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CEO Characteristics and Investment Efficiency in Swedish Firms

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Abstract: This study investigates the relationship between CEO characteristics and investment efficiency. Using a large panel dataset of listed Swedish firms between 2015 and 2024, we examine whether observable CEO traits (age, tenure and gender) are associated with a firm's ability to invest at optimal levels. The analysis employs a two-stage regression framework. In the first stage, we estimate an investment model to determine firms' expected investment levels based on relevant firm characteristics. The residuals from this model capture deviations from expected investment and are used as a proxy for investment efficiency. In the second stage, these residuals are used as the dependent variable in regressions examining their relationship with CEO characteristics. For CEO age, no consistent tendency towards over- or underinvestment is found. However, younger and older CEOs exhibit greater deviations from optimal efficiency levels than their middle-aged counterparts. For CEO tenure, we find an inverted U-shaped relationship with underinvestment, suggesting that CEOs in early and late stages are more prone to underinvesting. Finally, no consistent relationship is found between CEO gender and investment efficiency.

Keywords: CEO Characteristics, Age, Tenure, Gender, Agency Costs

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1 Introduction

1.1 Background and Research Question

Corporate governance is an area of great importance in the capitalist economic system. It is also an area that for a long time has gotten significant attention within the economic literature. With the topic being problematized as early as 1776 when Adam Smith in his famous *The Wealth of Nations* wrote about the issues surrounding managers being hired to manage other people's money or companies, and later being classified as the problem of decoupling of ownership and control by Berle and Means in 1932, it is clear that the topic has kept economists involved for a long time (Jensen & Meckling, 1976). While the main issue has always remained the same, more recent efforts have gone more into depth in different areas of corporate governance. Jensen and Meckling (1976) develop the framework commonly used to classify what can be said to be the core problem of corporate governance, namely the principal-agent problem. Furthermore, Fama (1980) and Fama and Jensen (1983) continue developing the research revolving around the principal-agent problem. The key issue is, and has always been, the lack of insight, knowledge, and control for the owner in relation to the actions of the management. Most aspects of how companies are designed and run today can be traced back to the issue that comes with the separation of ownership and control. Corporate structures, incentive contracts, and limitations of management's decision-making power are all examples of attempts to practically limit the negative effects of the principal-agent problem. While the application to some extent differs between countries, it is clear that this is an issue that concerns all economies (Shleifer & Vishny, 1997).

It is a complex but also well-researched topic. Yet, it appears to be difficult for investors to create effective incentive contracts for management. The typical approach would be to tie executive compensation to some measure of annual accounting performance. Research points towards this creating costs for the investors in the form of an increased short-term focus, leading to managers focusing on short-term profits, or smoothing earnings (Dechow & Sloan, 1991). To create more effective measures of control, investors need information about the drivers of management behaviour. To keep costs down, this would ideally be data that provides valuable insights and is easily attainable. CEO characteristics are one such type of information that is easy for the investor to get hold of, and if it can be used to predict CEO behaviour it can also prove valuable when designing incentive contracts.

Hambrick and Mason (1984) establish the usefulness of management characteristics when predicting organizational outcomes through their Upper Echelons perspective. They provide a theoretical foundation as the basis of their proposition that management characteristics can be used to predict the outcomes of the organization. Later studies have confirmed the relevance of using management characteristics as a predictor of financial outcomes also when basing it on real-world data (notably Bertrand & Schoar (2003), followed by a stream of studies looking at more specific enquiries). While efforts in the field have been fruitful, the aspects of a business that are directly influenced by management are many, and so are also the number of manager characteristics one can easily identify. With a nearly infinite number of possible combinations of manager characteristics and organizational outcomes to look for relations between, efforts need to be directed in the right direction.

The possibility of using management characteristics to predict the strategic choices taken within the organization can prove especially useful in mitigating the issues arising from the principal-agent problem in corporate governance. By utilizing the predictive power of manager characteristics more accurate incentive contracts can be created, at a low additional cost. In this study we choose to focus on investment efficiency. Corporate investment is particularly sensitive to incentive discrepancies between the owner and the manager. As investments encompass present-day sacrifices in return for long-term gains, a manager that is motivated by too short-sighted incentives would be prone to underinvesting, and vice versa. If any relationships between management characteristics and investment efficiency can be found, they can be utilized to create more incentive-compatible contracts and better mandates. Thus we arrive at the following research question:

Are CEO characteristics related to investment efficiency in Swedish firms?

We answer the research question by investigating the explanatory power of CEO age, CEO tenure, and CEO gender on a firm's investment efficiency. Our study is conducted by performing OLS regressions based on panel data encompassing listed Swedish firms. We begin with evaluating the investment efficiency of each firm year by following the well established model for determining ideal investment levels developed by Richardson (2006). The model utilizes both accounting and market data in determining optimal investment levels, making it a reliable estimate of a firm's investment efficiency. When each firm year has received a measure of investment efficiency, we regress those measures against our independent variables CEO age,

CEO tenure, and CEO gender.

1.2 Scope and Delimitations

As previously mentioned, there exists a large number of available CEO characteristics which could possibly be used to look for relationships with investment efficiency. Given the scope of our study, and to ensure that all relationships can be investigated thoroughly enough, a selection needs to be made. We apply three main criteria in the selection of which CEO characteristics to base our study on. First, there needs to be a large amount of relevant data available for each characteristic used. Second, given that the general ambition of the study is to provide predictive knowledge based on as easily attainable information as possible in order to reduce agency costs, the characteristics chosen need to be easy to attain for anyone. Third, the characteristics cannot be ambiguous in their nature. One example of a CEO characteristic commonly used in previous studies which does not satisfy these criteria is CEO education, often in the form of a dummy variable for if the CEO has reached a certain level of education or not. This characteristic violates our third criterion as there can be expected to be a large variance in, for example, which school the CEO graduated from, in what subject, with what grades, et cetera, thus creating ambiguity.

We apply these three criteria to a number of possible CEO characteristics in order to arrive at a selection. Most fail at the first criterion, but also the second and third are cause for exclusion in some cases. Our final selection of CEO age, tenure, and gender satisfy all three criteria. We believe this to be a suitable selection that has the potential to help us fulfill the purpose of the study.

In addition to the choice of CEO characteristics, the study is delimited in two main ways. Firstly, the time period of choice is 2015-2024. This selection allows us to use recent data, while still being able to retrieve a satisfyingly large dataset. We choose the cutoff-point to be 2015 as the availability of data on CEO characteristics deteriorates quite substantially in years earlier than 2015. Secondly, we restrict the scope of the study to only apply to Swedish listed companies. Prior research on the relationship between CEO characteristics and firm investment in Swedish listed companies is scarce. The influence and behavioural profile of the CEOs, as well as the effectiveness of corporate governance mechanisms, is likely to differ between countries due to cultural and institutional differences (Shleifer & Vishny, 1997). By confining the study to the Swedish setting we ensure the practical relevance of our findings while also bridging an existing

research gap. Private companies are excluded since market data is required for some inputs.

1.3 Results and Contribution

We find a significant curvilinear relationship between CEO age and absolute investment efficiency, implying that younger and older CEOs are more prone to deviating from the firm's optimal investment levels. Additionally, we find a significant curvilinear relationship between CEO tenure and underinvestment, indicating that CEOs at the early and late stages of their tenures are more prone to underinvesting. We do not find any consistently significant relationship between CEO gender and investment efficiency.

Our study makes two contributions to the existing literature. First, it provides insights into a research area with an absence of previous literature, namely the relationships between CEO characteristics and investment efficiency in Swedish listed firms. Second, literature relating CEO characteristics to corporate investment typically either investigates linkages with levels of investment expenditure without evaluating efficiency, or makes inferences about investment efficiency by using industry median levels or similar methods of peer evaluation. By relating CEO characteristics to an established method for determining investment efficiency based on a company's inherent growth opportunities, we increase the practical relevance of our findings.

2 Theoretical Framework and Previous Research

2.1 Literature Review

2.1.1 Effect of the Individual CEO

There exists a significant amount of already conducted research that investigates both the impact of the individual CEO and the effect different CEO characteristics might have. Hambrick and Mason (1984) argue, through their upper echelons perspective, that the top management of a firm has a significant effect on the firm's strategic choices and ultimately its financial results. They also highlight the explanatory power observable managerial characteristics can have. It is shown in a study by Bertrand and Schoar (2003) that the individual manager does have a significant effect on a number of corporate decision areas, including investments in CAPEX, risk management, firm performance, as well as a number of additional financial decisions. They also discuss the effect of certain CEO characteristics where the most relevant finding for our purposes

is that of a negative correlation between CEO age and investment expenditure. These results are in line with other literature also investigating manager fixed effects which all document significant influence by the individual manager (Malmendier et al., 2011; Weisbach, 1995). Additionally, Graham et al. (2013) find that CEO traits are significantly related to a firm's financial policies.

Based on the above, it is possible to conclude that the individual CEO does have a significant influence on how the firm is being run, and how investment decisions are being made. This being the case is a prerequisite for the continued exploration of how that effect might play out, and what the drivers of it are. We will now survey literature discussing those topics.

2.1.2 CEO Age

In general, the literature surveyed suggests that older CEOs normally try to lower the risk profile of the firm, while younger CEOs unintentionally or intentionally end up doing the opposite. Serfling (2014) finds a negative relationship between CEO age and firm risk levels, which are measured through stock return volatility. Older CEOs reduce firm risk by, for example, investing less in R&D, maintaining lower operating leverage, and making more diversifying acquisitions. It is also found by Li et al. (2017) that younger CEOs are more active in their investment practices, and that they use a wider selection of investment techniques, often riskier than their older counterparts. Barker and Mueller (2002) show that CEO characteristics, including CEO age, can be used as a predictor of R&D spending, where CEO age is found to have a negative relationship with R&D spending. McClelland and O'Brien (2011) provide a possible explanation for this. CEO stock ownership in the firm tends to increase with age. Combined with a shorter career horizon as their age increases, older CEOs therefore tend to adopt a more risk-minimizing behaviour than their young counterparts. When a significant proportion of the CEO's future wealth is tied up to the individual firm, it is perfectly logical for them to try to lower the risk of that exposure as the time-horizon shortens. Ladika and Sautner (2020) find that management tends to decrease investment levels when their incentives become more short-term. Managers driven by short-term targets tend to adopt myopic behaviours where one common action is to cut down on investment. This is to be expected as investment has few positive effects on short-term profits, thus making it an attractive area to save costs in when trying to improve a firm's financials short-term. These findings are in line with previous results from Graham et al. (2005), who, in a qualitative study, found that 78% of surveyed CFOs would be willing to sacrifice long-term

profitability in order to smooth or boost earnings at present day.

Slightly contradictory results are provided by Cheng et al. (2024) who relate CEO career horizons to CEO age by showing that an inverted U-shaped relationship is present between CEO age and R&D spending in U.S. software firms. Earlier literature has been centered around how older CEOs' career horizons can create myopic behaviour. These findings show that also young CEOs can exhibit myopic behaviour as a consequence of their career horizons.

2.1.3 CEO Tenure

Research on relations between CEO tenure and firm outcomes is mostly centered around financial performance, and different approaches to explaining management behaviour. Hambrick and Fukutomi (1991) argue that a CEO's tenure will follow a seasonal path where the CEO undergoes intensive learning in the first parts of their tenure, and then becomes increasingly conservative, less receptive to new information, and more prone to choosing the most comfortable alternative. Similar arguments are presented by Prendergast and Stole (1996). They argue that at the beginning of the tenure, the CEO will be prone to acting aggressively on new information and taking drastic actions. As the manager's tenure increases, he or she will be more bound up by previous decisions and thus become more conservative in their decisions, including investments. Additionally, evidence for CEO conservatism increasing with tenure is presented by Musteen et al. (2006). In an attempt to quantify the effects, Weis (2025) shows that CEOs begin their tenure with a focus on short-term gains in an effort to quickly solidify their position. They later adopt a long-term perspective once they have established themselves, but towards the end of their tenure they once again revert to a short-term mindset.

