Learning about CEO Ability and Stock Return Volatility

Yihui Pan
University of Utah

Tracy Yue Wang
University of Minnesota

Michael S. Weisbach
Ohio State University, NBER, and SIFR

February 27, 2013

Abstract

When there is uncertainty about a CEO's quality, news about the firm causes rational investors to update their expectation of the firm's profitability for two reasons: Updates occur because of the direct effect of the news, and also because the news can cause an updated assessment of the CEO's quality, affecting expectations of his ability to generate future cash flows. As a CEO's quality becomes known more precisely over time, the latter effect becomes smaller, lowering the stock price reaction to news, and hence lowering the stock return volatility. Thus, in addition to uncertainty about fundamentals, uncertainty about CEO quality is also a source of stock return volatility, which decreases over a CEO's tenure as the market learns the CEO's quality more accurately. We formally model this idea, and evaluate its implications using a large sample of CEO turnovers in U.S. public firms. Our estimates indicate that there is statistically significant and economically important market learning about CEO ability, even for CEOs whose appointments appear to be unrelated to their predecessors' performance. Also consistent with the learning model is the fact that the learning curve appears to be convex in time, and learning is faster when there is higher ex ante uncertainty about the CEO's ability and more transparency about the firm's prospects. Overall, uncertainty about management quality appears to be an important source of stock return volatility.

JEL classification: G32, G34, M12, M51
Key words: CEO turnover, exogenous turnover, stock return volatility, idiosyncratic volatility, Bayesian learning, learning speed

Contact information: Yihui Pan, Department of Finance, David Eccles School of Business, University of Utah, email: yihui.pan@business.utah.edu; Tracy Yue Wang, Department of Finance, Carlson School of Management University of Minnesota: email: wangx684@umn.edu; Michael S. Weisbach, Department of Finance, Fisher College of Business, Ohio State University, Columbus, OH 43210, email: weisbach@fisher.osu.edu. We thank Hengjie Ai, Frederico Belo, Miriam Schwartz-Ziv, Berk Sensoy, Yingdi Wang, Jun Yang, Jianfeng Yu, and seminar participants at University of Minnesota for helpful suggestions.

1. Introduction

In recent years, CEO changes have become highly visible events, and are often portrayed as portents of a rosier future for the company. Presumably, a new CEO can influence a corporation's activities, and ultimately its profits, in a meaningful manner. Yet, a new CEO also brings substantial uncertainty to the firm; it is impossible to know for sure what the particular decisions the CEO will make and the strategic direction he will take, let alone the overall effect of the CEO on the firm's value. When a firm gets a new CEO, his uncertain ability to change the firm's value will be revealed over time to the market. The process through which the market learns about this ability will affect the way in which it responds to news about the firm, and consequently will impact the firm's stock return volatility.

This paper explores the idea that the market's learning about CEO ability will affect stock return volatility from both theoretical and empirical perspectives. We first present a model in which the firm's cash flow stream follows a random process, with the drift of that process depending on an unknown ability of the CEO to add value. The firm's value depends on the market's assessment of the CEO's ability, and the market updates this assessment when it receives any relevant information about it. Thus, when there is news about the firm, the firm's value changes for two reasons: First, there is a direct effect of the news on the firm's expected cash flows, and second, the news will change the market's expectation of the manager's quality and therefore influence its expectation of future cash flows. Over time, as the CEO becomes more of a "known quantity", the market's updates of its expectation about his quality become smaller conditional on a particular signal, so that the firm's stock price will move less for a given piece of information. Therefore, a firm's stock return volatility should decline with the CEO's tenure.

The model contains a number of predictions about the relation between the firm's stock return volatility and the CEO's tenure. The model implies that the sensitivity of stock return volatility to CEO tenure depends on the ratio of the variance of the unknown ability to the variance of the firm's fundamentals. If uncertainty about the CEO's ability is resolved over time, then volatility should decline with CEO tenure. The rate of this decline should be higher when uncertainty about CEO ability is higher. Thus, as uncertainty about the CEO's ability decreases because of market learning, the rate at which the volatility decreases with CEO's tenure also declines. Consequently, the model implies that the volatility-tenure slope should be convex.

We evaluate these predictions empirically using a sample of 1,873 CEO turnovers in 1,582 U.S. publicly traded firms occurring between 1992 and 2006. If CEOs were irrelevant for firm value, then there would be no relation between volatility and CEO tenure; however if CEOs create or destroy value, then the market should update its assessment of their abilities to do so, leading to more precise estimates of ability and lower subsequent stock return volatility. Our estimates indicate that there is a robust relation between CEO tenure and the firm's stock return volatility: Volatility increases around the time of CEO turnover, and then decreases subsequently. The magnitudes of the effects are substantial; idiosyncratic return volatility declines by 14% and total return volatility declines by 10% over the 36 months after the CEO took office. This pattern is consistent with the predictions of the learning model, in that there is likely to be large uncertainty about the new leadership at the time of the turnover, and after the CEO change, volatility declines as the CEO's ability becomes known more precisely.

An alternative interpretation to learning for these results is that CEO turnovers tend to occur at times of high fundamental uncertainty, so that the post-turnover decline in volatility simply reflects reversion to a normal level of volatility. We empirically assess the extent to which the patterns in volatility over CEO tenure reflect learning or endogenous timing of turnovers. To do so, we estimate the sensitivity of volatility to tenure subsequent to a subsample of turnovers that are arguably exogenous: turnovers due to deaths, health issues, and retirements of the departing CEOs. For this subsample of turnovers, there is still a decline in volatility with the tenure of the replacement CEO, although the decline is smaller for this subsample of turnovers than for the subsample of "forced" turnovers. This finding suggests that although many CEO turnovers are nonrandom and tend to occur at times of high fundamental volatility, there nonetheless is learning about CEO ability subsequent to all turnovers that is reflected in stock return volatility.

Another reason why firms' fundamental volatilities could change subsequent to CEO turnovers is that CEO turnovers are often followed by substantial changes in the firm. These changes either reflect the vision of the new leadership (e.g., expansion, divestiture, new product development) or occur because of revelation of (negative) information about the firm's fundamentals that had been withheld by the previous management (e.g., accounting write-off, earnings restatement, fraud investigation). Post-turnover real actions or information releases could affect volatility either directly by changing the risk (or the perceived risk) of the assets, or indirectly by conveying information that affects the market's learning about the CEO's ability. We control for both the direct and indirect effects of various actions enacted by new CEOs. We find that the volatility-tenure sensitivity is statistically significant and economically important regardless of whether there are substantial actions after turnover.

The model also contains predictions about the time series and cross-sectional patterns in the speed at which the market learns about the CEO's ability: In particular, it suggests that the "learning speed" should decrease over time, and it should increase with the initial uncertainty about the CEO's ability and with the informativeness of signals available to the market. To test these predictions, we first use both polynomial and spline specifications to estimate the curvature of the volatility-tenure sensitivity, which reflects the learning speed. Our estimates indicate that the learning curve is convex, with learning being much faster in the first year of the new CEO's tenure than in the second and third years. The convexity in the learning speed is consistent with the intuition that a given signal affects learning more at the beginning of a CEO's tenure when uncertainty about the management is highest.

To test the predictions about the cross-sectional determinants of the learning speed, we estimate the sensitivity of volatility to tenure for each new CEO in our sample and then measure the extent to which it is related to the firm's information environment and the level of prior uncertainty about the CEO's ability. The resulting estimates suggest that learning about CEO ability is faster in more transparent firms and for CEOs with higher prior uncertainty (i.e., outsider CEOs, younger CEOs, and less experienced CEOs). These findings are consistent with the notion that learning about CEO ability is faster when there is more uncertainty about the ability, and also when signals about that ability are more informative.

An implication of the model is that a given piece of news will have a larger impact on the firm's stock price when uncertainty about the CEO's ability is larger. We test this implication directly by considering the way in which the absolute value of stock price reactions to news varies over the CEO's tenure. We consider four types of announcements: expansions/downsizing, new products, dividend changes, and earnings surprises. For each type, the absolute value of stock price reactions declines significantly over a CEO's tenure, with the rate of decrease becoming smaller over time, similar to the finding of the convex volatility-tenure slope. This result is consistent with the view that a component of stock price reactions to news is information about the CEO's ability, and that this component declines in importance as the CEO's ability becomes better known over time.

Finally, the model allows us to quantify the importance of uncertainty about CEO ability relative to the firm's fundamental cash flow uncertainty. Our estimates show that at the time of CEO turnover, uncertainty about management quality contributes to 26% to 29% of the total stock return volatility. The impact of uncertainty about management quality also exhibits significant heterogeneity across different manager types and firm types. For example, uncertainty about younger CEOs is more than twice as much as the uncertainty about older CEOs, relative to the firm's fundamental uncertainty. Although these estimates are potentially sensitive to the assumptions in the model, they do provide initial estimates of the extent to which uncertainty about management quality, as well as the uncertain nature of the policies management will adopt, can contribute to the overall firm uncertainty and stock return volatility. Uncertainty about management appears to be a non-trivial source of uncertainty that affects stock price movements.

Overall, the results strongly suggest that the process of the market's continual evaluation of a firm's management quality affects the volatility of the firm's stock return. These adjustments account for a reasonable fraction of the firm's overall stock price movements. Numerous patterns in the data suggest that the process by which the market learns about the firm's management quality can be well characterized by a Bayesian learning model. More importantly, this analysis implies that there are substantial differences in managerial quality, and these differences lead to important differences in firm performance.

The paper spans the usual dichotomy in finance research between corporate finance and asset pricing, and is related to literatures in each subfield. This paper builds on a literature within asset pricing focusing on the way in which learning about fundamentals affects stock return volatility. Early work by Timmermann (1993) shows that such learning can help resolve the "excess volatility puzzle" posed by Shiller (1981). Pastor and Veronesi (2003) develop a stock valuation model in the presence of learning about the average profitability. The model predicts that stock valuation increases with uncertainty about average profitability, and declines over a firm's lifetime as such uncertainty decreases due to learning. Pastor and Veronesi (2009) survey a number of other related papers, which show how learning can help explain a wide range of asset pricing phenomena, including predictability of returns, stock price bubbles, portfolio choices, among others. Most recently, Pastor and Veronesi (2012) use the learning framework to understand the impact of uncertainty about government policy on stock prices.

The model presented below combines insights from this asset pricing literature on the effects of learning, with specific learning features inherent when a firm's profitability depends on the unknown ability of the manager. As such it draws on a literature inspired by Holmström (1999) that explains aspects of management incentives and governance using the learning process about management ability as one key ingredient (see Gibbons and Murphy (1992), Hermalin and Weisbach (1998, 2012), Hermalin (2005), and Taylor (2010)).[1]

Two particularly related papers are Clayton, Hartzell and Rosenberg (2005) and Taylor (2012). Clayton et al. (2005) document an increase in stock return volatility around CEO turnovers. Our work extends this analysis, formalizing the relation between CEO turnover and stock return volatility in a framework of Bayesian learning about CEO ability and testing the model predictions about the learning process. Taylor (2012) uses a model similar to ours to study the way in which CEO pay is related to the CEO's bargaining power. Taylor's model does contain a prediction about the relation between stock return volatility and the market's estimates of CEO quality, and he uses this relation to identify parameters of his structural model. In contrast, our study focuses on testing whether this and other predictions in learning

[1] In addition, several studies apply the learning framework to understand managerial incentives in the money management industry (e.g., Berk and Green (2004), Chung, Sensoy, Stern and Weisbach (2012), and Lim, Sensoy, and Weisbach (2013)).

models of management ability are consistent with the data, and evaluating the extent to which uncertainty about management contributes to stock return volatility.

The remainder of our paper proceeds as follows. Section 2 presents the formal model. Section 3 describes the data and the empirical approach. Section 4 presents evidence of a robust relation between stock return volatility and CEO tenure, documents that the learning curve is convex, and also considers the possibility that these findings could occur because of nonrandom timing of turnovers or substantial post-turnover changes enacted by the new leadership. Section 5 analyzes the cross-sectional determinants of the learning speed, and the relation between market reaction to corporate news and CEO tenure. It also provides estimates of the importance of uncertainty about the management relative to that of fundamental uncertainty. Section 6 discusses the implications of the paper's findings and concludes.

2. Uncertainty about CEO Ability and Stock Return Volatility: A Simple Model

In this section we develop a simple model based on Pastor and Veronesi (2003, 2009) to formalize the link between uncertainty about CEO ability and stock return volatility. In the model, there is an unknown managerial ability that affects profits. Over time, market participants draw inferences about this ability when news arrives about the firm.

When there is uncertainty about CEO ability, news about the firm has two effects on the firm's expected future prospects. First, the news can lead the market to update its expectation about the firm's future profits directly. Second, the news can also lead the market to update its assessment of the manager's ability, and thus indirectly change the expected future profits from the change in the assessment of ability. For example, if there is positive news about the firm's cash flows, the market will value the firm's cash flows at a higher level and consequently will increase the firm's value. In addition, the positive news is likely to reflect well on the management, increasing the market's estimate of his ability and further increasing its expectation of the firm's future cash flows. This indirect effect through learning about managerial quality will augment the direct effect of news on expected profitability, leading to higher stock return volatility.

