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Master Thesis Financial Economics

Does CEO type matter for the market learning Speed?

Evidence from CEO turnover events

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Abstract

This paper examines the relationship between CEO tenure and stock return volatility, using both a realized return volatility measure and an idiosyncratic volatility measure. With a sample of 1,489 CEOs in 1,200 publicly traded firms during a time period of 1992 to 2006, a negative convexity relationship between CEO tenure and stock return volatility is found. These results suggest that the market needs time to learn about CEO ability and the learning appears to be faster when CEO is recently on-board. This paper also studies the impact of different CEO types on market learning speed. We provide supporting evidence for the positive effect of company outsider CEOs on market learning speed, while the general ability and age of CEO has no significance impact on learning speed. Corresponding to prior researches, those firms which are in Hi-Tech and lower average sales growths industry, younger and more transparent are accepted faster by the market.

Keywords: Learning speed; Bayesian Learning; CEO Turnover; Stock Return Volatility; Idiosyncratic Volatility

Contents

1. Introduction

The Chief Executive Officer (CEO) has been viewed as the face of the company, when the face of the market changes, market needs time to accept the new appearance of the company. In other words, the appointment of a new CEO would raise market's uncertainty regarding to the future of the firm. However, as time passes, the CEO ability is gradually known to the public. Given the Bayesian learning model, we would expect the market to learn faster in the start and mitigate as CEO succession period spreads. The reason for CEO tenure to have an impact on market updating speed of the CEO ability is that the news released first concerning the CEO ability are more informative than the poster news during the CEO succession period (CEO tenure). Apart from the CEO tenure, industry level factors, firm level factors and CEO level factors would all affect the market learning speed. This paper has focused on the CEO level factors due to unique talent, ability and characteristic each CEO holds which would influence the firm performance and investment strategies (Kaplan, Klebanov, & Sorensen, 2012; Thong & Yap, 1995). Furthermore, unlike the firm and industry characteristics that remain the same before and after the CEO appointment, CEO level factors are more likely to explain the difference in learning speed. The heterogeneous features of CEOs might impact the market recognition of pre-succession uncertainty level and gain the investors' confidence in this learning process. Therefore, this paper raised the following question for the time period of 1992-2009:

> ***How does the market learning speed vary across different types of CEOs regarding the CEO turnover events?***

A faster learning speed of market can bring some practical benefits to the firm. First, the confidence and forecast accuracy of the investors is boosted owing to the decreasing volatility (Du & Budescu, 2007). Second, the CEO ability is recognized earlier yields to a less sensitive reaction of the market towards news announcements. Since the releasing of news contains not only a direct effect on stock return volatility but also an incidental effect by publishing information about CEO ability (Pan, Wang & Weisbach, 2015). When CEOs' managing skills and performance- improving talents are recognized by the market, the indirect volatility part is diminishing. Third, faster learning speed can narrow down the harmful period caused by high volatility after the CEO succession. Given the time-varying risk premia theory, growing forecasted volatility could immediately cause a decline in stock price via an increase in required expected future stock returns (Pindyck, 1984; French, Schwert, & Stambaugh, 1987). Moreover, increased volatility leads to the rising cost of capital which further aggravate the risk of the company's equity and slashes the equity attractiveness in acquisitions or compensations. With a faster learning speed, companies are able to recover faster from those negative impacts of high volatility.

Previous studies have shown that firms implemented multiple selection processes to choose the most outstanding successor (Finkelstein & Hambrick, 1996; Friedman & Olk, 1995). Kaplan, Klebanov, and Sorensen (2012) stated that the CEO candidates with better general abilities are more likely to be hired for their execution and team related skills. Firms also lean towards the

CEO with experience, characteristics and background interacting with company characteristics, so that there is a better match between the CEO and firm (Guthrie & Datta, 1997). However, these selections are either from the firm's perspective or the perspective of the personal characteristic and abilities of the CEO, while the market perception of the CEO succession seems missing. Thus, this paper is aiming to distinguish the suitable types of CEO based on the market's recognitions.

To answer this question, the paper first tests if there is significant stock volatility change over the CEO tenure. Based on a sample of 1,489 CEOs over the period 1992-2006 in 1,200 publicly traded firms, we found that the idiosyncratic return volatility declines by 13.0% percent and total return volatility (realized return volatility) declines by 6.8% percent in three years after the new CEO takes office. Then a stylized Bayesian learning model is built to prove that the stock return volatility declines with CEO tenure in a convex manner by using the splined and polynomial regressions.

After verifying the existence of market learning effect, we are then interested in the factors that might influence the market's learning speed. The market learning speed is generated by taking the coefficients of CEO tenure on stock volatility. Although the main focus of this paper is the effect of different CEO types on learning speed, still the firm and industry level factors are included in the regression analysis. The purpose is to check if CEO types remains significant after taking out firm and industry effects. The industry level factors contained in the regressions are the industry category, industry sales growth, industry HHI and Industry research and development expenses (R&D). The transparency level, company size and company age are added as the firm level determinates. Under the CEO level, we mainly study the internal effect, the specialism and the age of CEOs. This paper suggests that learning appear to be faster for the replacement with company outsider CEO. Market quickly adapts to the replacement of CEO in those younger and more transparent firms. In addition, companies belonging to Hi-Tech industry and lower sales growth industry are also learnt faster by the market than the rest.

This thesis contributes to current scholarship in various ways. First, this paper fulfills the gap in the existing literature, by providing new insight into the general ability index of CEO when studying the market learning speed differences among CEO types. Second, instead of grouping CEOs into outsider CEOs and insider CEOs as prior researches, this paper labeled industry external, company external and company internal CEOs, which enables us to compare the CEO replacement type more specifically and comprehensively. Third, this paper is helpful for the firm to realize the importance of the volatility changes after the CEO succession. It provides guidance on firms' hiring procedures when determining the most favorable CEO type concerning the market learning speed. The discussions of this paper are also beneficial for the firms to narrow down the negative impacts of CEOs turnover events on stock return volatility.

The rest of the paper is structured as follows. Section 2 motivates three hypotheses and presents the theoretical framework, which reviews prior studies on market learning speed. Section 3 describes the data collection procedures and presents the descriptive statistics of the sample. Section 4 discusses the methodologies used for particular models. Section 5 provides statistical evidence to prove the relationship between stock return volatility and CEO tenure found by Pan, Wang and Weisbach (2015). Afterwards, the empirical results of how different CEO types affects market learning speed is illustrated. Section 6 covers conclusions, the limitations of this study, and recommendations for future research.

2. Hypothesis development

2.1 Market Learning Effect

Definition of learning effect

Learning effect is not a new phenomenon. Learning about disseminated information can be realized by observing the actions of the others which asymptotically leads us to the truth (Guţă & Kotłowski, 2010). The beliefs are gradually updated by extracting useful information from the public environment. When the surrounding environments are more complicated, the other irrelevant factors might interfere with the learning of information (Epstein & Schneider, 2007). The ambiguity progressively decreases until all the possible learnings are realized. Still it would not evaporate in the long run. Once the population is refreshed or a learning of a new subject starts, the sophistication level goes back to its original level and a leaning cycle is restarted.

Market learning of CEO turnover

The market learning effect of CEO turnover follows the process of Bayesian learning. As an representation of market uncertainty, the stock return volatility is highest when the new CEO takes office. As the CEO ability gradually recognized by the market, the stock return volatility would deline.

There are several reasons that could explain why the market has strong uncertainty when the new CEO takes office. These worries mainly come from the ambiguous ability of the successor CEO and whether the new CEO and firm would match. The ability of CEO is most commonly understood as how much value can the CEOs meaningfully add to the companies they manage (Chang, Dasgupta, & Hilary,2010). In practice, the company's R&D activities, the synergies and the recourses reallocations can all have an impact on the CEO added value (Rose & Shepard, 1994). The match between CEOs and firms consists with the job match theory provided by Garen (1988), assuming the initially unknown quality of worker-firm matches to both parties and the heterogeneity in the productivity of these matches. The match theory is further proved by (Allgood & Farrell, 2003). If a firm is better matched with the CEO and early turnover is avoided, the organization is more stable during the time of turnover.

Meanwhile, the outcome of succession choices might significantly influence the directions and policies of the organization (Zald, 1970). From the firm's perspective, top management changes can have a large impact on the operating performance, the level of corporate control activity and asset restructuring (Denis & Denis, 1995).

Apart from that, the incumbent CEO often leaves a poor firm condition to the successor CEO with a great burden. Most prior researches have argued that the likelihood of CEO turnover would increase due to the poor firm performance (e.g., Coughlan and Schmidt, 1985; Weisbach, 1988; Parrino, 1997). Following a bad industry and bad market performance, CEOs are significantly more likely to be dismissed from their jobs due to the negative performance shocks to their peer group (Jenter & Kanaan, 2006). Evidence also indicates that CEOs are often blamed for poor firm performance even when their decisions are similar to the decisions made by the CEOs of comparable firms (e.g., Khanna and Poulsen, 1995; Farrell and Whidbee, 2002). To improve short-term earnings performance, CEOs spend less on researches and development during their final years in office (Dechow & Sloan, 1991). It makes harder for the new CEO to pull the company out of the mire.

Due to the relative bad performance of the prior CEO, when the incoming CEO take office, he or she is more likely to move to income-reducing accounting methods (Moore, 1973), divestiture of previous acquisitions and the write-off of unwanted operations and unprofitable divisions (Strong and Meyer, 1987; Elliott and Shaw, 1988). So as to implicitly blame their predecessors for past "mistakes" and send a positive signal to the market (Weisbach, 1995).