Real-world evidence strengthens the notion of CEOs acting with a short-term horizon in the beginning and end of their tenures. Ali and Zhang (2015) find that early-tenure CEOs are more prone to managing earnings, and find partial evidence that late-tenure also manage earnings. They also find that CEOs tend to reduce R&D investment in the early years of their tenure. Pan et al. (2016) show that in the beginning of their tenure, CEOs disinvest heavily, and that investment increases as the tenure increases. Both insights point to CEOs being more short-sighted in the beginning of their tenure. Lastly, it is found by Dechow and Sloan (1991) that managers in the end of their tenures tend to cut down on R&D expenditure in an attempt to improve earnings.

Our review of the empirical literature on CEO tenure suggests a coexistence of a linear relationship between CEO tenure and increased conservatism and a decreased proneness to risk, and an inverse U-shaped relationship between tenure and time horizon. A possible inference from this coexistence is that excessive manager conservatism increases towards the end of a tenure, and the relatively higher eagerness to make a change in the beginning of the tenure can both create incentives for acting in a more short-term oriented manner. While literature on the link between tenure and investment efficiency is lacking, the coherent results on management conservatism and time horizon in relation to tenure provide insights into what could be expected when investigating links to investment efficiency.

2.1.4 CEO Gender

Contrary to CEO age and tenure, CEO gender is a characteristic that has received some, but not very extensive, attention within the economic research literature. While studies investigating the specific link between CEO gender and investment are lacking, a substantial amount of literature discussing more general aspects of decision making related to gender is available. A comprehensive review of literature examining experiments on gender differences in decision making is provided by Croson and Gneezy (2009). The finding most relevant for our study is that their literature review shows that men in general are more risk-prone than women. This has been shown in a number of different objective probability lottery experiments. Further, it is found that women take less risk in their personal finance decisions, for example in choosing pension risk allocation and ownership of common stock.

It appears from research conducted on real-world data that results on female CEO and executive risk taking are mixed. Palvia et al. (2015) find that US commercial banks with female CEOs and board chairs took on lower levels of risk in their capital levels during the latest financial crisis. Contrary to this, Adams and Funk (2012) find that female board directors are in fact more prone to risk than male directors. Berger et al. (2014) show that firms with boards composed of more women take slightly higher risk, based on a sample of German banks. As these findings come from studies mostly looking at the board of directors these findings are not fully transferable to our purposes. However, the mixed results and, most importantly, the lack of relevant research, strengthen the relevance of this part of our study.

One alternative perspective, explaining why female executives might take more risk, can be provided by the findings previously discussed from Prendergast and Stole (1996). The argument that younger CEOs tend to act more aggressively upon new information, and invest more on average as they feel the need to prove themselves could be theorized to apply to female CEOs as well. In our sample, the proportion of female CEO firm years only proportion to 8.96 percent. It is also established that female professionals risk facing additional barriers during their careers (Oakley, 2000). This could result in a scenario where the situation of the female CEO becomes similar to that of the young CEO, thus creating the perceived need to prove themselves by making more aggressive investment choices. The reasoning is speculative, but if it is found that female CEOs invest more or take more investment risk, this could be one possible explanation for that.

2.2 Theoretical Framework

2.2.1 Principal Agent Theory

A principal-agent relationship takes place when one party (the principal) contracts another party (the agent) to, given a predetermined framework, act on the behalf of the principal. This type of relationship can take place in almost any setting, but a very common one is in shareholder-management relationships. In many firms, the shareholders are not able to care for the operations of the firm themselves. This results in them hiring someone else to do it for them, in most cases the board which in turn hires the CEO. The shareholders thus end up being the principals, and the CEO/management becomes the agent (Shleifer & Vishny 1997).

Jensen and Meckling (1976) develop a framework for seeing how the principal-agent relationship leads to the occurrence of agency costs, and what determines the nature of those costs. The agency costs incurred are composed of three parts: the monitoring costs for the principal, the bonding costs for the agent, and a residual. The monitoring costs come from the effort required to monitor the actions of the agent, as well as the effort to control the actions of the agent through contracts, rules, etc. The bonding costs are incurred by the agent and involve costs taken on by the agent in an attempt to convince the principal that the agent will act in a certain way. The residual is the loss of wealth for the principal that comes from the agent taking actions that to some extent diverge from what would have been the optimal course of action with regard to the principal's wealth (Jensen & Meckling, 1976).

A mitigating factor often highlighted with regard to manager performance is the career concerns of the individual manager. Even if the owner does not possess enough information to effectively control the manager's action or design effective incentive contracts, the manager can still be motivated to perform at a high level as the results the manager gets in the company will be an important part of the manager's future attractiveness on the market. Through this, a certain degree of self-motivation will be achieved, but total efficiency is not likely to be accomplished. The effect of any career concerns would likely also decrease with age (Gibbons & Murphy, 1992; Holmström, 1999).

2.2.2 Information Asymmetry

One area of high relevance when discussing principal-agent issues is that of information asymmetries. An information asymmetry occurs when one party in a transaction has access to more (relevant) information than the other party. This can risk creating inefficiencies as the parties might value the transaction differently based on the information they possess, leading to market inefficiencies. The most well-known exemplification of this problem is presented by Akerlof (1970) with his description of how the existence of "lemons" (cars of low quality) in the car market leads to market inefficiencies. In short, the prediction is that if a buyer of a car cannot know for certain the quality of a car, he or she will only be prepared to pay a price that reflects the risk of getting a car of poor quality. However, as the seller knows the quality of the car, no seller of a high-quality car would be willing to accept a lower price than the fair value for said car. This discrepancy leads to an inefficiency where the extreme outcome is that there are only low-quality cars being traded on the market, traded at the fair value for a low-quality car. In the real world, a number of measures are taken to counteract the effects of information asymmetry, such as signaling or licensing.

The hypothetical situation can be extended to also describe the principal-agent relationship between a firm and the employee, or the owner and the manager. In a situation where the owner does not have any (or sufficient) information about the company, how much effort the manager is putting into the work, or the results of the manager's actions, the rational owner will only be willing to pay the fair value for a low-quality manager. Assuming the market for managers follows the reasoning outlined above for cars, this would result in no manager being willing to perform at a high level, as they will only be compensated based on a low-quality performance. Similarly to the example with the car market, this results in a market with only low-performing

managers. The negative implications of this are obvious, highlighting the need for measures that prevent this outcome. Different mechanisms, such as signaling, incentives, and qualifications in the appointment process help mitigate the issue, but it is also clear that owners having access to information that can help lessen the information asymmetry is an important component (Mishra et al., 1998).

2.2.3 Approaches to Defining Ideal Investment

In order to investigate our research question, we need a way to confidently determine if a firm is over- or underinvesting. In the academic literature there are a number of different approaches taken when measuring investment efficiency. Some (e.g. Eisdorfer et al., 2013) use the straightforward method of using industry median or average investment (typically scaled by for example total assets) to determine if a firm is over- or underinvesting. The benefits of using this method include that it is easy to calculate and requires fewer input variables. However, the application will always be subject to a conflict between the sample sizes within the industries, and the granularity of the classification of industries. Many (few) industries mean more (less) similarity between companies classified as being within the same industry, but it does also mean smaller (larger) sample sizes. Unless the total sample size is very large, we believe that it will be difficult to solve both these issues simultaneously in a satisfactory way.

Others (e.g. McNichols & Stubben, 2008; Richardson, 2006) use formulas or models aimed at capturing a firm's investment opportunities and through that calculating ideal levels of investment on a firm level. Following Myers (1977), the value of a firm can be decomposed into $V = V_A + V_G$ where V is the value of the firm, V_A is the value of assets currently in place, and V_G is the present value of future investment opportunities, representing the growth opportunities of the firm. However, in reality V_G is unrealized in the sense that the firm might choose not to do the investment. This means that V_G can be seen as the value of the option to later invest into these opportunities (Myers, 1977). By determining the value of the firm's growth opportunities, it is possible to determine the ideal investment levels of the firm. By calculating needed investment into maintaining V_A, and finding a proxy for estimating investments into growth opportunities V_G, an ideal investment level can be calculated. The proxy is typically constructed by dividing the market value of the firm by some measure of the value of V_A, basing it on the assumption that the market will be able to efficiently include the growth opportunities when assigning a value to the firm. The most commonly used method for doing this is to use Tobin's Q (market

value of assets over the replacement cost of assets)(Richardson, 2006). However, the Tobin's Q formula implies that the value of assets currently in place is equal to the replacement cost of assets. This simplifying assumption does not take future earnings arising from the assets currently in place into consideration. For example, if a company owns a production facility that has been generating steady cash flows for the past 10 years, one can surely expect that same facility to keep generating at least some level of cash flow for some time forward. As the Tobin's Q formula does only value this asset at replacement cost, the future cash flows arising from the asset are not fully reflected in the value of that asset. This means that there is a possibility that too large of a proportion of the value of the future cash flows that the market expects is classified as arising from investments into growth opportunities (investment opportunities) instead of arising from assets currently in place, leading to an overestimation of the firm's growth opportunities. Richardson (2006) argues that formulas such as book-to-market of equity and Tobin's Q require that earnings are fully transitory to confidently capture growth opportunities. The only scenario where it can capture growth opportunities in a satisfactory way is if the current cash flows arising from assets currently in place have no predictive power at all about if those same assets will produce cash flows in the following year as well. We believe that to be an unrealistic assumption, and this is the main reason for us not using Tobin's Q, and instead choosing Richardson's (2006) method for measuring investment, where the value of assets in place is derived using Ohlson's (1995) residual valuation framework. We discuss the application of this in section 3.2.

Another topic worth mentioning in this section is that of the inclusion of R&D as a part of investment expenditure. Most of the surveyed literature that deals with investment levels or investment efficiency chooses to include research and development expenses as part of investment expenditure or as a measure of risk-taking. R&D is often used as a part of the evaluation of the effect CEO age or other characteristics have on investment policies (e.g. Serfling, 2014; Murphy, 1992; Bertrand & Schoar, 2003). It is sometimes also incorporated in measures of investment expenditure that are used to evaluate investment efficiency (e.g. Biddle et al., 2009; Richardson, 2006). The inclusion of R&D expenditure as a part of investment could to some appear unexpected as, while it can be capitalized under certain conditions, it is typically not treated as an investment expenditure in the financial statements, but rather expensed fully in the same year as a part of operating expenses. However, for the purposes of understanding the allocation of a firm's funds, it can for good reasons be considered part of corporate investment. The key trait of investment is that it involves sacrificing present-day funds in return for some

future expected return. The reason that R&D is not treated in the same way in the accounting standards is that those future returns generally are too uncertain, and that the correlation between spending and returns can be ambiguous. However, R&D does certainly encompass sacrifices made today for rewards at a future date. Since it also is something that is controlled by the firm's management, it is logical to include it when looking at corporate investment in a research setting.

