The effect of the presence of CTO on CEO turnover: Evidence from the technology industry

Paschalis Rapi

Student Number: 436131

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Supervisor: Jaeyoon Yu

Co-reader: Chris Knoops

ERASMUS SCHOOL OF ECONOMICS

ERASMUS UNIVERSITY ROTTERDAM

MSc ACCOUNTING, AUDITING & CONTROL

Abstract

This thesis focuses on the structure of the top management team. More specifically, it examines how the presence of a Chief Technology Officer (CTO) affects the magnitude of strategic change of a firm and the Chief Executive Officer (CEO) turnover under specific firm performance conditions, in technology firms in U.S. With data from 119 companies from the Dow Jones Technology Index and 61 CEO turnovers, empirical results suggest that the presence of a CTO reduces the magnitude of strategic change under poor firm performance conditions, but it increases the magnitude of strategic change under conditions of good firm performance. On the other hand, the results show that the presence of the CTO has no impact on the CEO turnover-performance sensitivity under any conditions of firm performance, either high or low.

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1. Introduction

The dot-com bubble in the late 1990s was characterized by a rapid increase of investments in internet-focused companies. During that period, the value of equity markets grew exponentially with a NASDAQ index, highly technology dominated at the time, rising from under 1,000 to more than 5,000 after 1995 and until 2000. Griffin et al. (2011, p.1251) claim that "The stock market run-up in the mid to late 1990s was the greatest in the last 140 years of U.S. history in terms of both price appreciation and market-wide valuation multiples". The burst of the bubble though, led the majority of the "dotcom" companies to their demise by the end of 2001. However, Bart (1996) supports that there is no doubt that technology firms are necessary sources of innovation and growth for all the economies around the world, even though they continue to fail in our age. For example, companies like Intel, Oracle, IBM, Microsoft, were leading the growth in the technology sector in the late 1990s and are still contributing nowadays to its ever increasing expansion.

The technology industry has seen significant growth during the past decade. Innovations like the Internet of things, cyber security, analytics and cloud technologies have changed the strategic business decisions, and firms are in need of executives that understand the technology and its applications. Smith (2003) supports that many firms tried to satisfy this need by hiring a Chief Technology Officer/Chief Information Officer (CTO/CIO), who has the important duties of overseeing and monitoring new technologies, products and processes, as well as implementing all the above into the corporate strategy of the firm.

The purpose of this thesis is to examine the relation between the presence of a CTO and the Chief Executive Officer (CEO) turnover. More specifically, this thesis investigates how the presence of a CTO can influence the magnitude of the strategic change and the CEO turnover, under different performance conditions in technology firms, at U.S. after the tech bubble of 2000. The research question is the following:

> *RQ: Does the presence of a CTO increase the likelihood of CEO turnover in technology firms in United States of America under different performance conditions, after the tech bubble of 2000?*

The literature on corporate governance has paid significant attention to the relation between CEO turnover and firm performance. Khanna and Poulsen (1995) and Ertugrul and Krishnan (2011) find negative market reaction for CEO turnover. On the other hand, Adams and Mansi (2009) find positive abnormal returns following a CEO turnover. Despite the ambiguous results, there are indications of a strong relation between CEO turnover and firm performance. Furthermore, several papers have addressed the issue regarding the determinants

that lead to CEO turnover. Weisbach (1988) gives insights into how the composition of the board of directors affect the CEO turnover. More specifically, he indicates that the relation between firm performance and CEO turnover is stronger when the majority of directors in the board are outsiders. Furthermore, Parrino (1997) and DeFond et al. (1999) give new insights in industry related factors that affect the probability of CEO turnover. In addition, Hennes et al. (2008) and Engel et al. (2003) focus more on the relation between the accounting information and CEO turnover, by highlighting the importance of the irregularities in restatement that lead to higher CEO turnover rates than the errors. Finally, Engel et al. (2003) suggest that when accounting information is precise, it gains greater weight on the decision of a firm to dismiss its CEO.

The literature on corporate strategy has focused on the relation between the top management team and the ways it affects the strategy change. There are several papers that have examined the factors of strategic change. Goodstein and Boeker (1991) researched whether the changes in the ownership and the management of a firm leads to a strategy change, concluding that it indeed has an important impact. Furthermore, Wiersema and Bantel (1992) conducted a research on whether the demographic characteristics of top management teams are related to the corporate strategy change and the findings support the hypothesis that they are somehow connected to it.

Farrell and Widbee (2003) support that whether a firm performs as expected or not, is taken into account by the board in order to take the decision to replace a CEO. Thus, combining all the aforementioned it will be very interesting to investigate, how does the presence of a CTO affect the magnitude of strategic change and the turnover of the CEO under specific performance conditions. Shen and Cannella (2002) suggest that many times, senior executives can be power contestants for the position of the CEO. Thus, since the CTO is a senior executive and especially in cases where he affects the strategic change, it can be argued that the he becomes a possible candidate to replace the CEO. Furthermore, it will be very interesting to investigate a less explored issue as the aforementioned one, since the question whether the existence of a CTO on a technology firm has a positive, negative or negligible effect on CEO turnover, remains unanswered, in order to deepen the understanding behind the determinants of CEO turnover. That need is also supported by Brickley (2003, p. 227), who states "We will have to consider other less-explored issues to increase our understanding of CEO turnovers and replacements".

In this thesis I will follow Zhang's (2006) research design but with small differences. I use a general linear model to estimate the possible effect that the presence of a CTO might have

on CEO turnover under specific performance conditions and how does this presence affect the decisions for strategic changes that are taken by the firm. For the latter one I will use the same method that both Zhang (2006) and Zhang and Rajagopalan (2010) used to examine the level of strategic change on the basis of source allocation, since I will use firms only from one industry. The sample consists of technology firms from the Dow Jones Technology Index (DJTI) between 2008-2013 and it includes 119 firms with 61 CEO turnovers.

Two hypotheses are formulated in this study. The first one is about the role of the CTO in improving the organization's efficiency by affecting the magnitude of strategic change. The second one is about the CEO turnover-performance sensitivity and the effect the presence of a CTO has in this relation.

Considering the first hypothesis, I found a statistically significant positive relation between the presence of a CTO and the magnitude of strategic change at a 5% confidence level, under specific performance conditions. This means that the CTO is usually seen as buffer and a way to defend the current strategy of the firm under poor performance conditions and not as means in order to change it. This happens because the CTO has the necessary expertise and knowledge of the industry that enables him to better recognize the opportunities and threats of the industry. Thus, a decision taken by a management team with the CTO inside can be defended, even though the benefits may not be visible on the short term. Furthermore, under good firm performance conditions, the CTO is respected as the cornerstone of new innovations and there is a high probability that the firm will follow any proposes he has about strategic changes.

Considering the second hypothesis, there was no confirmation from the empirical results that the presence of a CTO affects the CEO turnover-performance sensitivity. Although, there are indications that this might be the case, the relation is not statistically significant. This means that although the CTO is a very important executive who plays a significant role in the strategic planning of the technology firms, he doesn't have the power to affect the CEO turnover under any specific firm performance conditions.

This study contributes to both the corporate governance and corporate strategy literature. It contributes to the corporate governance literature by answering the question of whether the presence of a CTO in the top management team, affects the CEO turnover-performance sensitivity. It gives insights into the CEO-CTO relation and is actually broadening the existing literature on the effects that specific executives have on CEO turnovers. Zhang (2006) examined a similar topic by researching the relation between the COO/president and CEO turnover and he found statistically significant results. Although in this study the relation

examined was not confirmed in the empirical analysis, it is still very important that the implications of an important executive like the CTO on the CEO turnover, were researched. These implications become even more interesting if we take into account the fact that the CTO is an executive accountable to the CEO, contrary to the COO/President who is considered to be a co-leader to the CEO. Although he is a top executive, he still has to account to the CEO for all his actions. To the best of my knowledge this is the first study that examines such a relation.

Moreover, this thesis contributes to the literature of corporate strategy as it examines the relation between the presence of a CTO and the magnitude of strategic change under specific firm performance conditions. There are a lot of studies that focus on corporate strategy like Goodstein and Boeker (1991) and Wiersema and Bantel (1992) who examined the relation between the changes in corporate strategy and the changes in ownership and the demographic characteristics of the top management respectively. This thesis contributes by adding the very important factor of the presence of the CTO in the top management structure and its implications on the strategic change of the firm.

Finally, this research can act as a basis to the opening of a research field for the role of the CTO which may be investigated in the future by a wider range of research studies and can be supported by other types of research such as questionnaires and interviews. This will help to draw results from experts in the field and may end up with more significant or different findings. In addition, it can divert the interest of future researches to other important executives that the firms have.

Finally, this research will be very useful to all the stakeholders in the technology industry, from investors, to the board of directors, to the top management team and even to the employees of the firm. All the people of interest can anticipate what the future performance of a technology firm will be, based on the decisions that the firm is taking about changes on strategy or about a replacement of the CEO, if the firm has a CTO in the structure of the top management team.