The shape of Market learning

Amador and Weill (2012) realized the learning of information is low at the start, then exaggerates, and eventually slows down. This S-shaped curve of learning is different from the findings of Pan, Wang, and Weisbach (2015). They believe there is a larger update about the market's belief from a particular signal of the information availiable for predicting the CEO ability at the start of the CEO sucession. Overtime, the new information affecting the market recognation has less impact on the investors' belief, when the investors have already known that the CEO have the ability to manage the affairs and control the situations. Nevertheless, the research from Clayton, Hartzell, and Rosenberg (2005) only documented the raising stock volatility around CEO turnover. Their study has not found the convextity of learning curve. The contradicting opinions on the shape of market learning raises our interests to examine the relationship between CEO and stock return volatility. This leads to our first hypothesis:

> *Hypothesis 1: The stock return volatility decreases over the CEO tenure and the decreasing speed slows down .*

2.2 Market Learning Speed

The faster learning speed of the market regarding the turnover events has many possible explanations.

The high prior uncertainty when the new CEO takes office provide more rooms for market learning of CEO ability. If the market has less information regarding the CEO ability and are more worried about the match between the CEO and company, any additional news would have a higher impact on the uncertainty than the firms with lower prior uncertainty level.

Number of information avaliable also determines the market learning speed. The diverged interests between firm managers and stockholders is commonly accepted (Nyberg et al., 2010).

The information asymmetric between CEO and stockholders would raise the market's worries of moral hazard. Healy and Palepu (2001) argued the importance of financial reporting and information disclosure as an efficient way to communicate with the public. As the financial accounting information would affect the identifying promising investment opportunities, discipline the managers behaviors and reduce the information asymmetries among investors (Bushman & Smith, 2003). When the company performance and the management strategy are known to the outside investors, there is less agency problems. With a more transparent firm, the learning speed is also expected to be faster.

Nonetheless, not all the information is useful for market to understand the ability of CEO. The noise in the financial market causes the inefficiency and uncertainty (Black,1986). These impact of these gathered minor noise from small events could be much powerful than the impact of large events that rarely happen. The market has to separate the effective information from the mixture of noise and meaningful news. The information processing speed of an individual is fixed, indicating that when the investor is brimming with noise, he needs more time to process the information. Thus, the learning speed will be lower when the market is flooded with noise.

To create value for shareholders, leaders of the company need to convert their visions, goals, and strategies into the operative values of their employees (Lichtenstein, 2012). However, in some industries or specific environments, the influence of the CEO is limited. For example, the board of directors could affect firm's strategy and influence the CEO power (Haynes & Hillman, 2010; Goodstein et al., 1994). If the new CEO has limited power on value creation, then a change of CEO is not likely to alter the company's strategy, which mitigates the learning effect of the market. Under the circumstances where CEO ability is more meaningful in company's structural reform and product development, the market learning speed would be faster.

2.3 CEO Types

Insider VS Outsider CEO

The hiring type of the CEO is either an insider (promoted from within the firm) or an outsider (brought in from outside the firm). Nowadays, U.S. corporate governance is having a prevalence of appointing CEOs through external hiring rather than internal promotions. And there is an increasing trend for company to hire outside CEOs with prior experience as CEOs (Murphy & Zabojnik, 2007). There are several reasons for causing these trends when company considering the hiring decisions.

An outsider CEO is correlated with chaning patterns of administrative and resource allocations. On the other hand, an insider CEO within an organizaiton is often found to maintenance the current strategy (Helmich & Brown, 1972; Lewin & Wolf, 1974). Especially if the company's forecasted 5-year earnings per share(EPS) growth is low and the dispersion among analysts about the firm's long-term forecasts is great (high uncertaity about the company's future), the boards are more likely to appoint a CEO that will change firm policies and strategies (i.e., an outsider) (Farrell & Whidbee, 2003). Likewise, Parrino (1997) found an inverse relationship between the likelihood of an outside replacement and prior firm performance. When the previous CEO was "forced" out of office, the board of directors are more likely to implement outside replacement, since they are eager for the strategic changes of the company.

Given the "fat cat" theory from Bebchuk, Fried and Walker (2002), entrenched CEOs could deal themselves with large increases in pay at the expense of companies' shareholders by using captive boards of directors. The internal CEOs are more likely to have closer ties with the firm's board of directors thus are more likely to harm the shareholder's benefit by having a higher compension level than the outsider CEO. However, Gilson and Vetsuypens (1993) draw a different conclusion. They found that newly appointed CEOs with ties to previous management are typically paid 35% less than prior CEOs. The outside replacement CEOs on the contrary are typically paid 36% more than their predecessors.

Regardless of the effect of CEO compensation, this paper believes that the dramatic strategic changes expecting from the outsider CEO would raise the prior uncertain level of the market's belief. Unlike the insider CEO who is already familiar with the company's policy and culture, the investors might doubt the match between the ousider CEO and the firm. Based on these reasons, this paper raised the following hypothesis:

H2: Learning appears to be faster for outsider CEOs.

Generalist VS Specialist CEO

Apart from the market recognition of external and internal CEOs, this paper is also interested in the different market responses to generalist and specialist CEOs.

Generalist CEOs are often presumed as the ones with more past work experience as a top manager and more industry mobility comparing to the specialist CEOs. These generalist CEOs was deemed to be precious organization capital during times of shock and restructuring by the market (Eisfeldt & Papanikolaou, 2013). Similarly, Custódio, Ferreira, and Matos (2013) found firms are willing to pay an annual compensation premium of 19% for generalist CEOs relative to specialist CEOs. The pay premium is even higher when the generalist CEOs are hired to perform complex tasks such as restructuring and acquisitions to adapt to an evolving business environment. Although specialist CEOs might have "firm-specific human capital" (valuable only within the organization), the firms seem to be more partial to the "general managerial ability" that is transferable across firms or industries (Murphy & Zabojnik, 2007). This higher demand for general skills talent could result from the higher foreign competition faced by the company (Cuñat & Guadalupe, 2009a). Alternatively, changes in the industry deregulation (Cuñat & Guadalupe, 2009b), technology and management practices can all increase the company's prevalence of "general managerial ability " rather than "firm-specific human capital" (Murphy & Zabojnik, 2007). Additionally, the productivity yield from general managerial ability is greater due to the gradual accumulation of knowledge pertinent to the management of public corporations, including advances in accounting, economics, finance, marketing, and management science.

However, there are some researchers holding conflicting point of view. Smith and White (1987) exposed the specialist CEOs governing the IPO firms in general have a lower failure probability and a longer survive time comparing to their generalist competitors. They also found that specialist CEOs are more likely to enhance the viability of IPO firms for a longer period of time due to the more alignment between CEO incentives and those of the firms and its shareholders.

The empirical research from Custódio, Ferreira, and Matos (2017) shows that CEOs with "general managerial ability" produce more patents over their lifetime work experience. This paper raises two reasons to explain why generalist CEOs are more enthusiastic about spurring innovation. Firstly, generalist CEOs have more chances to acquire knowledge beyond the firm's current technological domain. Secondly, unlike specialist CEOs who are more sensitive to the risk of termination, a generalist can move across industries more easily based on their diverse and considerable experience. Even if the specialist CEO failed in one place, this failure might not necessary give a bad signal of his ability in other companies or industries. Although CEO is the one who makes the management decision, still shareholders are tolerating the risk. The CEOs with higher general managerial skills may lead to higher agency problems because the risk-taking incentives are different and are even more costly to retain in times. Considering the potential higher possibility for agency problem, the investors require higher returns from firms with generalist CEOs, especially those firms with high organization capital, that belong to M&A-intensive industries and that have complex operations, high agency problems and high anti-takeover provisions (Mishra, 2014).

Regardless of the strong ability to deal with complicated cases, the fast adaptation speed to the industry or market requirement, and the enthusiasm against innovations, the generalist CEOs seem to only have a significant impact on the firms' stock returns and volatilities in the long run. In the short run, the generalist CEOs appears to be more risk seeking and involve in more crucial agency problems and thus should be associated with higher prior uncertainty about their ability. The higher prior uncertainty indicates the learning speed for the generalist should be higher, which leads us to raise the following hypothesis:

H3: Learning appears to be faster for generalist CEOs.

3. DATA part

This paper uses five main sources of data: Execucomp database for the CEO turnover information of 1,490 CEOs of 1,200 publicly traded companies during 1992 to 2006, Center for Research on Securities Prices (CRSP)/Compustat for stock return volatility and firm level information data, home page of Eisfeldt and Kuhnen (2013) for CEO replacement and departure type information, home page of Custódio, Ferreira, and Matos (2017) for the general ability index of CEOs and the Institutional Brokers' Estimate System (IBES) for the estimate earning data.

3.1 Market Learning Effect

CEO turnover

Our sample for CEO turnover is based on a time period of 1996-2006 and consists of 45,941 firm-year observations collected from the ExecuComp database by setting the constrain of annual CEO flag equal to "CEO". This sample contains the job title, the date becoming CEO, the date left as CEO and the CEO annual flag. For each CEO-firm observation the event month is set to be equal to 0 when the CEO take office. Subsequently, this paper rules out the turnover events involving transitory CEOs such as turnaround specialists and interim CEOs (the tenure of whom is shorter than three years). It should be noted that these short-term CEOs are represented in the robustness check. Our final sample is constructed after these process, consisting of 1,200 unique firms and 1,490 CEOs. The details of the year distribution of CEO turnover events from 1996 to 2006 can be found in the Appendix B Table a.

CEO tenure

Based on the labeled CEO turnover event, we set the tenure of CEO in two ways, a set of categorical variables and a single discrete variable, respectively. In the first way of defining CEO tenure, every twelve months after the new CEO is assigned has been grouped into year_n category with n range from 0 to a maximum of 3. In each year group the number month is scaled by twelve. For the 1st to 12th month since the new CEO takes office, Tenure (year_1) takes the value of 1/12 to 1, while the variables Tenure (year_2) and Tenure (year_3) take the value of 0. For the 13th to 24th month, Tenure (year_1) takes the value of 1, Tenure (year_2) takes the value of 1/12 to 1, and Tenure (year_3) takes the value of 0. For the 25th to 36th month, Tenure (year_1) and Tenure (year_2) take the value of 1, and Tenure (year_3) takes the value of 1/12 to 1. The other way to define tenure is by scaling the number of event month after the assigning of the new CEO from month 0 to month 36 by twelve. These two measures of CEO tenure enable us to present a robustness check for the trend for volatility change over the CEO tenure.