2.3 Hypotheses

Our first hypothesis investigates the explanatory power of CEO age on investment efficiency. We hypothesise that this will show as a positive correlation between CEO age and underinvestment. As evident from the literature review (e.g. Serfling, 2014; Barker & Mueller, 2002; Bertrand & Schoar, 2003), it is already established that a negative correlation appears to exist between CEO age and expenditure on a number of items related to corporate investment. However, this doesn't necessarily mean that the same will apply for investment efficiency as it is evaluated differently than total expenditure. But, in the absence of clearly indicative research on age and investment efficiency specifically, we find it reasonable to hypothesise that the direction, if any is found, of the correlation will be the same as when only looking at spending.

H1: CEO age is negatively correlated with overinvestment.

Our second hypothesis investigates the effect of CEO tenure on investment efficiency. As evident from our literature review, empirical evidence on any relationships between CEO tenure and investment efficiency is scarce. It is, however, found that investment expenditure is lower in the beginning of the tenure (Pan et al., 2016), and lower in the end (Dechow & Sloan, 1991). In our hypothesis we combine this insight with the extensive research existing on how CEO behaviour and incentives related to time horizon change during the course of the CEO lifecycle. The main conclusion based on our literature review is that CEOs tend to become more conservative, more risk-minimizing, and less emotionally invested in the business as the tenure increases (e.g. Hambrick & Fukutomi, 1991; Prendergast & Stole, 1996), and that they tend to act short-sightedly at the beginning and end of their tenures (Weis, 2025). We hypothesise that the lower investment levels previously identified at the beginning of the tenure, combined with the conservatism and short-sightedness occurring at the end of it, will make the CEO more prone to underinvesting in the beginning and the end of their tenure. This leads us to our second

hypothesis:

H2: CEO tenure exhibits an inverted U-shaped relationship with investment efficiency, where CEOs in the early and late stages of their tenures are more prone to underinvesting.

For our third hypothesis, we investigate the effect of CEO gender on investment efficiency. As evident from our literature review, the predictive power of the existing research on how CEO gender might influence investment efficiency is not high. There exists evidence suggesting both that female CEOs would reduce firm risk (Palvia et al., 2015), and that they would increase it (Adams & Funk, 2012). There is however abundant research on differences between men and women when it comes to risk preferences in experimental settings, with a consistent indication being that women typically are less risk-prone than men (Croson & Gneezy 2009). While the straightforward inference would be that a lower risk tolerance indicates a lower willingness to invest, that is an assumption which is not fully applicable to corporate investment. Cutting investments can in some instances decrease short-term risk, but on the other hand increase long-term risk.

We do not believe the available literature foundation is sufficiently developed to make a directional prediction on how CEO gender might affect investment efficiency. However, we do believe it to be established that female and male risk preferences differ, and that investment decisions can be at least perceived as decisions carrying some degree of risk. Building on these arguments, we choose to design our third hypothesis with an exploratory objective, with the foundational assumption being that the observed differences in decision-making between the genders will appear also in corporate investment decisions.

H3: CEO gender can be related to differences in investment efficiency.

3 Method

3.1 Research Design

We test our hypotheses using a research design consisting of two separate steps. First, we define firm investment efficiency by calculating residuals for over- or underinvestment for each firm year. The method and theoretical underpinnings for this part are discussed in section 3.2. Second, we use the residuals generated in step one as our dependent variable when testing for re-

lationships between the selected CEO characteristics and investment efficiency. This is further discussed in section 3.3.

3.2 Framework for Determining Investment Efficiency

3.2.1 Initial Assumptions

In order to capture over- or underinvestment, we follow the model developed by Richardson (2006) for determining the ideal level of investment. Firstly, total (actual) investment can be defined as I_{TOTAL} = *CAPEX* + *Acquisitions* + R&D - *SalePPE*. To improve data availability, we do not use the cash flow statement measure of capital expenditure, but instead construct it using balance sheet data. This is done through the following formula: *CAPEX* = PPE_t - PPE_{t-1} + *Depreciation*. As the construct encapsulates *SalePPE* as well, *SalePPE* is not included as a standalone component in Equation 1. For *Acquisitions* we use cash flow data, where *Acquisitions* is defined as the gross outflow spent on acquisitions less the share attributable to acquired PPE, which is estimated from a random sample. Contrary to common accounting practice, which classifies R&D as an expense, it is here treated as an investment as it encompasses present-day sacrifices in return for long-term returns, making it similar to investments in how it might be treated by management. Richardson (2006) further establishes that total investment can be decomposed to the sum of the variables $I_{MAINTENANCE}$ and I_{NEW}, of which the former captures investment needed to maintain the current asset base, and the latter the remaining funds put towards investment into new projects.

$$I_{TOTAL,t} = CAPEX_t + Acquisitions_t + R\&D_t \tag{1}$$

$$I_{TOTAL,t} = I_{MAINTENANCE,t} + I_{NEW,t} \tag{2}$$

Combining these two different definitions of total investment yields us a formula for I_{NEW}, which depends on CAPEX, acquisitions, R&D, and depreciation and amortization for any time t.

$$I_{NEW,t} = CAPEX_t + Acquisitions_t + R\&D_t - I_{MAINTENANCE,t} \tag{3}$$

$I_{MAINTENANCE}$ is estimated using the firm's expenditure on depreciation and amortization. While this is a reasonable proxy for what is needed in terms of investments into maintaining the current asset base, it is not perfect. If the depreciation schedule of an asset does not align with its lifetime the proxy can become inaccurate. To account for this, prior year investment is included in Equation 5 as a control variable (Richardson, 2006).

3.2.2 Decomposing New Investment

I_{NEW} can further be described as the sum of two parts: (1) one for expected investment into NPV-positive opportunities denoted by I^{*}_{NEW} and (2) a second for unexpected investment denoted by I^{ε}_{NEW}. The latter component can be thought of as a residual either capturing under- or overinvestment (a positive value implies overinvestment while a negative implies underinvestment).

$$I_{NEW} = I^{*}_{NEW} + I^{\varepsilon}_{NEW} \tag{4}$$

In order to determine unexpected investment, a regression is run for I_{NEW}, with the explanatory variable of choice being V_{AIP} (value of assets in place) divided by the market value of the firm, along with controls and fixed effects.

$$\begin{aligned} I_{NEW,t} &= \alpha + \beta_1 V_{AIP}/P_{t-1} + \beta_2 Leverage_{t-1} + \beta_3 Cash_{t-1} \\ &+ \beta_4 Age_{t-1} + \beta_5 Size_{t-1} + \beta_6 StockReturn_{t-1} + \beta_7 I_{NEW,t-1} \\ &+ \sum YearIndicator + \sum IndustryIndicator \end{aligned} \tag{5}$$

Conceptually, I^{ε}_{NEW} is the statistical error term in Equation 5. Practically this means that the regression will first have to be run to get the intercept and coefficient values, to then be applied to each firm year in order to obtain a value for either over- or underinvestment (the deviation from the fitted line, or error term). As the expected investment is based on our sample, it implies that the mean residual for inefficient investment will be zero, which is correct only under the assumption that the sample will invest efficiently on average (Richardson, 2006).

3.2.3 Value of Assets in Place

V_{AIP} is derived from the residual valuation model developed by Ohlson (1995) and its associated assumptions: (1) market value is equal to discounted expected dividends, (2) clean surplus relation applies: book values solely depend on earnings and dividends, (3) abnormal earnings follow an autoregressive process dependent on an earnings persistence parameter. Firm value absent growth opportunities is thus defined as:

$$V_{AIP} = (1 - \alpha r)BV + \alpha(1 + r)X - \alpha r d \tag{6}$$

Where *r* is the discount rate, BV is book value of equity, X is operating earnings (EBIT), *d* is dividends, and $\alpha = \omega/(1+r-\omega)$. ω in turn is earnings persistence, a correlation measure between the earnings from year to year for firms.

In Equation 5, V_{AIP} is divided by the market value of the firm. This is done in order to capture the growth opportunities of the firm. To estimate a reliable measure of ideal investment, both I_{NEW} and $I_{MAINTENANCE}$ need to be estimated. As previously stated, $I_{MAINTENANCE}$ is proxied by depreciation and amortization. As the optimal level of $I_{MAINTENANCE}$ is relatively fixed, a firm's investment efficiency will to a large extent depend on its ability to allocate the appropriate amount of funds into investments in new investment opportunities. The optimally investing firm will invest in all NPV-positive projects available to it. If the firm does not invest in all NPV-positive projects, it is underinvesting. On the other hand, if it invests more funds than its available NPV-positive projects can absorb, it overinvests as funds end up being suboptimally allocated. Evident from this is that estimating I_{NEW} relies on being able to estimate the size of the NPV-positive investment opportunities the firm has. It follows from our discussion in the theoretical framework (section 2.2.3) where we relate the value of the firm's growth opportunities V_G to the value of its investment opportunities following Myers (1977) and Richardson (2006) that the appropriate way to estimate the growth opportunities of the firm is to divide the measure of value of assets in place with the market value of the firm. The market valuation of the firm is likely to be the best estimate of the combined value of the value of assets currently in place and the growth opportunities. As we estimate the value of assets currently in place separately through V_{AIP} the division with the market value of the firm allows us to gauge the size of the growth opportunities, and through that the size of the NPV-positive investment opportunities (Richardson, 2006).

Practically, this means that a firm where a large proportion of the firm's value consists of growth opportunities will receive a lower value when dividing it with the market value. The coefficient β_1 for V_{AIP}/P_{t-1} in Equation 5 can therefore be expected to have a negative sign when testing the model.

3.2.4 Further Theoretical Adjustments

We choose to deviate slightly from Richardson (2006) in two areas. Richardson uses fixed inputs for the firm-level cost of capital *r*, and a measure of earnings persistence ω that is not based on his sample, in the calculation of V_{AIP}. Richardson addresses this and claims that this simplification does not significantly impact results. However, we believe using firm-specific measures for the cost of capital and a sample-specific rate of earnings persistence would yield more precise results that better reflect reality. Additionally, we would not be able to use Richardson's inputs

for any of these as they are based on US data. For the calculation of firm-level cost of capital, we use the Capital Asset Pricing Model. Where $r = r_f + \beta * (r_{mrp})$, and r is the cost of capital, r_f is the risk-free rate, β is the firm market beta, and r_{mrp} is the market risk premium (Sharpe, 1964; Lintner, 1965). To be able to calculate firm-specific r, we need to estimate firm-specific β. To do this, we use monthly stock return data from the period 2010-2014 (60 months). For firms that have between 24 and 60 observations in this period, we regress those observations against the monthly returns of the OMXSPI index during the same time period to arrive at firm-specific betas. A number of firms do not have enough observations during the time period to be able to calculate betas, for example due to not being publicly listed, or even founded, at that time. For those firms, we calculate and apply industry average betas based on our sample, using FF48 industry groupings (Fama & French, 1997). For the very limited number of firms where we cannot apply an industry average beta, we use the sample average. For the risk-free rate r_f, we use the average of the Swedish Riksbank's 10-year interest rate during the period 2010-2014, 2.19%. We get the market risk premium r_{mrp} from PWC (2024) and use the average Swedish Market Risk Premium for the period 2010-2014, giving an r_{mrp} of 5.3%. To calculate a sample-specific measure of earnings persistence ω, we regress earnings on prior-year earnings on the firms in our sample which have data available for the period 2010-2014, following Dechow et al. (1999). For the purpose of estimating earnings persistence, we use the following model:

$$x^a_{i,t+1} = \omega_0 + \omega_1 x^a_{i,t} + \varepsilon_{i,t+1} \tag{7}$$

Where $x^a_{i,t}$ is abnormal earnings for year t, ω_1 is the coefficient measuring earnings persistence, and $\varepsilon_{i,t}$ is the error term. Abnormal earning for the year, $x^a_{i,t}$, is defined as:

$$x^a_{i,t} = x_t - rb_{t-1} \tag{8}$$

Where, x_t is net income before extraordinary items, r is the cost of equity, and b is the book value of equity. In line with Dechow et al. (1999), we assume a general cost of equity for the whole market. As Dechow's study is based on US data, we cannot use their assumed value, and instead use an assumed value based on our Swedish setting. We construct an assumed market required return on equity by taking the average 10-year Swedish Riksbank risk-free rate from the period 2010-2014 (2.19%), and adding the average Swedish market risk premium for the same period (5.3%), which we get from PWC (2024). We arrive at a market required return of 7.49%. After running the model, we arrive at a value of ω of 0.72.

