEO. In column (2) of Table 5, we combine the specifications from columns (1) and (3) of Table 4 and add the triple interaction between our CEO turnover, manager tenure, and incoming CEO tenure indicators. Here, our triple interaction term is negative and significant at better than the 8% level. This means that the marginal effect of manager tenure on CMTA is decreasing in the tenure of the incoming CEO. Thus, while having a tenure similar to that of the departing CEO leads to an increased CMTA, having a tenure similar to the incoming CEO leads to a decreased association.

As above, we interpret our findings by constructing a simple chart. As Panel B of Figure 1 indicates, CMTA is smallest when the manager and the incoming CEO both have long tenures. Further, while long-tenured managers are only moderately (2.0 percentage points) more likely to turn over when there is an incoming long-tenured CEO, they are substantially more likely to turn over (8.9 percentage points) when there is an incoming short-tenured CEO. This difference is significant at far better than the 1% level. Our finding from Table 4—that non-CEO managers are more likely to depart the firm when the incoming CEO is relatively new to the firm—appears to be driven by departure of managers who have been with the firm for more than five years.

We repeat this analysis using contemporaneous and prior-year CEO turnover in columns (3) and (4) of Table 5. While the interaction effects keep the same sign, they are reduced in magnitude and lose statistical significance. This suggests that the tenure-interaction effects operate contemporaneously with CEO turnover.

We ran additional specifications combining the explanatory variables in columns (1) and (2) of Table 4, and including the four-way interaction between CEO Turnover, Manager Tenure < 5 years, Departing CEO Tenure < 5 years, and Incoming CEO Tenure < 5 years. This allows the construction of a three-dimensional analogue to the matrices in Figure 1, where the three dimensions are non-CEO manager tenure, departing CEO tenure, and incoming CEO tenure. Estimation of this model confirms that both interaction effects identified above are present in the data when controlling for the other. The quadruple interaction had little effect.

Finally, we note that our reasoning from Section 2 can be applied not just to CEO/manager relationships, but also to manager/manager pairs. To examine our main hypotheses in the manager/manager context, we dropped all managers holding the title “president/chief operating officer” or “chief financial officer” from our sample of non-CEO managers. We then constructed an indicator variable for high-ranking managerial turnover, where a manager is considered to be of high rank if he holds one of these three positions. Using specifications similar to column (3) of Table 3, we found that high-ranking managerial turnover is significantly associated with low-ranking managerial turnover, even when restricting the sample to firm years where there is no CEO turnover. Further, we find a similar pattern to that in Panel A of Figure 1 with regard to tenure matches between high- and low-ranking non-CEO managers, albeit without statistical significance.

We conclude that the evidence in this subsection is consistent with our second and third hypotheses. Specifically, we have found that the marginal effect of manager tenure on CMTA increases with tenure of the departing CEO but decreases with the tenure of the incoming CEO.

3.4 Incoming Non-CEO Managers

Next, we briefly examine the characteristics of incoming non-CEO managers. Our objective here is to look for evidence of complementarity between CEOs and managers who are new to the firm. As we discussed above, one potential explanation for our Figure 1 Panel A result is that short-tenured CEOs and short-tenured managers accumulated specific skills by working together at another firm prior to joining the present employer.²⁴

To do this, we look at the characteristics of managers who enter a firm’s group of proxy-named executives. Specifically, we examine the likelihood a manager who joins the proxy group has been with the firm for less than five years; that is, we study the “short-tenure probability conditional on joining” defined as

24. A large literature examines the circumstances in which firms are likely to hire from outside, who the outsiders are likely to be, and the implications of this choice. See, for example, Parrino (1997), Davidson et al. (2002), Murphy and Zabochnik (2003), and Agrawal et al. (2005) for recent work in this area. This literature has not focused closely on the composition of management teams constructed by new CEOs.

Prob[manager is short-tenured | manager joins group
of proxy-named executives].

In our data, there are 4711 cases where a manager makes his first appearance in a firm's group of proxy-named executives.²⁵ Of these, 54.5% have tenure at their firm of less than five years. Therefore, the short-tenure probability conditional on joining over our entire sample is 54.5%.

Given our coworker complementarity hypothesis, we would expect the short-tenure probability conditional on joining to be high when a short-tenured manager becomes CEO. Similarly, when a long-tenured manager is promoted to CEO, we would expect newcomers to the top-management group to be likely to come from inside the firm (that is, we expect a low short-tenure probability conditional on joining). Both of these patterns are found in the data.