Stock return volatility

To investigate our main question on the market learning effect for CEO turnover, we use both a general risk measurement, "Realized return volatility", and a unique risk measurement, "Idiosyncratic return volatility" to represents the firm-level equity volatility for a period from 1993 to 2009.

The "Realized return volatility" is calculated based on the standard deviation of daily stock holding period returns within a month which obtained from CRSP. We take the average value daily volatilities and multiply by $\sqrt{21}$[1] for aggregating the data to monthly level, the formula calculating the daily stock return standard deviation (s) is shown below:

[1] The average trading days in a month is approximate 21 days.

$$S = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(hpr_i - \overline{hpr}\right)^2}$$

where n represents the number of observations, hpr_i represents the daily holding period return, $\overline{hpr}$ is the average of historical holding period return.

The "Idiosyncratic return volatility" to measure the unique risk to a specific firm (firm-specific risk) is independent of the common movement of the market. Based on the paper written by Ang, Hodrick, Xing, and Zhang (2006), we calculated the residual stock return volatility with respect to the Fama-French three factor model using the following regression:

$$R_\tau^i - r_\tau = \alpha_t^i + \beta_{tMKT}^i\left(R_{\tau MKT}^i - r_\tau\right) + \beta_{tSMB}^i SMB_\tau + \beta_{tHML}^i HML_\tau + \varepsilon_\tau^i$$

where $R_\tau^i - r_\tau$ is the daily excess U.S. dollar return of stock i collected from the Center for Research on Securities Prices (CRSP). The daily stock return $R_{\tau MKT}^i - r_\tau$ is the excess return on the market which is calculated as the value-weight return on all NYSE, AMEX, and NASDAQ stocks (from CRSP) minus the one-month Treasury bill rate (from Ibbotson Associates). SMB (Small Minus Big) is the average return on the three small portfolios less the average return on the three big portfolios. HML (High Minus Low) is the average return on the two value portfolios minus the average return on the two growth portfolios. The daily-factor data is downloaded from Kenneth R. French's website[2]. τ is the subscript for the day, t is the subscript for the month, $\tau \in t$, and i is the superscript for the firm. The time series regression for each stock is performed monthly. By computing the standard deviation of regression residuals ε_τ^i times $\sqrt{21}$, we get the monthly idiosyncratic volatility of stock[3]. The summary statistics for the Realized return volatility and Idiosyncratic return volatility can be found in Table 1. The mean for idiosyncratic volatility is 9.32% that is almost 2.18% lower than the realized return volatility (11.50%) due to the prior volatility has already taken out the volatility of systematic risks. The mean for market beta 1.04 proving the risk preference for our sample is neutral. The average values for SMB beta (0.52) and HML beta (0.34) are both positive, pointing out the firms in our sample is tilting towards small-cap value stocks.

Control variables

A set of firm characteristic variables are included to control for the non-management related factors that would potentially affect volatility. For "Realized return volatility", we controlled for both corporate fundamental factors and the firm's systematic risk measured by the monthly betas of the three Fama-French factors. For "Idiosyncratic return volatility", we only controlled the corporate fundamental factors since the idiosyncratic volatility is calculated as the residual volatility after netting out these factors.

[2] The website: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

[3] Idiosyncratic return volatility is defined as $\sqrt{Var(\varepsilon_\tau^i)}$ from the regression.

The corporate fundamental control variables are obtained from CRSP on a firm-year level from the period 1993 to 2009, which ensures us to cover the 36 months after the CEO succession. We use debt ratio to account for leverage (book value of debt divided by total assets), dividend dummy to account for the corporate payout strategy, the logarithm of asset to account for firm size, market to book ratio to account for market-based firm performance, return on equity to account for the operating firm performance and residual variance of profitability to account for the uncertainty of mean profitability. The summary statistics of these variables can be found in the following table and the extensive variable definitions are presented in Appendix A. The Table 1 demonstrates the average leverage ratio for firms is 19.36%. Approximately 63.79% of all the firms pays out yearly common dividend, with an average M/B ratio equal to 2.77, logarithms of asset 7.70, M/B ratio 2.77, ROE 7.75% and volatility in profitability (VOLP)[4] 52.19%. To avoid the multicollinearity problem, this paper also checks for the correlation between all the variables which can be found in Appendix B table b.

Table 1

Summary statistics

This table represents the summary statistics of the volatility, three Fama-French risk factors and the firm attributes that used as control variables. For each variable, this table summarize its number of non-missing observations, mean, 25th percentile of the distribution, median and 75th percentile of the distribution on a firm-month level from 12 months before CEO turnover to 36 months after it. This sample make sure that the successor CEO does not overlap with the post-turnover period (-12, 36) of the departing CEO. The definitions for the variables can be found in Appendix A.

	Obs.	Mean	25th percentile	Median	75th percentile
Realized return volatility	68,329	11.496	6.461	9.295	13.910
Idiosyncratic volatility	68,352	9.320	5.034	7.419	11.296
Market beta	68,329	1.042	0.435	0.972	1.581
SMB beta	68,329	0.522	-0.367	0.368	1.268
HML beta	68,329	0.340	-0.688	0.343	1.397
Leverage	66,825	0.194	0.051	0.171	0.293
Dividend dummy	67,016	0.638	0.000	1.000	1.000
M/B	66,950	2.772	1.448	2.146	3.494
Log(Assets)	66,994	7.700	6.442	7.570	8.835
ROE	66,968	0.078	0.038	0.128	0.203
VOLP	68,227	0.522	0.071	0.122	0.247

[4] The residual variance of profitability, as a measure of uncertainty of mean profitability, is obtained from the residual variance of an AR(1) model fit on firm's ROE following Pastor and Veronesi (2003) using a series of at least ten years of annual ROE, with the small-sample bias correction method of Marriott and Pope(1954). Given the findings from Pastor and Veronesi (2003), the past profitability (ROE) and the volatility of past profitability (VOLP) are important drivers of volatility.

3.2 Market Learning Speed

By running the regressions of idiosyncratic return volatility on Tenure and a constant term, we obtained a learning slope for each firm-CEO pair:

$$Vol_t^i = \alpha^i + \beta^i * Tenure + \varepsilon_t^i$$

where i refers to the unique firm and CEO pair, t refers to month, α^i represents the constant term, ε_t^i is the error term and β^i is the market learning speed that we are interested in. After getting the coefficients for each firm-CEO pair, we first multiplied all the values by -1 and then normalize it with its empirical cumulative distribution function. The reason to multiply all the coefficients by -1 is that we assume there is a negative relationship between CEO tenure and stock return volatility. Thus, we expect the coefficient of the tenure to be negative, indicating that the learning speed would be faster if the negative number of coefficient is larger. Multiplying by -1 doesn't change our results, it just changes the sign of the coefficients and reverse the previous mentioned relationship. These two steps make sure the adjusted coefficients fall in the range from 0 to 1.

To explore the elements that would have an impact on market learning speed, we examine the CEO replacement type, CEO general ability level, firm transparency level and industry characteristics.

CEO replacement type

The CEO replacement type has been separated into three categories, from inside the company, from outside the company but inside the industry, or from outside the industry, respectively. The CEO replacement data is obtained from the home page of Eisfeldt and Kuhnen (2013), who hand collected the data by looking up the firms from which that new CEOs arrive. Their home page also contains the data of the reason why CEOs left. They separated the category by manually looking up the firms from which the new CEOs arrive. As Appendix B Table c shows, of all CEO replacements, 71.4% are company insiders, 7.92% are company outsiders from the same industry, and 20.54% are industry outsiders.

CEO general ability level

This paper use the General ability index (GAI) defined by Custódio, Ferreira, and Matos (2013) to measure the generality based on CEO's lifetime work experience in publicly traded firms prior to his current CEO position. It is calculated as:

$$GAI = 0.268 * Number\ of\ positions + 0.312 * Number\ of\ firms + 0.309 * Number\ of\ Industries + 0.218 * CEO\ Experience\ Dummy + 0.153 * Conglomerate\ Experience\ Dummy$$

The higher value of GAI indicated the CEO is inclining to a generalist than a specialist.

Firm transparency level

The number of unique earnings analysts and the analyst earnings forecasts error are the two techniques to evaluate the firm transparency level. The former variable is the number of unique analyst within a year before the actual earnings are announced. The latter variable is the absolute difference between the median analyst earnings forecast prior to an annual earnings announcement and the actual earnings announcement. Our sample is constructed for each firm-year with the accouchement date of the actual value, analyst code, estimate value and actual value acquired from IBES database.

Industry characteristics

To analyze the impact of industry characteristics we added three explanatory variables, Industry R&D, Industry HHI and Industry sales growth. Industry is defined by the Fama-French 48-indutry classification. Industry average research and development spending is calculated by taking the average of the firms' R&D intensity within an industry-year. Industry HHI is calculated by summarize the squared term of the average sale within an industry-year. The formula to calculate HHI is as follow:

$$HHI = \sum_{k=0}^{n} (\frac{firm\ sale}{industry\ total\ sale})^2$$

where n represents the number of firms within an industry. Industry sales growth is the average firm sale in industry i in year t divide by the average sale in year t-1 in industry i and minus 1.

4. Methodology

To examine the market's learning effect over CEO tenure, we first conduct a piecewise-linear (spline) function. By using the spline specification (Friedman, 1991) with cutoff points at tenure=1(first year) 2, second year, the market's learning effect is estimated separately in each of the first three years of the CEO's Tenure. Multivariate adaptive regression splines (MARS) not only builds flexible models by fitting piecewise linear regressions but also avoids the overfitting problem.

$$Return\ Volatility_t^i = \beta_0^i + \beta_1^i * Tenure(first\ year)_t^i + \beta_2^i * Tenure(second\ year)_t^i + \beta_3^i * Tenure(third\ year)_t^i + \beta_4^i * Tenure(Controls)_t^i + \alpha^i + \gamma_t + \varepsilon_t^i$$

where *i* refers to the unique firm and CEO pair, *t* refers to month, α^i represents the firm-CEO fixed effects, γ_t represents year-month fixed effects and ε_t^i is the error term. Tenure (first year), Tenure (second year), Tenure (third year) here are all categorical variables as we mentioned in data part. As a robustness check for the market learning effect, subsamples with long-tenured CEO and pre-CEO turnover are used. We define long-tenured CEOs are those who have governed the company for 7 years. Therefore, we also add categorical variables Tenure (fourth year) and Tenure (fifth year) to examine the long term effect of CEO turnover on Stock return volatility. Including the 12 month before the CEO take office gives us pre-CEO turnover sample. Similarly, the categorical variables Tenure (prior year) is added to check the stock volatility changing trend before CEO assigned.