2. Theoretical background

The literature (Daily and Dalton 1997, Jensen and Zazac 2004, Zhang 2006) focuses heavily on the leadership structure in modern firms, especially in executive positions like the role of the president or the role of the board of directors. These roles are a key requirement for the development of businesses. They are also very important for the understanding of the changes of their environment and are responsible for taking the necessary decisions in order to adapt. Especially in the executive positions of an organization where the stakes are high, the

leadership structure at the top management team is able to affect the broader operation, profitability and development of the firm (Jensen and Zazac 2004).

The board of directors and more specifically the executive elites of the firms determine the governance of companies, always within the framework of the laws and regulations of the countries in which they operate in. They are responsible for managing risks that the firm is facing by assuming, avoiding or transferring them. Each action should be characterized by honesty and transparency towards the shareholders and towards all other interested parties or stakeholders (Mallin 1995). Within the boards of the directors, the one who has the substantial role to lead and determine the direction of the firm, is the CEO. However, this is a two-way relation as the CEO is also judged by the way he is leading the firm. According to Krause and Semadeni (2014), the main responsibilities of the CEO refer to the determination of the business policy and strategy, the monitoring and determination of the responsibilities of the executive directors of the company, the examination of the company's progress in relation to the objectives that have already been set and finally to ensure the interests of the shareholders and all the other stakeholders of the company (Abid and Ahmet 2015).

The success or not of the executive elites and particularly of the CEO depends, on the ability to achieve the desired results and on acting honestly and with integrity (Hernández-Lara et al. 2014). In several cases, the executive elites fail in this dual role. The ease of generating profit through fraudulent procedures becomes attractive and this increases the risks, which may result in sanctions by the legitimate stakeholders of the company such as, for example, the State itself. Often the CEOs and the executive elites of the firms put forward their personal interest in their immediate aspirations, rather than the interest of the organization, which leads to dead-end situations, crises and generally to financial deadlocks (Hernández-Lara et al. 2014).

Historically the views differ regarding the relation between the CEO or the executive elites and firm performance. There are the theorists like Khanna and Poulsen (1995) and Ertugrul and Krishnan (2011) who do not accept this relation and on the other hand, there are those who identify a positive relation and give consideration to the role of the CEO and the role of the board, considering them as a key regulatory instrument of business development like Adams and Mansi (2009). They also argue that all the decisions are taken from there, start and end there, and so it cannot be disputed that the progress of an organization is based on specific groups of people (Daily and Dalton 1997). The same and other theorists (Daily and Dalton 1997, Krause and Semadeni 2013) also described the way in which the executive elites through their representatives, namely the board, the president, and even more so the CEO, who operates essentially on the progress of the firm, influence the business operation in which they participate

in and run. This is done by enhancing their power and controlling what will be expressed and what their beliefs will be.

Another aspect of the literature is that expressed by Krause and Semadeni (2013) who talked about the importance of job rotation, the management of apprentices, departures, changes and demotions. Generally, they support that the empowerment of individuals or groups within an organization is not the best option for its development since it hinders the progress of the organization and sometimes leads to deadlocks. According to Morris (2008) such a period, that actually showed the importance of the proper management and avoided the commitments to specific administrative groups and administrative operating data, was the period before the burst of the dot-com bubble or else called the tech bubble in the late 1990s. In that period, a euphoric situation was created in the technology market around the vast capabilities that the new technologies, based on the Internet, had to offer. However, ultimately the anticipated results never became fruitful, and that period actually damaged many businesses without being limited only to the technology industry. This gave rise to the question whether the absolute confidence to the executive elites or to a president, is correct, or the use of other specific executives, like in the case of this study, the Chief Technology Officer (CTO) should be preferred, who, having fewer jurisdictions and requirements will bring better results within an organization while at the same time he would take authorities away from the elites (Zhang 2006, Ragowsky et al. 2014, Joynt et al. 2014). Eventually, the view that was developed was that the presence of the CTO would, either help the CEO to reach or to even increase his potential, given the knowledge he has from within the organization and especially in a company of new technologies, or lead to CEO turnover because of the increased authorities and the new strategic role the CTO would have. This is also reflected at the papers of Farrell and Widbee (2003) and Gentry et al. (2013) who supported that a company's operation and the new role of the CTO may lead to the decision to keep the CEO or not. The role of the CEO and generally the executive elites of an organization, go through inspection and assessment and it is to be determined whether some senior executives will stay or not.

All the aforementioned present an overview of the contribution of the CEO to the wider development of an organization, in a period of change and generally under various conditions. There are also references regarding the CEO's removal when an organization is able to control its progress through another specialized executive such as the CTO or the COO/president (Zhang 2006). The whole subject is related to corporate governance literature.

In terms of corporate governance literature, the role of the executive elites of a firm is a topic under considerable research. The executive elite that is mostly researched is the CEO.

More specifically, the evaluation of his role takes place in areas such as the business risks, the internal control of companies, the strategic development, the financial management and at the level of transparency of his actions and positions within the organization (Gormley et al. 2013, Nwachukwu 1995, Felo 2010). In particular, there is a special control committee which is related to these actions and determines the usefulness of the CEO and whether there is a need of a CEO replacement (McConnell 2016). Generally, based on the above, the corporate governance literature, through its representatives, focuses on defining the role of the CEO, based on the needs of the organizations.

Another view which also relates to the corporate governance literature, refers to the role of the CEO in different environments. It refers to how his role and generally the roles of the executive elites are controlled and influenced by the environment. The significant role of the external environment of the firm is also supported by Parrino (1997). He also claims that the role of the CEO is significant to the identification and to the management of the external forces of the environment of the firm. In less competitive markets, the role of the CEO is less important, with lower control and fewer requirements, in contrast to the role of the CEO in competitive markets where it is more important, more intense, the control becomes more insistent and the requirements are more pronounced. Finally, according to Tricker (2015), the evaluation of the role of the CEO is of significant importance depending on the environment, because he can contribute to the proper functioning of an organization. Based on the matter under consideration in this thesis, at the level of technology organizations, the position of the CEO is more controlled in view of the market complexity and the frequent changes.

Furthermore, there are also views which highlight the importance of the control of the CEO and generally the position of the firm in the wider environmental agency. Specifically, Engel et al. (2003) refer to the importance of the economic progress of an organization to judge the presence of the CEO, and highlights the need to add another dedicated executive, in order to increase profits and strengthen the financial position of those companies. Zhang (2006) considers that the existence of a responsible executive who also strengthens the position of an organization, can reduce the power that the CEO has in a company. The presence of another qualified executive could certainly lead to the removal of the CEO if the organization performs poorly, and even change the structure and the function of the organization. According to Boeker and Goodstein (1993), in organizations where strategic changes are implemented, the presence of an executive with special expertise can aid to their success.

Finally, according to Shen and Canella (2002), all views can be questioned and controlled and can lead to replacements, always depending on the performance of an

organization. No position enjoys potential immunity. According to Joseph et al. (2014), the concept of corporate governance determines the administrative roles and contributes to the fact that when an organization is more effective on the cause for which it was created and achieves its goals, then the one who helps in this has the primary role, even if there are people with stronger leadership. Furthermore, there are views and opinions that support the importance of evaluation and investigation of the role of the CEO in an organization. Namely, Brickley (2003) and Bilgili et al. (2016), argued that it is important to consider and raise views and opinions on the replacement of the CEO when mistakes are made or when it is determined that a different scheme would work better.

The ones who demonstrate the need for change and sets the vision are those in the top management. They define the main objectives, parameters and requirements. The top management needs to form broad and long-term objectives and needs to be able to motivate the employees to remain faithful to these objectives, even in the early stages where the resistance and obstacles sometimes seem to be overwhelming (Black et al. 2002). There should be a specific direction and a detailed description of the final situation. There should also be a commitment from the side of the top management to the proposed means of achieving the desired result and this is essential to be understood by the CEO in order to be engaged and to help in the process (Carnall 2007). But as important as the commitment of the top management is, it is equally difficult. Stability and consistency within the unstable climate that exists during the process of change, are difficult to achieve. However, the CEO and all the other executive elites of the organization must support the effort and stand behind the change, becoming a role model and inspiration to all employees. Only then there are chances for success (Chevalier and Segalla 1996). If this is not possible, the company tries to find alternatives, at this point it might even think to replace the CEO, with another elite executive with good knowledge both of the firm's and the industry's environment.