We first examine how the short-tenure probability conditional on joining is affected by CEO turnover. We find that if there was CEO turnover from year t to year $t + 1$, then managers who join the firm's group of proxy-named executives in year $t + 1$ are actually less likely to be short-tenured. Of the 701 managers who joined their firms' proxies in the year after CEO turnover, 346 (49.4%) had tenure less than five years. A chi-square test rejects the hypothesis (at better than the 1% level) that the short-tenure probability conditional on joining is the same when there is CEO turnover compared with when there is no turnover.

When the incoming CEO is relatively new to the firm, however, the short-tenure probability conditional on joining is higher. Our sample contains 253 managers who join their firm's proxy-named executive groups in the year after a short-tenured executive becomes CEO; of these, 149 (58.9%) had been with the firm for less than five years. On the other hand, we have 448 managers who join the proxy-named executive groups in the year after a long-tenured executive becomes CEO; of these, only 197 (44.0%) had been with the firm for less than five years. We can reject the hypothesis that the short-tenure probability conditional on joining is the same after short- and long-tenured CEO succession at better than the 1% level.²⁶

These findings raise the following question: To what extent do new CEOs bring non-CEO managers with them from prior places of employment? That is, do top-management teams tend to move en masse from one firm to another? To answer this question, we revisit firms' proxy statements and annual reports and collect information (where available) regarding the prior place of employment

25. One source of bias in our measure is that we do not observe groups of proxy-named executives for years prior to 1994. Hence, a manager who is in the group of proxy-named executives in 1993 and again in 1995 will be treated by our measure as being new to the group of proxy-named executives in 1995. As a robustness check, we redefined our measure of "joining" to include any manager who is present in a group of proxy-named executives in year t but not in year $t - 1$. This had little effect on our findings.

26. We observe a similar pattern with respect to departing CEOs, but lose statistical significance. Specifically, the short-tenure probability conditional on joining is 48.7% when a long-tenured CEO departs, but 56.5% when a short-tenured CEO departs. The p -value from a chi-square test is 0.138.

for all short-tenured CEOs in our sample. We collect the same information for short-tenured managers who join the firms' groups of proxy-named executives under these CEOs.

We find little evidence that short-tenured CEOs bring managers from their prior places of employment. Of the 510 short-tenured, new-to-proxy managers who are paired with short-tenured CEOs, we are able to locate prior-employer information for both the manager and the CEO in 445 cases. In only 43 (9.7%) of these cases did the manager and the CEO share the same prior employer.²⁷ Thus, it appears that while new CEOs are disproportionately likely to hire managers from outside the firm, these managers are quite unlikely to have the same prior place of employment as the CEO. This result suggests that accumulation of coworker-specific human capital at a prior place of employment does not play a significant role in explaining our results from Panel A of Figure 1.

4. Other Theories of Associated Turnover for Top Executives

As we discussed in the introduction, coworker complementarity is not the only theory that can predict contemporaneous turnover among members of top-management teams. Other candidates include learning models in which corporate boards use correlated signals to update beliefs regarding executives' abilities; tournaments; and models in which executives' skills complement a particular strategy or set of business practices.

In this section, we discuss each candidate theory in turn. We first sketch how the theory can generate a positive CMTA. We then discuss any additional implications of each theory, and report our attempts to evaluate these implications using our data. In each case, we argue that there are key implications that are not supported by the data (though the implications are not necessarily strongly rejected by it, either). We also argue that for each alternative theory, there are some implications of coworker complementarity supported by the data that the alternative theory cannot easily explain. We will therefore conclude that while each of these alternatives could certainly play a role in determining CMTA, coworker complementarity appears to be important as well.

4.1 Learning

CEO and managerial turnover may be associated if boards of directors use positively correlated signals to update beliefs regarding these executives' abilities. Hermalin and Weisbach (1998), for example, consider a setting where a board and a CEO are symmetrically uninformed regarding the CEO's ability at the time of hiring. The board uses any information it receives to make inferences regarding ability, and it fires the CEO if its belief about the executive's ability

27. This number reflects 39 unique firms, as there are four cases where two managers follow a CEO from one firm to another. For example, Apple Computer appointed Gil Amelio as CEO in 1996. Amelio had previously been employed as CEO of National Semiconductor, and managers George Scalise and Ellen Hancock entered Apple's group of proxy-named executives from National Semiconductor under Amelio. Notably, three other managers entered Apple's group of proxy-named executives under Amelio: one each from IBM, Texas Instruments, and ADP.

falls below some critical level at which the board prefers to hire the best alternative CEO. A straightforward extension of such a model would allow boards to make simultaneous inferences regarding the abilities of both CEO and non-CEO managers. If the signals used to make inferences regarding these managers are positively correlated (as would be the case if firm performance is used to assess both), then the board's assessment of the ability of non-CEO managers is likely to be low relative to the next alternative manager around times of CEO turnover. This effect may take the form of "throwing the rascals out," where a board, unable to determine which individual from among a group of executives is responsible for poor performance, fires the entire group.