Apart from the piecewise-linear regression, we also use a polynomial function by adding the squared and cubic term of CEO tenure to the regression.

$$Return\ Volatility_t^i = \beta_0^i + \beta_1^i * Tenure_t^i + \beta_2^i * (Tenure_t^i)^2 + \beta_3^i * Tenure(Controls)_t^i + \alpha^i + \gamma_t + \varepsilon_t^i$$

In this regression, tenure, a discrete variable ranging from 0 to 3, is the number of event month after the assigning of the new CEO from month 0 to month 36 scaled by twelve. The cubic term of tenure is also considered in this paper, but it is omitted due to the multicollinearity.

To test the determinants of market learning speed, this paper uses fixed effects models and employs different variables such as CEO replacement type, CEO general ability level and firm transparency level. The dependent variable we used is captured for each firm-CEO pair. Therefore, the regression used is cross-sectional specification:

$$Learning\ slope^i = \beta_0 + \beta_1 * x^i + \gamma_t + \varepsilon^i$$

where x represents the determinants of market learning speed (CEO, firm and industry level), β_0 represents the constant, i refers to firm-CEO pair, γ_t is the year fixed effect and ε^i is the residual value for each regression.

5. Result

5.1 Measuring the Relation Between CEO Tenure and Volatility

The graphical representation of the relation

The trends of realized return volatility and idiosyncratic return volatility are represented in the following two graphs. By taking the period of time from 12 months before the new CEO is assigned to 60 months after it, both two measures of return volatility first show an increasing trend followed by a drop. The highest return volatility is found around the event time takes 0, when the CEO takes office. This trend coincides with our assumption that the volatility decreases over the CEO tenure. Additionally, the decreasing trend of realized return volatility does not seem to be as powerful as the idiosyncratic volatility. This could be caused by the systematic risk contained in the realized return volatility. To further to test the systematic risk that the firms exposures to, this paper also studies the trend of market beta, HML beta and SMB beta in Figure 2 over the same period.

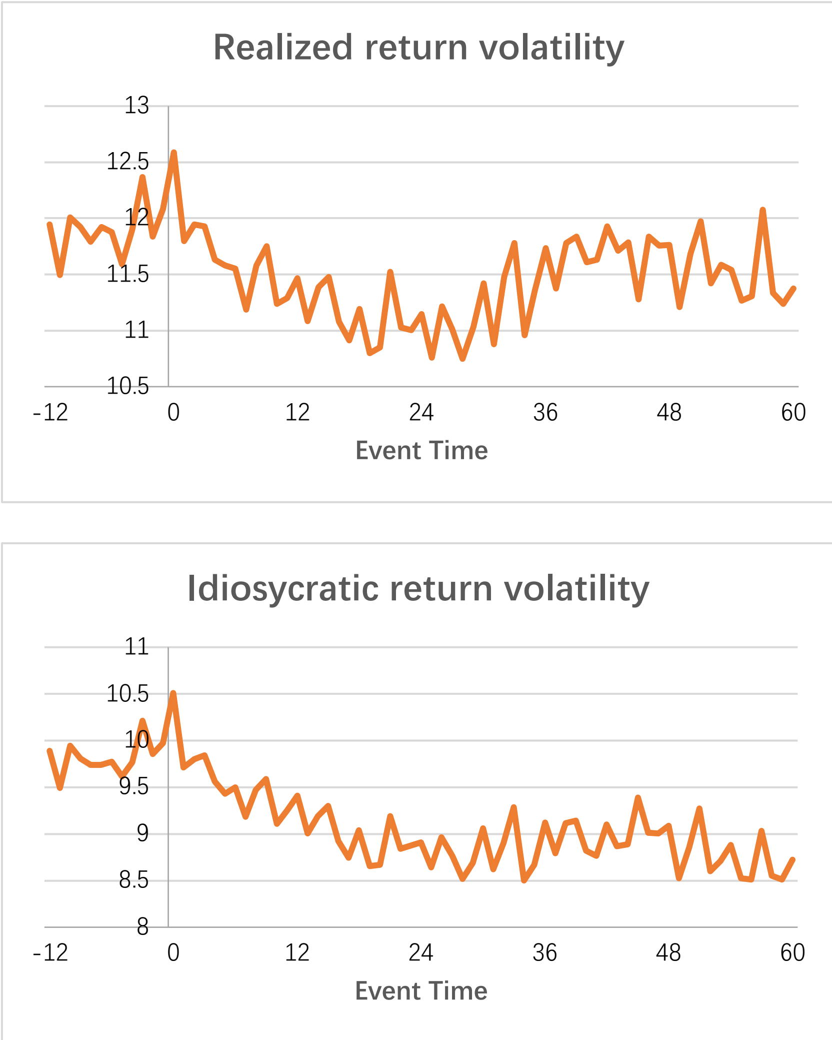


Figure 1:
Stock return volatility around CEO turnover

The figures represent the average return volatility 12 months before the CEOs take office and 60 months after the CEOs take office. The event time is the event month count from -12 to 60 and it is set to take the value of 0 when the new CEO is appointed. This sample contains 95,095 observations over 73 months for 1420 CEOs within 1156 firms. Realized return volatility is the standard deviation of daily stock returns in a month, aggregated to the monthly level. Idiosyncratic return volatility is the volatility of residual return from the Fama-French (1993) three factor model, aggregated to the monthly level. Both of the volatility measures are in percentage.

In line graphs below, the coefficients of three systematic factors are randomly fluctuating within the 73 months without showing any obvious trend. This proves that changes in systematic risk and the expected return volatility would not have an impact on the stock return volatility over the CEO turnover. This finding coincides with the prediction of Pastor and Veronesi (2003) who believes that the learning has an impact on firm's idiosyncratic volatility rather than systematic risk.

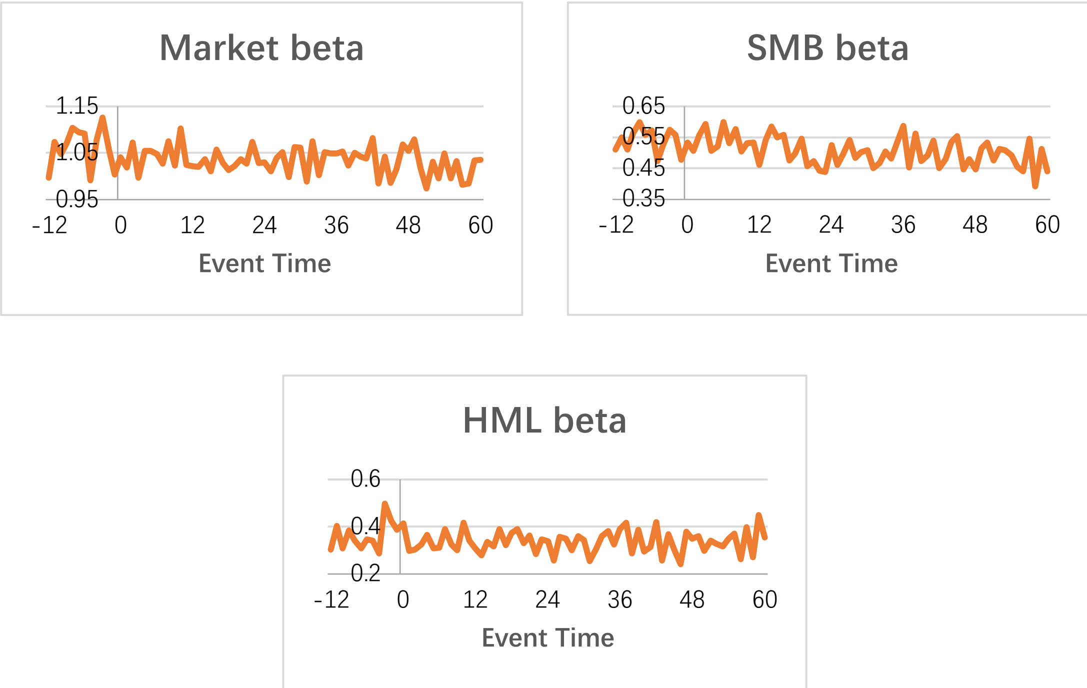


Figure 2:
Systematic risk betas around CEO turnover

The figures represent the average betas 12 months before the CEOs take office and 60 months after the CEOs take office. The event time is the event month count from -12 to 60 and it is set to take the value of 0 when the new CEO is appointed. This sample contains 95,095 observations over 73 months for 1420 CEOs within 1156 firms. The coefficients on the excess market return, SMB and HML in the Fama-French (1993) three-factor model are estimated at the monthly level using daily stock returns, determined by linear regression: $R_\tau^i - r_\tau = \alpha_t^i + \beta_{tMKT}^i (R_{\tau MKT}^i - r_\tau) + \beta_{tSMB}^i SMB_\tau + \beta_{tHML}^i HML_\tau + \varepsilon_\tau^i$.

The regression analysis of the relation

The negative value of the piecewise-linear (spline) regressions' coefficients present a negative and significant relationship between stock return volatility and CEO tenure. In tenure year 1, we would expect an average decrease of 1.08 in realized return volatility and an average decrease of 1.07 in idiosyncratic return volatility. In tenure year 2, the decrease within one year for realized return volatility would be 0.38 and 0.37 for idiosyncratic return volatility. In the third year the falling number would be 0.55 and 0.48 for realized return volatility and idiosyncratic return volatility, respectively. The negative coefficient for the Tenure (year1) is almost twice as large as the other years (within three years), indicating that the stock return volatility declines faster in the earlier period. The negative declining coefficients over CEO tenure is consistent with our first hypothesis that the stock return volatility decreases slower over the CEO tenure (Pan, Wang, and Weisbach, 2015).