3.3 Relating Investment Efficiency to CEO Characteristics

We test the hypotheses using a second OLS-regression based on the residuals for over- or underinvestment created by subtracting the value predicted for I_{NEW} by the fitted line based on Equation 5, from the actual value of I_{NEW} for each firm year. By regressing CEO age, tenure, and gender against said residuals we can test for relationships between those CEO characteristics and firm investment efficiency. The baseline specification is presented in Equation 9, from which we deviate by adding or removing terms to test for alternative relationships. Equation 9 draws on Serfling (2014), both in terms of included control variables and fixed effects, as well as in how the explanatory variables are treated.

$$\begin{aligned} I^{\varepsilon}_{NEW,t} &= \alpha + \beta_1 Age_{CEO,t} + \beta_2 Tenure_{CEO.t} + \beta_3 Gender_{CEO,t} + \beta_4 Size_t \\ &+ \beta_5 MtB_t + \beta_6 Leverage_t + \beta_7 ROA_t + \beta_8 SalesGrowth_t + \beta_9 FirmAge_t \\ &+ \beta_{10} StockReturn_t + \sum YearIndicator + \sum IndustryIndicator \\ &+ \sum FirmIndicator \end{aligned} \tag{9}$$

3.3.1 Dependent Variable

I^{ε}_{NEW} is the measure of investment efficiency, derived using accounting and market data following the method developed by Richardson (2006). A positive value I^{ε}_{NEW} indicates that a firm overinvests, whereas a negative value indicates underinvestment. In section 3.2 we discuss the theoretical foundations for I^{ε}_{NEW} and how it is calculated.

3.3.2 Independent Variables

Age_{CEO} is the age of the Chief Executive Officer of the firm while $Tenure_{CEO}$ is the number of years the CEO has held their position. Our third explanatory variable of interest is $Gender_{CEO}$, which is specified as a dummy variable, taking the value of 1 in cases of female CEOs, and 0 for male CEOs.

3.3.3 Control Variables and Fixed Effects

Following Serfling (2014), several control variables are accounted for: *Size* is the book value of assets. *Market-to-Book (MtB)* is the market value of the firm divided by the book value of assets. *Leverage* is the total debt divided by total assets. *Return on Assets (ROA)* is net income divided by average total assets. *Cash* is the book value of cash divided by total assets. *Sales Growth* is

the percentage increase in sales from the previous firm year. *Firm Age* is the number of years since incorporation. *Stock Return* is the percentage change in the firm's market capitalization from the previous year. Log transformations are used for *Size* and *Firm Age*.

We also employ time fixed effects and industry- or firm fixed effects. The addition of firm fixed effects is common practice when investigating effects of both the individual CEO and any CEO characteristics on firm outcomes. By controlling for firm fixed effects we ensure that any findings are in fact related to the specific characteristic we are looking at, and not an effect of differences between firms, for example matching effects where firms recruit CEOs that suit the firm's existing investment profile (Bertrand & Schoar, 2003; Serfling, 2014).

3.4 Sample Selection

Our sample consists of 505 Swedish firms listed on the Stockholm Stock Exchange (Compustat exchange code 256) at some time during the years 2015-2024. Of these firms, 501 are still active today, and 4 are inactive. This results in a sample size of 3776 listed firm years with on average 7.49 firm years per company. The data is primarily collected from Compustat, S&P Capital IQ (pro), and Business Retriever. For a detailed breakdown of the source of each data item, see Table A1 in the appendix.

3.5 Data Processing

We extract data on all public, Swedish companies available in the Compustat: Global database. This yields us a dataset of 10,469 firm years. We then delete all firm years with firms having SIC codes 9900-9999 and 6000-6999, as the financial statements of companies in these categories typically deviate from the norm in their composition. This removes 2,131 firm years and leaves us at 8,338 firm years. After that, we delete all firm years with Compustat exchange codes 1, 154, 212, 228, 257, 305, 344 as these exchanges (e.g. Aktietorget) contain a large number of small firms, firms with worse data availability or less relevant data, and state owned/non listed firms. This means dropping 1,723 firm years, leaving us with 6,615 firm years. We then remove all non-listed firm years, as well as all firm years missing an ISIN identification code, resulting in 2,036 and 33 deleted observations respectively, and a new total of 4,544 firm years. We delete 754 firm years where we cannot find the CEO characteristics in Business Retriever, the firm year is missing essential data, or if there is a mismatch between the databases used to complement

the dataset (i.e. a firm year being available in our Compustat dataset, but not being available in, for example, the S&P Capital IQ pro database). Finally, we delete 14 firm years where there are duplicates due to the firms changing the month of their fiscal year end. This results in our final sample of 3,776 firm years. However, in some of the regression results that are displayed, the number of firm years included differs from the original sample size. That is because some formulas used require prior year inputs, which means we can only use a subset of our full sample for those regressions.

Table 1: Sample Selection

Sample Selection Procedure	**Sample Attrition**	**Firm-year Observations**
All firm-year observations 2015–2024		**10,469**
Less observations with SIC codes 9900–9999 and 6000–6999	-2,131	8,338
Less observations with non-target exchange codes	-1,723	6,615
Less non-listed firm years and observations missing ISIN	-2,069	4,544
Less observations with missing CEO characteristics, essential data, or database mismatches	-754	3,790
Less duplicate firm years due to fiscal year-end changes	-14	3,776
Final sample		**3,776**

Notes: The table reports the sample selection procedure. The initial sample consists of all public Swedish companies available in the Compustat Global database. Observations are removed sequentially based on the criteria listed above, resulting in a final sample of 3,776 firm-year observations across 505 listed Swedish firms for the period 2015–2024.

4 Results

4.1 Description of Data

Table 2: Summary Statistics

Variable	N	Mean	Std. Dev.	Min	Q1	Median	Q3	Max
Total Investment	3776	0.134	0.163	-0.052	0.037	0.085	0.166	0.950
Investment New	3776	0.082	0.155	-0.110	0.000	0.030	0.103	0.900
Maintenance Investment	3776	0.050	0.045	0.000	0.021	0.040	0.065	0.239
Acquisitions	3776	0.018	0.048	-0.003	0.000	0.000	0.007	0.309
Capex	3776	0.056	0.070	-0.058	0.012	0.037	0.073	0.399
Research and Development	3776	0.056	0.130	0.000	0.000	0.003	0.047	0.816
Investment Residual	3266	0.000	0.119	-0.559	-0.054	-0.015	0.029	0.859
CEO Age	3776	51.5	7.3	24.0	47.0	52.0	57.0	76.0
CEO Tenure	3776	4.6	4.9	0.0	1.0	3.0	6.0	35.0
CEO Gender (1=female)	3776	0.09						
Firm Age	3776	27.4	26.2	1.0	11.0	18.0	32.0	137.0
ROA	3776	-0.117	0.324	-1.463	-0.212	0.014	0.069	0.300
Stock Return	3767	0.246	0.863	-0.814	-0.257	0.042	0.442	4.532
Market-to-Book	3767	2.834	3.842	0.108	0.746	1.478	3.216	23.772
Leverage	3776	0.170	0.171	0.000	0.018	0.135	0.275	0.760
Sales Growth	3593	0.334	1.221	-0.979	-0.021	0.102	0.276	9.641
Cash	3776	0.214	0.228	0.003	0.051	0.120	0.292	0.950
V(AIP)/P	3767	0.288	0.663	-2.592	0.032	0.286	0.571	2.322
Assets (total)	3776	9864.2	29443.0	11.8	113.4	550.1	3757.7	196351.0

Notes: The table reports summary statistics for all variables based on our full sample. All items relating to investment are scaled by average total assets. All variables except *CEO Age*, *CEO Tenure*, and *CEO Gender*, are winsorized at the 1st and 99th percentiles. *Total Investment* is equal to *Capex* + *Acquisitions* + *R&D*. *Investment New* is equal to *Total Investment* - *Maintenance Investment*. *Maintenance Investment* is proxied by Depreciation and Amortization. *Acquisitions* is the gross outflow spent on acquisitions, less the share attributable to acquired PPE. *Capex* is equal to PPE_t - PPE_{t-1} + Depreciation. *R&D* is expenditure on Research and Development. For *R&D* and *Acquisitions* we assume the value to be zero in all instances where the firm has not reported a value. *ROA* is return on assets, measured by net income divided by average total assets. *Stock Return* is the percentage change in the market value of the firm in the prior year. *MtB* is the market value of the firm divided by book value of assets. *Leverage* is total debt divided by total assets. *Sales Growth* is the percentage change in sales from the previous year. *Cash* is cash divided by total assets. V_{AIP}/P is the value of assets in place divided by the market capitalization. $V_{AIP} = (1 - \alpha\, r)BV + \alpha(1 + r)X - \alpha$ rd, where $\alpha = \omega/(1+r-\omega)$, ω is earnings persistence, r is the cost of capital rate, BV is book value of equity, X is EBIT, and d is dividends.

Table 2 reports the summary statistics of our sample. We show the mean and standard deviation for each item, as well as quartile distribution. The items included are all items that are used to calculate investment, as well as all variables used in our regressions, including independent,

dependent, and control variables. The most relevant items worth highlighting in this section are those relating to investments, as well as the CEO characteristics. The average firm in our sample invests 13.4% of its total assets, of which 8.2% is investments into new investment opportunities, and 5% is maintenance investment. The median total investment is 8.5%, indicating a right skew of the data. The average total investment can be derived from an average spending of 1.8% on acquisitions, 5.6% on CAPEX, and 5.6% on R&D.

With regard to our chosen CEO characteristics it can be seen that the average CEO in our sample is 51.5 years old. The oldest CEO is 76 and the youngest is 24 years old. The average tenure is 4.6 years. Looking at the quartile distribution it is clear that the typical CEO does not stay in their position for an extended amount of time, with 75% of the sample having held their position six years or less. Of our sample of firm years, 9% have female CEOs.

To ensure that the data does not contain any issues related to multicollinearity which could distort results we provide a Pearson Correlation Matrix. We also calculate Variance Inflation Factors for all variables used in our two main regression models (Equation 5 and Equation 9).

The Pearson Correlation Matrix is reported in Table A2 in the Appendix. If one or more variables included show signs of strong correlations between them, there might be a risk for multicollinearity impacting results. Cut-offs for when a correlation can be seen as strong varies, but for these purposes a correlation of 0.8< is often seen as problematic (Mason & Perreault, 1991). As shown in Table A2, the correlations within our set of variables range between approximately -0.5 and 0.5, suggesting that no issues with multicollinearity should be present.

The Variance Inflation Factor measures the level of multicollinearity between independent variables in regression models. A number of suggested thresholds have been put forward for when VIF values indicate that multicollinearity is at levels which need to be addressed. Most commonly, VIF values exceeding 10 are considered to be one such threshold, but it has also been suggested that levels as low as four should be reason for caution (O'Brien, 2007). The calculated VIF values for our variables range between 1.05 and 2.42, suggesting that no serious multicollinearity issues are present in our sample. All VIF values are reported in Table A3 in the Appendix.