While learning models have many implications, one important prediction here is that the association between CEO and managerial turnover should depend on firm performance. Because it is unlikely that learning is behind CEO turnovers that are accompanied by good firm performance, the likelihood of managerial turnover should be lower around such events.²⁸ To examine this issue, we interact CEO turnover with industry-adjusted firm-performance variables. We can then test the joint hypothesis that the firm-performance-indicator/CEO-turnover-interaction are nonzero. We estimated a number of such models; for example, in Panel A of Table 6, we report the results of two regressions in which we interact ROA and RET quintiles of firm performance with CEO turnover. In neither regression can we reject the hypothesis that these firm-performance/CEO-turnover interaction terms are all zero. The one notable effect in the table is that the CEO turnover/first ROA quintile marginal effect is statistically significant at the 10% level.

To further explore the hypothesis that CMTA is higher when accounting performance is particularly poor, we re-ran the regression in column (3) of Table 3, limiting the sample to only firms that were in the third through fifth quintiles of both firm-performance variables in the year of the observation. Because this sample is limited to firms that are performing relatively well, the CMTA would not be found here (or would be substantially reduced) if the association were driven by board learning. We found that the CMTA was 0.037, which is similar in magnitude to the estimate in Table 3. Thus, we are unable to reject the null hypothesis of no connection between poor performance and CEO/manager turnover. Failure to reject a null hypothesis is, of course, not the same as confirmation of that null, so it is not possible for us to assert that learning effects play no role in explaining patterns in management turnover. Despite this, we conclude that there seems to be very little evidence in support of the learning hypothesis, and this hypothesis cannot explain the CMTA by itself.

28. Note, however, that good firm performance should lead to increases in the estimated ability of all executives, which could result in improved outside options for all executives. If CEOs and managers are all more likely to be hired away when firm performance is good, then turnover can be associated with good firm performance. In our logit model, this effect would manifest itself as a higher CMTA when firm performance is in the highest quintile. We expect that few such events are present in our data, because CEO-to-CEO job movements are rare.

Table 6. Tests of Alternative Theories

Panel A: Learning	
CEO Turnover × First ROA Quintile	0.030 (1.68)
CEO Turnover × Second ROA Quintile	0.004 (0.21)
<hr/>	
CEO Turnover × First RET Quintile	0.005 (0.26)
CEO Turnover × Second RET Quintile	-0.005 (0.24)
<hr/>	
Panel B: Tournaments	
CEO Turnover × Age Less than 55	-0.013 (0.19)
CEO Turnover × Age Between 55 and 63	-0.019 (0.26)
CEO Turnover × Age Greater than 66	0.049 (0.49)
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CEO Turnover × Age	0.001 (1.31)
<hr/>	
Panel C: Skills that Complement Strategy	
CEO Turnover × Asset Drop	0.007 (0.58)
<hr/>	
CEO Turnover × Employee Drop	0.007 (0.56)
<hr/>	
CEO Turnover × Layoff	0.014 (0.53)
<hr/>	

CEO = chief executive officer; ROA = return on assets; RET = shareholder return.

Each regression (separated by horizontal lines) is a version of the regression in column (3) of Table 3, where we have interacted additional explanatory variables with the CEO turnover variable. Panel A regressions include all firm-performance quintile indicators interacted with CEO turnover, but we omit the fourth and fifth quintiles for brevity. Panel C regressions include an indicator for a 5% or larger drop in assets from year t to year $t + 1$, an indicator for a 5% or larger drop in employees from year t to year $t + 1$, and an indicator for a large layoff announced in the *Wall Street Journal* (see Hallock, 1998, for a description of the data).

This conclusion differs from that of Fee and Hadlock (2004), who argue, on the basis of the fact that the CMTA is positive, that “this evidence appears consistent with managers being evaluated, in part, as a group.” They also argue that this same result is consistent with “team-specific human capital.” However, because their focus is on labor-market outcomes for departing managers rather than on efficient work groups in firms, they make no attempt to distinguish between these ideas. In addition, although they never discuss the implications of this analysis for the learning hypothesis, they do find that CMTA is quite similar whether or not the firm’s performance is bad leading up to CEO turnover (see their table 6). We believe that the correlated-signals hypothesis is not strongly supported by closer inspection of the CMTA in this paper or in Fee and Hadlock (2004).