In addition, the regression estimates also show that after the first year CEOs are appointed the market learning speed seems to be stable. To further test if the coefficients keep declining over time, in Appendix B Table d we extend our period of interest to 5 years after the CEO is appointed, by using a smaller sample for long tenured CEOs. This smaller sample requires CEO to be at least 7 years in office and the first five years of tenure are included in the regression analysis as discrete variables for robustness check. The first year is the only period of time that appears to be significant for both stock return volatility measures, with the coefficients around -0.81 and 0.85.

Table 2

Spline regression

This table represents the nonlinear relationship between stock return volatility and CEO tenure by using the spline regression from the 12 months before the CEOs take office and 3 years after the CEOs take office. In the regression (1) and (2), we are interested in the period from the time when the CEO is appointed to 3 years after that. In the regression (3) and (4) we include the 12 months before the CEOs take office. For all the regressions we controlled for both calendar year-month fixed effects and the firm-CEO fixed effects. Huber-white robust standard errors are clustered by firm-CEO. The coefficient and t-statistics are listed for each variable. *, ** and *** for the coefficients indicate the significant level of 10 ,5 and 1 percent, respectively.

	(1) Realized return volatility	(2) Idiosyncratic return volatility	(3) Realized return volatility	(4) Idiosyncratic return volatility
Tenure (year-1)			-0.117	-0.131
			(-0.959)	(-1.171)
Tenure (year1)	-1.083***	-1.068***	-1.194***	-1.193***
	(-4.21)	(-4.564)	(-4.189)	(-4.561)
Tenure (year2)	-0.380*	-0.374**	-0.596**	-0.617**
	(-1.921)	(-2.074)	(-2.087)	(-2.334)
Tenure (year3)	-0.548**	-0.484**	-0.736**	-0.693**
	(-2.503)	(-2.454)	(-2.439)	(-2.522)
Market beta	0.730***		0.730***	
	(7.660)		(7.659)	
SMB beta	0.177**		0.177**	
	(2.313)		(2.314)	
HML beta	-0.166***		-0.166***	
	(-3.083)		(-3.085)	
Leverage	0.427	0.568	0.428	0.569
	(0.544)	(0.850)	(0.546)	(0.853)
Dividend dummy	-1.276***	-1.183***	-1.277***	-1.185***
	(-2.767)	(-2.792)	(-2.769)	(-2.795)
M/B	-0.000	-0.000	-0.000	-0.000
	(-0.025)	(-0.611)	(-0.027)	(-0.614)
Log(Assets)	-0.725**	-0.864***	-0.726**	-0.865***
	(-2.069)	(-2.823)	(-2.071)	(-2.826)
ROE	-0.113	-0.109	-0.113	-0.109
	(-0.900)	(-1.060)	(-0.899)	(-1.058)
VOLP	-0.033	-0.032	-0.033	-0.032

	(-1.179)	(-1.352)	(-1.184)	(-1.359)
Calendar year-month fixed effects	Yes	Yes	Yes	Yes
Firm-CEO fixed effects	Yes	Yes	Yes	Yes
Obs	46,535	46,535	66,576	66,576
Adj. R-squared.	0.613	0.564	0.613	0.564

This paper is also interested in the stock volatility changes before the CEO takes office. Adding one year before the CEO turnover event gives us the same trend of volatility and the coefficients of Tenure (year-1) are not significant (Table 2 Regression (3) and (4). Indicating that these is no obvious trend of stock return volatility before the CEO turnover event. We also test the coefficient of prior year on stock return volatility in the long tenured CEOs sample, which also appears to be insignificant (Appendix B Table d).

According to Table 3, the linear term on idiosyncratic return volatility in polynomial regression is significant negative and the squared term is significant positive. This supports the previous findings from the spline regression that the market gradually learn about CEO ability and the speed is declining over time. However, this trend is not found to be significant for the realized return volatility. The reasons for causing that could be the noise from the systematic risks. The cubic term of tenure is also tested in the regression. However due to its strong collinearity with first term, it is omitted in the regression. The stock volatility changes before the CEO takes office are again checked. The linear term and squared term are both statistically insignificant, implies that the period before CEO turnover would not help us to explain anything about market learning effect.

Table 3

Polynomial regression

This table represents the nonlinear relationship between stock return volatility and CEO tenure by using the polynomial regression from the 12 months before the CEOs take office and 3 years after the CEOs take office. In the regression (1) and (2), we are interested in the period from the time when the CEO is appointed to 3 years after that. In the regression (3) and (4) we include the 12 months before the CEOs take office. For all the regressions we controlled for both calendar year-month fixed effects and the firm-CEO fixed effects. Huber-white robust standard errors are clustered by firm-CEO. The coefficient and t-statistics are listed for each variable. *, ** and *** for the coefficients indicate the significant level of 10 ,5 and 1 percent, respectively.

	(1) Realized return volatility	(2) Idiosyncratic return volatility	(3) Realized return volatility	(4) Idiosyncratic return volatility
Tenure	-0.330	-0.475**	-0.035	-0.039
	(-1.272)	(-2.04)	(-0.592)	(-0.740)
Tenure^2	0.098	0.138**	-0.007	-0.000
	(1.570)	(2.481)	(-0.390)	(-0.027)
Market beta	0.643***		0.730***	
	(5.668)		(7.651)	

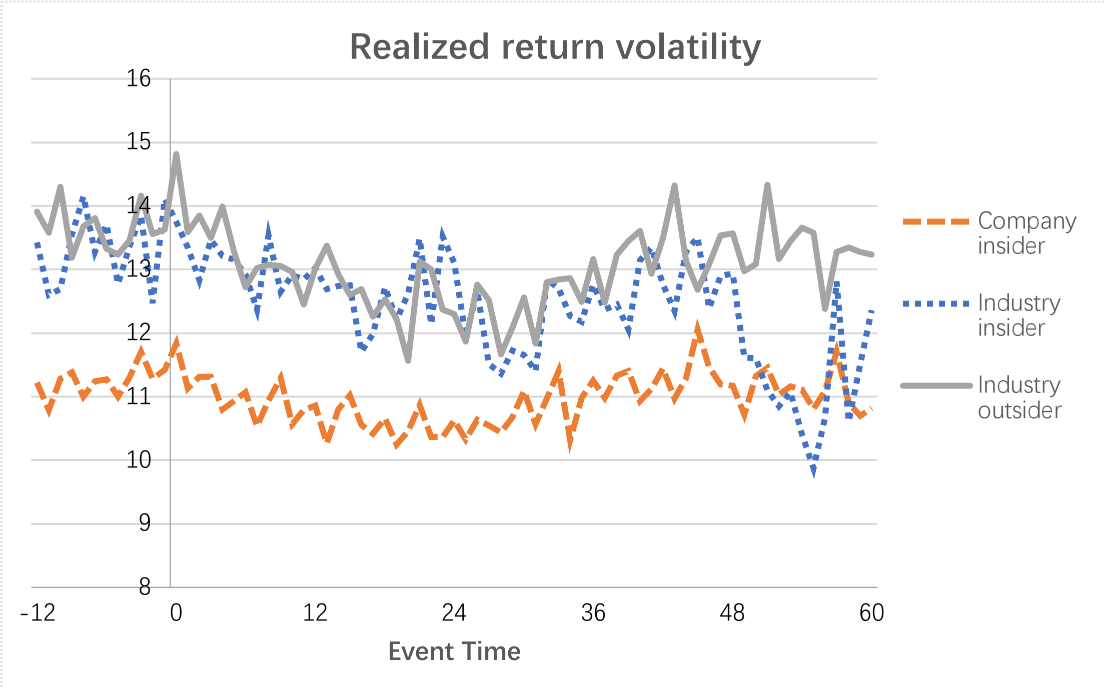
SMB beta	0.154		0.177**	
	(1.582)		(2.312)	
HML beta	-0.131**		-0.166***	
	(-2.020)		(-3.078)	
Leverage	0.881	0.720	0.443	0.584
	(0.813)	(0.735)	(0.565)	(0.875)
Dividend dummy	-1.341**	-1.168*	-1.275***	-1.183***
	(-2.035)	(-1.93)	(-2.769)	(-2.796)
M/B	0.000	0.000	-0.000	-0.000
	(0.385)	(0.056)	(-0.035)	(-0.622)
Log(Assets)	-0.752*	-0.893**	-0.729**	-0.869***
	(-1.815)	(-2.529)	(-2.079)	(-2.836)
ROE	-0.381***	-0.321***	-0.114	-0.110
	(-3.315)	(-2.920)	(-0.909)	(-1.071)
VOLP	-0.052	-0.052	-0.034	-0.033
	(-0.932)	(-1.070)	(-1.191)	(-1.364)
Calendar year-month fixed effects	Yes	Yes	Yes	Yes
Firm-CEO fixed effects	Yes	Yes	Yes	Yes
Obs	46,535	46,535	66576	66576
Adj. R-squared.	0.6296	0.58	0.6122	0.5633

5.1 The market learning speed

Confirming to the previous finding, the statistically significant coefficients for the polynomial regression is only found on idiosyncratic return volatility. When calculating the slope of market learning for each firm-CEO pair, this paper uses only idiosyncratic return volatility. The summary statistics of the estimated learning speed and its determinates can be found in the Appendix B Table e.

CEO replacement type

Given the graph below, the different trends of return volatility for company insiders, company outsiders and industry outsiders suggest that the CEO replacement type would have an impact on volatility. Moreover, the industry outsider CEOs appear to be the ones that have highest stock return volatility when the CEOs take office, which coincides with our hypothesis that the market's prior uncertainty regarding to the outside promoted CEO is higher than the inside promoted CEO. However, the gap between industry outsider and company outsider is much narrower than the gap between industry outsider and company insider. The potential cause for this could be the market values more on company inside information against the industry inside information.