What we refer to as "ability" in the model can be thought to exist for a number of reasons, each of which provides a mechanism through which a CEO could add value to a particular firm. First, "ability" in the model could refer to raw talent that will improve performance in any situation. Second, "ability" could arise from the quality of a match between a particular CEO and firm (Pan, 2012). In this case, the match quality could be uncertain even for established executives who have been CEOs in other companies, or for executives who have been with their current firms in other positions. Third, "ability" could refer to a corporate strategy that the CEO is hired to enact. If the success of the strategy is uncertain, then market participants will update their priors about the strategy's profitability exactly as described by the model.

We assume that stock prices are formed based on an efficient market with a representative agent:

$$P_t = \frac{1}{1+r} E(P_{t+1} + D_{t+1} | I_t), \qquad (1)$$

where P_t is the stock price at time t; D_{t+1} is the dividend (or equity earnings) at time t+1; r is the expected rate of return; I_t denotes the common information set of investors at the end of t. Suppose that the firm's dividend process follows the geometric Brownian motion:

$$\frac{dD_t}{D_t} = \alpha dt + \sigma dW_t, \qquad (2)$$

where α is the (true) CEO ability that determines the average dividend growth rate, σ reflects the volatility of the firm's dividend or earnings growth, and dW_t is a Wiener process. We refer to σ as "fundamental volatility" because it represents the volatility that the firm would have absent uncertainty about the CEO's ability. We assume that α follows a truncated normal distribution with prior mean θ_0 and variance δ_0^2, and $\alpha < r$ with probability one. While investors cannot directly observe α, they continually update their belief about it according to Bayes' rule. At any time t, we have

$$\alpha_t \sim N(\theta_{t,} \delta_t^2), \alpha_t < r \qquad (3)$$

$$d\theta_t \approx m_t [\frac{dD_t}{D_t} - \theta_t dt], \text{ with } m_t = \frac{\delta_t^2}{\sigma^2} \qquad (4)$$

$$\delta_t^2 = \frac{\sigma^2 \delta_0^2}{\sigma^2 + \delta_0^2 t} \qquad (5)$$

Equations (4) and (5) represent Bayesian updates of θ and δ^2 (see, e.g., Pastor and Veronesi, 2009**).** Equation (4) is an approximation because α follows a truncated normal distribution, and holds exactly only when α is non-truncated normal. Equation (4) implies that the speed of learning about managerial ability is equal to m_t, which is the ratio of uncertainty about the CEO's ability δ_t^2 to the firm's fundamental cash flow uncertainty σ^2. Equation (5) suggests that uncertainty about the CEO's ability δ_t^2 decreases over time due to learning, and δ_t^2 is convex in t. Consequently, the above equations imply that there should be a convex learning curve about CEO ability, in which there is faster updating about CEO ability in earlier periods than in later periods during the learning process.

In Appendix A, we show that in this framework, the stock price is given by:

$$P_t = E_t\,[\int_t^{\infty} e^{-r(\tau-t)} D_\tau d\tau] = D_t \int_{-\infty}^{r} \frac{1}{r-\alpha} f_t(\alpha) d\alpha\,, \qquad (6)$$

where $f_t(\alpha)$ is the truncated normal density function with mean θ_t and variance δ_t^2. This equation indicates that not only the perceived average CEO ability (θ_t) affects stock valuation (positively), but the uncertainty about it (δ_t^2) also does (non-monotonically). However, a more easily testable implication of this model concerns the stock return volatility, which is given by:

$$vol(\frac{dP_t}{P_t}) \approx \sigma \times [1 + (\frac{\partial \log(P/D)_t}{\partial \theta_t}) m_t]\,. \qquad (7)$$

Equation (7) characterizes the way in which market learning about CEO ability influences the firm's stock return volatility, and implies that a firm's stock return volatility contains two components, the fundamental volatility and the volatility due to the market updating its assessment of the CEO's ability (see Appendix A for proof).[2] The term $\frac{\partial \log(P/D)_t}{\partial \theta_t}$ equals the marginal return to expected CEO ability: When

[2] We can also obtain a result similar to Equation (7) in a two-state continuous time Bayesian learning model, in which CEO ability is assumed to be high with probability π_t and low with probability (1- π_t). With this distributional assumption, an equation comparable to Equation (7) holds exactly. We focus on the case in which ability is distributed

it is positive, then a shock to the perceived ability translates to greater movements in stock prices, and when it equals zero, then uncertainty about CEO ability will affect neither firm value nor return volatility. Therefore, the first empirical implication of Equation (7) is that when CEO ability matters for firm value, then the firm's stock return volatility should increase with the amount of uncertainty about the CEO's ability (δ_t^2). Second, over time as the market learns about α, δ_t^2 should decline, leading stock return volatility to decline as well and eventually converge to the level of fundamental volatility ($vol\left(\frac{dP_t}{P_t}\right) \rightarrow \sigma \; as \; \delta_t \rightarrow 0$).[3] Third, since δ_t^2 is decreasing and convex in t, stock return volatility should also be decreasing and convex in t. Finally, learning should affect the firm's idiosyncratic risk, but not its systematic risk or expected rate of return (see Pastor and Veronesi (2003, 2009) for more discussion and proof).

Equations (4), (5), and (7) suggest that, holding other factors constant, a more negative volatility-tenure relation over a CEO's career reflects a faster learning speed (m_t). The model establishes a link between the empirically estimable volatility-tenure relation and the concept of learning speed formalized by this model. Thus, the model provides a roadmap for inferring the nature of market learning about CEO ability based on the dynamics of stock return volatility.

In summary, this model provides a theoretical link between market learning of a firm's CEO ability and the dynamics of its stock price movements. Examining the way stock return volatility changes during the learning process provides us with estimates of the extent to which the market learns about the CEO's abilities, the speed of learning, and the factors that affect this learning process.

3. Empirical Design and Specification

---

normally because the posterior variance is characterized by the formula presented in Equation (5) and is a monotonic function of time, which provides cleaner guidance for the empirical analysis.

[3] The model presented here assumes that CEO ability α is constant over time so that the uncertainty about it δ_t^2 converges to zero. If CEO ability changes over time, then the uncertainty about it converges to a stationary level above zero (e.g., Holmstrom, 1999). In this case, the stock return volatility will always be above the level of fundamental volatility.

3.1. CEO Turnover and Stock Return Volatility

Evaluating the model's predictions on the relation between uncertainty about CEO ability and stock return volatility is complicated by the fact that there is some uncertainty about the ability of *every* CEO, and for every stock, this uncertainty will contribute somewhat to its volatility. However, the theory presented above suggests that learning about CEO ability should be most important when uncertainty about ability is highest, presumably when a new CEO takes office. Therefore, if the goal is to measure the way in which the market learns about a CEO's ability, a natural place to study is the period following the succession of a new CEO. For this reason, we consider a sample of CEO turnovers and draw inferences about the process by which the market subsequently learns about the new CEOs' abilities.

Prior to the turnover, uncertainty about the new management is likely to increase because the market does not necessarily know who will be the new CEO, or even if there will be a new CEO. After the turnover, the market will learn about the new CEO's ability and strategy for managing the firm, leading it to update its assessment to a more precise estimate of the CEO's ability α. When α is known more precisely, the impact of new information on the market's estimate of α declines, lowering stock market volatility. Thus, assuming that fundamental volatility remains constant, we expect the stock return volatility to rise around the time of a CEO turnover, and then to decline over the CEO's tenure.

The underlying assumption in this argument is that fundamental volatility of a stock is unrelated to the management change. It is possible, however, that CEO turnovers tend to occur at times of high uncertainty about the firm's fundamentals, and thus fundamental volatility tends to be unusually high around turnover. To evaluate this possibility and to isolate the effect of learning, we examine the pattern around "exogenous" turnovers that are likely to be unrelated to other sources of uncertainty about the firm's value.

A second reason why fundamental volatility could change subsequent to CEO turnovers is that CEO turnovers are often followed by substantial real changes in the firm. Post-turnover real changes in the firm's assets could have two different effects on the firm's stock return volatility. First, they can have a direct impact on volatility since they change the firm's asset portfolio. Second, they can serve as signals about the new management's quality and thus indirectly affect volatility through the learning channel. For this reason, we use data on post-turnover real changes in the firm both to ensure that any relation we estimate between CEO tenure and stock return volatility is not spurious because of the tendency of real changes to occur following turnover, and also to evaluate the extent that real changes are signals that provide information about the CEO.

A third and related concern is that CEO turnover could increase the likelihood of the revelation of (negative) information about the firm's fundamentals that had been withheld by the previous management. The new information could accelerate the market's update about the firm's expected profitability and contribute to the increase in return volatility around CEO turnover. To address this concern, we control for information disclosure immediately after CEO turnover through announcements of accounting write-offs, earnings restatements, securities fraud investigation, divestitures, and termination of investment. In addition, we consider a subsample of mature firms for which the uncertainty about the fundamentals is presumably low, and had exogenous CEO turnovers without major post-turnover actions to confirm the robustness of the learning pattern.

3.2. Sample Construction

We start with 24,780 firm-year observations from 1992 to 2006 for which we can identify the CEOs from the *ExecuComp* database. We use the information on job title, the date becoming CEO, and the CEO annual flag provided by *ExecuComp* to identify CEOs at the firm-year level. For each firm, we compare the designated CEO in each fiscal year with the CEO in the previous year to identify whether there is a CEO turnover in that year. For each CEO, the calendar year-month in which the CEO takes office is designated as event month 0. We exclude turnover events involving transitory CEOs such as turnaround specialists and interim CEOs (with tenure shorter than 3 years). This process leads to a sample of 1,873 CEO turnovers at 1,582 firms. Panel A of Table 1 describes the distribution of turnovers over time.

We classify CEOs based on their succession origin. Using information on the time of a CEO "joining company" from *ExecuComp*, supplemented by the data on "starting job" from *Boardex*, we classify CEOs who have been with the firm for less than two years when becoming CEO as outsider CEOs, and those who have been with the firm for at least two years as insider CEOs. Based on this classification, about 33% of new CEOs in our sample are considered as outsider CEOs. This fraction is consistent with those reported in other studies such as Parrino (1997), Murphy and Zabojnik (2007), and Cremers and Grinstein (2011).

Since the purpose of our empirical work is to examine the post-turnover dynamic of firm stock return volatility, it is important to know the reasons for the CEO turnover. Unfortunately, firms are generally secretive about the true reasons for CEO changes and usually offer bland, uninformative reasons when announcing CEO departures (e.g., he wants to "spend more time with his family").[4] It is possible, however, to classify a subset of turnovers as either exogenously occurring, or forced. We follow Fee et al. (2013) and use the Factiva news search to identify CEO departures due to health issues and deaths. We classify turnovers as retirement-related if the departing CEO is older than 65. We consider turnovers caused by illness, death, or retirement of the departing CEOs to be exogenous turnovers. We also use the Factiva news search approach to determine whether a turnover is overtly forced (e.g., forced to leave or left under pressure).[5] Through this process, we end up with 211 exogenous turnovers, 56 of which were related to health issues and deaths, and 101 forced turnovers.

3.3. Stock-Return Volatility

We rely on three measures of monthly firm level equity-based volatility: "*Option-implied Volatility*", "*Realized Return Volatility*", and "*Idiosyncratic Return Volatility*". *Option-implied Volatility* is the monthly average of the implied volatility calculated based on the daily prices of the 30-day at-the-money call options written on the firm's common stock. This measure represents an estimate of volatility based on the market's forward-looking assessment of the firm's risk. *Realized Return Volatility* is the standard deviation of daily stock returns within a month, based on data from CRSP. To estimate

---

[4] See Warner, Watts and Wruck (1988) or Weisbach (1988) for more detail. Schwartz-Ziv and Weisbach (2013) use private data on board meetings to document details of specific cases in which CEOs are forced out of their jobs, but for which one could never tell so using publicly-available information.

[5] We thank Edward Fee, Charles Hadlock, and Joshua Pierce for kindly providing us with their classification of turnovers.

Idiosyncratic Return Volatility, we follow the method in Ang et al. (2006) and calculate the monthly volatility of the residual stock return of the following Fama-French three-factor model.

$$r_t^i = \alpha^i + \beta_{MKT}^i MKT_t + \beta_{SMB}^i SMB_t + \beta_{HML}^i HML_t + \varepsilon_t^i \,.$$

"*Idiosyncratic Return Volatility*" is defined as $\sqrt{Var(\varepsilon_t^i)}$ from the above equation. All three volatility measures are calculated for each firm-month in the three years after each CEO turnover in our sample. All three volatility measures are aggregated to the monthly level by multiplying them with $\sqrt{21}$, the square root of the average trading days in a month.

Panel B of Table 1 reports statistics on the volatility measures. Both *Realized Return Volatility* and *Idiosyncratic Return Volatility* data are from 1992 to 2009, and *Implied Volatility* data are from 1996 to 2009.[6] The average monthly option implied volatility is 17%, the average realized monthly volatility is 12%, and the average monthly idiosyncratic volatility is 10%. We also report the summary statistics of the betas on the three Fama-French factors, which measure the firm's systematic risks. The average market beta in our sample is 1.06, the average SMB beta is 0.62, and the average HML beta is 0.27.