During challenging times, like in the period of crisis in the technology sector in the late 1990s, it is important for a firm to be led by someone who knows what and when to do something and can easily recognize the opportunities and threats. This person must identify and analyze the objectives and develop an action plan. Although there are some elements that must, necessarily, be taken into account in the development of the plan, each firm is different and it is impossible to have a uniform planning (Kotter 1990). A plan that does not lead to action cannot be effective. And it certainly cannot be effective if the parties cannot understand the series of actions that are included into the process. The key elements of the plan should determine who does what and when. The detailed record is not useful because it hampers

flexibility and adaptation of the plan to undesirable and uncontrollable situations that may arise. The plan should be flexible, independent and able to adapt to any situation. The preparation of a separate plan for the critical transitional period of the change is proposed, which can last a longer time than expected. During this period, the points of conflict and pressure become obvious and this may require appropriate reforms or measures. The selection of the suitable individuals to take the lead will ensure a successful change. These people are not necessarily the most powerful in the company and they don't need to belong to the elites, but are gifted, popular, dynamic and are able to influence others (Cornelli and Karakas 2015).

Each renewal program starts by one or two people. In cases of successful reforms, this initial core is being developed continuously. But when this doesn't happen in time, it can cause a failure to the effort of change. In small companies this initial core is usually 3 to 5 people during the first year, and in the large firms this number is even bigger at around 20 to 50 people. The companies that fail at this stage usually underestimate the difficulties that may occur during the change. Sometimes they have a reduced capacity for teamwork at the management level. Other times there is simply no appropriate administrative body that could rally a strong team around the process (Herrmann and Nadkarni 2014). Zhang and Rajagopalan (2010) recognized the importance of the role of the external consultant to the positive or negative situation that creates a change, and consider this role more influential than the CEO's. Finally, Westphal and Fredrickson (2001) generally highlighted the role of those having management roles in strategic changes, since through the changes their contribution to the organizations, is evaluated.

The growing influence of the external environment is also considered in the corporate strategy literature, especially in modern organizations. In recent years this role has been sufficiently analyzed due to the increasing pace at which the changes take place in the various sectors of the external environment. The degree that these changes influence the firm, is of course different for every firm. The purpose of the analysis of the external environment is precisely this, to determine the type and intensity of the influence on the firm (Weng and Lin 2014). The role of the person responsible refers to the identification of the changes, the identification of the impact of those changes to the external environment and finally, the impact of the different dynamics and their management with the appropriate procedure to enable the organization to address them properly and to achieve its objectives. The specialization of the person in charge of the change is the cornerstone for an organization to achieve its goals. In case this person does not have the knowledge but simply an administrative role, which is the case with many CEOs, the project may fail.

Finally, an additional point for discussion focuses on the new CEOs. Specifically, when new CEOs join a company, they choose to make changes in their effort to show that they have different plans from their predecessors, and they also want to show that they have a plan to upgrade and run the organization more effectively. When this is done without a plan it can lead to failure. It is essential to supervise the new CEOs, and their coexistence with a specialized executive would help, especially in technological ventures where it is appropriate to be experienced regarding new technologies (Auster and Hillenbrand 2016). According to Lee and Johnson-Laird (2013) it is important to apply changes specifically to solve problems that exist at the present time, and for that, the enthusiasm of a new CEO is important. The problem is to have the appropriate knowledge to achieve the objectives, while co-existing with other executives that have the knowledge to help and generally enhance the whole project and to help achieve the organization's objectives. It is not possible for a CEO that just started and needs time to adapt and to realize how to achieve the targets set by the firm, to be withdrawn from the first moment because of a mistaken assessment. The organization must support, help and evaluate him after a reasonable time has passed. Thus, the inclusion of a CTO next to a CEO in technology companies may lead to better results. Moreover, it could also lead to the replacement of the CEO by the CTO in any future time under specific firm performance.

Based on the above it is easily understandable that the CEO's role is critical in all organizations and when this role is not successful then there is a high possibility that the CEO will be removed. What is not clear and should be studied is, how the presence of a specialized executive with strategic role such as the CTO contributes to the above process, namely how the CTO contributes in the implementation of the changes within an organization, whether he has a positive or negative impact on the replacement of the CEO, a positive or negative contribution to the successful changes and a positive or negative contribution to the strategic function of an organization. The significance of the CTO is not clear and will be investigated through the research that follows, where there will be an attempt to fill this gap in the corporate governance and corporate strategy literature, and to clarify the role of the CTO and more specifically the dynamics of this role in modern organizations.

3. Hypothesis Development

The technology industry is characterized by an ever changing environment where firms and their management have to adapt to the changes in order to succeed. Barr et al. (1992) state that both in a declining and a fast growing industry, top managers must follow the changes in their industry otherwise they might fall behind their competitors. Furthermore, Boeker (1997)

supports that poor organizational performance acts as an indicator for top management to realize that the current plan needs to be changed and that the top management has a strong influence on the strategic changes that the firm will undergo in order to have better future results. This claim is also supported by Goodstein and Boeker (1991, p.324) who indicates that "changes in ownership and management have an important effect on strategic change". Westphal and Fredrickson (2001, p. 1113) found that "executive effects on strategy can mask board effects" giving credit to the executives about changes they didn't initiate. Usually the executive who gets the credit for the strategic changes, especially those strategic changes that lead to better firm performance, is the CEO. However, the ones suitable for leading and implementing those changes are not always the most powerful executives but the more gifted ones and the ones who understand the firm and industry better (Cornelli and Karakas 2015). Therefore, it can be argued, especially in case of a technology firm, that a CTO, who is an important executive, can affect the strategy change and more specifically the resource allocation to the key dimensions of the firm under conditions of poor performance. Moreover, the presence of a CTO can influence and even reduce the power of the CEO and his political resistance which is one of the internal barriers to strategic change (Zhang 2006). Especially, a CTO would take an initiative for strategic changes when firm performance is poor. Thus, my first hypothesis is as follows:

H1: Firms with a CTO are more likely to pursue strategic changes when their performance is poor.

There is a variety of papers focusing on the relation between firm performance and CEO turnover. Engel et al. (2003) and Farrell and Whidbee (2003) explain how different performance measures can explain the CEO turnover. Brickley (2003) claims that, although "the relation between CEO turnover and firm performance is statistically significant, its economic significance is arguably quite small". Thus, other aspects of this relation needs to be explained and researched to get a better understanding. Zhang (2006) claims that CEO dismissal happens under unusual conditions such as poor firm performance. The main goal of a firm is to be profitable and the person responsible for taking the right decisions in order to achieve this goal is the CEO. Therefore, it is logical that when a firm is not performing well or at least as well as expected then the ability of the person in charge is questioned. Furthermore, even in cases where the firm is performing well, it's not always necessary that the CEO is the one responsible. There are cases where the board or another executive took the right decisions which led to the good performance of the firm (Westphal and Fredrickson 2001). Boeker (1992) supports that the dismissal of a CEO depends on two factors, 1) the power that the specific CEO has and 2) the

structure of the board. This thesis is based on firms from the technology industry which means that in their boards is very likely that a CTO can be found. This adds one more top executive to the boards with the necessary knowledge and capabilities to take on strategic tasks and implement medium and long-term planning other than the CEO. If the argument that the power of a CEO is reduced if he confronts competition by other top executives (Shen and Canella 2002) is also taken into account, then the CTO is capable of reducing the power of a CEO, especially in technology firms. If the CEO is also questioned due to poor firm performance it can be argued that the presence of the CTO can increase the probability of a CEO turnover. Thus, my second hypothesis is as follows:

H2: The CEO turnover-performance sensitivity is higher for firms with a CTO than for firms without a CTO.

These (H1) and (H2) hypotheses are formulated to showcase the power of the CTO in the organization and the effect that his presence has on the CEO turnover under specific performance conditions, respectively. The higher the probability of the CTO presence to affect the magnitude of strategic change in a firm, the higher his power over the decision making process of the top management is. Consequently, the more powerful the CTO, the higher the probability of his presence to affect the CEO turnover under specific performance conditions.

4. Research Design

The Libby-Boxes presented in the Appendix of this proposal show how the conceptual relations examined in this thesis, are operationalized in the research design. As already mentioned, this thesis examines the relation between CEO turnover and the presence of a CTO under specific firm performance conditions, in technology firms and how does this presence affects the strategic change of the firm.

I will follow the research design of Zhang (2006) but with small differences. Zhang (2006) uses a Generalized Estimating Equation (GEE) method. However, in my study I use a General Linear Model (GLM). The reason is that with the GEE method the empirical based standard errors underestimate the true ones, unless a very large sample size exists (Hu et al. 1998). Since my sample is relatively smaller from Zhang (2006), I will use a GLM for a better estimation.

In my analysis I use two models to answer each of the aforementioned hypotheses. In the first model, I estimate the effect that the control variables and the prior firm performance have on the dependent variables. In the second model, I add the interaction of the presence of

the CTO with the prior firm performance as independent variable in order to show the effect of the presence of the CTO on the dependent variables under specific firm performance conditions.