Taken together, the results presented in the correlation matrix and the calculated VIF values lead us to conclude that our dataset does not have any issues with multicollinearity.

4.2 Hypothesis Testing

In this section we test our three hypotheses. After addressing diagnostic and robustness considerations, we provide results for our investment model, Equation 5. The residuals generated from applying the investment model on our sample are then used as a basis for the remaining parts. We test for linear and quadratic relationships between CEO age and investment efficiency, followed by the same tests for CEO tenure. Finally, we test for any relationship between CEO gender and investment efficiency.

4.2.1 Diagnostic Tests and General Robustness Procedures

Several diagnostic tests are conducted to identify potential issues in the data and model specification across both steps of our two-stage approach. To assess the normality of residuals, we examine quantile-quantile plots, which indicate that residuals are reasonably well-behaved with only minor tail deviations. Skewness-Kurtosis tests formally reject normality, but this is expected at large sample sizes such as ours. The Central Limit Theorem ensures that inference remains valid regardless. Potential multicollinearity is evaluated both using Pearson correlation matrices and VIF scores. As previously discussed in Section 4.1, neither indicate any issues with multicollinearity. To asses linearity we use Ramsey RESET tests on different versions of Equation 9, which all yield p-values under 5%, suggesting that the model likely benefits from adding non-linear combinations of the independent variables. Although the Ramsey RESET tests indicate potential model misspecification, it does not identify which variables may benefit from transformation. Therefore, both linear and quadratic versions of our regressions are reported.

As previously mentioned, year and industry fixed effects are applied to the Investment Model, while year and either industry or firm fixed effects are applied to our CEO characteristics models, following Richardson (2006) and Serfling (2014) respectively. The addition of firm fixed effects in the latter regressions serves as a robustness test to capture within-firm variation. Regressions in both steps are estimated using firm-level clustering for the standard errors to account for within-firm correlation over time. This approach ensures that statistical inference is robust to potential serial correlation and heteroskedasticity. It further accounts for unobserved firm-specific heterogeneity in the panel data structure. Lastly, as there are multiple ways to measure growth opportunities for firms other than V_{AIP}/P (discussed in Section 2.2.3), we rerun all re-

gressions in untabulated analysis using Tobin's Q as an alternative measure. Our results are robust to this test.

4.2.2 Investment Model Used for Hypotheses

Table 3 reports the results received from running the investment model, Equation 5. We run four models. Model (1) only includes V_{AIP}/P_{t-1}, and no controls or fixed effects. We get significant results for the independent variable V_{AIP}/P_{t-1} at the third degree of significance (p<0.01). In Model (2), we include time and industry fixed effects, but no other variables. The R^2 is 11%. In Model (3), we include all control variables. $Leverage_{t-1}$ (p<0.01) and $Cash_{t-1}$ (p<0.01) both show significant explanatory value. As can be expected given the high earnings persistence calculated for our sample (0.72) (see section 3.2.4), $I_{NEW,t-1}$ has a high predictive value for $I_{NEW,t}$ with a coefficient of 0.5854, third degree significance, and a high t-statistic of 11.62. In Model (4), we include all variables as well as time and industry fixed effects. All variables with significant explanatory value in Model (1), (2), and (3) also show significant explanatory value in Model (4), with the addition of $Size_{t-1}$ which is assigned third degree significance in Model (4). Overall, coefficient signs (most importantly the negative sign for V_{AIP}/P_{t-1}) are in line with what can be expected with regard to the theoretical underpinnings of the model and previous research (Richardson, 2006). The model has an adjusted R^2 of 40.03%, meaning that it explains a sizable proportion of the variation in I_{NEW}.

The results from Model (4) are used for the purpose of creating the residuals for over- or under-investment used in the coming sections. In Figure A1, the residuals and their means are plotted against age and tenure. Although the hypothesis testing in the coming sections incorporates control variables and fixed effects, the visual patterns in these figures provide an indication for the relationships found in H1 and H2.

Table 3: Investment Model

Model	(1)	(2)	(3)	(4)
V(AIP)/P_{t-1}	-0.0534***			-0.0220***
	(-4.92)			(-4.92)
$Leverage_{t-1}$			-0.0588***	-0.0675***
			(-3.26)	(-3.74)
$Cash_{t-1}$			0.0821***	0.0473***
			(4.99)	(2.85)
Firm Age_{t-1} (log)			0.0011	0.0008
			(0.36)	(0.25)
$Size_{t-1}$ (log)			0.0013	0.0038***
			(1.01)	(2.78)
Stock $Return_{t-1}$			-0.0039	-0.0032
			(-1.15)	(-0.93)
Investment New_{t-1}			0.5854***	0.5601***
			(11.62)	(11.43)
Time fixed effects	No	Yes	No	Yes
Industry fixed effects	No	Yes	No	Yes
Observations	3266	3266	3266	3266
R^2	0.0432	0.1100	0.3728	0.4098
Adj. R^2	0.0429	0.0976	0.3717	0.4003

$$I_{NEW,t} = \alpha + \beta_1 V_{AIP}/P_{t-1} + \beta_2 Leverage_{t-1} + \beta_3 Cash_{t-1} + \beta_4 Age_{t-1} + \beta_5 Size_{t-1} + \beta_6 StockReturn_{t-1} + \beta_7 I_{NEW,t-1} + \sum YearIndicator + \sum IndustryIndicator$$

T-statistic values in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Notes: All continuous variables are winsorized at the 1st and 99th percentile to reduce the influence of outliers. V_{AIP}/P is the value of assets in place divided by the market capitalization. V_{AIP} = (1 – α *r*)*BV* + α(1 + *r*)*X*– α rd, where α =*ω*/(1+*r*-*ω*), ω is earnings persistence, *r* is the cost of capital rate, *BV* is book value of equity, *X* is EBIT, and *d* is dividends. $Leverage$ is total debt divided by total assets. $Cash$ is cash scaled by total assets. $FirmAge$ is the number of years since incorporation. We use the natural log values of $FirmAge$ and $Size$. $StockReturn$ is the percentage change in the firm's market capitalization in the prior year. $InvestmentNew_{t-1}$ is prior year Investment New scaled by average total assets.

4.2.3 Testing H1

For our first hypothesis, four regression models are run. Model (1) tests for a linear relationship between CEO age and investment efficiency. It includes all control variables from Equation 9, as well as industry and firm fixed effects. Model (1) results suggest that no significant linear relationship exists. The P-value is high, the T-statistic is low (0.71), and the R^2 is 5.01% in-

dicating that the model explains only a small proportion of the variation in I_{NEW}. Model (2) tests for any quadratic relationships by including also the interaction term $Age^2_{CEO,t}$. It also includes controls as well as industry and year fixed effects. In Model (2), we find a significant quadratic relationship between CEO age and investment efficiency. $Age^2_{CEO,t}$ is significant at the first significance level. The coefficient of -0.00006 indicates that the relationship is an inverse U-shaped (concave) relationship. The linear component is also significant at the first level. The adjusted R^2 is 3.46% so the explanatory value of the model is only marginally higher than Model (1). In Models (3) and (4) we replicate the analysis from Models (1) and (2), but replace industry fixed effects with firms fixed effects. Including firm fixed effects is necessary to ensure that any findings are in fact driven by the independent variable Age_{CEO} and not differences between firms. As can be seen in the results reported for Model (4), the finding of a significant relationship in Model (2) does not persist when including firm fixed effects. This indicates that the relationship found is in fact driven by differences between firms rather than the age of the CEO.

To explore the possibility of any other relationships existing between CEO age and investment efficiency, we extend our analysis beyond what is presented in Table 4. In the following Table 5 we conduct several tests. We begin by splitting our sample into two parts, one for underinvesting firms and one for overinvesting firms. Doing this allows us to investigate how CEO age might relate to investment efficiency within these settings. In the next step, we use the absolute values of the residuals determining investment efficiency. Converting our sample of residuals into absolute values allows us to test the overarching investment efficiency of the CEOs, without being restricted to if they are over-or underinvesting. When residuals are converted to absolute values they simply denote how successful a CEO is in their investing.

Table 5 is reported below. Panel A reports results from the regressions based on our sample of overinvesting firms. Models (1) and (2) test for linear and quadratic relationships respectively. Models (3) and (4) replicate these tests but with the inclusion of firm fixed effects instead of industry fixed effects. Model (2) is close to finding a significant relationship, but does not reach the threshold for the first significance level. Model (4) reports results that indicate that a U-shaped (convex) relationship exists between CEO age and overinvestment at the first significance level. The Model has an adjusted R^2 of 29.38%, indicating that it explains a sizeable proportion of the variation within the overinvesting firms. Panel B replicates the analysis of Panel A, but this

time based on the sample of underinvesting firms. Model (8) includes firm fixed effects and reports a second level significant, inverse U-shaped (concave) relationship between CEO age and underinvestment. The coefficient of $Age^2_{CEO,t}$ in Model (8) is -0.00006 which indicates that the curve has a flatter slope than in Model (4). The adjusted R^2 of the model is 18.25%.

The findings from Panel A and B are confirmed in Panel C, which reports results based on a sample where all residuals are converted into absolute values. Significant results are found in Model (12). In Model (12), a U-shaped relationship (convex) is found where $Age^2_{CEO,t}$ is assigned a coefficient of 0.00007, with p<0.05, a t-statistic of 2.27, and an adjusted R^2 of 27.44%. The results reported in Panel C provide evidence suggesting that, on a firm level, relatively younger and older CEOs are worse at matching their investment expenditure to the needs of the firm. These results are expected given the results in Panel A, where young and old CEOs overinvest more than the middle aged CEOs, and the same results in reverse in Panel B.

The key inference from these results is the suggestion that the lack of clear directional relationships in Table 4 does not mean that no relationship exists between CEO age and investment efficiency. As shown, a significant relationship exists between CEO age and investment efficiency in the sense that the accuracy of the investment expenditure is best when the CEO is middle-aged, while young and old CEOs are more prone to either overinvesting or underinvesting, and less likely to invest optimally. Put simply, middle-aged CEOs appear to be better at investing than young and old CEOs.

Table 4: Age Regressions

Model	(1)	(2)	(3)	(4)
$\text{Age}_{CEO,t}$	0.00026	0.00685*	0.00020	0.00613
	(0.71)	(1.82)	(0.47)	(0.18)
$\text{Age}^2_{CEO,t}$		-0.00006*		-0.00006
		(-1.73)		(-1.31)
Control variables	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	No	No
Firm fixed effects	No	No	Yes	Yes
Observations	3266	3266	3245	3245
R^2	0.0501	0.0515	0.2289	0.2294
Adj. R^2	0.0335	0.0346	0.0901	0.0904

$$I^{\varepsilon}_{NEW,t} = \alpha + \beta_1 Age_{CEO,t} + \beta_2 Age^2_{CEO,t} + \beta_3 Tenure_{CEO,t} + \beta_4 Gender_{CEO,t} + \beta_5 Size_t + \beta_6 MtB_t + \beta_7 Leverage_t + \beta_8 ROA_t + \beta_9 SalesGrowth_t + \beta_{10} FirmAge_t + \beta_{11} StockReturn_t + \sum YearIndicator + \sum IndustryIndicator + \sum FirmIndicator$$

T-statistic values in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Notes: The regressions test for linear and quadratic relationships between CEO age and over- or underinvestment. $Age_{CEO,t}$ is the age of the CEO at time t. $Gender_{CEO,t}$ is the gender of the CEO, 1 for female and 0 for male. $Tenure_{CEO,t}$ is the number of years the CEO has held their position. $Size_t$ is the total assets of the firm. MtB_t is the Market-to-Book ratio. $Leverage_t$ is total debt divided by total assets. ROA_t is net income divided by average total assets. $SalesGrowth_t$ is the sales growth from the prior year in percent. $FirmAge_t$ is the number of years since incorporation. $StockReturn_t$ is the percentage change in market capitalization from the prior year. $FirmAge_t$ and $Size_t$ are in log form. All continuous variables except the CEO characteristics are winsorized at the 1st and 99th percentile.