3.4. Other Variables

To control for non-management related factors that potentially affect volatility, we also include a set of firm characteristics. Panel C of Table 1 contains summary statistics of these control variables for each firm-year for the three years after turnover. The firms in our sample are covered by *Execucomp* and thus are S&P 1500 firms. About 55% of them pay common dividends. The average firm in our sample is about 22 years old since IPO, has book assets of about $1.5 billion, 20% leverage (long-term debt to total assets), market equity to book equity ratio (MB) 2.6, and return on equity (ROE, net income divided by book equity) 8%. The volatility in profitability (VOLP) is estimated as the annual residual volatility from an AR(1) model of ROE, and has an average value of 57%. Appendix B provides variable constructions for the main measures we use in this paper.

[6] The data on option prices are from *OptionMetrics* and are only available after 1996, so this measure of volatility is only available after 1996.

4. Measuring the Relation between CEO Tenure and Stock Return Volatility

The theory discussed in section 2 implies that the market is continually updating its assessment of the CEO's ability, as well as the expected change in future profits resulting from any change in its estimates of his ability. Since uncertainty about managerial quality is likely to increase prior to a CEO turnover, and decline as the CEO's quality becomes revealed over time, the model predicts that stock return volatility should increase around CEO turnover and then decrease over the CEO's tenure. Additionally, this pattern should be mainly driven by changes in idiosyncratic return volatility, not in the firm's systematic risk.

Figure 1 portrays a graphical depiction of the relation between monthly average stock return volatility and CEO tenure from 12 months before CEO turnover to 60 months following it.[7] Panel A presents the figure using the option implied volatility, while Panel B uses realized volatility, and Panel C uses idiosyncratic volatility to measure firm-level volatility. For each measure, Figure 1 indicates that volatility increases substantially around the time of the turnover, and decreases subsequently. The decrease is particularly pronounced in the first three years of the CEO's tenure.

Figure 2 illustrates firms' systematic risk over the same period relative to CEO turnover. Panel A shows the pattern of the market beta, while Panels B and C use the SMB beta and HML beta respectively. This figure indicates that, unlike idiosyncratic risk, the betas of systematic factors do not have a clear relation with CEO tenure. The implication is that changes in stock return volatility around CEO turnover are unlikely to be driven by changes in the firm's systematic risk and expected rate of return.

4.1. Estimating the Volatility-Tenure Sensitivity

The patterns in these figures are consistent with the notion that uncertainty about the management quality and the market learning of it are reflected in stock return volatility, and particularly in the idiosyncratic volatility. However, they do not control for other potentially relevant factors that could be related to both CEO turnovers and volatility. Therefore, we estimate multivariate models predicting a

[7] To construct the sample for this figure, we require CEOs to have at least 60 months of tenure and that the pre-turnover sample period (-12, 0) of the successor CEO does not overlap with the post-turnover sample period (0, 60) of the departing CEO.

stock's volatility as a function of CEO tenure, as well as other relevant factors. We use a number of alternative specifications to characterize this relation, which can be summarized by the following equation:

$$Vol_t^{ij} = f(Tenure) + \alpha^{ij} + \lambda_t + Controls_t^i + \varepsilon_t^{ij},$$

where Vol_t^{ij} is one of the three volatility measures; α^{ij} is the firm-CEO fixed effect for the pair of firm *i* and CEO *j*; λ_t is the calendar year-month fixed effect. The variable "*Tenure*" is the number of months since the CEO took office, scaled by 12, so that the variable takes discrete values between 0 and 3. We focus on the three years following the turnover, since Figure 1 suggests that the decrease in volatility occurs primarily in this period. Since the theory predicts that volatility should be a convex function of CEO tenure, we use a specification that allows for a nonlinear relation between tenure and volatility, denoted by the function *f(.)*. We allow *f(.)* to be either a polynomial function or a spline function to estimate the degree of convexity in the learning curve. For the two total volatility measures (*Option-implied Volatility* and *Realized Return Volatility*), we control for the firm's systematic risk measured by the monthly betas of the three Fama-French factors, as well as the set of firm characteristics discussed above. For *Idiosyncratic Return Volatility*, we do not control for the factor betas because the idiosyncratic volatility is calculated as the residual volatility after netting out these factors.

Panel A of Table 2 reports estimates of the relation between volatility and tenure based on a polynomial specification. Models (1) to (3) estimate this relation using linear and quadratic terms of *Tenure*. The theory presented above suggests that the volatility-tenure relation should be convex, i.e., the volatility should decrease at a decreasing rate over CEO tenure. In this specification, convexity means that the coefficient on the linear term should be negative and on the quadratic term should be positive. The estimates in Panel A of Table 2 follow exactly this pattern, and the results are statistically significant and robust across different volatility measures.[8]

[8] All the CEOs in our sample have at least three years of tenure. Thus, the decrease in stock volatility is not driven by CEOs in high-volatility firms being fired quickly. We have also estimated these equations including CEOs with tenure shorter than 36 months as well, and the results are similar to those reported in Table 2. For example, the coefficient

In models (4) to (6), we add a cubic term of *Tenure* to evaluate the importance of higher-order terms. In each of the three models, the coefficient on the cubic term itself is not statistically significantly different from zero, and its sign varies across specifications. However, the linear term and the quadratic term still have the expected signs and remain statistically significant. These results suggest that the first two terms of *Tenure* are sufficient to characterize the convex shape of the volatility-tenure relation.

In Panel B of Table 2, we present results using a spline specification (Friedman, 1991) with cutoff points at *Tenure* = 1 (first year), 2 (second year). This specification allows us to estimate the learning slope separately in each of the first three years of the CEO's tenure. The convexity of the learning speed m_t in t implies that stock return volatility should decline faster in earlier periods of the CEO tenure than in later periods. In each of the spline models presented in Panel B of Table 2, we find that the slope estimate is significantly more negative in year 1 than in year 2. The absolute value of the estimated slope coefficient in year 2 is less than half of its value in year 1. The slope estimate in year 3 is less negative than that in year 2, although the difference across these two years is not always statistically significant. In Model (4), we include the first five years of tenure in the spline regression for CEOs with at least 7 years in office as a robustness check. Using this specification, the slope estimates for the first three years are still negative and significant. The slope estimates for the periods after year 3 are also negative, although not statistically significant. This pattern confirms the intuition that learning is most pronounced when uncertainty about CEO ability is highest.

In summary, the results in Table 2 imply that the firm's stock return volatility decreases in the first three years of a CEO's tenure, with fastest decline in the first year. These results are consistent with the implications of the model presented above. Market learning about the CEO's ability leads to decreasing uncertainty about the CEO, which in turn leads to decreasing stock volatility (particularly idiosyncratic volatility) over the CEO's tenure. The learning curve appears to be convex, with faster learning in earlier

---

estimate on *Tenure* is -0.593 (p-value<0.001) and that on $Tenure^2$ is 0.137 (p-value<0.001) using the specification of Model (3) of Table 2.

periods immediately after turnover. A signal with a specified precision helps the updating of CEO ability more in earlier years when uncertainty about his ability is higher.

4.2. Exogenous and Other Turnovers

The high level of stock return volatility around the time of CEO turnovers and the subsequent decline are consistent with high uncertainty about the new CEO's quality. However, an alternative explanation to learning is that CEO turnovers tend to occur at times when there is a high level of fundamental volatility. Both the underlying uncertainty about the firm's prospects and the uncertainty about the new CEO's ability could potentially lead to heightened stock return volatility around CEO turnover. A long literature beginning with Warner, Watts, and Wruck (1988) and Weisbach (1988) documents that CEO turnovers, and particularly forced turnovers, are more likely to occur subsequent to poor firm performance, which are also likely to be times of unusually high stock return volatility. However, this literature also documents that turnovers due to exogenous events such as illness, death, and normal retirements of the departing CEOs do *not* occur subsequent to unusual performance (e.g., Weisbach, 1988, Fee et al., 2013). Therefore, the exogenous turnovers in our sample should provide a subsample for which it is unlikely that volatility will be unusually high for reasons other than learning.

Panel A of Table 3 reports the summary statistics of firm performance and characteristics prior to turnover for the exogenous turnover sample, forced turnover sample, and other turnovers. Consistent with the findings in the literature, exogenous turnovers in our sample do not tend to follow poor performance, while forced turnovers do. Firms with turnovers classified as exogenous also tend to be more mature than other firms: they are more likely to be dividend payers and have lower volatility in profitability. From these statistics, it seems unlikely that the turnovers we classify as exogenous tend to occur during periods of high firm fundamental volatility.

In Panel B of Table 3 we separately estimate the volatility-tenure slope for the subsamples of exogenous turnovers (Model (1)), forced turnovers (Model (2)), and other turnovers (Model (3)), using *Idiosyncratic Return Volatility* and the polynomial specification of *Tenure*. The results indicate that subsequent to all types of turnovers, there is a negative and convex volatility-tenure relation. Even when the turnover is due to exogenous reasons, the idiosyncratic volatility declines with CEO tenure. In these turnovers, which are unlikely to be caused by prior poor performance and high fundamental volatility, the subsequent decline in volatility likely reflects the market's learning about the ability of the new CEO.

Panel B of Table 3 also shows that the volatility-tenure sensitivity, and hence the learning speed, is significantly lower following exogenous turnovers (-0.693) than following forced turnovers (-1.615). This pattern is also consistent with the model, since equations (4) and (5) imply that the learning slope (m_t) should be steeper when uncertainty about the management quality (δ_t) is higher. Since most of the exogenous turnovers tend to be associated with well-planned successions, there is likely to be relatively less uncertainty about the new management than in the cases of forced turnovers.

The fact that the volatility-tenure relation is negative across all types of CEO turnovers suggests that the post-turnover decline in stock return volatility is not driven by the nonrandom timing of turnovers, and is consistent with uncertainty about CEO quality decreasing over time because of market learning.

4.3. Post-Turnover Real Changes and Information Revelation

CEO turnovers are often followed by substantial policy changes in the firm. These changes often reflect the vision of the new leadership to change the firm's strategies and policies. Post-turnover real changes could affect the firm's stock return volatility in two ways: First, if they change the firm's asset portfolio or business policies, then the firm's fundamental uncertainty will change as well. Such a change could lead to a shift in the *level* of volatility. Second, if such corporate decisions provide signals about the CEO's ability, then they can change the speed at which the market learns about the CEO. Consequently, post-turnover real actions could affect the *sensitivity* of volatility to tenure through the learning channel.

It is also possible that CEO turnover lead to an increase of additional information about the firm's fundamentals. Career concerns could motivate incumbent management to withhold negative information about the firm's profitability and to hold onto poorly performing investments for too long. When a new CEO takes over, he has incentives to let the market know about the negative information quickly so as to not be held responsible for the poor decisions of his predecessor. For this reason, CEO turnovers can facilitate information revelation and investment re-optimization (Kanodia, Bushman, and Dickhaut, 1989; Boot, 1992). Consistent with this argument, empirical studies have shown that substantial accounting write-offs and divestitures are more likely to occur following CEO turnover and the market seems to be surprised by the new information conveyed in these actions (e.g., see Murphy and Zimmerman (1993) on "accounting bath", and Weisbach (1995) and Pan and Wang (2012) on downsizing). The additional information revelation and the corresponding "corrective" actions could potentially contribute to the increase in return volatility around CEO turnover.

To evaluate the effects of post-turnover real changes or information releases on stock volatility, we gather data on (1) three types of actions that have real effects on the firm's asset portfolio: downsizing, expansion, and introduction of new products; and (2) three types of actions that reveal information about the firm's fundamentals: accounting write-offs, earnings restatements, and securities fraud investigations. For each type of action except the revelation of fraud, we obtain information about action announcement from the "Key Developments" database from *Capital IQ*, which starts in 2001. We classify announcements as "downsizing" if they contain announcements of "seeking to sell/divest" and "discontinued operation/downsizing". "Expansion" announcements are those containing "seeking acquisitions/investment", or "business expansion", or "M&A transaction announcement". "New Product" announcements contain "product-related announcements" that are related to new product releases. "Restatement/Writeoff/Fraud" contains announcements of "restatement of operating profits", and "impairments/write-offs". We augment this category with announcements about securities fraud investigations, taken from the Federal Securities Regulation (FSR) database (Karpoff et al., 2012), which contains all securities fraud cases during our sample period. We create dummy variables that equal one if there is any one of the above announcements in a particular month. About 5% of firm-month observations in our sample contain downsizing announcements, 12% contain expansion announcements, 13% contain new product announcements, and 1% contain restatement/writeoff/fraud announcements.

We estimate the effects of these changes on the dynamics of volatility after turnovers. Since these actions could either affect the level of volatility, or the volatility-tenure slope, in Table 4 we use *Tenure*, a monthly announcement indicator (downsizing in model (1), expansion in model (2), new product release in model (3), and restatement/writeoff/fraud in model (4)), the interaction of the two, as well as other control variables to predict the firm's monthly idiosyncratic volatility.