Another way to explore the learning hypothesis would be to identify cases of exogenous CEO departures. If such departures were associated with an increased likelihood of non-CEO turnover, then it would be clear that learning with correlated signals was not the reason for such managerial departures. We considered examining sudden deaths of CEOs but simply found very few such cases in our data.

Instrumenting for CEO turnover offers yet another potential approach. A good instrument here would be a variable that affects the likelihood that a CEO leaves his job but does not (except through its effect on CEO turnover) affect turnover of other senior managers. As noted in some of the literature on CEO changes and subsequent organizational changes (see Weisbach, 1995), finding a good instrumental variable for CEO turnover is difficult. We experimented by instrumenting for CEO turnover with CEO and manager turnover rates at the two-digit SIC industry level. When replicating our Table 3, column 3, regression using this approach, we still find a positive and statistically significant relation between CEO turnover and manager turnover. For example, we estimate (using industry CEO turnover as an instrument) that the probability of non-CEO turnover is 0.68 percentage points higher when the predicted likelihood of CEO turnover is one percentage point higher (t -statistic 4.40). These findings are consistent with our main hypothesis. They are not consistent with the learning (or “throw the rascals out”) notion, because that idea suggests that some (potentially unobserved) firm-specific factor causes turnover of both the CEO and the manager. However, we think it best to interpret these findings very cautiously, as the validity of the available instruments is questionable. While industry-level CEO turnover rates are likely to pick up some factors affecting a firm’s likelihood of replacing its CEO (such as the importance of firm-specific human capital), many of these same factors would presumably affect the likelihood that the firm replaces non-CEO managers as well.

4.2 Tournaments

Following Lazear and Rosen (1981), a large literature studies the role of promotion tournaments in providing effort incentives in firms. Managers who narrowly miss out on being selected as the next CEO do occasionally depart the firm, as some recent high-profile examples attest. If this effect is common, then the CMTA could reflect the decisions of tournament losers to leave.

However, it is not obvious that tournament theory predicts positive CMTA in the absence of coworker complementarity. Specifically, there is nothing in the theory that requires the so-called loser of the tournament to be employed by a different firm subsequent to the resolution of tournament uncertainty. If the loser’s skills are more highly valued at the original employer than elsewhere in the economy (as one might expect if firm-specific human capital is present), then it is efficient for the loser to remain with the original employer.

In order for tournament theory to explain CMTA in the absence of coworker complementarity, one must answer the question of why it is efficient for

tournament losers to depart the firm. We argue that there are at least two potential ways of answering this question. First, the CEO job is unique in that firms typically need exactly one such employee and that an employee's marginal product in this job is higher than in any other job in the firm. Hence, a tournament loser's marginal product could be higher as a CEO of another firm than as a manager for his original employer. This would then cause tournament losers to be bid away by other employers. Second, the presence of a qualified successor (in the person of the tournament loser) may undermine the productivity of the newly selected CEO.²⁹

This theory suggests that the increase in the likelihood of managerial departure around times of CEO turnover should be larger for those managers who are participants in the promotion tournament. This would lead us to expect the CMTA to be larger for executives who are not close to retirement age, as these are presumably the managers who are competitors in the promotion tournament. We experimented with a number of specifications where we interacted manager age (both linearly and with a variety of formulations of age categories) with CEO turnover but could find little evidence of a relationship. Panel B of Table 6 shows results of two of these regressions. In the top regression, we interact CEO turnover with our manager age categories, while the bottom regression interacts CEO turnover with manager age linearly. As with our tests regarding the learning model, we do not find strong support in favor of the tournament hypothesis. We cannot reject the hypothesis that all categorical interaction effects are zero, and the linear interaction term is positive but not significant. Unfortunately, the imprecision of our estimates makes it difficult to definitively rule out the possibility that manager age is positively related to CMTA. Note, however, that in the absence of some form of coworker complementarity, tournament models do not suggest a link between CMTA and the characteristics of the departing or incoming CEOs.³⁰ That is, the statistically and economically significant tenure-interaction effects in Table 5 are not predicted by tournament theory, but they are implied by coworker complementarity.

We therefore conclude that in the absence of some form of coworker complementarity, tournament theory cannot by itself fully explain the empirical patterns in CMTAs. This does not, of course, imply that our findings constitute

29. The 2001 CEO succession tournament at General Electric (GE) provides an example of both phenomena. After Jeffrey Immelt was named the tournament winner, Bob Nardelli and James McNerney were quickly hired as CEOs of Home Depot and 3M, respectively, at salaries comparable to that earned by Immelt at GE. It seems unlikely that these managers could have been as valuable to GE as non-CEO managers as they were to their new employers as CEO. GE fired both Nardelli and McNerney at the time Immelt was promoted. Explaining this decision, departing CEO Jack Welch (2001) wrote of Immelt, "I don't want him looking over his shoulder."