Table 5: Alternative Age Regressions

Panel A: Overinvesting Firms

Model	(1)	(2)	(3)	(4)
$\text{Age}_{CEO,t}$	-0.00004	-0.00732	-0.00064	-0.01314*
	(-0.07)	(-1.38)	(-0.82)	(-1.85)
$\text{Age}^2_{CEO,t}$		0.00007		0.00012*
		(1.38)		(1.82)
Observations	1304	1304	1221	1221
R^2	0.2223	0.2235	0.4873	0.4889
Adj. R^2	0.1893	0.1899	0.2924	0.2938

Table 5: Alternative Age Regressions (continued)

Panel B: Underinvesting Firms				
Model	(5)	(6)	(7)	(8)
$\text{Age}_{CEO,t}$	0.00006	0.00367*	0.00043	0.00713**
	(0.30)	(1.86)	(1.29)	(2.23)
$\text{Age}^2_{CEO,t}$		-0.00004*		-0.00006**
		(-1.85)		(-2.11)
Observations	1956	1956	1895	1895
R^2	0.1399	0.1416	0.3669	0.3694
Adj. R^2	0.1160	0.1172	0.1798	0.1825
Panel C: Absolute Residuals				
Model	(9)	(10)	(11)	(12)
$\text{Age}_{CEO,t}$	0.00000	-0.00369	-0.00008	-0.00793**
	(0.01)	(-1.31)	(-0.20)	(-2.26)
$\text{Age}^2_{CEO,t}$		0.00004		0.00007**
		(1.31)		(2.27)
Observations	3266	3266	3245	3245
R^2	0.1531	0.1538	0.3838	0.3853
Adj. R^2	0.1383	0.1388	0.2729	0.2744
Control variables	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	No	No
Firm fixed effects	No	No	Yes	Yes

$I^{\varepsilon}_{NEW,t} = \alpha + \beta_1 Age_{CEO,t} + \beta_2 Age^2_{CEO,t} + \beta_3 Tenure_{CEO,t} + \beta_4 Gender_{CEO,t} + \beta_5 Size_t + \beta_6 MtB_t + \beta_7 Leverage_t + \beta_8 ROA_t + \beta_9 SalesGrowth_t + \beta_{10} FirmAge_t + \beta_{11} StockReturn_t + \sum YearIndicator + \sum IndustryIndicator + \sum FirmIndicator$

T-statistic values in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Notes: Panel A reports results based on our sample of overinvesting firms, Panel B on our sample of underinvesting firms, and Panel C on our whole sample but with all residuals turned into absolute values. $Age_{CEO,t}$ is the age of the CEO at time t. $Gender_{CEO,t}$ is the gender of the CEO, 1 for female and 0 for male. $Tenure_{CEO,t}$ is the number of years the CEO has held their position. $Size_t$ is the total assets of the firm. MtB_t is the Market-to-Book ratio. $Leverage_t$ is total debt divided by total assets. ROA_t is net income divided by average total assets. $SalesGrowth_t$ is the sales growth from the prior year in percent. $FirmAge_t$ is the number of years since incorporation. $StockReturn_t$ is the percentage change in market capitalization from the prior year. $FirmAge_t$ and $Size_t$ are in log form. All continuous variables except the CEO characteristics are winsorized at the 1st and 99th percentile.

In this section we provide evidence of a significant, U-shaped relationship between CEO age and absolute investment efficiency. While that is the case, we fail to find evidence for any directional

indication towards over- or underinvesting within that relationship. Based on this, we reject our first hypothesis that CEO age is negatively correlated with overinvestment.

4.2.4 Testing H2

Results for the test of H2 are reported in Table 6. Model (1) tests for any linear relationship between CEO tenure and investment efficiency. It includes all controls from Equation 9 as well as industry and year fixed effects. The model fails to find any significant relationship. In Model (2), we test for a quadratic relationship between CEO tenure and investment efficiency. It is found that a significant relationship exists at the second significance level ($p<0.05$). The quadratic component $Tenure^2_{CEO,t}$ is allocated a coefficient of -0.00008 which indicates an inverse U-shaped relationship, where CEOs in the beginning and end of their tenures are more prone to underinvesting. The linear component $Tenure_{CEO,t}$ is significant at the first level with a coefficient of 0.00199. In Models (3) and (4) we substitute industry fixed effects for firm fixed effects to ensure findings are not driven by differences between firms. As can be seen, Model (4) continues to show a significant inverse U-shaped relationship between CEO tenure and investment efficiency. The coefficient for $Tenure^2_{CEO,t}$ changes to -0.00015, indicating a slightly steeper slope than in Model (2). The significance level also changes to the third significance level. The linear component of CEO tenure is still significant, but at the second significance level. The adjusted R^2 of Model (4) is 9.06% compared to the 3.39% of Model (2). The changes that occur between Model (2) and Model (4) strengthen the evidence for a relationship between CEO tenure and investment efficiency. If tenure is a genuine driver of investment efficiency outcomes, its effects should persist, or even become stronger, when introducing firm fixed effects. The results of Model (4) support this as it has higher levels of significance and a higher adjusted R^2 than Model (2). Together, these findings provide evidence that CEO tenure is associated with investment efficiency within firms, rather than a reflection of stable differences across firms.

Table 6: Tenure Regressions

Model	(1)	(2)	(3)	(4)
$\text{Tenure}_{CEO,t}$	0.00050	0.00199*	0.00039	0.00253**
	(1.09)	(1.93)	(0.62)	(1.99)
$\text{Tenure}^2_{CEO,t}$		-0.00008**		-0.00015***
		(-2.12)		(-2.65)
Control variables	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	No	No
Firm fixed effects	No	No	Yes	Yes
Observations	3266	3266	3245	3245
R^2	0.0501	0.0508	0.2289	0.2297
Adj. R^2	0.0335	0.0339	0.0901	0.0906

$$I^{\varepsilon}_{NEW,t} = \alpha + \beta_1 Tenure_{CEO,t} + \beta_2 Tenure^2_{CEO,t} + \beta_3 Age_{CEO,t} + \beta_4 Gender_{CEO,t} + \beta_5 Size_t + \beta_6 MtB_t + \beta_7 Leverage_t + \beta_8 ROA_t + \beta_9 SalesGrowth_t + \beta_{10} FirmAge_t + \beta_{11} StockReturn_t + \sum YearIndicator + \sum IndustryIndicator + \sum FirmIndicator$$

T-statistic values in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Notes: The regressions test for linear and quadratic relationships between CEO tenure and over- or underinvestment. $Age_{CEO,t}$ is the age of the CEO at time t. $Gender_{CEO,t}$ is the gender of the CEO, 1 for female and 0 for male. $Tenure_{CEO,t}$ is the number of years the CEO has held their position. $Size_t$ is the total assets of the firm. MtB_t is the Market-to-Book ratio. $Leverage_t$ is total debt divided by total assets. ROA_t is net income divided by average total assets. $SalesGrowth_t$ is the sales growth from the prior year in percent. $FirmAge_t$ is the number of years since incorporation. $StockReturn_t$ is the percentage change in market capitalization from the prior year. $FirmAge_t$ and $Size_t$ are in log form. All continuous variables except the CEO characteristics are winsorized at the 1st and 99th percentile.

As evident from the literature review different behavior patterns have been identified for different stages of tenure (Hambrick & Fukutomi, 1991; Prendergast & Stole, 1996; Weis, 2025). Since it is unclear whether these patterns translate into gradual changes in investment efficiency, we re-estimate the regressions using subsamples based on tenure terciles. This approach allows us to examine whether the observed concave relationship is driven by local differences in the distribution of investment residuals across tenure stages. If it is continuously concave, all subsamples should exhibit significant p-values for the explanatory variables. Our subsample results are reported in Table A4 in the Appendix. The findings show that the statistically significant concave relationship in the full sample no longer holds for each subsample. It should be noted that dividing the sample into terciles reduces the number of observations per regression and may therefore increase p-values. Overall, the results suggest that the concave relationship primarily holds across the full tenure horizon rather than within its individual subperiods.

Based on our findings in this section, we find evidence to reject the implied null hypothesis of H2. We therefore accept our second hypothesis and through that provide evidence that a curvilinear relationship exists between CEO tenure and investment efficiency in our sample of listed Swedish firms. However, the tercile-based robustness tests suggest that the statistical significance depends on how the sample is partitioned.

4.2.5 Testing H3

In Table 7 we report our initial findings for the testing of hypothesis three. The independent variable, Gender$_{CEO,t}$ is a dummy variable taking the value 0 if the CEO is a male, and 1 if it is a female. In the application this means that the residuals reported in Table 7 represent the effect of the CEO being a female, compared to the baseline scenario of the CEO being a male. Model (1) includes all control variables from Equation 9, as well as industry and year fixed effects. Model (2) replicates this analysis but substitutes industry fixed effects for firm fixed effects. Both models fail to find any significant associations arising from the CEO being a woman.

Table 7: Gender Regressions

Model	(1)	(2)
Gender$_{CEO,t}$	0.00774	0.00800
	(0.83)	(0.90)
Control variables	Yes	Yes
Year fixed effects	Yes	Yes
Industry fixed effects	Yes	No
Firm fixed effects	No	Yes
Observations	3266	3245
R^2	0.0501	0.2289
Adj. R^2	0.0335	0.0901

$I^{\varepsilon}_{NEW,t} = \alpha + \beta_1 Gender_{CEO,t} + \beta_2 Age_{CEO,t} + \beta_3 Tenure_{CEO,t} + \beta_4 Size_t + \beta_5 MtB_t + \beta_6 Leverage_t + \beta_7 ROA_t + \beta_8 SalesGrowth_t + \beta_9 FirmAge_t + \beta_{10} StockReturn_t + \sum YearIndicator + \sum IndustryIndicator + \sum FirmIndicator$

T-statistic values in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Notes: The regressions test for a relationship between CEO gender and over- or underinvestment. $Age_{CEO,t}$ is the age of the CEO at time t. $Gender_{CEO,t}$ is the gender of the CEO, 1 for female and 0 for male. $Tenure_{CEO,t}$ is the number of years the CEO has held their position. $Size_t$ is the total assets of the firm. MtB_t is the Market-to-Book ratio. $Leverage_t$ is total debt divided by total assets. ROA_t is net income divided by average total assets. $SalesGrowth_t$ is the sales growth from the prior year in percent. $FirmAge_t$ is the number of years since incorporation. $StockReturn_t$ is the percentage change in market capitalization from the prior year. $FirmAge_t$ and $Size_t$ are in log form. All continuous variables except the CEO characteristics are winsorized at the 1st and 99th percentile.

To extend the analysis and look for any possible linkages to CEO gender we perform analysis on subsamples of our full sample, as is also done for H1. Table 8 reports our results from these tests. Table 8 replicates the tests of Table 7, but bases it on our sample of absolute investment residuals. Converting the residuals into absolute values allows us to test for any effects on investment efficiency as a whole, not constrained by the categorization into over- or underinvestment. In Model (2), we find a significant effect at the first level of significance (p<0.1), with a t-statistic of 1.81. The coefficient of 0.01288 suggests that the dispersion in the investment efficiency measurements is larger in the population of female CEOs than for male CEOs. In addition to testing on absolute residuals we also test for relationships within the subsamples of over- and underinvesting firms. In untabulated analysis we fail to find any significant relationships within those samples.