Several results are evident from Table 4. First, in all specifications, the direct effect of *Tenure* is negative and significant, with magnitudes comparable to those in previous specifications. This result suggests that idiosyncratic volatility decreases with CEO tenure even when there are no significant changes announced. Our main result on the relation between volatility and tenure does not appear to be driven by the higher likelihood of changes in the firm after CEO turnover. Second, announcements of post-turnover changes tend to increase firms' idiosyncratic volatility, with restatement/writeoff/fraud having the largest effect. This kind of announcements usually generates great uncertainty about the firm's fundamentals and future prospects. Finally, the interaction effect of real changes and tenure is negative, but is statistically significant at 5% level only for new product releases. The negative interaction effect with new product releases suggests that the introduction of new products helps speed up learning about the management quality.

In models (5)-(8) we repeat the analysis using only the exogenous turnovers. We find that the direct effect of *Tenure* is still negative and statistically significant, with estimated magnitudes comparable to those in previous specifications. These results suggest that idiosyncratic volatility decreases with CEO tenure even when the turnovers do not coincide with high firm fundamental volatility and when there are no post-turnover real changes or substantial releases of information.

5. Additional Implications of the Learning Model

We have documented that, holding other factors constant, a firm's stock return volatility decreases with CEO tenure subsequent to the turnover. This relation is robust to a variety of alternative specifications, and is driven neither by turnovers occurring at times of unusually high volatility nor their being followed by substantial changes in the firm. Instead, we argue that the decline in stock return volatility subsequent to CEO turnovers likely occurs because of the market's learning of the CEO's quality. As the CEO's ability becomes better known, signals that are informative about the CEO's ability have a smaller impact on firm value, leading to lower stock return volatility.

One implication of the learning model that we have already tested is that the learning curve should be convex, meaning that volatility should decrease at a decreasing rate. The learning model also contains a number of other empirical implications. First, it predicts that the speed at which the market learns about the CEO should be a function of the initial uncertainty of the CEO's ability, as well as the quality of information available to market participants about this ability. Second, the key idea underlying the model is that the effect of news on firm valuation should depend on how certain management quality is known; consequently, stock price reactions to news that potentially reflects CEO ability should be larger in absolute value when CEOs are newer. Finally, the model implies that uncertainty about the CEO's ability can be an important component of firm-level volatility: Equation (4) shows that the learning speed (m_t) equals the ratio of the variance of CEO ability to the variance of the fundamentals. Therefore, estimates of the learning speed are also estimates of the relative importance of CEO-related uncertainty to fundamental uncertainty in determining firm-level volatility. Equation (7) provides a way to estimate m_0 based on the volatility-tenure relation. These estimates of m_0 also measure the contribution of uncertainty about management to overall stock return volatility. In this section we explore these implications empirically.

5.1. Cross-Sectional Determinants of the Learning Speed

In the learning model presented above, market participants continually update their assessment of the CEO's ability using Bayes' rule. The magnitude of these updates, which we refer to as the learning speed (m_t), depends on the precision of the market's prior estimate of the CEO's ability, relative to the quality of information about the CEO. Therefore, the model predicts that the learning speed should increase in the amount of uncertainty about the CEO's ability (δ_t) and the signal precision ($1/\sigma^2$).

To test these implications, we use a two-stage procedure. We first estimate the volatility-tenure slope separately for each CEO in the sample, using data from the CEO's first 36 months in office. As discussed in Section 2, a more negative volatility-tenure slope corresponds to a faster learning speed. We then test whether factors associated with uncertainty about the CEO's ability or the signal precision affect the magnitude of the estimated slopes across CEOs.

To estimate CEO-firm-specific volatility-tenure slopes, we rely on the following specification:

$$Vol_t^{ij} = \eta + \beta^{ij} \times Tenure + \varepsilon_t^{ij}, \qquad (8)$$

where Vol^{ij} refers to idiosyncratic volatility under CEO *i*'s tenure in firm *j*, and *Tenure* is the month in office count scaled by 12 (0, 1/12, … 3). The coefficient β^{ij} captures the average rate of decline in volatility during the tenure of CEO *i* in firm *j*. For our purpose here, we refer to ($-\beta$) as the "*Learning Slope*", which should be positively related to the average learning speed. To mitigate the noise in the estimated slope, we normalize it using its empirical cumulative distribution function, so that slopes are ranked between 0 and 1, reflecting the relative rankings of learning speeds across firms. A learning slope of 1 corresponds to the fastest speed.

In the second stage regression, we relate these estimated learning slopes to firm and CEO characteristics, which according to the model should affect the learning speed. The specification for the second-stage cross-sectional regression is:

$$LearningSlope_{ij} = X_{ij}'\gamma + u_{ij}$$

The results from this two-stage estimation process are summarized in Table 5. Panel A groups estimates of learning slopes from the first stage by the Fama-French 10 industry classification (see detailed definitions in http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html). The two industries for which our estimates indicate that learning speeds are the highest are the technology industry (computers, software, and electronic equipment) and the healthcare industry (healthcare, medical equipment, drugs), while the two industries with the lowest learning speeds are the energy and utilities industries. The difference between the estimated learning slopes between the top and the bottom industries are statistically significant.

We use a number of variables to measure the degree of prior uncertainty about CEOs' abilities to add value to their firms. First, the existence of an "heir apparent" usually indicates a well-anticipated succession, so it seems likely that the appointment of a new CEO who was expected to be appointed to the job should be associated with relatively low uncertainty about his ability. For this reason, we follow Naveen (2006) and classify heir-apparent CEOs in our sample as executives with the title “president” or “chief operating officer (COO)” prior to becoming CEO. Similarly, we expect an outsider CEO to have higher prior uncertainty than an insider CEO because of the unknown quality of the match between the outsider and the new firm. In addition, younger CEOs generally have shorter track records and less visibility than older CEOs, so younger CEOs should be associated with higher prior uncertainty about their abilities. Uncertainty about ability is also likely to be inversely related to the CEO’s experience, so we create a variable called “*Prior Experience*”, equal to the number of previous executive positions the CEO held before taking the current position. We construct these variables using data on job title and CEO age from *Execucomp*, and on prior managerial experience from *BoardEx*.

Since the theory predicts that the informativeness of the signals about the CEO should affect the learning speed, we also construct measures of the quality of the information available about the firm that can be used to infer the CEO’s ability. More transparent firms, which presumably release more and higher-quality information, are likely to provide more informative signals about management quality. We measure the firm’s transparency using two analyst-based variables, both measured as of the year of turnover: “*Number of Analysts*” is defined as the number of unique financial analysts that post forecasts for a firm in the fiscal year, while “*Analysts Forecast Error*” is calculated as the absolute difference between the mean analyst forecast of the annual earnings per share prior to the earnings announcement and the actual earnings in a given year. We expect the learning speed to be faster for more transparent firms, measured by higher analyst coverage and a smaller forecast error.

We also control for other factors that are likely to affect the learning slope. Pastor and Veronesi (2003) document that uncertainty about the firm’s profitability and thus stock return volatility decreases over time as the firm grows and matures. We measure firm size by the logarithm of the market value of equity “*Log(MV)*”. “*Log(Firm Age)*” is the logarithm of the number of years since IPO. We also control for turnover year fixed effects and in some regressions industry fixed effects (using the Fama-French 10 industry classification) as well. Panel B of Table 5 reports summary statistics on these explanatory variables.

Panel C of Table 5 reports results of the second stage estimation. Because a number of our independent variables are correlated with one another, we first present estimates in Columns 1 through 6 using each variable separately, with additional controls as discussed above. In Columns 7 and 8, we include all explanatory variables except *Outsider CEO* and *Prior Experience*, since they are highly correlated with *Heir Apparent*. .

The estimates indicate that learning about CEO ability is faster in firms with more analyst coverage and lower analyst forecast errors, although the forecast error is not statistically significant any more in the specifications using all variables (Columns 7 and 8). Learning is also significantly faster in younger firms, consistent with the results in Pastor and Veronesi (2003). As for the CEO characteristics, learning appears to be slower for heir apparent CEOs, but faster for outsider CEOs, younger CEO, and less experienced CEOs. All these findings are consistent with the notion that learning about CEO ability is faster when there is more uncertainty about the ability, and also when signals about that ability are more informative. The fact that the cross-sectional pattern of the volatility-tenure relation corresponds to that predicted by the learning model provides additional confirmation that the appropriate interpretation of them is that they reflect learning, not some unobserved factor that is correlated with CEO turnover.

In Model (8), when we include industry fixed effects, the estimates, as well as the adjusted R-Squared of the estimated equation, are similar to those in Column 7, which do not contain these fixed effects. The similarity between the equations with and without industry effects suggests that the differences across industries in learning speeds documented in Panel A are well captured by the determinants of the learning speed we study in this subsection. Indeed, in our sample, compared to energy firms and the utilities industry, technology and health care firms tend to be younger and have more junior CEOs, are more likely to hire outsider CEOs and less likely to have CEOs previously designated as heirs apparent.[9] The fact that differences in learning speeds across industries occur because of industries' differences in variables likely to reflect uncertainty about CEO ability and the firm's information environment provides external validation for these determinants.

5.2. CEO Tenure and Market Reactions to News

The learning model presented above predicts when there is uncertainty about CEO ability, news related to the expected profitability will cause the market to update its assessment of the CEO's ability and the future profits he will help to generate. The implication of this logic is that when there is good (bad) news about the firm, the direct effect of the news is augmented by a positive (negative) update to the market's assessment of the CEO's ability and hence future profits. When uncertainty about the CEO's ability is larger, the update to ability and future profits will be larger, so the stock price will change more in response to the news. Consequently, the model suggests that the absolute value of the stock price reaction to news will be larger when the market's estimate of CEO's ability is less precise.

Given that the CEO's ability should be known more precisely over time, this logic predicts that the absolute value of stock price reactions to news should decline over the CEO's tenure, holding constant the nature of the news. Consistent with this argument, Clayton et al. (2005) document that market reactions to earnings announcement surprises decrease over a CEO's tenure. We extend their analysis, using other kinds of news announcements that are likely to reflect the firm's future profitability: expansion/downsizing, product-related announcements, dividend changes (increase or cut), and we also replicate Clayton et al.'s analysis on earnings surprises. Data on the first three news announcements are from the *Capital IQ* database, and data on earnings announcements and surprises are from the *IBES* database. We define an earnings announcement as a "surprise" if the absolute percentage deviation of the actual earnings per share from the median analyst forecast is at least 10% (the median of the sample distribution).[10] For each news announcement, we calculate the announcement-day market-adjusted stock return ("AR") and then take its

[9] The average firm age is 11 years in the technology industry, and is 42 in the utilities industry. The average CEO age is 51 in the technology industry, and is 55 in the utilities industry. The probability of having an heir apparent CEO is 12% in the technology industry, and is 23% in the utilities industry.
[10] The results are similar to those reported below if we use 8% or 12% as the cutoff.

absolute value. We then examine how market reactions to each type of news change over CEO tenure using the following specification:

$$|AR_t^{ij}| = \beta_0 + \beta_1 \times Tenure + \beta_2 \times Tenure^2 + MktVol_t + \alpha^{ij} + \varepsilon_t^{ij} \qquad (9)$$

where *Tenure* is the month in office count (from 0 to 36) scaled by 12, α^{ij} is the firm-CEO fixed effect for the pair of firm *i* and CEO *j*, and $MktVol_t$ is the cross-sectional standard deviation of all CRSP firm returns on date *t*.

Table 6 reports estimates of this equation. Model (1) reports the results for the sample of expansion/downsizing announcements, Model (2) for the sample of new product releases, Model (3) for the sample of dividend changes, and Model (4) for the sample with earnings surprises. The estimates in Table 6 indicate that for each type of news, the absolute value of the stock price reaction is decreasing with CEO tenure. The negative coefficient on tenure is consistent with the notion that over time, the indirect effect of the news through the learning channel decreases. Additionally, since the model predicts that uncertainty about CEO ability will decline at a decreasing rate, we expect that the decrease in the absolute value of stock price reactions over time should also decline at a decreasing rate. Consistent with this idea, the coefficient on the squared term of *Tenure* is positive in each specification, suggesting that the relation between the absolute value of stock price reactions to news and CEO tenure is convex.[11] Overall, estimates of the relation between the reaction to news and CEO tenure provide strong support for the learning model.

5.3. The Magnitude of Ability-Induced Volatility

Equation (7) shows how the firm's stock return volatility can be decomposed into two components: the fundamental uncertainty about the firm's cash flow (σ) and the uncertainty about the management quality (δ). While under the model's assumptions, both factors should contribute to volatility, it is unclear that the latter of these two effects, the uncertainty due to management quality, is quantitatively important relative to the firm's fundamental uncertainty. Conveniently, the learning speed parameter in the model,

[11] We have also estimated specifications that control for the magnitudes of the earnings surprises, and obtained similar result to those in Table 6.

$m_t = \delta_t^2 / \sigma^2$, equals the square of the volatility ratio, Thus, estimates of this parameter allows us to gauge the relative importance of the two components of volatility.