Regarding my first hypothesis (H1), the equations of the models are the following (all independent variables are lagged one year):

$$Magnitude\ of\ strategic\ change_t = a_0 + a_1 CEO\ tenure_{t-1} + a_2 Firm\ size_{t-1} + a_3 Board\ size_{t-1} + a_4 Outside\ directors\ \%_{t-1} + a_5 CEOage_{t-1} + a_6 CEO\ shareholding_{t-1} + a_7 Prior\ firm\ performance_{t-1} \quad (1)$$

$$Magnitude\ of\ strategic\ change_t = b_0 + b_1 CEO\ tenure_{t-1} + b_2 Firm\ size_{t-1} + b_3 Board\ size_{t-1} + b_4 Outside\ directors\ \%_{t-1} + b_5 CEOage_{t-1} + b_6 CEO\ shareholding_{t-1} + b_7 Prior\ firm\ performance_{t-1} CTO.dummy_{t-1} \quad (2)$$

where *Magnitude of strategic change* is the dependent variable in both equations and is measured as the average value of six key strategy dimensions which will be used as an index of performance (Zhang 2006, Zhang and Rajagopalan 2003, Finkelstein and Hambrick 1990). These strategy dimensions are the following: (1) advertising intensity (advertising/sales), (2) research and development intensity (R&D/sales), (3) Property, Plant and Equipment newness (net PP&E/gross PP&E), (4) nonproduction overhead (selling general and administrative (SGA) expenses/sales), (5) inventory levels (inventories/sales), (6) financial leverage (debt/equity). More precisely, for each of the six dimensions, the absolute value of change between current year and the previous year is calculated (if there is no change the firm maintains the status quo, otherwise it doesn't). Afterwards, the results of these calculations are standardized within the sample. This means that for each dimension the mean value and the standard deviation is calculated. Then this mean value is subtracted from the absolute values calculated above and the result is divided by the standard deviation. The final results for each dimension for each firm year are added and divided by six. This is the magnitude of strategic change for each firm for each firm year. I selected this specific measurement type in order to calculate more accurately the Magnitude of strategic change, due to the fact that sample consists of firms from the same industry.

As indicated by the (H1) hypothesis I expect a statistically significant negative sign for coefficient b_7 in equation (2), which will indicate that the presence of a CTO is negatively related to the magnitude of strategic change in technology firms under specific firm performance conditions.

Regarding my second hypothesis (H2), the equations of the models are the following (all independent variables are lagged one year):

$$CEO\ turnover_t = a_0 + a_1 CEO\ tenure_{t-1} + a_2 Firm\ size_{t-1} + a_3 Board\ size_{t-1} + a_4 Outside\ directors\ \%_{t-1} + a_5 CEOage_{t-1} + a_6 CEO\ shareholding_{t-1} + a_7 Prior\ firm\ performance_{t-1} \quad (3)$$

$$CEO\ turnover_t = b_0 + b_1 CEO\ tenure_{t-1} + b_2 Firm\ size_{t-1} + b_3 Board\ size_{t-1} + b_4 Outside\ directors\ \%_{t-1} + b_5 CEOage_{t-1} + b_6 CEO\ shareholding_{t-1} + b_7 Prior\ firm\ performance_{t-1} CTO.dummy_{t-1} \quad (4)$$

where *CEO Turnover* is the dependent variable in both equations. It's a dummy variable which equals to 1 if there is a replacement of the CEO during the firm year and 0 otherwise.

Aligned with the H2 hypothesis I expect a statistically significant negative a_7 coefficient to equation (3), which will indicate that the prior firm performance is negatively related to CEO turnover. Then, I expect a statistically significant negative coefficient for b_7 coefficient in equation (4), higher in absolute value than the a_7 coefficient, which will indicate that the CEO turnover-performance sensitivity is higher for firms with a CTO than for firms without a CTO.

In equations (1) and (3) the independent variable is the *Prior firm performance*. This variable is operationalized as Return On Equity (ROE) adjusted for industry differences by subtracting the median ROE of the sample (Contractor et al. 2007). In this way, firms with performance below zero will represent the group of poor prior performance and firms above zero will represent the group of high prior performance. By doing this, I will be able to test and compare the two different groups against my hypothesis.

In equations (2) and (4), the independent variable is the interaction of the variable *Prior firm performance* and the variable *CTO.dummy* (*Prior firm performanceXCTO.dummy)*. *CTO.dummy* is a dummy variable which indicates whereas there was a CTO employed by the firm for each firm year or not. It equals 1 in case there was a CTO (or a CIO for specific technology firms) identified as an employee and 0 otherwise.

To control for possible confounding effects, I will use control variables that might have an effect to the dependent variables. The control variables which will be used are, namely, *CEO tenure, Firm size, Board size, Outside directors %, CEOage, CEO shareholding*. More

information about the measurement and definition of the control variables is given in the Appendix Table I. The empirical analysis is executed with the use of the STATA tool.

With the above research design, I differentiate even more from the Zhang (2006) paper. Zhang (2006) in his corresponding (1) and (3) equations controls also for the presence of the executive he is examining and then in equation (2) and (4) he adds the interaction between the relevant executive and the prior firm performance. However, in my research, in equations (1) and (3) I do not control for the presence of the CTO. I first estimate the impact of the prior firm performance on the dependent variables and then the direct impact of the presence of the CTO on the same dependent variables with the role of *Prior firm performance* as a mediating variable. This allows for a clearer and more direct estimation on how the CTO presence impacts the dependent variables than what the Zhang's (2006) study does.

Therefore, these four equations are needed in order to better showcase the impact that the presence of the CTO has, under specific performance conditions, to the magnitude of the strategic change and to the probability of CEO turnover. This is achieved by comparing the results of two equations each time, equation (1) with equation (2), and equation (3) with equation (4) respectively.

The sample data is consisted of companies from the DJTI. The sample period is from 2008 to 2013, a six-year period, the same as in Zhang's (2006) research design and the data were collected from the Wharton Research Data Service (WRDS). More specifically for each variable:

- *CEO turnover*: Data were collected from ISS (formerly Risk Metrics). In this database it is not possible to recognize who was the CEO of the company for each year. That's why additional data were needed for all the directors, their employment title (whether it was a CEO or not) and whether they were employed by the company or not. Then, this information was used in order to determine each company's CEO for each year. The turnover of the CEO was recognized every time there was a different CEO in firm year *t* from the firm year *t-1*.
- *CTO.dummy*: Data were hand collected for this variable by searching through the annual reports of each firm for the whole six-year period. In many firms the annual reports were made in a more interactive way for the investors and they included only the key figures and no information for the top management could be found. Therefore, when it was not possible to collect the data from the annual reports the 10-K or 20-F SEC filings were searched for each company. If the information was not available to these filings as well, then the DEF-

14A SEC filing was checked. To reduce the margin of error, the findings for all the companies and at all the years, were checked with the latter, the DEF-14A SEC filing (a proxy statement for executive compensation).

- *CEO tenure, Board size, Outside directors percentage, CEO age, CEO shareholding*: The data for all these variables were collected from the ISS (formerly Risk Metrics) and the COMPUSTAT.
- *Prior firm performance, Magnitude of strategic change* (and all of its components): The data for these variables were collected from the COMPUSTAT. Data for all the components for each of the variable were collected and the calculations were executed as described in the Table 5 in the Appendix. For the *Prior firm performance,* the net income for each company and for each year was collected and it was divided by the total equity for the same company in the same year. This is how the ROE for each firm was calculated. Then the mean ROE of the sample of all the firms was subtracted from each firm. The end result is the proxy of prior firm performance for each firm in each specific year. Regarding the *Magnitude of strategic change* variable, there were some difficulties regarding the data of advertising and R&D expenses where a few values were missing and I had to cross check with the annual reports and 10-K SEC filings whether it was coincidental or not. Then a missing value analysis was conducted and the mean value substitution was selected as initial and more convenient solution.

The data collection method is similar to Zhang's (2006) research. Companies that are included in DJTI were selected because they form a representative sample and it could be easily assumed that the findings of this research could be applicable to all other technology firms of the U.S. Finally, I selected this six-year period of 2008-2013 since it's after the tech bubble which was a critical point in history where technology industry started shaping in the way it is today. Furthermore, the selection of the specific period was done, also, due to the high data availability on this period.

The process I followed in order to reach to the final sample that was used in the statistical analysis is the following:

- Initially 156 companies were identified from the DJTI as mentioned before. Ten firms were dropped due to the complete lack of available data. Finally, the number of companies was reduced to 119 as all the companies that didn't have available data for all the variables used in the research were removed.

- For these remaining 119 companies, 724 observations were available initially. In the process the data were screened for false values like negative CEO tenure or very large estimates of ROE in prior firm performance. These values were excluded from the analysis. Furthermore, in order to have more reliable estimates of the coefficients in the statistical models it was decided to remove the upper and lower 1% outliers of the observations of the most influential variables. These were the *Magnitude of strategic change*, the *Firm size* and the *Prior firm performance*. After this process was implemented the data sample was reduced to 658 observations.