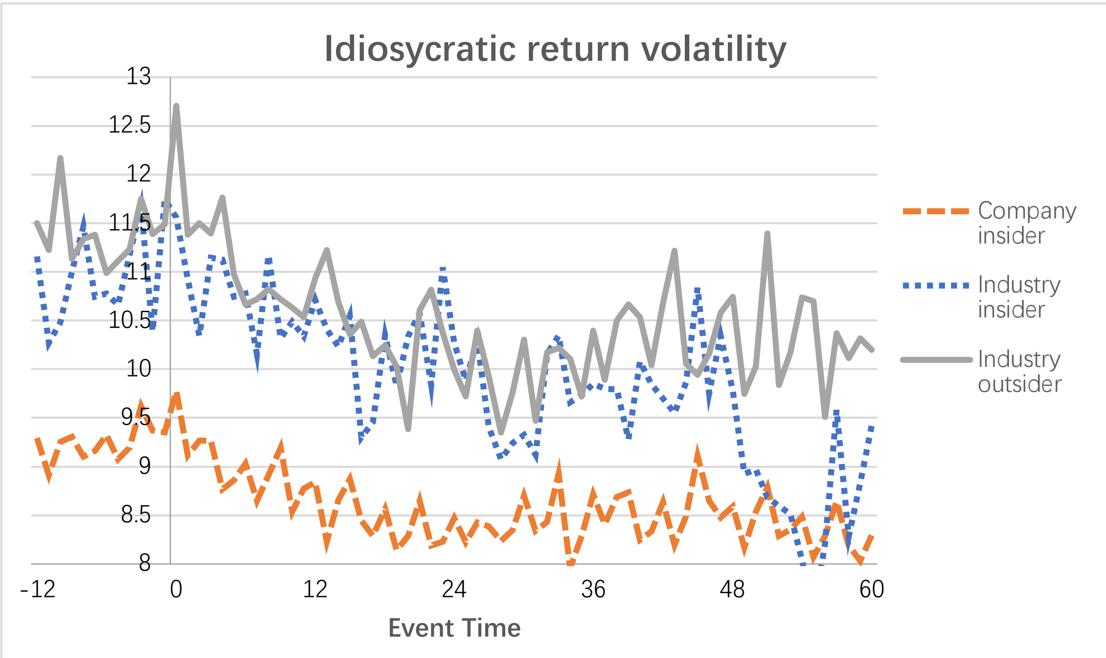


Figure 3:

Stock return volatility around CEO turnover separated in different CEO replacement types

The figures represent the average return volatility 12 months before the CEOs take office and 60 months after the CEOs take office separated in three types of CEO. The event time is the event month count from -12 to 60 and it is set to take the value of 0 when the new CEO is appointed. This sample contains 95,095 observations over 73 months for 1420 CEOs within 1156 firms. Realized return volatility is the standard deviation of daily stock returns in a month, aggregated to the monthly level. Idiosyncratic return volatility is the volatility of residual return from the Fama-French (1993) three factor model, aggregated to the monthly level. Both of the volatility measures are in percentage. When the industry that the company belongs to is different from the industry[5] that the new assigned CEO previously worked and the CEO is not promoted inside the firm, the dummy variable "Industry outsider" takes the value of 1. When the industry that the company belongs to is the same from the industry that the new assigned CEO previously worked and the CEO is not promoted inside the firm, the dummy variable "Company outsider" takes the value of 1. When the CEO is promoted inside the firm, the dummy variable "Company insider" takes the value of 1

It still worth questioning if the higher prior uncertainty would indicate faster market learning speed. From the regression (1) and (6) in the following table, we only found a positive effect of company outsider on learning speed. Although the prior uncertainty level of industry outsider and company outsider CEOs are both high, there are more information for the investors to learn when the new appointed CEO comes from outside of the industry. The noise about the industry information slows down the speed for the investors to further study the ability of new CEO. In regression 6, we added other factors to check if the effect of company outsider CEOs on market learning speed remains. The coefficient is no longer significant, and it seems that the other factors have taken out the effect of company outsider CEOs.

Table 4

Industry level characteristics influence learning slope

This table represents the impact of CEO level characteristics and firm level characteristics on market learning slopes, controlling for MV, firm age and the year fixed effects. Huber-white robust standard errors are clustered by Fama-French 10-indutry classification. The coefficient and t-statistics are listed for each variable. *, ** and *** for the coefficients indicate the significant level of 10 ,5 and 1 percent, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
			Learning slope			
Industry Outsider	0.009					
	(0.829)					(0.001)
Company Outsider	0.022*					0.022
	(1.874)					(0.825)
Ln(CEO age)		-0.019				0.006
		(-0.387)				(0.117)
No. of analysts			0.003***			0.003***
			(3.603)			(3.126)
Forecast error				-0.016		-0.005
				(-1.435)		(-0.414)
GAI					-0.000	-0.000
					(-0.046)	(-0.034)
Log(MV)	-0.003	-0.003	-0.014**	0.002	-0.001	-0.009
	(-0.865)	(-0.894)	(-2.262)	(0.630)	(-0.282)	(-1.376)
Log(Firm age)	-0.038***	-0.041***	-0.033***	-0.039***	-0.037***	-0.034***
	(-5.457)	(-5.550)	(-4.107)	(-4.878)	(-4.999)	(-3.969)

[5] Industry is defined by the Fama-French 48-indutry classification.

Constant	0.634***	0.730***	0.632***	0.588***	0.610***	0.584**
	(17.475)	(3.605)	(12.406)	(11.716)	(11.75)	(2.454)
Year Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Obs	1268	1249	960	960	1118	857
Adj. R-squared.	0.4715	0.4735	0.5136	0.508	0.4957	0.5246

Firm and CEO characteristic variables

In table 4, the coefficients of CEO age and the general ability index are found to be insignificant, proving that the assignment of young CEO and generalist CEO would not lead to a faster market learning speed. Unlike the CEO characteristic variables, firm characteristic variables, firm age and number of analysts are both found significant even under the specification using all variables. The negative coefficient of firm age shows that the learning is faster in younger firms. As a measurement of firm transparency, the higher the number of analysts is, the more transparent the firm is. The coefficient of logarithm of market value is also significant negative. Although the effect is not significant after including all the variables, still this indicates the learning speed is faster in small firm. All these findings are consistent with the notion that learning about CEO ability is faster when there is more uncertainty about the general or firm-specific CEO ability, and also when signals about that ability are more informative (Pan, Wang, & Weisbach, 2014).

Industry characteristic variables

We rank the different industry defined by Fama-French 10-indutry classification based on learning speed. The technology industry that mainly consist of business equipment (Computers, Software, and Electronic Equipment) has the highest estimated learning slope with an average of 0.561. Conversely, the traditional industries like utilities (Oil, Gas, and Coal Extraction and Products) and consumer durables (Cars, TV's, Furniture, Household Appliances) are found to have a much lower learning speed. We also run a Wilcoxon Z statistics test[6] for the difference between the top (Hi-Tech) and bottom industry (Consumer Durables) demonstrating that the learning speed is significant higher in the Hi-Tech industry comparing to the traditional consumer durables industry. This is probably due to the fact that CEO has limited impact on the traditional industry like consumer durables and utilities, where the learning effects of the market seems to be limited. The burgeoning industries however might contain more habits and characteristics of the CEO. Moreover, unlike the practical products sold by the traditional industries, the services provided by the Hi-Tech and Telephone and Television Transmission industry makes it hard to predict the profitability and the quality of the service, which raises the uncertain level when a new CEO is appointed. If the industry has a larger variance in CEO ability, the ability-induced volatility would capture a larger fraction of firm's total volatility and would decrease faster. The importance of CEO ability in that specific industry would then increase. This logic is used to evaluate the circumstances under which CEOs are relatively important.

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6 An additional Wilcoxon Z statistics test is also presented for the two top (Hi-Tech & Telephone and Television Transmission) and bottom (Consumer Durables & Utilities) industries to further prove the differences of learning speed between the top and bottom industries.

Table 5

Summary statistics of the estimated learning speed by industry

This table reports the summary statistics of the estimated learning speed by industry defined as Fama-French 10-indutry classification.

Industry	Obs	Mean	Std. Dev.	Median
Hi-Tech	208	0.561	0.332	0.630
Telephone and Television Transmission	22	0.547	0.330	0.502
Healthcare, Medical Equipment, and Drugs	87	0.531	0.290	0.517
Oil, Gas, and Coal Extraction and Products	57	0.517	0.275	0.452
Other	279	0.511	0.277	0.538
Wholesale, Retail, and Some Services	146	0.501	0.296	0.524
Manufacturing	251	0.471	0.272	0.470
Consumer NonDurables	88	0.466	0.275	0.449
Utilities	86	0.447	0.242	0.428
Consumer Durables	47	0.390	0.266	0.369
Total	1,271	0.500	0.289	0.500
Wilcoxon Z-statistic for the difference between the two top and two bottom industries	Z = -3.805***			
Wilcoxon Z-statistic for the difference between the top and bottom industries	Z = 3.186***			

Apart from the industry classification, we also used industry competitiveness, R&D expenditure and sales growth to identify under which circumstances the CEO ability is more important. There is a significant negative impact of industry sales growth on learning slope. The industries with lower average sales growth have a higher learning speed and the ability of CEOs is more important in these industries. If an industry is expanding, the industry information available to the public is also increasing. With more information available, investors need more time to process the unique company information, which lower the market learning speed for CEO turnover. The technology and the consumer durables industry are included in column (4) and (5). Similar as the Wilcoxon Z statistics test results, the dummy variable consumer durables industry has a coefficient value of -0.065 and the coefficient for Hi-Tech industry is 0.027. This tells us on average the normalized learning speed of consumer durables industry is 0.065 lower than the other industries and the Hi-Tech industry's learning speed is 0.065 points higher than the others. Accordingly, CEO ability is more important and the learning speed is faster in Hi-Tech industry and the industry with lower average sales growths.