5.3.1. Decomposing Volatility.

Since both the theory and the empirical work strongly suggest that learning speeds decline over time, any measurement of a learning speed requires specifying a particular time. The learning speed at time 0 when the new CEO takes office is particularly meaningful because $m_0 = \delta_0^2 / \sigma^2$, tells us how large the *prior uncertainty* about the CEO is relative to the fundamental uncertainty. Also, given the function $m_t = \frac{1}{1/m_0 + t}$ implied by Equations (4) and (5) of the model, any value of m_0 leads to an implied learning speed and volatility ratio at any subsequent time t.

We present two approaches to estimate m_0. In the first approach, we start with equation (7). Using *Vol* to denote stock return volatility, we define $Vol' \equiv \frac{Vol}{\sigma} - 1$. We can interpret *Vol'* as the percentage excess volatility. Let $K_t = \frac{\partial \log(P/D)_t}{\partial \theta_t}$, which is the sensitivity of the price-dividend ratio to average CEO ability, a measure of the marginal return to CEO ability. Equation (7) implies that $Vol_t^{'} = K_t m_t$. The percentage change in *Vol'* from 0 to t is:

$$\frac{\Delta Vol'}{Vol_0^{'}} = \frac{\Delta m}{m_0} + \frac{\Delta K}{K_0} \times (1 + \frac{\Delta m}{m_0}) \qquad (10)$$

where Δ is the first difference operator. We do not have a closed form for K as a function of t. Our numerical simulation suggests that K is increasing in t for reasonable parameter values, but the sensitivity of K to t is very small ($\frac{\Delta K}{K_0}$<1% over a three-year period). This implies that $\frac{\Delta m}{m_0} \approx \frac{\Delta Vol'}{Vol_0^{'}}$. In other words, the percentage update in uncertainty about CEO ability approximately equals the percentage change in the excess volatility *Vol'*. Then we have:

$$\frac{\Delta m}{m_0} = \frac{1}{1+m_0 t} - 1 \approx \frac{\Delta Vol'}{Vol_0'} = \frac{\Delta Vol}{Vol_0} \times \frac{Vol_0}{Vol_0 - \sigma}$$

We observe in the data that the average percentage change in the realized return volatility in the first three years of CEO tenure is $\frac{\Delta Vol}{Vol_0}$ = -10%, the average (annualized) return volatility at month 0 (*Vol_0*) is about 45%, and the average annual firm-level volatility of dividend growth rate (σ) for the dividend-paying firms in our sample ranges from 23% to 28%, depending on how we define a dividend-paying firm and the time period that we use for the estimation of σ. Thus, suppose that σ = 28%, then $\frac{\Delta Vol'}{Vol_0'}$ = -26.5%, which means that uncertainty about CEO ability on average declines by about 26.5% in the first three years of tenure. With t=3, we have $m_0 = \frac{1}{3}[\frac{1}{1-26.5\%} - 1] \approx 12\%$, which implies that at time 0 the uncertainty about the management quality (δ) is approximately 35% ($=\sqrt{12\%}$) of the magnitude of the fundamental volatility (σ). The magnitude of the prior uncertainty about management quality is clearly nontrivial.

The second approach we propose to estimate m_0 is to consider a Taylor expansion of m_t at t=0 in equation (7). For simplicity, we assume that K is constant over time. Then Equation (7) can be written as:

$$\begin{aligned} vol(\frac{dP_t}{P_t}) &\approx \sigma + \sigma K m_t = \sigma + \sigma K \frac{1}{1/m_0 + t} = \sigma + \sigma K\{m_0 - [m_0{}^2]t + [m_0{}^3]t^2 - ...\} \\ &\approx \sigma(1+Km_0) + [-\sigma K(m_0)^2]t + [\sigma K(m_0)^3]t^2 + \varepsilon_t^i \qquad (11) \\ &= \alpha^i + \beta^i t + \gamma^i t^2 + \varepsilon_t^i \end{aligned}$$

where ε_t represents the sum of all the higher order terms. Note that $m_0 = -\beta_2 / \beta_1$ in equation (10). Thus, we can estimate m_0 using the coefficient estimates from the polynomial specification in Table 2. The benefit of this regression approach is that we can control for other factors that may affect volatility, and the estimation does not rely on any specific estimates of the fundamental volatility (σ). Panel A of Table 2 suggests that m_0 is about 17% using the realized return volatility, and is about 22% using the implied volatility or the idiosyncratic volatility. While these estimates are higher than those from the first approach, they are not that different. The fact that the estimates of m_0 using different approaches are similar provides, at least to some extent, external validity for these estimates.

If we take 17% as a representative estimate of m_0, then the amount of stock return volatility induced by uncertainty about CEO ability is $\frac{\delta_0}{Vol_0} = (\frac{\delta_0}{\sigma}) \times (\frac{\sigma}{Vol_0}) = \sqrt{17\%} \times (28\% / 45\%) \approx 26\%$ at the time of turnover. In other words, 26% of stock-return volatility at the time of turnover is due to uncertainty about CEO ability, or about the policies the CEO will choose to introduce in the firm.

This calculation potentially overestimates the contribution of uncertainty about CEO ability to stock return volatility because of the endogenous nature of CEO turnover (see discussions in Sections 3.1, 4.2, 4.3). Therefore, we also estimate m_0 using a "cleaner" subsample of turnovers that are (1) due to exogenous reasons, (2) with no disclosure of negative information through the announcements of restatements, write-offs, fraud investigations, or downsizing in the three years after turnover, and (3) in mature firms that were publicly-traded for at least 22 years at the time of turnover (the median of the sample distribution). Estimation using this subsample is likely to reflect the impact of a new draw of CEO on equity volatility rather than other factors. Using this relatively small subsample of 84 turnovers, we obtain estimates of m_0 ranging from 17% to 20% using the second approach discussed above. The fact that estimates using the "clean" subsample are comparable to those based on the full sample suggests that nonrandom timing of turnovers and information releases following them is not the primary determinant of our estimates of m_0 and volatility ratios.

To estimate m_t, we use the estimates of m_0 together with the function $m_t = \frac{1}{1/m_0 + t}$, which follows from Equations (4) and (5). Given a representative estimate of m_0 equal to 17%, the implied value of m equals 11% (δ/σ = 33%) three years after turnover, and 8% (δ/σ = 28%) six years after turnover. Therefore, uncertainty about CEO ability appears to remain as an important source of stock return volatility even years after CEO turnover.

5.3.2. Cross-Sectional Variation in Volatility Ratios

Both the learning model and results from Table 5 suggest that there should be substantial heterogeneity in ability-induced volatility across different types of CEOs and different types of firms. To evaluate the quantitative importance of these differences, we estimate the learning speed (m_t) as well as the volatility ratio (δ_t / σ) at the time of turnover and at the end of year 3 for several subsamples, using the regression approach based on Equation (11) (specifically, Model (3) in Panel A of Table 2 using idiosyncratic volatility).

The estimates presented in Table 7 indicate that there are substantial cross-sectional heterogeneity in the magnitude of ability-induced volatility. The estimated m_0 and volatility ratio are substantially larger for younger CEOs (age <53) than for older ones (m_0: 35% vs. 13%, δ_0 / σ: 59% vs. 36%). They are also larger for outsider CEOs than for insider CEOs (m_0: 26% vs. 18%, δ_0 / σ: 51% vs. 43%). These estimates imply that the ability-induced volatility varies substantially with the experience and succession origin of the CEO.

Firm characteristics matter as well because the learning speed also depends on the quality of information available for assessing CEO ability. For example, the estimated m_0 and volatility ratio are larger for more transparent firms than for less transparent ones, likely due to the higher signal precision in more transparent firms. Finally, the estimated volatility ratio is 45% in high-tech and healthcare industries, and 43% in utilities and non-durable goods industries. The cross-industry difference in learning speeds is much smaller than the cross-CEO-type difference, which is also consistent with the learning model, since it is likely that uncertainty about the CEO's ability depends more on the CEO's background than on the industry in which he works.

Of course, all these estimates are based on the underlying assumptions in the model as well as the estimation approach discussed in section 5.3.1. However, they do provide, for the first time, some idea about how much uncertainty about management quality can contribute to the overall firm uncertainty and stock return volatility. Moreover, comparing across managers and firms, learning about management contributes more to volatility exactly in those circumstances predicted by the learning model. These results suggest that the estimated learning curves occur because of learning and not because of an econometric misspecification. Uncertainty about management quality appears to be a non-trivial source of stock return volatility.

6. Discussion and Conclusion

When management's quality is not known perfectly but nonetheless affects profitability, any news about the firm's profits will lead rational investors to update their assessment of the management's ability to generate future profits. For example, if there is positive news about the firm, the market is likely to update positively not only its estimate of current cash flows, but also its expectation about the management's ability to earn profits in the future. The magnitude of the updating on CEO ability, which is a function of stock price reaction to news and hence the stock return volatility, will be larger when there is more uncertainty about the CEO's ability. As the market learns about the CEO, we expect a corresponding decrease in stock-return volatility, since new information about the firm will cause less of an update to the market's expectation of future profits.

This paper formalizes this idea, and evaluates the importance of its implications for both the economics of the firm and for capital markets. We first present a model of the process by which the market learns about the CEO's quality. In the model, cash flows are determined by both management's ability and also other factors beyond his control, which we refer to as fundamental volatility. The market's assessment of management ability is updated continuously using Bayes' rule, causing the price to change accordingly, increasing the firm's stock return volatility. We show that this effect will add to the firm's idiosyncratic, but not systematic risks, and that this increment to volatility will decline at a decreasing rate as the CEO's ability becomes better known.

The model has a number of empirical implications that we evaluate using a large sample of CEO turnovers in publicly-traded U.S. firms. First, the model predicts that volatility should decline with CEO tenure. Our evidence suggests that there is indeed such a decline; using three alternative measures of volatility, we find that all measures decline subsequent to a turnover. A concern in interpreting this relation is that turnovers and volatility could be jointly determined by a third factor. In particular, the turnovers could occur at times of high volatility or at times when substantial changes are likely to occur. Using a subsample of "exogenous" turnovers that are unlikely to be performance-based as well as data on important post-turnover actions that firms take, we find that the measured decline in volatility after turnover is not a consequence of nonrandom timing of CEO turnovers, and is not driven by post-turnover real changes in the firm's activities.

Second, the model predicts that the volatility-tenure slope should be convex, because learning about ability is faster in earlier periods than in later periods. When the CEO's ability is known more precisely, adjustments to the market's estimate of ability will be smaller, and the sensitivity of volatility to CEO ability should decline with tenure. Using both spline and polynomial specifications, we find strong evidence that the volatility-tenure relation is convex: Learning appears to be fastest in the first year of the CEO's tenure, and the majority of the relation between volatility and tenure occurs in the three years following the turnover.

Third, the model predicts that learning about CEO ability should be largest when the ability is most uncertain, and when the signals about the CEO are most informative. To evaluate these predictions, we examine the cross-sectional determinants of the learning speed. The estimates indicate that the speed at which the market learns about a CEO and the stock return volatility that is induced by this learning varies substantially across CEOs and firms. Consistent with the model, a CEO's background, which is closely related to uncertainty about his ability, has a large effect on learning speeds and volatility caused by this learning. In general, learning is affected by factors reflecting the degree of prior uncertainty about the CEO's ability to add value to the firm, as well as factors related to the quality of information that the market can use to update its priors about the CEO's ability.

Fourth, the model suggests that market reactions to news about the firm should depend on the extent to which the market knows the CEO's ability. Consistent with this idea, the absolute values of stock price movements to different types of newsworthy announcements about the firm declines over a CEO's tenure. This pattern suggests that the market's inferences about management quality are an important component of stock price reactions to news.

Finally, the model allows us to quantify the importance of uncertainty about management quality in determining the overall stock return volatility. Our estimates suggest that uncertainty about management is non-trivial relative to the magnitude of the fundamental uncertainty, and it remains so even after the CEO has been in office for a few years. The estimates of ability-induced volatility are substantially larger for managers for whom ex ante uncertainty is higher, and in firms for which information availability for updating management quality is better.

These results together strongly suggest that the process of learning about the CEO, and more generally, about the management team, advances our understanding of not only corporate governance, but also stock return volatility. At least since Timmermann (1993) and Pastor and Veronesi (2003), it has been argued that market learning about the firm's cash flow generating process can influence the firm's stock return volatility. Our study contributes to this literature by isolating the process of learning about an important source of value, the quality of the firm's management.

CEOs of public firms have become well-known public figures, who are generally believed to be important sources of value in firms. Yet, the common occurrence of high expectations surrounding new appointments combined with disappointment when they are fired, indicates that there is often substantial uncertainty about a CEO's ability to add to his firm's profits. Our model implies that there is a fundamental link between this uncertainty about ability and stock return volatility. The empirical evidence suggests that uncertainty about management is an important component of stock return volatility. In addition, the estimates indicate that there is substantial variation in management quality, and that this variation leads to meaningful differences in firm profitability and valuations. Exploring the extent of the effect of management quality differences on valuation would be an excellent topic for future research.

References

Ang, A., R. J. Hodrick, Y. Xing, and X. Zhang, 2006, "The Cross-Section of Volatility and Expected Returns.," *Journal of Finance*, 61, 259-299.

Berk, Jonathan and Richard Green, 2004, "Mutual Fund Flows and Performance in Rational Markets," *Journal of Political Economy*, 112, 1269-1295.