Table 8: Alternative Gender Regression

Absolute Residuals

Model	(1)	(2)
Gender$_{CEO,t}$	0.00563	0.01288*
	(0.83)	(1.81)
Observations	3266	3245
R^2	0.1531	0.3838
Adj. R^2	0.1383	0.2729
Control variables	Yes	Yes
Year fixed effects	Yes	Yes
Industry fixed effects	Yes	No
Firm fixed effects	No	Yes

$I^{\varepsilon}_{NEW,t} = \alpha + \beta_1 Gender_{CEO,t} + \beta_2 Age_{CEO,t} + \beta_3 Tenure_{CEO,t} + \beta_4 Size_t + \beta_5 MtB_t + \beta_6 Leverage_t + \beta_7 ROA_t + \beta_8 SalesGrowth_t + \beta_9 FirmAge_t + \beta_{10} StockReturn_t + \sum YearIndicator + \sum IndustryIndicator + \sum FirmIndicator$

T-statistic values in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Notes: The regression is based on our sample of residuals converted to absolute values. Using absolute values allows us to capture investment efficiency without confining it to over- or underinvestment. $Age_{CEO,t}$ is the age of the CEO at time t. $Gender_{CEO,t}$ is the gender of the CEO, 1 for female and 0 for male. $Tenure_{CEO,t}$ is the number of years the CEO has held their position. $Size_t$ is the total assets of the firm. MtB_t is the Market-to-Book ratio. $Leverage_t$ is total debt divided by total assets. ROA_t is net income divided by average total assets. $SalesGrowth_t$ is the sales growth from the prior year in percent. $FirmAge_t$ is the number of years since incorporation. $StockReturn_t$ is the percentage change in market capitalization from the prior year. $FirmAge_t$ and $Size_t$ are in log form. All continuous variables except the CEO characteristics are winsorized at the 1st and 99th percentile.

While we in this section provide partial evidence for the existence of a relationship between CEO gender and absolute investment efficiency, the results are mixed and of low significance. Most importantly, they are not robust across specifications. We do not find enough evidence to reject the implied null hypothesis of our third hypothesis, and therefore we reject our third hypothesis. We cannot prove that CEO gender show a consistently significant association with investment efficiency.

5 Discussion

5.1 Discussion of H1

Given both the extensiveness and the conformity of results presented in the literature review related to the topic of relationships between CEO age and different measures of investment levels and firm risk levels, our results can be seen as unexpected. The previous literature provides two clear conclusions. First, several studies have confirmed negatively correlated relationships between CEO age and firm spending on a number of items relating to investments (Barker & Mueller, 2002; Bertrand & Schoar, 2003; Li et al., 2017). Second, CEO age is negatively correlated with firm risk levels and the perceived risk taken in investment choices (Serfling, 2014; McClelland & Obrien, 2011). Given this, one could expect a similar relationship to exist between CEO age and investment efficiency. However, our results fail to confidently confirm any linear relationships. While we find a significant quadratic relationship when controlling for industry and year fixed effects, we fail to replicate that finding when controlling for firm fixed effects (Table 4). This discrepancy indicates that the driver of the correlational relationship is in fact not the CEO age specifically, but rather a matching effect where firms with certain investment policies are matched to certain CEOs. If in fact CEO age were a reliable predictor of a firm's investment policies it could be expected that the relationship would persist when also controlling for firm fixed effects. It is possible to arrive at a number of different explanations for this, which we present in this section.

One distinction that is important to make is that of the difference between investment levels and investment efficiency. Measures of investment levels do not take the inherent investment needs of the company into account. A firm investing relatively less than another firm does not mean it is not investing enough. Firms simply have different investment needs. However, as the findings from previous studies typically are confirmed with firm fixed effects, this explanation

does not hold entirely.

Similarly, a distinction does also need to be made between firm risk and investment efficiency. In the literature, risk is treated both as a measurable item (for example, stock price variance in Serfling, 2014), and as a more wide-ranging term encompassing a broader variety of corporate actions (e.g. Li et al., 2017). When using the broader definition, corporate investment is typically regarded as a driver of risk, so that lower investment levels equal lower risk and vice versa. The inference often drawn from this is that since older CEOs typically invest at lower levels, they should also be less risk-prone. While that may be true to some extent (especially regarding R&D expenditure which in its nature is associated with a higher degree of risk), we believe it to be a simplified conclusion. It could be argued that underinvesting poses an equal amount of risk to the firm as overinvesting does. While an overinvesting firm risks spending funds on projects which will not generate adequate returns, thus depleting resources, an underinvesting firm does not only miss out on potential returns generated, but also risks falling behind competition, depleting its asset base, or creating an aggregated investment demand which will impact future results.

While we fail to find any robust relationships of a directional nature, i.e. predicting tendencies to over- or underinvest, we do provide strong evidence for the existence of a relationship between CEO age and an absolute measure of investment efficiency. The results reported in Table 5 indicate that a robust, U-shaped, relationship exists between CEO age and investment efficiency as an absolute measure, meaning that relatively younger and older CEOs are more likely to invest poorly, regardless of if that is done through overinvesting or underinvesting. As with most statistical analysis, it is difficult to establish causality based on correlational relationships. It is possible that this relationship is driven by some degree of inability among the groups of young and old CEOs to accurately identify the firm's optimal investment level. But it is also possible that there is an entirely different mechanism that causes the finding.

5.2 Discussion of H2

Our second hypothesis is supported by the argument that the concave relationship between CEO tenure and time horizon evident from the literature (Weis, 2025) indicates that CEO tenure and investment efficiency should follow the same relationship. Our finding that CEO tenure is significantly related to investment efficiency in the form of an inverted U-shaped relationship where

CEOs in the beginning and end of their tenures are more prone to underinvesting is in line with this argument.

The most expected part of the results is the increased proneness to underinvesting evident towards the end of a CEO's tenure. Given the documented increasing conservatism during the tenure, and the decreasing incentives to act long-term, some decrease in investments can be expected. As with CEO age, the literature suggests that CEOs will be less risk prone as their tenure increases (Hambrick & Fukutomi, 1991; Prendergast & Stole, 1996; Musteen et al., 2006). In the previous section we argue that risk-aversion should not immediately be seen as a reason to underinvest. However, when looking at the potential risks arising from underinvesting compared to overinvesting, it is clear that the risks arising from underinvestment are more likely to occur long-term, while underinvestment (especially in R&D) can improve bottom-line results short-term. So if it is true that CEOs become more risk-averse as their tenure draws to its end, it is possible that their simultaneously increasing short-termism makes them value the risks associated with underinvesting as less of a deterrent than the risks associated with overinvesting.

The literature predicts a clear short-term mindset and a tendency to employ profit-maximizing measures in the early years of the CEO's tenure (Weis, 2025; Ali & Zhang, 2015; Dechow & Sloan, 1991). However, it is still somewhat unexpected that the apparent tendency to underinvest in the early years of the tenure is such a substantial driver of the curvilinear relationship. With a focus on short-term profit improvement, cutting R&D is a logical approach. Long-term investments on the other hand do not affect bottom-line profits as much as the costs are capitalized. Additionally, the new CEO will also be able to reap the benefits of the long-term investments if they manage to keep the position, in contrast to the late-stage CEO. We argue that the high focus on short-term profit improvement can only partially explain the tendency to underinvest in the early years. Instead, we resort to the theory on managerial seasons provided by Hambrick and Fukutomi (1991) as a complementary explanation. In the first years of the tenure the CEO will be operating under a clear mandate (not seldom with the objective to quickly improve previously poor financial results), with relatively low decision-making power. Our argument is that the weak position of the new CEO, combined with the short-term profit focus create incentives to cut investment.

5.3 Discussion of H3

Given the variety of conflicting conclusions provided by the literature review, it is not completely unexpected that we fail to find any significant directional relationship between CEO gender and underinvestment (Palvia et al., 2015; Adams & Funk, 2012; Berger et al., 2014). With that being the case, it is still established that female and male risk preferences do differ at a more general level (Croson & Gneezy, 2009). In testing for influences of female CEOs on absolute measures of investment efficiency we find a significant relationship suggesting that female CEOs are more prone to investing sub-optimally than male CEOs are. However, this result is only evident at the first level of significance and is not consistently significant across specifications. We do not believe the result to be strong enough to say that an association exists. One compromising factor in our tests is the low share of female CEOs. With only 9% of the CEOs in the sample being women, the sample size becomes small.

5.4 General Discussion

Taken together, our results provide an answer to our research question that is both clear and equivocal at the same time. It is clear that CEO characteristics can be used to identify patterns in top management decision-making related to investments. At the same time, it has become apparent that this usage has to be subject to precise interpretation. Firstly, correlation does not imply causality so all findings should be handled with caution when trying to make predictive inferences. Second, our results provide further nuance to the usage of behavioral mechanisms as explainers of investment behavior. In the existing literature discussing CEO characteristics and investment expenditure, three main behavioral biases can be identified that are attributed especially high relevance, the degree of conservatism, the time-horizon, and the risk-tolerance. Based on our results, we argue that of these, CEO time-horizon and, to some extent, CEO conservatism can be said to provide predictions that are in line with the results we see when investigating investment efficiency and not investment levels. Risk-tolerance, on the other hand, we argue should be treated with particular caution. The literature discussing risk preferences connected to age, tenure, and gender, in relation to investment expenditure makes inferences about which effect the CEO's risk preferences can be expected to have on investment levels, and in through that on investment efficiency. The implied prediction of the literature is that as proneness to risk decreases, the tendency to underinvest should increase. Our results, primarily

related to tenure, but also complemented by the absent results in relation to gender, contradict these predictions. CEOs early in their tenure are said to be more willing to take on risk, but are still relatively more prone to underinvesting.

6 Conclusion

Our study reinforces the already established notion of using CEO characteristics to predict organizational outcomes. We confirm the usefulness of this method in the setting of Swedish listed firms. We provide evidence for that a curvilinear relationship exists between CEO age and absolute investment efficiency, and that a curvilinear correlational relationship exists between CEO tenure and investment efficiency.

Our study makes two key contributions to the current literature. First, we extend the existing methodology of linking CEO characteristics to organizational outcomes to the setting of Swedish listed firms. The current literature is almost exclusively based on U.S. data, making any deviation from that norm a valuable contribution. Also, there is a specific lack of relevant research linking CEO characteristics to investments and investment efficiency in the Swedish setting. Secondly, the typical approach taken in previous literature is to relate CEO characteristics to measures of investment either based on investment levels, or on benchmarking against peers. By using an established, evaluative method for determining investment efficiency at a firm level we create an organizational outcome in the form of investment efficiency which provides more insight into the actual implications of the relationships found, increasing the value of the findings. To our knowledge, no previous literature links CEO characteristics to outcomes measured with the model developed by Richardson (2006).

6.1 Limitations

An inherent limitation of our method is the reliance on market data for a number of inputs. While enabling us to leverage the information provided by the pricing mechanisms in the market, it also means that the method can only be applied to listed companies. It could be argued that the usefulness of the study would increase if the findings would be applicable to private companies as well, as passive owners in private companies face additional difficulties in monitoring the management of their firms.

In addition, the most relevant limitation is the number of CEO characteristics studied. In order to

maintain quality within the scope of this study we make a selection of a few CEO characteristics to conduct our study on. However, as previously discussed, the number of viable characteristics is large and a study which incorporates a higher count of unique characteristics while maintaining quality would likely provide even more actionable insights.