Table 6

Industry level characteristics influence learning slope

This table represents the relationship between industry level characteristics and market learning slopes, controlling for firm and CEO attributes found in previous regression and the year fixed effects. Huber-white robust standard errors are clustered by Fama-French 10-indutry classification. The coefficient and t-statistics are listed for each variable. *, ** and *** for the coefficients indicate the significant level of 10 ,5 and 1 percent, respectively.

	(1)	(2)	(3)	(4)	(5)
	Learning slope				
Industry HHI	-0.145				-0.094
	(-1.716)				(-1.094)
Industry R&D		0.018			0.019
		(1.566)			(1.734)
Industry sales growth			-0.191*		-0.190*
			(-2.156)		(-2.048)
Consumer Durables				-0.065***	-0.065***
				(-6.436)	(-5.855)
Hi-Tech				0.031***	0.027***
				(4.981)	(3.930)
Industry Outsider	-0.000	-0.001	0.000	-0.003	-0.004
	(-0.042)	(-0.068)	(0.005)	(-0.171)	(-0.264)
Company Outsider	0.021	0.020	0.014	0.015	0.004
	(0.511)	(0.496)	(0.348)	(0.360)	(0.100)
Log(MV)	-0.008	-0.01	-0.009	-0.008	-0.009*
	(-1.516)	(-1.691)	(-1.795)	(-1.625)	(-1.946)
Log(Firm age)	-0.034***	-0.034***	-0.031***	-0.031***	-0.028***
	(-5.788)	(-5.593)	(-4.665)	(-5.141)	(-3.963)
Ln(CEO age)	0.001	0.010	-0.005	0.015	0.001
	(0.030)	(0.194)	(-0.103)	(0.298)	(0.024)
No. of analysts	0.003**	0.003**	0.003**	0.002**	0.003**
	(2.502)	(2.654)	(2.730)	(2.475)	(2.712)
Forecast error	-0.005	-0.005	-0.002	-0.007	-0.004
	(-0.446)	(-0.456)	(-0.229)	(-0.620)	(-0.353)
GAI	0.000	0.000	0.000	-0.000	0.002
	(0.061)	(0.030)	(0.107)	(-0.036)	(0.249)
Constant	0.616**	0.571**	0.604**	0.533**	0.580**
	(2.493)	(2.371)	(2.629)	(2.302)	(2.490)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Obs	857	857	834	857	834
Adj. R-squared.	0.525	0.525	0.533	0.527	0.536

6. Conclusion and further research

This paper investigates the learning of stock market between year 1993 and 2006. We provide evidence that the stock return volatility decreases over the CEO tenure period and the speed of decreasing is declining over time. This is in consistency with the results found by Pan, Wang, and Weisbach (2015). The potential explanations for the high volatility at the time CEO assigned could be the uncertainty of the CEO ability and the potential changes he might brought to this company. This uncertainty would decrease over time as the CEO's ability gradually known by the market. Learning appears to be fastest in the first year and the majority of the relationship between volatility and tenure can be explained in the first three years.

There are several determinants of the learning speed, by analyzing firm level, CEO level and industry level characteristics. Due to the large number of efficient and accurate information available, learning tends to be faster in transparent firms. The fast learning speed regarding young firms could be explained by the high uncertainty of the market during the CEO turnover. Similarly, the company outsiders and industry outsiders are both found to have a high prior uncertainty level comparing to the company insiders. Nevertheless, only the company outsider CEOs are found to be accepted faster by the market, because there are less noise for the market to learn comparing to the industry outsider CEOs. Finally, Hi-Tech industry and the industry with lower average sales growths are also found to have a faster learning speed. Since in these industries, CEO ability place a more important role and the noise is less disturbing.

The results of this paper can provide some effective instructional strategies for the companies that are intended to change their CEOs. Since the volatility is cause by the prior uncertainty of CEO ability, firms could exposure more information about the management ability of the CEO and increase its transparency level to eliminate the worries of the investors. In addition, when firms are weighing the candidate's qualification for a successful hire, they might also consider the market's acceptance of the new CEO. The company outsider CEOs are preferred as the market is more confident in their ability and favor to the strategic changes brought by those CEOs.

The CEO turnovers studied in this paper are occurred during the time span from 1992 to 2006. This is due to the limited data available. A more recent investigation period of CEO turnover events is encouraged for further research. Additionally, the CEO types (Industry outsider VS Company outsider VS Company insider; Generalist VS Specialist; Old VS Young) considered by this paper are restricted to some extent. Further research could shed some light on other CEO characteristics and abilities that would influence the market learning speed, such as confidence level and the past experience of CEOs.

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Appendix A.

	Variable	Definition
Firm performance		
Dependent variables	Realized return volatility	The standard deviation of daily stock holding period returns within a month (data item *RET* in CRSP), aggregated to the monthly level by multiplying $\sqrt{21}$.
	Idiosyncratic return volatility	The volatility of residual return from the Fama-French(1993) three factor model in a month, aggregated to the monthly level by using daily data. Determined by linear regression: $R_{\tau}^{i} - r_{\tau} = \alpha_{t}^{i} + \beta_{tMKT}^{i}(R_{\tau MKT}^{i} - r_{\tau}) + \beta_{tSMB}^{i} SMB_{\tau} + \beta_{tHML}^{i} HML_{\tau} + \varepsilon_{\tau}^{i}$.
Independent variables	Tenure	Tenure is the number of event month from month 0 to month 36 scaled by twelve after the new CEO is assigned.
	Tenure(year_n)	Every twelve months after the new CEO is assigned has been grouped into year_n category with n range from 0 to a maximum of 3. In each year group the number month is scaled by twelve. For the 1st to 12th month since the new CEO takes office, Tenure (year_1) takes the value of 1/12 to 1, while the variables Tenure (year_2) and Tenure (year_3) take the value of 0. For the 13th to 24th month, Tenure (year_1) takes the value of 1, Tenure (year_2) takes the value of 1/12 to 1, and Tenure (year_3) takes the value of 0. For the 25th to 36th month, Tenure (year_1) and Tenure (year_2) take the value of 1, and Tenure (year_3) takes the value of 1/12 to 1.
	Market beta	The coefficient on the excess market return in the Fama-French (1993) three-factor model estimated at the monthly level using daily stock returns. Determined by linear regression: $R_{\tau}^{i} - r_{\tau} = \alpha_{t}^{i} + \beta_{tMKT}^{i}(R_{\tau MKT}^{i} - r_{\tau}) + \beta_{tSMB}^{i} SMB_{\tau} + \beta_{tHML}^{i} HML_{\tau} + \varepsilon_{\tau}^{i}$.
	SMB beta	The coefficient on the SMB (Small Minus Big) factor in the Fama-French (1993) three-factor model estimated at the monthly level using daily stock returns. Determined by linear regression: $R_{\tau}^{i} - r_{\tau} = \alpha_{t}^{i} + \beta_{tMKT}^{i}(R_{\tau MKT}^{i} - r_{\tau}) + \beta_{tSMB}^{i} SMB_{\tau} + \beta_{tHML}^{i} HML_{\tau} + \varepsilon_{\tau}^{i}$.
	HML beta	The coefficient on the HML (High Minus Low) factor in the Fama-French (1993) three-factor model estimated at the monthly level using daily stock returns. Determined by linear regression: $R_{\tau}^{i} - r_{\tau} = \alpha_{t}^{i} + \beta_{tMKT}^{i}(R_{\tau MKT}^{i} - r_{\tau}) + \beta_{tSMB}^{i} SMB_{\tau} + \beta_{tHML}^{i} HML_{\tau} + \varepsilon_{\tau}^{i}$.
	Dividend dummy	If the total amount of dividends (other than stock dividends) declared on the common/ordinary capital of the company (data item *DVC* in Compustat) is larger than 0 in a year then the dummy variable takes the value of one. The variable is constructed for each firm-year.
	Leverage	The leverage ratio is calculated as total long-term debt (data item *DLTT* in Compustat) divided by the total assets (*AT*), constructed for each firm-year.
	M/B	The market to book ratio is calculated as market value of equity divided by the book value of total equity *(CEQ)*, constructed for each firm-year.

		The market value of equity is calculated as the close price of the stock each fiscal year (data item *PRCC_F* in Compustat) times the number of common shares outstanding (*CSHO*) times.
	Log(Assets)	The logarithm of the total book asset in million dollars (*AT*), constructed for each firm-year.
	VOLP	The residual variance of profitability, as a measure of uncertainty of mean profitability, is obtained from the residual variance of an AR(1) model fit on firm's ROE following Pastor and Veronesi (2003) using a series of at least ten years of annual ROE, with the small-sample bias correction method of Marriott and Pope(1954).
	ROE	Net Income (data item *NI* in Compustat) divided by the book value of common equity in the previous year (*CEQ*).
Learning speed: Committee involvement		
Dependent variable	Learning slope	By running the regressions of Idiosyncratic return volatility on Tenure and a constant term, we obtained a learning slope for each firm-CEO pair (the coefficient on Tenure multiplied by -1). The learning slope is normalized with its empirical cumulative distribution function, with its value falls in the range from 0 to 1.
Independent variables	Industry outsider CEO	When the industry that the company belongs to is different from the industry that the new assigned CEO previously worked and the CEO is not promoted inside the firm, this dummy variable takes the value of one. Industry is defined by the Fama-French 48-indutry classification.
	Company outsider CEO	When the industry that the company belongs to is the same from the industry that the new assigned CEO previously worked and the CEO is not promoted inside the firm, this dummy variable takes the value of one. Industry is defined by the Fama-French 48-indutry classification.
	Company insider CEO	When the CEO is promoted inside the firm, this dummy variable takes the value of one.
	No. of analysts	The number of unique analysts that post forecasts for a firm in a fiscal year obtained from IBES database, constructed for each firm-year.
	Forecast error	The analyst forecast error is the absolute difference between the median analyst earnings forecast (data item *value* in IBES) prior to an annual earnings announcement and the actual earnings announcement (data item *actual* in IBES), constructed for each firm-year.
	Industry R&D	Industry average research and development spending is calculated by taking the average of the firms' R&D intensity within an industry-year. Industry is defined by the Fama-French 48-indutry classification. R&D intensity is the R&D expense (data item *XRD* in Compustat) divided by the total book asset (data item *AT* in Compustat).
	Industry HHI	Industry HHI is calculated by summarize the squared term of the average sale within an industry-year. The formula to calculate HHI is as follow: $HHI = \sum_{k=0}^{n} (\frac{firm\ sale}{industry\ total\ sale})^2$ where n represents the number of