Boot, Arnoud W.A., 1992. "Why hang on to losers? Divestitures and takeovers," *Journal of Finance* 47, 1401-1423.

Chung, Ji-Woong, Berk A. Sensoy, Lea H. Stern and Michael S. Weisbach, 2012, "Pay for Performance from Future Fund Flows: The Case of Private Equity," *Review of Financial Studies*, 25, 3259-3304.

Clayton, Matthew, Jay Hartzell and Joshua Rosenberg, 2005, "The Impact of CEO Turnover on Equity Volatility," *The Journal of Business*, 78 (5), 1779-1808.

Cremers, Martijn and Yaniv Grinstein, 2011, "The Market for CEO Talent: Implications for CEO Compensation," Working Paper, University of Notre Dame and Cornell University.

Fee, C. Edward, Charles J. Hadlock and Joshua R. Pierce, 2013, "Managers with and without Style: Evidence using Exogenous Variation," *Review of Financial Studies*, forthcoming.

Friedman, Jerome H., 1991, "Multivariate Adaptive Regression Splines," *Annals of Statistics* 19, 1–67.

Gibbons, Robert and Kevin J. Murphy, 1992, "Optimal Incentive Contracts in the Presence of Career Concerns: Theory and Evidence," *Journal of Political Economy*, 100, 468-505.

Hermalin, Benjamin E., 2005, "Trends in Corporate Governance," *The Journal of Finance*, 60, 2351-2384.

Hermalin, Benjamin E. and Michael S. Weisbach, 1998, "Endogenously Chosen Boards of Directors and their Monitoring of the CEO," *American Economic Review*, 88, 96-118.

Hermalin, Benjamin E. and Michael S. Weisbach, 2012, "Information Disclosure and Corporate Governance," *Journal of Finance*, 67, 195-233.

Holmström, Bengt, 1999, "Managerial Incentive Problems: A Dynamic Perspective," *Review of Economic Studies*, 66, 169-182.

Karpoff, Jonathan M., Allison Koester, D. Scott Lee, and Gerald S. Martin, 2012, "An analysis of database challenges in financial misconduct research," Working paper, University of Washington.

Kanodia, Chandra, Robert Bushman, and John Dickhaut, 1989. "Escalation errors and the sunk cost effect: An explanation based on reputation and information asymmetries," *Journal of Accounting Research,* 27(1), 59-77.

Lim, Jongha, Berk A. Sensoy and Michael S. Weisbach, 2013, "Indirect Incentives of Hedge Fund Managers," Working Paper, Ohio State University.

Naveen, Lalitha, 2006, "Organizational Complexity and Succession Planning", *Journal of Financial and Quantitative Analysis*, 41(3), 661-683.

Murphy, Kevin J. and Ján Zábojník, 2007, "Managerial Capital and the Market for CEOs," Working Paper, University of South California.

Murphy, Kevin J. and Jerold L. Zimmerman, 1993. "Financial performance surrounding CEO turnover," *Journal of Accounting and Economics*, 16, 273-315.

Pan, Yihui, 2012, "The Determinants and Impact of Executive-Firm Matches," Working Paper, University of Utah.

Pan, Yihui and Tracy Yue Wang, 2012, "CEO Turnover and Value Creation: Insights from Post-Turnover Firm Action Choices," Working Paper, University of Utah and University of Minnesota.

Parrino, Robert, 1997, "CEO Turnover and Outside Succession: A Cross-Sectional Analysis," *Journal of Financial Economics*, 46, 165-197.

Pastor, Lubos and Pietro Veronesi, 2003, "Stock Valuation and Learning about Profitability," *Journal of Finance*, 58, 1749-1789.

Pastor, Lubos and Pietro Veronesi, 2009, "Learning in Financial Markets," *Annual Review of Financial Economics*, 1,361-381.

Pastor, Lubos and Pietro Veronesi, 2012, "Uncertainty about Government Policy and Stock prices," *Journal of Finance*, 67, 1219-1264.

Schwartz-Ziv, Miriam and Michael S. Weisbach, 2013, "What do Board Really do? Evidence from Minutes of Board Meetings," *Journal of Financial Economics*, forthcoming.

Shiller, Robert J., 1981, "Do Stock Prices Move too Much to Be Justified by Subsequent Changes in Dividends?" *American Economic Review*, 71, 421-436.

Taylor, Lucian, 2010, "Why are CEOs Rarely Fired? Evidence from Structural Estimation," *Journal of Finance*, 65, 2051-2087.

Taylor, Lucian, 2012, "CEO Wage Dynamics: Estimates from a Learning Model," *Journal of Financial Economics*, forthcoming.

Timmermann, Allan G., 1993, "How Learning in Financial Markets Generates Excess Volatility and Predictability in Stock Returns," *Quarterly Journal of Economics*, 108, 1135-1145.

Warner, Jerold, Ross L. Watts, and Karen H. Wruck, 1988, "Stock Prices and Top-Management Changes," *Journal of Financial Economics*, 20, 461-492.

Weisbach, Michael S., 1988, "Outside Directors and CEO Turnover," *Journal of Financial Economics*, 20, 431-460.

Weisbach, Michael S., 1995, "CEO Turnover and the Firm's Investment Decisions," *Journal of Financial Economics*, 37, 155-188.

Appendix A: Proof of Key Model Equations

Proof for equations (6):

Let $f_t(\alpha)$ denote the probability density function of α at time t, and E be the expectation operator.

$$P_t = E_t\left[\int_t^{\infty} e^{-r(\tau-t)} D_\tau d\tau\right] = \int_{-\infty}^{r} E\left[\int_t^{\infty} e^{-r(\tau-t)} D_\tau d\tau \middle| \alpha\right] f_t(\alpha) d\alpha$$

The integral is from -∞ to r because α is bounded from above (less than r). Conditional on α, which is the CEO ability that controls the drift of the dividend growth process in equation (2), we can apply Ito's lemma for $g(D_t) = log(D_t)$ to get $D_\tau = D_t e^{\left(\alpha-\frac{\sigma^2}{2}\right)(\tau-t)+\sigma(W_\tau-W_t)}$. Thus,

$$P_t = \int_{-\infty}^{r}\int_t^{\infty} E[e^{-r(\tau-t)} D_t e^{\left(\alpha-\frac{\sigma^2}{2}\right)(\tau-t)+\sigma(W_\tau-W_t)} | \alpha]\, d\tau f_t(\alpha) d\alpha$$

Since $W_\tau - W_t \sim N(0, \tau - t)$, we use the moment generating function for this normal distribution to get

$$P_t = D_t \int_{-\infty}^{r}\int_t^{\infty} e^{-(r-g)(\tau-t)} d\tau\, f_t(\alpha) d\alpha$$

Finally, using the property of the finite integral for an exponential distribution, $\int_0^{\infty} e^{-(r-g)s}\, ds = \frac{1}{r-g}$, we get: $P_t = D_t \int_{-\infty}^{r} \frac{1}{r-\alpha} f_t(\alpha) d\alpha$, which is equation (6).

Proof for equations (7):

Note that $f_t(\alpha) \sim N(\theta_t, \delta_t^2)$ and α <r. The dynamics of θ_t, δ_t^2 are presented in equation (4). Let $F(\theta_t, \delta_t^2) \equiv \log\left(\frac{P_t}{D_t}\right)$. From Itō's lemma, $dF(\theta_t, \delta_t^2) = \frac{\partial F(\theta_t,\delta_t^2)}{\partial \theta_t}\, d\theta_t + o(dt)$ where *o(dt)* denotes the non-stochastic terms. Since $dlog\left(\frac{P_t}{D_t}\right) = \frac{dP_t}{P_t} - \frac{dD_t}{D_t}$, we have

$$\frac{dP_t}{P_t} = \frac{dD_t}{D_t} + \frac{\partial F(\theta_t,\delta_t^2)}{\partial \theta_t}\, d\theta_t + o(dt).$$

Combining the above equation with equation (4), we have:

$$\frac{dP_t}{P_t} \approx \frac{dD_t}{D_t} \times [1 + \left(\frac{\partial F(\theta_t, \delta_t^2)}{\partial \theta_t}\right) m_t] + o(dt)$$

Finally, taking standard deviation of both sides:

$$vol\left(\frac{dP_t}{P_t}\right) \approx vol\left(\frac{dD_t}{D_t}\right) \times \left[1 + \left(\frac{\partial F(\theta_t, \delta_t^2)}{\partial \theta_t}\right) m_t\right] = vol\left(\frac{dD_t}{D_t}\right) \times \left[1 + \left(\frac{\partial \log\left(\frac{P_t}{D_t}\right)}{\partial \theta_t}\right) m_t\right]$$

That is, the return volatility is approximately equal to dividend growth volatility time one plus the product of P/D ratio sensitivity to perceived average CEO ability and the learning speed *m*.

Appendix B: Variable Definitions

Tenure	The event month count from month 0 to month 36, with month 0 being the event month when the CEO takes office. Then scaled by 12.
Option-implied volatility	The average of implied volatility from daily prices of 30-day at-the-money call options written on the firm's common stock in a month, aggregated to the monthly level
Realized return volatility	The standard deviation of daily stock returns in a month, aggregated to the monthly level
Idiosyncratic return volatility	The volatility of the residual return from the Fama-French 3-factor model in a month, aggregated to the monthly level
Market beta	The coefficient estimate on the excess market return in the Fama-French 3-factor model, estimated at the monthly level using daily stock returns
SMB beta	The coefficient estimate on the SMB factor in the Fama-French 3-factor model, estimated at the monthly level using daily stock returns
HML beta	The coefficient estimate on the HML factor in the Fama-French 3-factor model, estimated at the monthly level using daily stock returns
Exogenous	Exogenous turnovers include cases where a) news searches revealed that the CEO departure was related to a health condition or death (from Fee et al. 2013), b) turnover reason provided in Execucomp is "deceased", c) departing CEOs older than 65 years.
Forced	Forced turnovers include the "overtly forced" group from Fee et al. (2013) with cases for which news searches indicated that the CEO was forced to leave or left under pressure.
Downsizing Announced	An indicator variable that equals to one if the company makes downsizing announcement (Events 1, 21 in Capital IQ) in a month
Expansion Announced	An indicator variable that equals to one if the company makes expansion announcements or M&A announcements (Events 3, 31, 80 in Capital IQ) in a month
Restatement/Write-off/Fraud Announced	An indicator variable that equals one if the company makes announcements regarding restatements of operating results (Event 43 in Capital IQ) or impairments/write-offs (Event 73 in Capital IQ) or securities fraud investigation (FSR database)
New Product Announced	An indicator variable that equals to one if the company makes new product or service related announcements (Event 41 in Capital IQ)
Dividend Change Announced	An indicator variable that equals to one if the company announces dividend increase or dividend decrease (Event 46 and 47 in Capital IQ)
Earning Surprise Announced	An indicator variable that equals to one if the company's actual quarterly earning exceeds 10% of the forecast median.
Firm Age	Age of the firm since IPO, using the first day appear in CRSP (or the IPO date in Compustat if missing)), constructed for each firm-year
Div. Payer	An indicator variable that equals 1 if the firm pays out dividend to common stock holders in a year
Leverage	Long-term debt/total assets), constructed for each firm-year

M/B	Market equity divided by book equity), constructed for each firm-year
Log(Assets)	Logarithm of the total book assets (in million dollars), constructed for each firm-year
Log(MV)	Logarithm of the market value of equity (in million dollars)), constructed for each firm-year using the end of fiscal year stock price
Return(-1)	Industry (Fama-French 49)-adjusted return as of the year before a CEO turnover
ROA(-1)	Industry (Fama-French 49)-adjusted ROA as of the year before a CEO turnover. ROA is defined as the earnings before interest, tax, and depreciation scaled by the beginning of fiscal year total book assets.
ROE	Net income scaled by the average of this period and last period's book equity), constructed for each firm-year
VolP	Residual volatility of the AR(1) process of ROE, following Pastor and Veronesi (2003)
Market Volatility	Cross-sectional standard deviation of all CRSP firm returns (ex-dividend) on a day
Learning slope	We run firm-CEO specific regressions of idiosyncratic volatility on *Tenure* and a constant term. For each firm-CEO pair, the learning slope is the estimated coefficient on *Tenure* multipled with -1 and then normalized with the empirical cumulative distribution function so it is between 0 and 1.
Number of analyst	The number of unique financial analysts that post forecasts for a firm in the fiscal year.
Analysts forecast error	Analyst forecast error, measured as the absolute difference between the (latest) mean analyst earnings forecast prior to an annual earnings announcement and the actual earnings.
CEO Age	The age of the CEO
Outsider CEO	An indicator that equals 1 if the CEO is hired from outside of the company (i.e, with the firm for less than three year when becoming CEO)
Heir Apparent	An executive with the title "president" or "chief operating officer (COO)" or both who is distinct from the CEO and the chairman
Number of prior positions	Number of positions the CEO took prior to become the chief executive (both within the current company and other companies)
|AR|	Absolute value of the market-adjusted announcement day return, where market return is the "value-weighted market return" from CRSP. Both market and firm returns are ex-dividend.