- For these 119 companies the distribution of the observations during the years was the following: 88 (13,37%) for 2007, 83 (12,61%) for 2008, 97 (14,74%) for 2009, 103 (15,65%) for 2010, 103 (15,51%) for 2011, 100 (15,20%) for 2012 and 84 (12,77%) for 2013. From the 119 companies, 15 (12.6%) had a CTO all the years during the 2007-2013 period, 8 (6,7%) had for 6 years, 6 (5,0%) had for 5 years, 7 (5,9%) had for 4 years, 4 (3,4%) had for 3 years, 2 (1,7%) had for 2 years, 8 (6,7%) had for 1 year and 69 (58.0%) did not have a CTO during this six-year period (I have to mention here that this distribution refers to the observations that remained in the final data, after screening e.t.c, not to the initial sample that was gathered).

- In relation to the CEO turnover, I identified 67 (11,28%) turnovers in total of 658 observations.
- In addition, I had 308 (46,81%) observations for CEOs' with age equal or above 55 years in total of 658 observations.
- Finally, the total number of observations representing the existence of a CTO was 235 (36,10%) in total of 651 observations (7 missing).

5. Empirical results and analysis

In this section, initially, I present the descriptive statistics of the variables that I used in the statistical analysis, followed by the two tests that I used in order to check the quality of my sample: 1) I present a table with the correlations of the variables I use in the empirical analysis in order to test for autocorrelation and 2) I present two graphs with residuals to check for heteroscedasticity. Finally, I present the results of the statistical models introduced in the research design section above.

Table 1 reports the descriptive statistics of the sample. More specifically, the mean value, the standard deviation, the minimum and the maximum value and the 1st, 2nd(Median)

and 3rd quartile of each variable. As it can be observed it is interesting to notice that the mean value of *Prior firm performance* is positive, which is an indication that the majority of the firms included in the sample have good financial performance compared to the index performance

Another interesting observation is that the mean value for the *Magnitude of strategic change* variable is different from zero, which indicates that there are changes during the examined period in the strategic planning of the firms, and 50% of the firms have values between -0.1333 and 0.2213 which is an indication of negative skewness.

In addition, the average CEO tenure is 10.50 years with the average number of board members equals to 8.64 directors per year and per company. Moreover, 50% of the CEOs have tenure less than 8 years and 50% of the firms have a board of directors sized from 7 and 10.

TABLE 1 – Descriptive statistics

Variable	Mean	SD	Min	Max	Q1	Median	Q3
Firm size	7.6056	1.4058	5.2804	11.6289	6.5274	7.3364	7.4464
Magnitude of strategic change	0.1223	0.4305	-0.3335	2.7602	-0.1333	0	0.2213
Prior firm performance	0.0586	0.2201	-1.0028	0.9945	-0.0704	0.0483	0.1975
CEO shareholding	0.0179	0.0313	0	0.2462	0.0031	0.0074	0.0178
Outside directors %	0.7954	0.0850	0.5	0.9231	0.75	0.8	0.8750
Board size	8.6413	1.7867	5	15	7	9	10
CEO tenure	10.5076	7.6876	1	39	5	8	14
CEO turnover	0.1018	0.3026	0	1	0	0	0
CTO.dummy	0.3610	0.4807	0	1	0	0	1
CEOage	0.4681	0.4994	0	1	0	0	1

M= mean value, SD= standard deviation, Min= minimum value Max= maximum value, Q1, Q3 1st and 3rd quartile respectively and Median= median

In Table 2, I present the correlations among the variables that are used in the statistical models. As it can be observed, there isn't any significant correlation between any pair of variables. This is very important since I avoid having two or more variables canceling each other or having a double effect on the dependent variable. Since there is no proof of significant correlations between the variables, multicollinearity should not be an issue and the coefficients of my variables will not be biased in order to result in an inaccurate estimation.

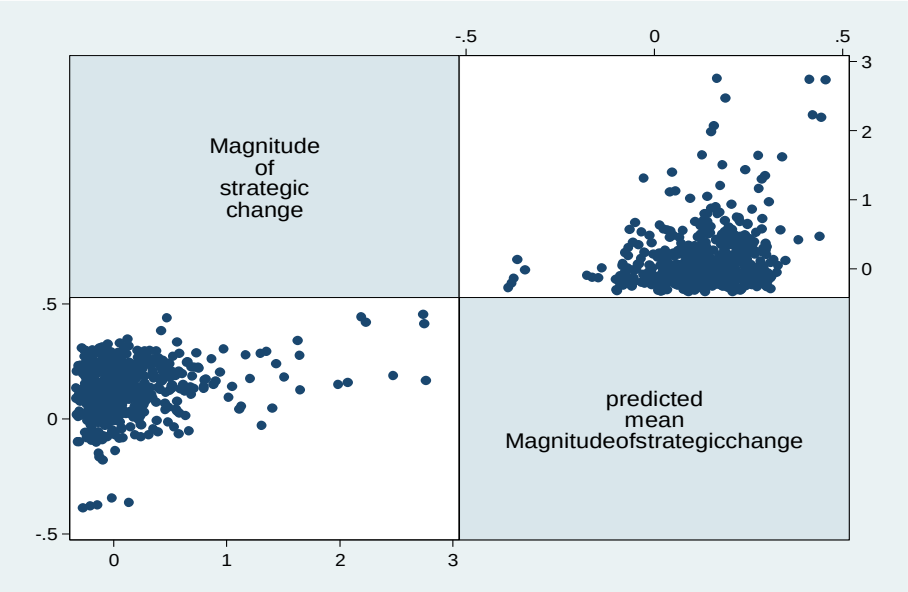
In Graphs 1 and 2, no significant heteroscedasticity problem is observed for the analysis on Tables 3 and 4. This can be observed since the dispersion of the data-dots is quite random. This means that the error variance is almost constant. Thus, the variance of the estimated coefficients has not been affected.

TABLE 2 – Correlations

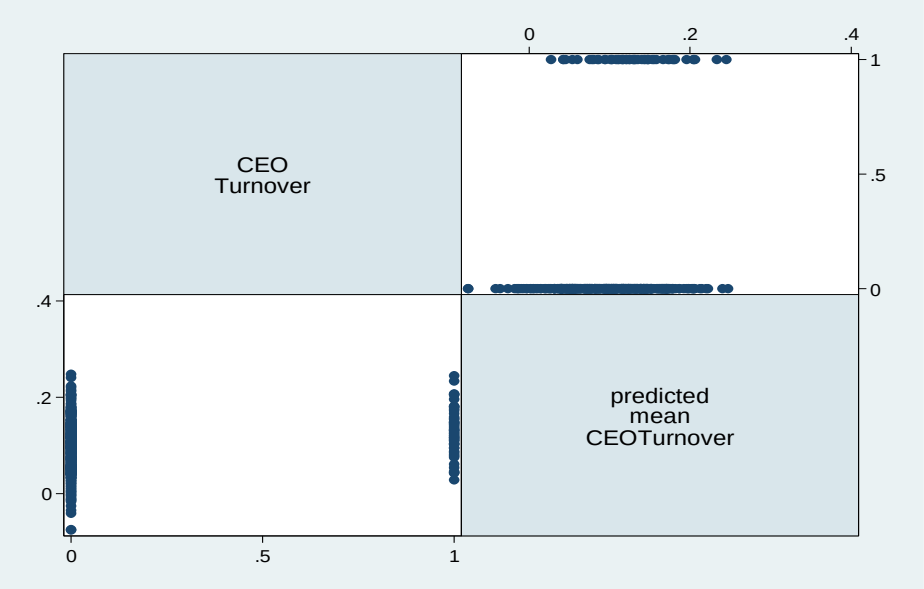
Variable	1	2	3	4	5	6	7	8	9	10
1. Firm size	1									
2. CEO turnover	0.0082	1								
3. Board size	0.5700***	-0.0087	1							
4. Magnitude of strategic change	-0.1594***	0.0258	-0.1774***	1						
5. CEO tenure	-0.0587	0.0902**	-0.1525***	0.0067	1					
6. CEOage	0.1240***	0.1008**	0.0641	-0.0573	0.3191***	1				
7. Prior firm performance	0.2382***	0.0608	0.1288***	-0.1342***	0.0431	0.0431***	1			
8. CEO shareholding	-0.3868***	0.0701*	-0.3339***	-0.0148	0.5850***	0.5850*	-0.0836**	1		
9. Outside directors %	0.1445***	-0.0792**	0.1599***	0.0679*	-0.0346	-0.0346	0.0642	-0.0467	1	
10. CTO.dummy	-0.0155	0.0089	0.0705**	0.0003*	-0.1723***	-0.1723***	0.0003	-0.1248***	-0.1535***	1

This table presents the Spearman's rho correlation index among all the variables used in the research

GRAPH 1



GRAPH 2



In Table 3, I present the estimates of the GLM with dependent variable the *Magnitude of strategic change.* Model 1 and 2 represent the equations (1) and (2) from section 4. Model 1 includes all the control variables and the main effects of the *Prior firm performance* variable without taking into account the presence of the CTO. Model 2 includes also the interaction between *Prior firm performance* and *CTO.dummy* (*Prior firm performance*CTO.dummy*) variables. The results of this Table help answering the H1 hypothesis.