	firms within an industry. Sale is the data item *SALE* in Compustat. Industry is defined by the Fama-French 48-indutry classification.
Industry sales growth	Industry sales growth is the average firm sale in industry i in year t divide by the average sale in year t-1 in industry i and minus 1. Sale is the data item *SALE* in Compustat. Industry is defined by the Fama-French 48-indutry classification.
GAI	The General ability index (GAI) is to measure the generality based on CEO's lifetime work experience in publicly traded firms prior to his current CEO position. Custódio, Ferreira, and Matos (2017) calculate GAI with the following regression[7]: $GAI = 0.268 * Number\ of\ positions + 0.312 * Number\ of\ firms + 0.309 * Number\ of\ Industries + 0.218 * CEO\ Experience\ Dummy + 0.153 * Conglomerate\ Experience\ Dummy$
CEO age	The age of the CEO (data item *AGE* in Compustat).
Firm age	The age of the firm, calculated by using the IPO date in Compustat. If the IPO date is missing, the first date that the firm appear in CRSP is designated.
Log(MV)	The logarithm of market value of equity, constructed for each firm-year. The market value of equity is calculated as the close price of the stock each fiscal year (data item *PRCC_F* in Compustat) times the number of common shares outstanding (*CSHO*) times.

[7] The detail of the definitions of the five proxies can be found in the paper "Generalists versus specialists: Lifetime work experience and chief executive officer pay" written by Custódio, Ferreira, and Matos in 2013.

Appendix B

Table a

The CEO Turnover Distribution on an annual basis

This table summarizes the distribution of CEO turnover events from 1993 to 2006 on an annual basis. The fiscal year when the CEOs take office is define as year became CEO. When a CEO name and ID number for the CEO in the year t is different from the name and ID number for the CEO in the year t-1, we report this as a turnover event in year t. We use the information on job title, ID number for each executive, name for each executive the date becoming CEO, the date left as CEO and the CEO annual flag provided by ExecuComp to identify CEOs at the firm-year level.

Year became CEO	Freq.	Percent
1993	23	1.54%
1994	84	5.64%
1995	103	6.91%
1996	99	6.64%
1997	94	6.31%
1998	112	7.52%
1999	121	8.12%
2000	149	10.00%
2001	157	10.54%
2002	103	6.91%
2003	122	8.19%
2004	117	7.85%
2005	122	8.19%
2006	84	5.64%
Total	1,490	100.00%

Table b

Correlations between variables

This table represents the correlation of the independent variables (volatilities), dependent variables (tenure) and the control variables (firm attributes and three Fama-French risk factors) used in the regressions. The definitions of all the variables can be found in Appendix A.

	RRV	IRV	Tenure (year1)	Tenure (year2)	Tenure (year3)	Leverage	Dividend dummy	M/B	Log(Assets)	ROE	VOLP	Market beta	SMB beta	HML beta
RRV	1.000													
IRV	0.959	1.000												
Tenure (year1)	-0.043	-0.064	1.000											
Tenure (year2)	-0.028	-0.051	0.730	1.000										
Tenure (year3)	-0.007	-0.029	0.412	0.684	1.000									
Leverage	-0.008	0.012	0.012	0.016	0.015	1.000								
Dividend dummy	-0.394	-0.389	-0.003	0.003	0.006	0.007	1.000							
M/B	-0.027	-0.031	-0.014	-0.011	-0.004	-0.024	0.030	1.000						
Log(Assets)	-0.312	-0.354	0.054	0.055	0.042	0.069	0.404	0.033	1.000					
ROE	-0.081	-0.083	0.028	0.019	0.010	-0.035	0.072	0.103	0.039	1.000				
VOLP	-0.030	-0.030	-0.002	0.009	0.008	-0.037	0.043	0.008	0.019	-0.081	1.000			
Market beta	0.208	0.125	-0.003	0.000	0.002	-0.029	-0.089	-0.010	-0.005	-0.012	0.006	1.000		
SMB beta	0.213	0.177	-0.009	-0.009	-0.001	-0.001	-0.160	-0.008	-0.223	-0.025	-0.001	0.455	1.000	
HML beta	0.023	0.018	-0.004	-0.001	0.001	0.058	0.057	0.006	0.025	-0.002	0.008	0.498	0.359	1.000

Table c

CEO replacement type

This table summarizes the CEO replacement type of 1490 CEOs.

CEO replacement type	Freq.	Percent
Industry outsider CEO	1,066	71.54%
Company outsider CEO	118	7.92%
Company insider CEO	306	20.54%
Total	1,490	100.00 %

Table d

Spline regression for long tenured CEOs

This table represents the nonlinear relationship between stock return volatility and CEO tenure by using the spline regression from the 12 months before the CEOs take office and 5 years after the CEOs take office. The long tenured CEOs subsample used here is formed by taking the CEOs who has been in office for at least 7 years. In the regression (1) and (2), we are interested in the period from the time when the CEO is appointed to 5 years after that. In the regression (3) and (4) we include the 12 months before the CEOs take office. For all the regressions we controlled for both calendar year-month fixed effects and the firm-CEO fixed effects. Huber-white robust standard errors are clustered by firm-CEO. The coefficient and t-statistics are listed for each variable. *, ** and *** for the coefficients indicate the significant level of 10 ,5 and 1 percent, respectively.

	(1) Realized return volatility	(2) Idiosyncratic return volatility	(3) Realized return volatility	(4) Idiosyncratic return volatility
Tenure (year-1)			-0.295*	-0.219
			(-1.907)	(-1.562)
Tenure (year1)	-0.810**	-0.845***	-1.094***	-1.057***
	(-2.478)	(-2.958)	(-3.066)	(-3.408)
Tenure (year2)	-0.090	-0.103	-0.143	-0.143
	(-0.448)	(-0.571)	(-0.719)	(-0.794)
Tenure (year3)	-0.232	-0.152	-0.218	-0.141
	(-1.363)	(-0.986)	(-1.281)	(-0.917)
Tenure (year4)	0.089	-0.042	0.086	-0.044
	(0.572)	(-0.293)	(0.550)	(-0.312)
Tenure (year5)	-0.147	-0.178	-0.146	-0.177
	(-0.814)	(-1.081)	(-0.809)	(-1.076)
Market beta	0.968***		0.968***	
	(12.040)		(12.043)	
SMB beta	0.162**		0.162**	
	(2.348)		(2.352)	
HML beta	-0.219***		-0.219***	

	(-4.879)		(-4.883)	
Leverage	0.284	0.647	0.284	0.647
	(0.429)	(1.027)	(0.430)	(1.027)
Dividend dummy	-1.317***	-1.089***	-1.318***	-1.090***
	(-3.853)	(-3.436)	(-3.858)	(-3.439)
M/B	0.002		0.002	
	(1.172)	(0.012)	(1.171)	(0.011)
Log(Assets)	-0.137	-0.3	-0.137	-0.300
	(-0.479)	(-1.238)	(-0.482)	(-1.240)
ROE	-0.348***	-0.277***	-0.348***	-0.277***
	(-4.312)	(-3.886)	(-4.313)	(-3.886)
VOLP	-0.107***	-0.095***	-0.107***	-0.095***
	(-2.747)	(-2.728)	(-2.746)	(-2.727)
Calendar year-month fixed effects	Yes	Yes	Yes	Yes
Firm-CEO fixed effects	Yes	Yes	Yes	Yes
Obs	69,851	69,851	69,851	69,851
Adj. R-squared.	0.563	0.501	0.564	0.501

Table e

Summarized statistics of the learning speed and its determinants

This table summarizes the number of observations, mean, standard deviation and median of the estimated learning speed and its determinants.

Industry	Obs	Mean	Std. Dev.	Median
Learning speed	1,271	0.500	0.289	0.500
CEO age	1,254	51.526	6.062	52.000
Log(MV)	1,269	7.518	1.690	7.429
Firm age	1,270	27.080	16.690	27.000
No. of analyst	961	14.109	10.207	12.000
Forecast error	961	-0.066	0.563	0.000
Indystry HHI	1,270	0.060	0.073	0.042
Industry R&D	1,270	0.164	0.474	0.070
Industry sales growth	1,223	0.045	0.106	0.038
Industry Outsider	1,273	0.192	0.394	0.000
Company Outsider	1,273	0.075	0.264	0.000
GAI(General ability index)	1,118	0.080	0.995	-0.079

Table 4

Industry level characteristics influence learning slope

This table represents the impact of Company Outsider and Industry Outsider on market learning slopes, controlling for MV, firm age and the year fixed effects. Huber-white robust standard errors are clustered by Fama-French 10-indutry classification. The coefficient and t-statistics are listed for each variable. *, ** and *** for the coefficients indicate the significant level of 10 ,5 and 1 percent, respectively. The sample used in the following two regressions has excluded the Company Insider CEOs.

	(1)	(2)
	Learning slope	
Company Outsider	0.004	0.017
	(0.294)	(0.627)
Ln(CEO age)		0.056
		(0.442)
No. of analysts		0.002
		(0.934)
Forecast error		-0.097**
		(-2.731)
GAI		0.009
		(0.450)
Log(MV)	-0.007	0.012
	(-0.779)	(1.127)
Log(Firm age)	-0.036**	-0.068***
	(-2.703)	(-4.440)
Constant	0.673***	0.327
	(9.366)	(0.629)
Year Fixed effects	Yes	Yes
Obs	339	214
Adj. R-squared.	0.422	0.557