Table 1: Summary Statistics

Panel A: Turnover Year Distribution

This table reports the distribution of turnover years. The sample contains all CEO turnover events identified in *ExecuComp* from 1992 to 2006 for CEOs that have tenure of three years or longer. We use the information on job title, the year becoming CEO, and the CEO annual flag provided by *ExecuComp* to identify CEOs at the firm-year level. For each firm, we compare the designated CEO in each fiscal year with the CEO in the previous year to identify whether there is a CEO turnover in that year.

Became CEO Year	Freq.	Percent
1992	125	6.67
1993	125	6.67
1994	129	7.00
1995	115	6.14
1996	109	5.82
1997	126	6.73
1998	129	6.89
1999	140	7.47
2000	146	7.79
2001	154	8.22
2002	110	5.87
2003	120	6.41
2004	113	6.03
2005	129	6.89
2006	103	5.50
Total	1,873	100

Panel B: Volatility and Risk Factor Measures

This table reports the summary statistics for the three volatility measures (at the monthly level and in percentage) and firm-level monthly estimated loadings on the three Fama-French risk factors during the 36 months after a new CEO takes office. The calendar year-month in which the CEO takes office is identified with the variable *becameceo* in *Execucomp*. Data on option-implied volatility is obtained from Option Metrics and available starting from 1996. Other volatility measures and factor loadings are estimated using CRSP data, as well as monthly factor data from the French data library.

Variable	Obs	Mean	25^{th} percentile	Median	75^{th} percentile
Option-implied Volatility	35,614	16.665	10.911	14.718	20.325
Realized Return Volatility	68,150	11.884	6.636	9.700	14.649
Idiosyncratic Volatility	64,899	9.907	5.378	8.011	12.275
Market Beta	68,150	1.060	0.378	0.979	1.662
SMB Beta	68,150	0.620	-0.357	0.459	1.449
HML Beta	68,150	0.268	-0.801	0.296	1.397

Panel C: Firm Attributes

This table reports the summary statistics (number of observations with non-missing value for the corresponding variable, mean, median, 25^{th} and 75^{th} percentile of the distribution) of firm attributes that we use as control variables. The observations are at the firm-year level for the first three years after each CEO turnover in our sample. Variables definitions are provided in Appendix A. Data on Company attributes are provided in *Compustat*.

Variable	Obs	mean	25th percentile	median	75th percentile
Div. Payer	5,193	0.549	0	1	1
Leverage	4,865	0.196	0.033	0.161	0.305
M/B	5,190	2.566	1.426	2.129	3.516
log(Assets)	4,878	7.249	5.956	7.203	8.460
VolP	4,878	0.569	0.253	0.287	0.436
ROE	4,878	0.079	0.041	0.119	0.186

Table 2: Time in Office and Volatility

Panel A: Polynomial Specification

This table reports the non-linear trend in various volatility measures from the time when the CEO took office to three years after that, using polynomial specifications. The definitions of all variables are in Appendix B. The Huber-White-Sandwich robust standard errors are clustered by firm-CEO. t statistics are reported in parenthesis. ***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

	(1) Option-implied Volatility	(2) Realized Return Volatility	(3) Idiosyncratic Return Volatility	(4) Option-implied Volatility	(5) Realized Return Volatility	(6) Idiosyncratic Return Volatility
Tenure	-0.786***	-1.030***	-0.725***	-0.741*	-1.531***	-1.056***
	(-3.728)	(-6.837)	(-3.893)	(-1.951)	(-4.999)	(-3.543)
$Tenure^2$	0.179***	0.173***	0.162***	0.141	0.606***	0.448**
	(3.076)	(3.964)	(4.193)	(0.502)	(2.623)	(2.140)
$Tenure^3$				0.008	-0.096	-0.063
				(0.138)	(-1.554)	(-1.417)
Market Beta	0.204***	0.605***		0.204***	0.605***	
	(7.195)	(8.208)		(7.194)	(8.206)	
SMB Beta	0.055***	0.141***		0.055***	0.141***	
	(2.698)	(2.595)		(2.698)	(2.595)	
HML Beta	-0.037*	-0.181***		-0.037*	-0.181***	
	(-1.876)	(-4.367)		(-1.876)	(-4.365)	
Div. Payer	-1.710***	-0.873**	-0.499	-1.709***	-0.880**	-0.503
	(-2.810)	(-2.288)	(-1.456)	(-2.808)	(-2.305)	(-1.470)
Leverage	2.290***	1.458**	1.385**	2.291***	1.451**	1.382**
	(2.837)	(1.990)	(1.991)	(2.838)	(1.981)	(1.988)
M/B	-0.001	0.001	0.001	-0.001	0.001	0.001
	(-0.330)	(0.531)	(0.663)	(-0.331)	(0.547)	(0.676)
log(Assets)	-0.895**	-0.804***	-0.981***	-0.895**	-0.808***	-0.984***
	(-2.231)	(-3.076)	(-3.738)	(-2.230)	(-3.092)	(-3.747)
VolP	0.191	0.289**	0.286**	0.190	0.292**	0.288**
	(1.210)	(2.302)	(2.466)	(1.210)	(2.321)	(2.478)
ROE	-0.275	-0.696***	-0.624***	-0.275	-0.696***	-0.624***
	(-1.555)	(-3.611)	(-3.666)	(-1.553)	(-3.616)	(-3.669)
Constant	22.895***	15.656***	17.503***	22.879***	15.792***	17.594***
	(7.471)	(8.643)	(8.554)	(7.432)	(8.685)	(8.559)
Calendar Year-Month F.E.	x	x	x	x	x	x
Firm-CEO F.E.	x	x	x	x	x	x
Obs.	33,336	64,142	61,011	33,336	64,142	61,011
Adj. R-sqr.	0.839	0.622	0.580	0.839	0.622	0.580

Panel B: Spline Specification

This table reports the non-linear trend in various volatility measures from the time when the CEO took office to five years after that, using spline regressions. Tenure(year i) is the spline for the 12 months in the *i*-th year after turnover. In models (1)-(3), we include all turnovers followed by CEOs with at least three years of tenure. In model (4), we focus on the subsample with long-tenured CEOs (at least 7 years). The Huber-White-Sandwich robust standard errors are clustered by firm-CEO. t statistics are reported in parenthesis.***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

	(1) Option-implied Volatility	(2) Realized Return Volatility	(3) Idiosyncratic Return Volatility	(4) Idiosyncratic Return Volatility
Tenure (year1)	-0.602***	-0.992***	-0.927***	-0.227***
	(-3.067)	(-7.003)	(-7.226)	(-5.249)
Tenure (year2)	-0.257*	-0.349***	-0.410***	-0.073**
	(-1.409)	(-2.862)	(-3.431)	(-2.146)
Tenure (year3)	0.121	-0.289**	-0.385***	-0.052*
	(0.813)	(-2.326)	(-3.157)	(-1.726)
Tenure (year4)				-0.047
				(-1.440)
Tenure (year5)				-0.066
				(-1.536)
Market Beta	0.204***	0.605***		
	(7.105)	(8.208)		
SMB Beta	0.055***	0.141***		
	(2.687)	(2.594)		
HML Beta	-0.037*	-0.181***		
	(-1.853)	(-4.366)		
Div. Payer	-1.709***	-0.879**	-0.754*	-0.137
	(-2.785)	(-2.304)	(-1.860)	(-1.539)
Leverage	2.291***	1.454**	1.347**	0.120
	(2.848)	(1.985)	(1.973)	(0.677)
M/B	-0.001	0.001	0.001	0.002
	(-0.329)	(0.548)	(0.367)	(1.474)
log(Assets)	-0.896**	-0.807***	-1.082***	-0.178***
	(-2.233)	(-3.090)	(-4.091)	(-2.812)
VolP	0.190	0.291**	0.308***	0.093***
	(1.208)	(2.316)	(2.739)	(3.256)
ROE	-0.275	-0.696***	-0.593***	-0.087**
	(-1.526)	(-3.615)	(-3.738)	(-2.277)
Constant	22.886***	15.737***	15.939***	3.310***
	(7.456)	(8.677)	(8.101)	(7.891)
Calendar Year-Month F.E.	x	x	x	x
Firm-CEO F.E.	x	x	x	x
Obs.	33,336	64,142	61,011	52,159
Adj. R-sqr.	0.839	0.622	0.570	0.570

Table 3: Different Types of Turnovers

Panel A: Firm Attributes for exogenous, forced, and in-between turnovers as of the turnover year

This table reports the summary statistics (number of non-missing observations for each variable, mean and median) for firm attributes for the three turnover types: exogenous, forced, and non-exogenous/non-forced (in-between). The definitions for exogenous and forced turnovers, as well as the firm attributes are provided in Appendix B. The Wilcoxon-Z statistics for comparing different turnover types (benchmarked on the in-between turnover sample) are reported in the last two columns. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Exogeneous Turnover			Forced Turnover			In-Between			Wilcoxon-Z (Exog. vs. In-Between)	Wilcoxon-Z (Forced vs. In-Between)
Variable	Obs	Mean	Median	Obs	Mean	Median	Obs	Mean	Median		
Return (-1)	205	0.076	0.007	96	0.051	-0.106	1,341	0.090	-0.009	0.480	-2.073**
ROA (-1)	203	0.061	0.040	96	0.072	0.021	1,274	0.041	0.019	2.710***	0.513
Div. Payer	211	0.654	1	101	0.426	0	1,561	0.546	1	2.971***	-2.345**
Leverage	203	0.188	0.160	95	0.217	0.177	1,438	0.195	0.160	-0.112	1.164
M/B	211	2.699	2.027	101	3.808	2.514	1,558	2.215	2.063	-0.410	2.407***
log(Assets)	204	7.322	7.292	97	7.756	7.588	1,441	7.052	7.046	1.864*	3.392***
VolP	204	0.400	0.276	97	0.633	0.359	1,441	0.627	0.291	-3.367***	2.666***
ROE	204	0.111	0.127	97	0.024	0.075	1,441	0.042	0.108	1.824*	-1.831*

Panel B: Learning Patterns across Turnover Types

This table reports the learning patterns for exogenous, forced, and in-between (non-exogenous/non-forced) turnovers, with the idiosyncratic return volatility as the dependent variable, using polynomial specifications. The definitions of exogenous and forced turnovers and Tenure are provided in Appendix B. The Huber-White-Sandwich robust standard errors are clustered by firm-CEO. t statistics are reported in parenthesis. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)
	Exogeneous	Forced	In-Between
	Idiosyncratic Return Volatility		
Tenure	-0.693***	-1.615***	-0.687***
	(-3.597)	(-3.153)	(-3.450)
$Tenure^2$	0.108*	0.344**	0.157***
	(1.748)	(2.084)	(3.598)
Dividend Dummy	0.961**	0.563	-0.765*
	(2.046)	(0.640)	(-1.961)
Leverage	1.476	2.482	1.242
	(1.613)	(1.318)	(1.601)
M/B	-0.006	-0.001	0.003
	(-0.481)	(-0.966)	(1.226)
log(Assets)	0.049	-1.509**	-1.037***
	(0.137)	(-2.123)	(-3.563)
Vol in Profitability	0.130	0.012	0.309**
	(1.014)	(0.046)	(2.372)
ROE	-0.215	-0.350	-0.710***
	(-1.191)	(-0.994)	(-3.566)
Constant	8.758***	24.973***	17.996***
	(3.424)	(4.592)	(8.180)
Calendar Year-Month F.E.	x	x	x
Firm-CEO F.E.	x	x	x
Obs.	7,492	3,494	50,025
Adj. R-sqr.	0.557	0.512	0.583

Table 4: Post-turnover Real Changes and Stock Return Volatility

This table reports results with regressing idiosyncratic return volatility on the tenure variable and interactions of tenure with indicator variables capturing post-turnover real change announcements for the turnover sample we study as well as the subsample with exogenous turnovers only. Variable definitions are provided in Appendix B. "(Action Announced)×T" is the interaction of the action announcement indicator variable and Tenure. All regressions include control variables (not reported): Div. Payer, Leverage, M/B, log(Assets), VOLP, ROE, as well as a constant term. The Huber-White-Sandwich robust standard errors are clustered by firm-CEO. t statistics are reported in parenthesis. ***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Full Sample				Exogeneous Sample			
Tenure	-0.864***	-0.835***	-0.829***	-0.856***	-0.778***	-0.788***	-0.748***	-0.801***
	(-3.308)	(-3.232)	(-3.180)	(-3.279)	(-3.891)	(-4.328)	(-3.957)	(-4.086)
Expansion announced	0.279				0.409			
	(1.342)				(1.190)			
(Expansion Announced)XT	-0.055				-0.229			
	(-0.478)				(-1.080)			
Downsizing announced		1.843***				1.231		
		(3.465)				(0.914)		
(Downsizing Announced)XT		-0.455*				-0.197		
		(-1.767)				(-0.325)		
New Product Announcements			0.510**				0.825	
			(2.202)				(0.912)	
(New Product Announcements)XT			-0.329***				-0.509	
			(-2.668)				(-1.153)	
Restatement/Write-off/Fraud				2.687***				-0.161
				(2.649)				(-0.225)
(Restatement/Write-off/Fraud)XT				-0.715				-0.055
				(-1.408)				(-0.135)
Controls	x	x	x	x	x	x	x	x
Calendar Year-Month F.E.	x	x	x	x	x	x	x	x
Firm-CEO F.E.	x	x	x	x	x	x	x	x
Obs.	30,128	30,128	30,128	30,128	3,911	3,911	3,911	3,911
Adj. R-sqr.	0.569	0.570	0.569	0.569	0.517	0.518	0.518	0.517

Table 5: Determinants of the Learning Speed

Panel A: Summary Statistics of the Learning Speed by Industry

This table reports the summary statistics of the normalized firm-CEO specific learning speed by Fama-French 10 industries. The construction of the learning slope is provided in Appendix B. The Wilcoxon Z statistics for the difference between the top and bottom industries, along with the significance levels, are reported as well. ***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

Industry	N	mean	std dev.	median
Hi-Tech	277	0.531	0.301	0.534
Health	137	0.525	0.299	0.549
Other	515	0.501	0.271	0.522
Wholesale	195	0.495	0.272	0.482
Manufacturing	279	0.493	0.246	0.489
Durables	57	0.490	0.258	0.453
Telecom	29	0.489	0.252	0.489
Energy	62	0.486	0.274	0.482
NonDurables	111	0.485	0.260	0.480
Utilities	121	0.438	0.196	0.431
Total	1,783	0.499	0.269	0.499
Wilcoxon Z for the difference between the top and bottom industries		2.621***		
Wilcoxon Z for the difference between the top two and bottom two industries		2.736***		

Panel B: Summary Statistics of the Determinants

This table reports the summary statistics of the determinants of the learning speed, including both firm and manager attributes as of the turnover year for the firm-CEO pairs in our sample. Variable definitions are in Appendix B. The analyst data is provided in *I/B/E/S*. The company financial information is provided in *Compustat*. Succession origin, designation of heir apparent, and manager attributes such as age and the number of previous positions are constructed based on information provided in *Execucomp* and *BoardEx*.