30. While selection of an outsider as CEO may make managers worse off if it indicates an increased willingness on the part of the firm to hire from outside, this does not by itself imply that outside CEO succession should have a greater effect on managerial turnover than inside CEO succession in the absence of coworker complementarity. If it is efficient to retain managers after naming an outsider to the CEO job, the firm can renegotiate compensation contracts with these managers in order to do so.

a rejection of tournament theory. Related work by Hermalin and Weisbach (1988) finds that insiders are disproportionately likely to be added to corporate boards just before CEO turnover, and disproportionately likely to leave just after. They interpret this as consistent with tournament theory, as boards promote insiders prior to a CEO change in order to learn about the contenders and then demote (or fire) all but the winner. Their finding that CEO turnover is associated with departure of incumbent managers from the board is also consistent with coworker complementarity. One point of differentiation between the studies is that we examine career outcomes for all non-CEO managers, not just those who are likely contenders for the CEO job. Tournament effects may be less prevalent in our sample as a result.

4.3 Skills that Complement Strategy

CEO and managerial turnover may be associated if executives invest in or possess skills that complement the firm's strategy or business practices (see, e.g., Van den Steen, 2005). In this hypothesis, a firm that seeks to change its strategy will place a reduced value on its incumbent managers. The key implication of this hypothesis is that the CMTA should be stronger when there are subsequent changes to the firm's strategy or business practices.

To examine this assertion, we estimated a number of models in which we allowed the CMTA to vary with indicator variables for subsequent reductions in assets or employment. Research on organizational changes following CEO turnover has shown that CEO turnover is associated with subsequent asset sales and employment reductions. We also obtained data on Fortune 500 firms' (a subset of our main sample) layoff announcements, and asked whether the pattern of top-management turnover was related to these events.³¹ Results of these regressions are shown in Panel C of Table 6. We report the results of three manager turnover regressions, each of which includes an interaction between CEO turnover and one of these indicator variables for organizational change. (To construct our organizational change indicators, we set the value of, for example, "Asset Drop" to 1 if the firm experiences a 5% or more reduction in assets from year $t + 1$ to $t + 2$.) In each case, we find that the point estimate of this interaction term is quite small and that the CMTA remains similar to that found in Table 3. That is, we could not find any evidence supporting the proposition that CMTA is related to subsequent changes in strategy. While asset sales and layoffs are rough measures of changes in firms' strategies, we also found no strong relation between CMTA and firm performance. If firms are more likely to change their strategy when they perform badly, then this hypothesis would lead one to expect poor firm performance to lead to a stronger CMTA.

Again, we must qualify our conclusions here somewhat. While there is no evidence supporting the idea that these proxies for changes in strategy are related to the CMTA, the interactions are imprecisely estimated. Changes in strategy

31. Our layoff data are those studied by Hallock (1998) and Billger and Hallock (2005).

could be contributing to the CMTA. However, the fact that the CMTA is strong at firms that are operating successfully suggests that the more basic coworker complementarity story is important even when firms are not making changes.

5. Conclusion

We have presented an empirical analysis with three main findings. First, the probability of non-CEO managerial turnover is higher around times of CEO turnover. Second, the marginal effect of manager tenure on CMTA increases with the tenure of the departing CEO. Third, the marginal effect of manager tenure on CMTA decreases with the tenure of the departing CEO.

We interpret our results as supporting the hypothesis of coworker complementarity. Such complementarities could arise either through matching or through investment in specific skills. While it is difficult to make sharp distinctions between these two hypotheses, the limited evidence available does point to the importance of matching in managerial labor markets. Relying solely on the specific-investment hypothesis, it is difficult to explain our findings that (1) short-tenured non-CEO managers are substantially more likely to depart when short-tenured CEOs leave, and (2) incoming non-CEO managers are unlikely to have worked previously with new CEOs. Specific investment could underlie some of our other results, however.

Because our analysis has focused on turnover, we cannot isolate who captures the value of coworker complementarity. These complementarities clearly lead to quasi-rents, and thus raise the possibility that either firms or employees could capture the associated benefits. A different empirical design would be necessary to determine the exact extent to which firms benefit from higher managerial productivity and to what extent managers capture the benefits through cronyism.

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