Lastly, there exists the risk of endogeneity. While firm fixed effects mitigate concerns related to time-invariant firm heterogeneity, reverse causality and omitted time-varying variables cannot be fully ruled out. Findings should therefore be interpreted as correlational rather than causal.

6.2 Suggestions for Future Research

We believe future research efforts should be directed in two primary directions. Firstly, our findings on relationships between CEO characteristics would benefit from being confirmed in more settings across other countries. Replicating the study in countries with similar governance structures and institutional environments, as well as larger sample sizes, such as Germany or other large European countries could be especially relevant. Conducting extended studies, covering additional CEO characteristics is also highly relevant.

Secondly, we argue that the existing literature, and the most common methods of relating CEO characteristics to financial outcomes, oftentimes do not use appropriately exact measures for the outcomes studied. As evident from our study, and a minority of other studies within the field, results and the implications of them can differ significantly depending on whether a descriptive (e.g. total expenditure on R&D) or an evaluative measure (e.g. investment efficiency) is used. By using evaluative measures, the practical relevance of the findings is increased. The current knowledge base about how CEO characteristics can be related to organizational outcomes in terms of descriptive measures is today well developed. Going forward, we believe that the approach within the field with the highest potential of generating new insights is to relate CEO characteristics to evaluative measures of organizational outcomes.

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Appendix

A.1 Data Sourcing

Table A1: Sourcing of Data

	Used for	Retrieved from
Accounting Data:		
Total Assets (at)	Control	Compustat
Total PPE (ppent)	I_{TOTAL} & I_{NEW}	Compustat
Cash (ch)	Control	Compustat
Debt in Current Liabilities (dlc)	Control	Compustat
Long-term Debt (dltt)	Control	Compustat
Depreciation & Amortization (dpc)	I_{TOTAL} & I_{NEW}	Compustat
Dividends (dvt)	V_{AIP}	Compustat
Operating Earnings (ebit)	V_{AIP}	Compustat
R&D (xrd)	I_{TOTAL} & I_{NEW}	Compustat
Stockholders Equity (teq)	V_{AIP}	Compustat
Sales	Control	Compustat
Net Income	Control (ROA)	Compustat
Sale of PPE	I_{TOTAL} & I_{NEW}	S&P Capital IQ pro
CEO data:		
Age, Tenure & Gender		S&P Capital IQ pro & Business:Retriever
Market Data:		
Monthly Stock Return Data 2010-2014	Beta	S&P Capital IQ
OMXSPI Index Monthly 2010-2014	Beta	Yahoo! Finance
Firm Market Capitalization	Control	S&P Capital IQ
Swedish 10-year Risk Free Rate	CAPM	Sveriges Riksbank
Swedish Market Risk Premium 2010-2014	CAPM	PWC
Other:		
Firm Age	Control	Business:Retriever
SIC codes	Fixed Effect	Compustat

Table A2: **Pearson Correlation Matrices**

Panel A: Step 1 Regressions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) New Investment	1.0000							
(2) V(AIP)/P (t-1)	-0.2078	1.0000						
(3) Leverage (t-1)	-0.0911	0.1519	1.0000					
(4) Cash (t-1)	0.2287	-0.3579	-0.4544	1.0000				
(5) Firm Age (t-1, log)	-0.0710	0.2791	0.0849	-0.2810	1.0000			
(6) Assets (t-1, log)	-0.0778	0.4751	0.4133	-0.4474	0.4747	1.0000		
(7) Stock Return (t-1)	0.0473	-0.0404	-0.0789	0.1069	-0.0730	-0.0939	1.0000	
(8) Investment New (t-1)	0.5920	-0.1956	0.0289	0.1567	-0.0840	-0.0378	0.0923	1.0000

Panel B: Step 2 Regressions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) CEO Age	1.0000										
(2) CEO Tenure	0.2378	1.0000									
(3) CEO Gender	-0.0715	-0.1463	1.0000								
(4) Assets (log)	0.1166	0.0492	-0.0484	1.0000							
(5) MtB	-0.0118	0.0854	0.0215	-0.2347	1.0000						
(6) Leverage	-0.0263	-0.0322	-0.0403	0.4032	-0.2179	1.0000					
(7) ROA	-0.0107	0.1082	-0.0569	0.5406	-0.0773	0.1409	1.0000				
(8) Cash	-0.0103	-0.0336	0.0658	-0.4442	0.2991	-0.4326	-0.4326	1.0000			
(9) Sales Growth	-0.0385	-0.0309	0.0336	-0.0979	0.0525	-0.0505	-0.0716	0.0267	1.0000		
(10) Firm Age (log)	0.1893	0.1245	-0.0020	0.4769	-0.1748	0.0837	0.3605	-0.2718	-0.1055	1.0000	
(11) Stock Return	-0.0590	-0.0108	0.0011	-0.0751	0.2870	-0.0703	0.0176	0.1098	0.1259	-0.0697	1.0000

Notes: This table reports correlation coefficients for variables used in our regressions. The table is divided into two panels, one for our investment efficiency regressions and one for our CEO characteristics regressions (labelled panel A and panel B respectively). The variables are constructed identically to those used in the regressions, meaning that some appear in logged form, lagged form, or both.

A.3 VIF Values

Table A3: Variance Inflation Factor Values

Panel: A VIF Values for Equation 5					
Variable	VIF	1/VIF	Variable	VIF	1/VIF
$V(AIP)/P_{t-1}$	1.54	0.650398	$Assets_{t-1}$	2.27	0.441044
$Leverage_{t-1}$	1.58	0.634733	$Stock\ Return_{t-1}$	1.16	0.858779
$Cash_{t-1}$	1.77	0.564782	$Investment\ New_{t-1}$	1.16	0.858842
$Firm\ Age_{t-1}$	1.56	0.640434			
Panel: B VIF Values for Equation 9					
Variable	VIF	1/VIF	Variable	VIF	1/VIF
$Age_{CEO,t}$	1.22	0.819903	$Tenure_{CEO,t}$	1.20	0.832510
$Gender_{CEO,t}$	1.07	0.937799	$Size_t$	2.42	0.413740
MtB_t	1.36	0.734569	$Leverage_t$	1.57	0.635081
ROA_t	1.83	0.547093	$Sales\ Growth_t$	1.05	0.954739
$Firm\ Age_t$	1.63	0.614276	$Stock\ Return_t$	1.23	0.811571

Notes: The tables report Variance Inflation Factors for all variables used in our regressions. Panel A reports values for the variables used in the investment model, Equation 5. Panel B reports values for all variables used in the baseline specification model used for testing the hypotheses, Equation 9.

A.4 Tenure Tercile Regressions

Table A4: Alternative Tenure Regressions

Panel A: First Tercile (0-2 years)				
Model	(1)	(2)	(3)	(4)
$Tenure_{CEO,t}$	0.00279	0.00835	0.00296	0.00334
	(0.70)	(0.54)	(0.70)	(0.21)
$Tenure^2_{CEO,t}$		-0.00283		-0.00020
		(-0.39)		(-0.03)
Observations	1395	1395	1339	1339
R^2	0.0472	0.0473	0.2772	0.2772
Adj. R^2	0.0097	0.0150	0.0319	0.0310

Table A4: Alternative Tenure Regressions (continued)

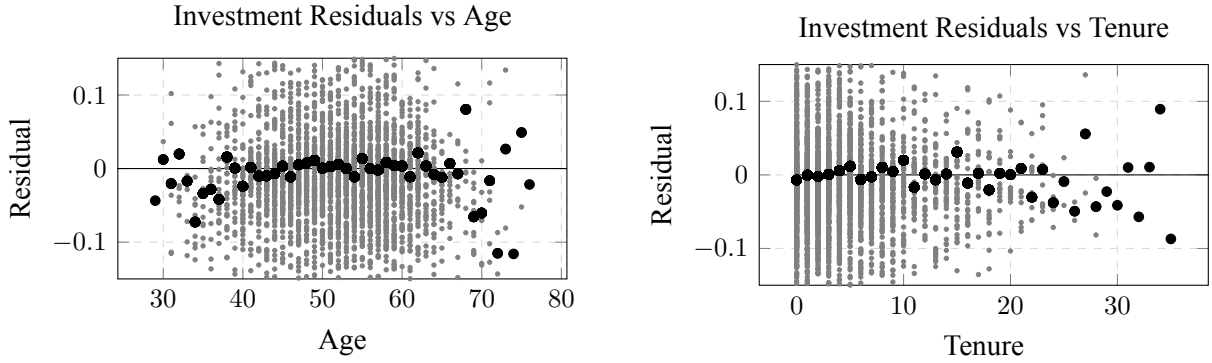
Panel B: Second Tercile (3-5 years)				
Model	(5)	(6)	(7)	(8)
$\text{Tenure}_{CEO,t}$	0.00436	-0.00576	0.01343**	-0.01964
	(0.98)	(-0.07)	(2.40)	(-0.24)
$\text{Tenure}^2_{CEO,t}$		0.00128		0.00418
		(0.13)		(0.42)
Observations	875	875	804	804
R^2	0.1015	0.1015	0.4291	0.4293
Adj. R^2	0.0447	0.0435	0.0975	0.0961
Panel C: Third Tercile (6+ years)				
Model	(9)	(10)	(11)	(12)
$\text{Tenure}_{CEO,t}$	0.00037	0.00254	-0.00168	-0.00197
	(0.52)	(0.85)	(-0.73)	(-0.46)
$\text{Tenure}^2_{CEO,t}$		-0.00008		0.00001
		(-0.86)		(0.10)
Observations	991	991	931	931
R^2	0.0931	0.0936	0.3397	0.3397
Adj. R^2	0.0428	0.0423	0.1164	0.1151
Control variables	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	No	No
Firm fixed effects	No	No	Yes	Yes

T-statistic values in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Notes: Panel A reports results based on the sample of CEOs who have held their position for 0-2 years, Panel B for 3 to 5 years, and Panel C for 6 years or more. $Age_{CEO,t}$ is the age of the CEO at time t. $Gender_{CEO,t}$ is the gender of the CEO, 1 for female and 0 for male. $Tenure_{CEO,t}$ is the number of years the CEO has held their position. $Size_t$ is the total assets of the firm. MtB_t is the Market-to-Book ratio. $Leverage_t$ is total debt divided by total assets. ROA_t is net income divided by average total assets. $SalesGrowth_t$ is the sales growth from the prior year in percent. $FirmAge_t$ is the number of years since incorporation. $StockReturn_t$ is the percentage change in market capitalization from the prior year. $FirmAge_t$ and $Size_t$ are in log form. All continuous variables except the CEO characteristics are winsorized at the 1st and 99th percentile.

A.5 Residual Distributions

Figure A1: Residual Distributions from the Investment model



Notes: The figures show the distribution of our residuals for over- or underinvestment, generated from the the investment model (Equation 5). The left scatter plot show residuals plotted against CEO age, and the right shows the residuals plotted against CEO tenure. The light grey dots are the single residuals for each firms years, while the black dots are the mean residual for each age/tenure.

A.6 Disclosure on the Usage of AI

In the writing of this thesis, we have used generative AI as an aid in certain parts of the process. Its primary use has been to generate code for the statistical analysis in STATA and the formatting of the thesis in LaTeX. It has also been employed to check for grammatical and linguistic errors. All suggestions provided by the AI models have been implemented only after careful review. All reasoning and analysis provided in this thesis are entirely our own. The models used are:

Chat GPT models 5.3-5.5 from OpenAI; https://chatgpt.com/

Claude Sonnet 4.6 from Anthropic; https://claude.ai/