	N	mean	std dev.	median
Number of analyst	1,669	11.813	9.627	9
Analysts forecast error	1,669	0.179	0.439	0.040
Log(MV)	1,678	6.886	1.749	6.843
Firm Age	1,743	22.124	16.051	18
Outsider CEO	1,874	0.312	0.464	0
Heir Apparent	1,874	0.165	0.372	0
CEO Age	1,439	53.575	7.216	53
Number of previous positions	678	3.155	2.561	3

Panel C: Determinants of the Learning Speed

This table reports the estimates from regressions of the estimated learning slopes (estimated based on equation (8)) on various firm and CEO attributes. Variable definitions, including the construction of the learning speed, are reported in Appendix B. The Huber-White-Sandwich robust standard errors are clustered by firm-CEO. t statistics are reported in parenthesis. ***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Learning Slope							
Number of analyst	0.003***						0.003***	0.002***
	(6.038)						(4.921)	(4.635)
Analysts forecast error		-0.029*					-0.016	-0.015
		(2.067)					(0.811)	(0.688)
Outsider CEO			0.016*					
			(1.897)					
Heir Apparent				-0.017**			-0.021*	-0.018*
				(-2.345)			(-2.209)	(-1.957)
ln(CEO Age)					-0.086**		-0.057*	-0.065*
					(-2.456)		(-1.841)	(-1.980)
# of previous positions						-0.007*		
						(-1.986)		
log(MV)	-0.018***	-0.002	-0.007	-0.007	-0.006	0.009	-0.014***	-0.014***
	(-5.734)	(-0.626)	(-1.610)	(-1.556)	(-1.512)	(0.883)	(-4.893)	(-4.109)
log(Firm Age)	-0.028***	-0.032***	-0.029***	-0.029***	-0.014*	-0.022**	-0.028***	-0.025***
	(-6.137)	(-7.031)	(-5.266)	(-5.425)	(-2.207)	(-2.562)	(-6.999)	(-6.029)
Constant	0.662***	0.603***	0.287***	0.413***	0.955***	0.179**	0.381**	0.364**
	(13.980)	(12.496)	(14.343)	(8.776)	(8.136)	(2.511)	(2.588)	(2.546)
Year F.E.	x	x	x	x	x	x	x	x
Industry F.E.								x
Obs.	1,481	1,481	1,568	1,568	1,295	604	1,291	1,291
Adj. R-sqr.	0.456	0.453	0.442	0.442	0.340	0.119	0.473	0.472

Table 6: Market Reactions to News

This table reports the pattern of market reactions to various types of corporate news over CEO tenure. We examine four types of news announcements: (1) Expansion/downsizing, (2) Product announcements, (3) Dividend changes (increase or decrease), (4) Earnings surprise (quarterly earnings announced exceed median analyst forecast for at least 10%). The dependent variable in all four regressions, |AR|, is the absolute value of market-adjusted announcement day return, where market return is the "value-weighted market return" from CRSP. Both market and firm returns are ex-dividend. Variable definitions are provided in Appendix B. The Huber-White-Sandwich robust standard errors are clustered by firm-CEO. t statistics are reported in parenthesis. ***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

	(1) Exp/Downs	(2) Product Ann	(3) Dividend Change	(4) Earnings Surprise
		| AR |		
Tenure	-0.046**	-0.0228***	-0.031*	-0.027*
	(-2.425)	(-2.584)	(-1.824)	(-1.759)
$Tenure^2$	0.001**	0.0004*	0.001**	0.001**
	(2.257)	(1.870)	(2.361)	(2.284)
Market Volatility	0.394***	0.4697***	0.456***	0.509***
	(5.908)	(4.678)	(3.015)	(6.735)
Constant	0.881***	0.2672	0.006	1.213***
	(2.804)	(0.662)	(0.012)	(3.101)
Firm-CEO F.E.	x	x	x	x
Obs.	7,370	12,859	2,046	10,873
Adj. R-sqr.	0.241	0.209	0.414	0.181

Table 7: Initial Learning Speed and Volatility Ratios in Subsamples

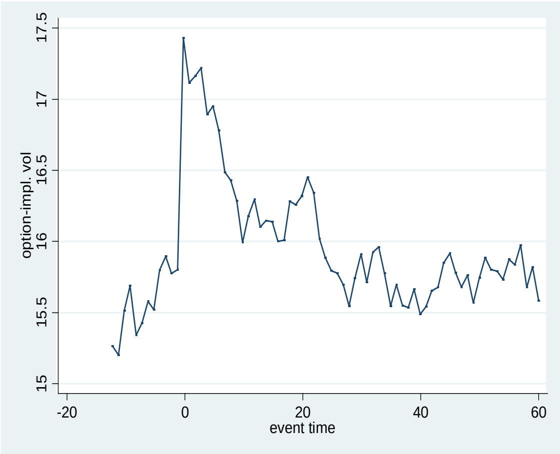
This table reports the estimated coefficients on Tenure and Tenure^2 using the specification in model (3) (idiosyncratic volatility) in Panel A of Table 2, for various subsamples based on CEO or firm attributes. We also report the estimated learning speed at the time of CEO turnover (m_0) and by the end of year 3 in office (m_3), as well as the ratio of uncertainty about CEO ability to fundamental volatility at these two times (δ_0/σ and δ_3/σ). As discussed in Section 5.2, m_0 equals the coefficient on Tenure^2 divided by the coefficient on Tenure and then times minus one, and $m_3 = \frac{1}{1/m_0 + 3}$. "Young (Old) CEO" is defined as a CEO younger than (at least) 53 years old when they take office. "Outsider (Insider) CEO" is a CEO hired from outside (promoted from inside) of the firm. "More (Less) Analyst Coverage" indicates whether a firm has at least (less than) 12 analysts. The industry classification follows the Fama-French 10-industry classification. The construction of the learning slope is provided in section 5.2. ***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

	Tenure	Tenure^2	m_0	δ_0/σ	m_3	δ_3/σ
Young CEO	-0.561**	0.196***	0.349	0.591	0.171	0.413
Old CEO	-0.579***	0.074	0.128	0.358	0.092	0.304
Outsider CEO	-1.006***	0.257***	0.255	0.505	0.145	0.380
Insider CEO	-0.360**	0.066***	0.183	0.428	0.118	0.344
More Analysts Coverage	-0.294*	0.086*	0.293	0.541	0.156	0.395
Less Analyst Coverage	-0.759***	0.174***	0.229	0.479	0.136	0.369
Hi-Tech and Health	-0.794***	0.160*	0.202	0.449	0.126	0.354
Utilities and Non-Durable	-0.463*	0.086	0.186	0.431	0.119	0.345

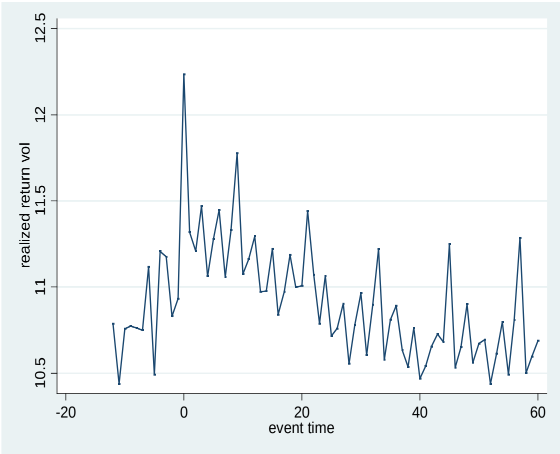
Figure 1: Stock Return Volatility around CEO Turnover

The figures graph the average monthly stock return volatility from 12 month before the CEO takes office (month 0) to 60 month (or 5 years) after that. "Event Time" is the event month count from -12 to 60. For each CEO, the calendar year-month in which the CEO takes office is designated as event month 0. "Option-implied volatility" is the monthly average of implied volatility from daily prices of 30-day at-the-money call options written on the firm's common stock. "Realized return volatility" is the monthly standard deviation of daily stock returns. "Idiosyncratic return volatility" is the monthly volatility of the residual return from the Fama-French 3-factor model. We include only non-overlapping event periods and require CEO tenure length of at least 60 months in the figures. We also drop the crisis period (year 2008 and 2009) to avoid a biased upward trending in volatility due to the uncertainty from the crisis.

a. Option-implied volatility



b. Realized return volatility



c. Idiosyncratic return volatility

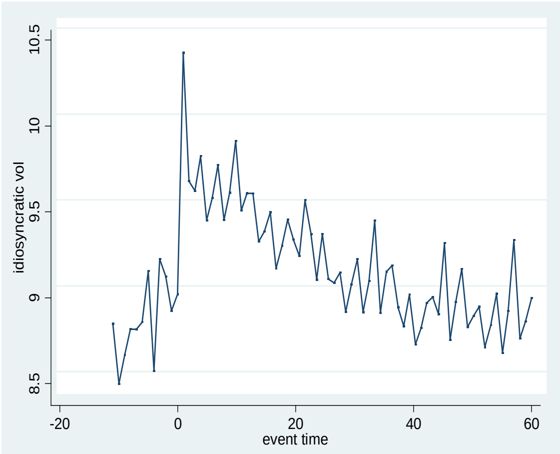
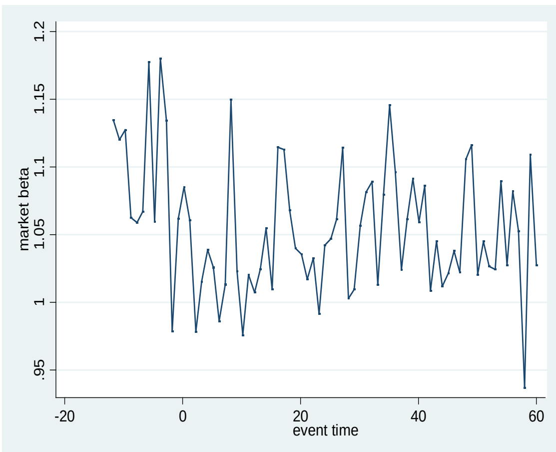


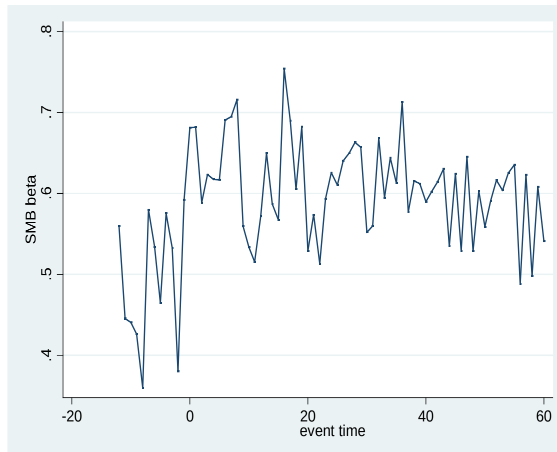
Figure 2: Firm Systematic Risk around CEO Turnover

The figures graph the average firm monthly loadings on the three systematic factors in the Fama-French 3-factor model from 12 month before the CEO takes office (month 0) to 60 month (or 5 years) after that. "Event Time" is the event month count from -12 to 60. For each CEO, the calendar year-month in which the CEO takes office is designated as event month 0. The data sample description is the same as in Figure 1.

a. Market beta



b. SMB beta



c. HML beta