Analytically, in Model 1, I observe that 3 coefficients have a positive sign and 4 coefficients have a negative sign. The variables with a positive coefficient are the *CEO tenure* (0.0072), the *Outside directors %* (0.7466) and the *CEOage* (0.0856). The variables with a negative coefficient are the *Firm size* (-0.0543), the *Board size* (-0.0014), the *CEO shareholding* (-2.1867) and the *Prior firm performance* (-0.0686). Moreover, there are 3 variables with coefficients that are statistically significant at 1% confidence level, the *Firm size*, the *Outside directors %* and the *CEO shareholding.* There are also 3 variables with coefficients statistically significant at 5% confidence level, the *CEO tenure*, the *CEOage* and the *Prior firm performance.* Finally, one variable is not statistically significant, the *Board size.*

Therefore, the variables that are significant predictors of the *Magnitude of strategic change* variable are the *CEO tenure*, the *Firm size*, the *Outside directors %*, the *CEOage*, the *CEO shareholding* and the *Prior firm performance*.

Regarding the variables that are positively related to the magnitude of strategic change the interpretation is the following. The positive sign of the *CEO tenure* variable (0.0072) means

that the longer the CEO keeps his position the higher the probability to affect the strategic planning of the firm. If the CEO stays in his position for a long period, he gains more experience and more power inside the company. Consequently, it is more probable that he will be able to recognize the changes that the firm needs, to initiate these strategic changes and to motivate the employees to follow these changes. The positive sign for the *Outside directors %* (0.7466) indicates that the higher the percentage of outsiders in the board, the higher the probability of strategic changes. Having more outsider directors in the structure of the board increases the objectiveness of the monitoring of the top management. Thus, it will be easier, since they also have no attachment to the top management, to push for strategic changes when they think is vital to do so. Moreover, the positive sign of *CEOage* (0.0856) seems to play its role in the pursuit of strategic change. The more experienced the CEO is the more likely it is that he will identify the changes needed in order for the firm to perform better. Thus, the older the CEO, the more probable it is for him to realize the need for changes of the firm and try to implement it.

Regarding the variables that are negatively related to the magnitude of strategic changes, the interpretation is the following. The negative sign of the *Firm size* coefficient (-0.0543) means that the larger the company the less likely it is to pursue strategic changes. This is logical since the bigger the firm the more difficult it is to implement changes and to motivate the large amount of people involved to put their efforts into implementing something they might not even understand and believe in. The negative sign of the coefficient of the *CEO shareholding* variable (-2.1867) means that the higher the percentage of the shares held by the CEO the less likely he is to try to implement strategic changes. Usually a CEO who holds a substantial amount of shares of the firm might avoid changing the strategy of the firm, especially if the firm performs well because he might think it's risky. If the changes he proposes end up having a negative effect on the performance of the firm, the shares will lose their value and the CEO wants to avoid that.

Finally, the case when a firm is not performing well or at least, as well as it is expected, indicates that a change is needed. This argument is used to explain why a negative sign in the coefficient of *Prior firm performance* variable (-0.0686) is observed, although the absolute value is small. Especially in firms focused on innovation and constant changes, like the technology firms, when the firm is not performing well, a strategic change seems inevitable.

In Model 2, I observe that 4 coefficients have a positive sign and 3 coefficients have a negative sign. The variables with the positive sign are the *CEO tenure* (0.0072), the *Outside directors %* (0.7334), the *CEOage* (0.0810) and the *Prior firm performanceXCTO.dummy*

(0.0857). The variables with the negative coefficients are the *Firm size* (-0.0558), the *Board size* (-0.0032) and the *CEO shareholding* (-2.1634). Moreover, there are 3 variables with coefficients that are statistically significant at 1% confidence level, the *Firm size*, the *Outsider directors %* and the *CEO shareholding*, 2 variables with coefficients statistically significant at 5% confidence level, the *CEO tenure* and the *Prior firm performanceXCTO.dummy* and 1 variable with coefficient statistically significant at 10% confidence level, the *CEOage*. Finally, there is only 1 variable without a statistically significant coefficient, the *Board size*. Since the results of both Models are almost the same regarding the control variables, the interpretation for them is the same as in Model 1.

However, there are two important observations that need to be highlighted regarding the results of the two models. The first observation is the high absolute value of the *CEO shareholding* coefficient (|-2.1867|, |-2.1634|) in both models. This means that the portion of the shares held from the CEO has a significant relation on the magnitude of strategic change, whether a CTO exists or not. As I already mentioned, CEOs are likely to avoid risks that have to do with changing the strategy of the firm due to the probability of affecting the value of the shares he possesses.

Finally, the second and most important observation is that after adding the interaction *Prior firm performanceXCTO.dummy*, I get a positive sign. This is of significant importance since the *Prior firm performance* variable on its own had a negative sign in Model 1. This means that the presence of the CTO changes the results of the decision making process. If a technology firm doesn't have a CTO is more probable that it will make strategic changes under poor performance conditions, than when it has a CTO. Regarding this positive sign of the interaction *Prior firm performanceXCTO.dummy*, it's not in line with my expectations from the first hypothesis (H1), meaning that firms with a CTO aren't more likely to pursue strategic changes under conditions of poor firm performance than firms without a CTO. This relation is statistically significant and it seems that technology firms which have a CTO, continue to follow the same strategy even though the firm performance is poor. They put their trust into the strategy path, which is introduced by the top management team, with the CTO included. On the other hand, technology firms without a CTO may panic under conditions of poor firm performance since they don't have the knowledge and the skills that the CTO has to offer to their top management team. Moreover, the coefficient is statistically significant at 5% significant level, thus the first Hypothesis is rejected by the empirical results.

The aforementioned results of the H1 hypothesis differentiate enough from Zhang (2006). At first, from a control variables perspective, the outside directors percentage and the

tenure of the CEO have a significant relation to the magnitude of strategic change. This is in contrast to Zhang's (2006) findings where there is no statistically significant relation. The mean values for these variables show that there wasn't any significant difference either on the time that a CEO remains on his position (10.50 years to 9.2 years), or on the percentage of the outside directors (79.54% to 74.2%), so this deviation may be the result of industry related factors. However, both in this study and in Zhang (2006) the size of the firm is negatively related to the magnitude of strategic change and this relation is significant at 1% confidence level.

TABLE 3 – GLM results First Hypothesis (H1)

	Model 1	**Model 2**
Variables	Coefficient (z score)	Coefficient (z score)
Magnitude of strategic change		
Constant	-0.1088	-0.0762
	(-0.50)	(-0.35)
Controls		
L1. CEO tenure	0.0072	0.0072
	(2.18)**	(2.19)**
L1. Firm size	-0.0543	-0.0558
	(-3.09)***	(-3.20)***
L1. Board size	-0.0014	-0.0032
	(-0.10)	(-0.24)
L1. Outside directors %	0.7466	0.7334
	(3.21)***	(3.15)***
L1. CEOage	0.0856	0.0810
	(2.00)**	(1.88)*
L1. CEO shareholding	-2.1867	-2.1634
	(-2.95)***	(-2.91)**
Predictors		
L1. Prior firm performance	-0.0686	
	(-1.99)**	
L1. Prior firm performance*CTO.dummy		0.0857
		(2.01)**
Observations	511	505

This table presents two different General Linear Models with dependent variable the *Magnitude of strategic change* and independent variables the *CEO tenure, Firm size, Board size, Outside directors %, CEOage, CEO shareholding and Prior firm performance* in Model 1 and the interaction of *Prior firm performance* with the *CTO.dummy* in Model 2. The L symbol represents the lagged values, 1 year back. *,**,*** indicate significance of the coefficients at 10%, 5% and 1% confidence level, respectively.

The main difference, in regard to the first hypothesis, of this study and Zhang (2006) is related to the effect that the of the presence of the executive under research has on the magnitude of strategic change under specific performance conditions. Although both studies find a significant negative relation between prior firm and performance and strategic change in model 1, after

adding the interaction with the presence of the executive, the result differs significantly. In this study there is a positive relation (0.0857) between the aforementioned interaction and the strategic change while in Zhang (2006) this relation is negative (-0.364). Finally, both relations are significant at a 5% percent confidence level.

As a final point, the above relation is also in line with the study of Smith (2003), which supports that many firms hires a CTO to help them change their corporate strategy and focus more on new products and processes.

In Table 4, I present the estimates of the GLM with dependent variable the *CEO turnover*. Model 1 and 2 represent the equations (3) and (4) from section 4. Model 1 includes all the control variables and the main effects of the *Prior firm performance* variable without taking into account the presence of the CTO. Model 2 includes all the control variables and the interaction of *Prior firm performance*X*CTO.dummy*. The results of this Table answer the H2 hypothesis.

In Model 1, I observe that 3 coefficients have a positive sign and 4 coefficients have a negative sign. The variables with a positive coefficient are the *CEO tenure* (0.0012), the *Board size* (0.0004) and the CEOage (0.0624). The variables with a negative coefficient are the *Firm size* (-0.0001), the *Outside directors %* (-0.3434), the *CEO shareholding* (-0.6833) and the *Prior firm performance* (-0.0334). Moreover, there are 2 variables with coefficient that is statistically significant at 5% confidence level, the *Outside directors %* and the *CEOage*. The rest of the variables, including the predictor variable *Prior firm performance*, have coefficients that are not statistically significant.

In Model 2, the results are almost the same for all the variables. I observe the variables with the positive and negative coefficient, respectively being the same as in Model 1 except for the *Board size* variable that has a negative coefficient in Model 1 (-0.0004) and a positive in Model 2 (0.0009). More specifically, the coefficients for the rest of the variables are the following: *CEO tenure* (0.0012), *Firm size* (-0.0026), *Outside directors %* (-0.3499), *CEOage* (0.0685), *CEO shareholding* (-0.7381) and *Prior firm performanceXCTO.dummy* (-0.1473).

The same happens with the statistically significant variables. Only *Outside directors %* and *CEOage* variables are statistically significant at 5% confidence level. Therefore, these are the variables that are significant predictors of the CEO turnover. The positive sign of the *CEOage* variable in both models (0.06242 and 0.0685 respectively) means that the older the CEO the more likely he is to leave the company. As I already said in the previous section, the technology firms are based on continuous innovation and they are constantly changing to adapt to their environment. Thus, these firms will most probably choose a younger CEO with fresh

ideas, who would take calculated risks to make the necessary changes, as supported by the first hypothesis, over an older one.

The negative sign of the *Outsider directors %* in both models (-0.3434 and -0.3499 respectively) means that the higher the outsider director percentage in the board of directors, the more likely it is that the CEO will leave or be replaced under conditions of poor firm performance. Outsider dominated boards usually perform a more effective monitoring of the firm and the top management decisions. Furthermore, since they are not part of the firm they are more objective in their decisions and as a consequence it is easier for them to take difficult decisions like changing the strategy or replacing the CEO. This is also supported by the first hypothesis. What is more noteworthy is that this relation is slightly stronger when the CTO is added to the top management (|-0.3434|>|-0.3499|). This means that it is even easier for the board to replace the CEO when they know that an executive with the knowledge and the expertise of the CTO is on the top management team. The same happens with the *CEOage* variable (|0.06242|>|0.0685|).

Regarding the second hypothesis, I expected a negative statistically significant negative coefficient for the *Prior firm performance* coefficient in Model 1 and statistically significant negative coefficient of *Prior firm performanceXCTO.dummy* in Model 2 with a higher absolute value for the latter. Although, from a sign perspective my expectations are confirmed, since they are both negative and the absolute value of the second coefficient is considerably higher than the first one (|-0.1473|>|-0.0334|), these relations are not statistically significant at any confidence level. This is not in line with my expectations in H2 hypothesis. Therefore, the H2 hypothesis is not confirmed. However, the empirical results don't reject it either. It seems that that there is no relation between the presence of a CTO in the top management and the decision of a firm to replace its CEO. This is also in line with the findings from Model 2 in Zhang (2006) study. Even though in his model, he controls for two different types of CEO turnover, the CEO dismissal (-2.22) and CEO voluntary turnover (0.65), the interaction of neither with the prior firm performance is statistically significant. Only after adding the interaction of the magnitude of strategic change, the study ends up with statistically significant results.

Moreover, the results indicate that there is no relation between the *Prior firm performance* variable and the *CEO turnover* variable as the relevant coefficient in Model 1 is not statistically significant in any confidence level, as I already mentioned. This means that the prior firm performance of the firm is not taken into account when the board decides whether to replace a CEO or not.

Finally, the results of the second hypothesis are not easily comparable with the Zhang (2006) study. This is due to the fact that Zhang (2006) controls for different types of CEO turnover, while this study isn't. Furthermore, he controls also for the magnitude of strategic change while estimating the impact of the presence of the COO/President. However, in this study, only on the impact of the presence of the CTO under specific performance conditions is taken into account. The magnitude of strategic change acts as measurement of the power the CTO has in the firm and whether he does have a strategic role or not.

TABLE 4 – GLM results Second Hypothesis (H2)

	Model 1	**Model 2**
Variables	Coefficient	Coefficient
CEO turnover		
Constant	0.3517	0.3668
	(2.37)**	(2.48)**
Controls		
L1. CEO tenure	0.0012	0.0012
	(0.55)	(0.53)
L1. Firm size	-0.0001	-0.0026
	(-0.01)	(-0.22)
L1. Board size	-0.0004	0.0009
	(-0.04)	(0.10)
L1. Outside directors %	-0.3434	-0.3499
	(-2.16)**	(-2.19)**
L1. CEOage	0.06242	0.0685
	(2.13)**	(2.32)**
L1. CEO shareholding	-0.6833	-0.7381
	(-1.35)	(-1.45)
Predictors		
L1. Prior firm performance	-0.0334	
	(-0.0334)	
L1. Prior firm performance*CTO.dummy		-0.1473
		(-1.52)
Observations	511	505

This table presents two different General Linear Models with dependent variable the *CEO turnover* and independent variables the *CEO tenure, Firm size, Board size, Outside directors %, CEOage, CEO shareholding and Prior firm performance* in Model 1 and the interaction of *Prior firm performance* with the *CTO.dummy* in Model 2. The L symbol represents the lagged values, 1 year back. *,**,*** indicate significance of the coefficients at 10%, 5% and 1% confidence level, respectively.

To sum up, it can be argued that the CTO is gradually gaining more power inside the technology firms and that he is playing an important role in the strategic planning. More specifically, the presence of the CTO enhances the magnitude of strategic change under

conditions of good firm performance and reduces it under conditions of poor firm performance. These are supported by the results of the first hypothesis (H1) as aforementioned.

However, although the CTO is considered a very important executive, the power and the strategic role of this position, are not enough to affect the probability of a CEO turnover under any firm performance conditions. Nonetheless, the empirical results give indications that CTO's presence enhances the relation between CEO turnover and both the outsider dominated boards and the age of the CEO. This is supported by the results from the second Hypothesis (H2). Finally, both in the analysis of *Magnitude of strategic change* and *CEO turnover*, there seems to be no significant relation between the number of the directors in the board, namely the board size, and the dependent variables.

6. Conclusion

This study investigates the potential impact of the presence of a CTO on CEO turnover in technology firms in United States of America under different performance conditions. This impact was estimated on the basis of magnitude of strategic change and CEO turnover-performance sensitivity. Two hypotheses were formulated respectively. At first the impact of the CTO presence on the magnitude of strategic change and secondly the same impact on the CEO turnover under specific performance conditions, is examined. A four equation structural model is used to estimate the empirical relations among the CTO presence and CEO turnover under specific performance conditions. The empirical results indicate that in most cases the presence of a CTO, while interacting with prior firm performance, is positively related to the magnitude of strategic change of a firm and has no relation with the CEO turnover-performance sensitivity after controlling for all the other factors.

Analytically, the analysis conducted in Section 5 rejects the first hypothesis. This means that, although the CTO can be a very important player concerning the strategic planning of a technology firm, especially under conditions of poor firm performance, he also acts as a defense line or a buffer for the already followed strategy. The decisions taken by a management team with the knowledge and expertise of a CTO included, seems to be more difficult to change even under poor firm performance conditions. More specifically, I found a statistically significant positive relation between the presence of a CTO and the magnitude of strategic change that happens in the firm, at a 5% confidence level, while I was expecting a negative one. Moreover, the demographic characteristics and the structure of the top management seem to have an important effect to the magnitude of the strategic as well. This is in line with the Wiersema and Bantel (1992) findings.

More specifically, the CEO age and whether the board of directors is outsider dominated, have a statistically significant relation with the magnitude of strategic change represented by a positive coefficient. This means that the higher the percentage of outsiders in the board of directors and the older the CEO, the more likely it is for the firm to pursue strategic changes. Furthermore, the size of the firm is also one more thing to consider while examining the magnitude of strategic change. The findings suggest that the bigger the firm the less likely it is to chase a strategic change. Zhang (2006) has similar findings for the relation between firm size and magnitude of strategic change. Finally, CEO-specific variables like *CEO tenure* and *CEO shareholding* have also a very significant relation with the magnitude of strategic change and should always be taken into account. On the other hand, the size of the board of directors doesn't have any effect on the magnitude of strategic change.

Regarding the second hypothesis, it was not confirmed by the empirical analysis which means that there is no evidence that CEO turnover-performance sensitivity is higher for firms with a CTO than for firms without a CTO. Although the CTO seems to be respected as an important executive as argued above, he doesn't have the power to affect the CEO turnover. More specifically, although the sign of the relation was negative as expected, the relation itself was not statistically significant under any confidence level. Furthermore, there are indications that there is no relation between the prior firm performance and CEO turnover as well. It seems that prior firm performance is not a criterion when the board decides whether to replace a CEO or not. This is in contrast with the findings of Farrell and Widbee (2003) who suggest that the firm performance is one of the criteria for taking a decision about the replacement of the CEO.

Finally, in this hypothesis the demographic characteristics and the structure of the board seem to have an effect on the CEO turnover as well. More specifically, the CEO age and the percentage of outsiders in the board of directors have a statistically significant relation to the CEO turnover. The older the CEO, the higher the probability that he will leave the firm under poor performance conditions. This is logical, especially in technology firms where the long term profitability is based on innovation and vision. Thus, when a technology firm is not performing well, they will prefer a younger CEO with new ideas to take over an older and more tired CEO. Finally, the more the outsiders in the board of directors the higher the probability for a CEO turnover under poor firm performance conditions. Usually outsiders in the board of directors can be more objective in their monitoring of the firm than the insiders and they are also more distant from the top executives. This makes their decisions easier and more objective, in case they decide to dismiss a CEO. The latter is also in line with Weisbach (1988) findings,

where he supports that the relation between firm performance and CEO turnover is stronger when the board is outsider dominated.

The results for this thesis are very important and are related mainly to the corporate governance and corporate strategy literature. It contributes to the corporate governance literature by examining the CEO-CTO relation on the basis of CEO turnover-performance sensitivity. Furthermore, it broadens the literature on the executive elites, since it gives insights to a completely unexplored topic for the corporate governance until now, that of the implications of the CTO on the CEO turnover. Although in the end no relation between the CEO turnover-performance sensitivity and the presence of a CTO was found, the examination of this relation from a technology firm perspective is very interesting. Moreover, this thesis contributes to the literature of corporate strategy by examining the effect the presence of a CTO in the top management team has on the decision of a firm to pursue several strategic changes. The same argument as for the corporate governance literature applies here as well. This was an unexplored topic until now. Furthermore, a statistically significant relation between the presence of a CTO and the magnitude of strategic change is observed making the contribution even more solid.

7. Limitations and future research

Every empirical research has limitations and this one is no exception. The time period which was selected, includes one of the most severe crises ever occurred in the U.S. Concerning that, the use of variables to control for the time effect would be preferred.

Another limitation is that the independent variable of the research design required hand collection of the data. Therefore, the limited resources that I had and the limited time becomes an important issue. Having more resources and time would enable the collection of a much bigger sample and the results may have been more significant.

Finally, in this study I included only companies that are listed in the U.S. stock exchange. Most of these companies are quite big. Therefore, although usually the indexes are good indicators of how an industry performs, the results may not be representative for smaller technology companies that are not listed.

My first proposal regarding future research concerns the above limitations. Professionals with more resources and more available time will probably gather bigger data samples that will be more representative also for smaller companies and that may lead to a more significant result.

A second proposal would be to broaden this research by controlling whether after the CEO turnover, the CTO took the place of the CEO or not. This will make the relation clearer and more concise. Furthermore, it could also control for the time effect as I already mentioned above.

Finally, different type of researches, like questionnaires and interviews from the executives themselves could be used to broaden the results from the first hypothesis about the magnitude of strategic change and the presence of the CTO. It could be used to figure out the reason behind the CTO acting as a buffer for the current strategy followed by the firm even though the firm is performing poorly.

8. References

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9. Appendix

Libby-Boxes

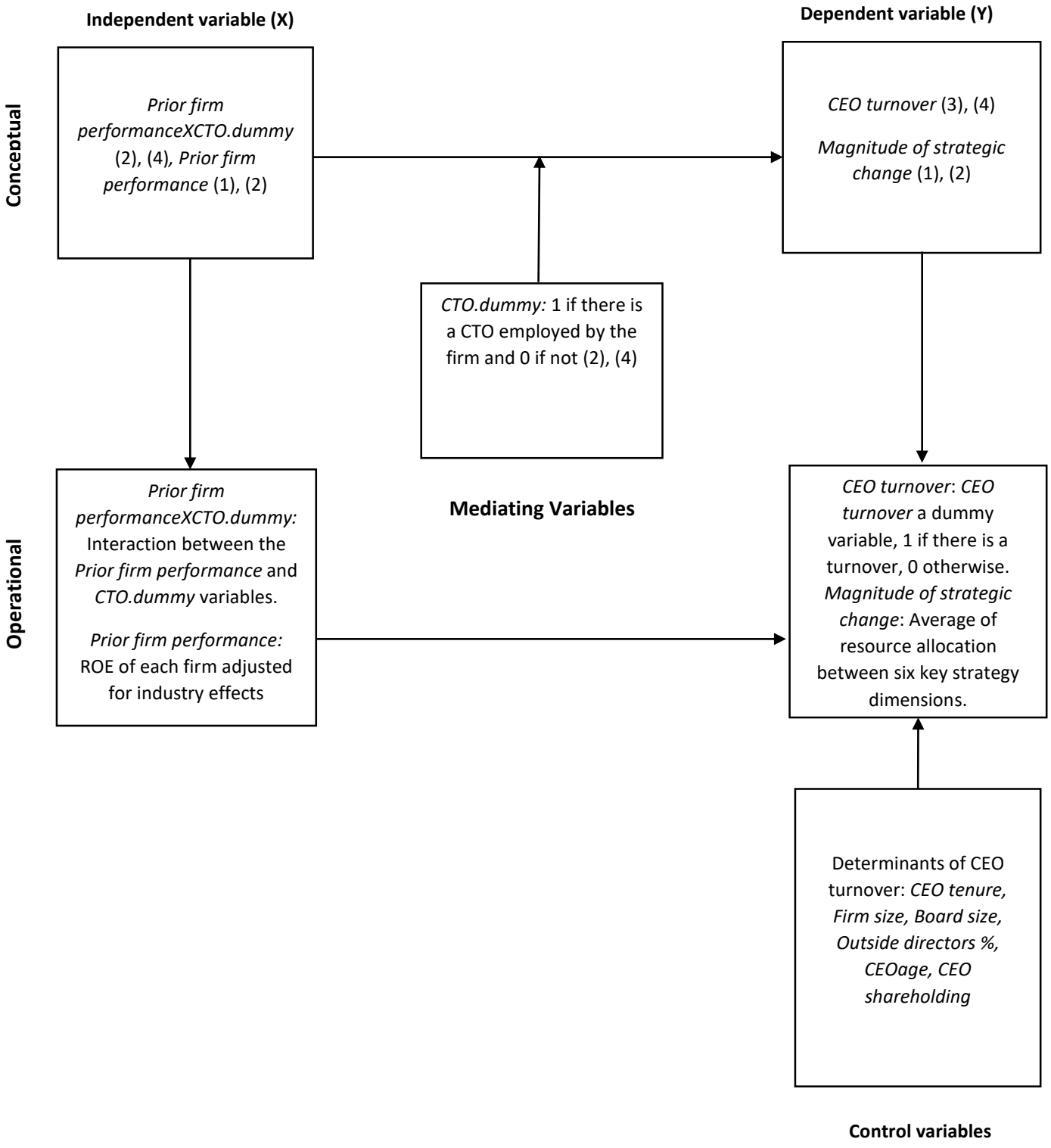

Table 5. Variable Definition

Dependent var.	**Definition**
CEO turnover	dummy, 1 if there is a turnover, 0 otherwise
Magnitude of strategic change	The average value of these six standardized dimensions, (1) advertising intensity (advertising/sales), (2) research and development intensity (R&D/sales), (3) Property, Plant and Equipment newness (net PP&E/gross PP&E), (4) nonproduction overhead (selling general and administrative (SGA) expenses/sales), (5) inventory levels (inventories/sales), (6) financial leverage (debt/equity)
Independent var.	**Definition**
CTO.dummy	a dummy variable, 1 if there is an executive holding the title, 0 otherwise
Prior firm performance	a proxy for firm performance which is operationalized as return on equity (ROE) adjusted for industry effects
Control var.	**Definition**
CEO tenure	measurement of the years that the CEO has been at that position
Firm size	the logarithm of firm's revenues per year
Board size	measurement of the total number of directors on the board
Outside directors %	measurement of the percentage of outside directors that the board is consisted of
CEOage	CEO's age at the time of succession. Dummy variable, 1 if the CEO at the of succession was 55 and above and 0 if he was below
CEO shareholding	percentage of CEO shareholding to total shares outstanding. A proxy to CEO power