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Managerial Overconfidence and Corporate Investment Decision-Making: Theoretical and Empirical Studies

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A thesis submitted to Department of Accounting, Finance and Economics at Birmingham City University in fulfilment of the requirement for the Degree of Doctor of Philosophy

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Declaration

I, Magdalena Kommalapati, hereby declare that this doctoral thesis entitled *Managerial Overconfidence and Corporate Investment Decision-Making: Theoretical and Empirical Studies* is my original work, conducted under the guidance of my supervisors, Xiehua Ji, Erez Yerushalmi and Anton Miglo. This thesis represents the culmination of my independent research and intellectual contributions as a doctoral student at Birmingham City University.

I affirm that:

The research presented in this thesis is the result of my own efforts, except where explicitly acknowledged and referenced.

Any assistance received from individuals, organizations, or published sources in the form of ideas, data, or written materials has been duly acknowledged and referenced.

The content of this thesis has not been submitted for any other academic qualification or degree at any other institution.

Any ethical considerations associated with this research, including the collection, analysis, and use of data, have been adhered to in accordance with the relevant guidelines and regulations.

Any conflicts of interest that may have influenced the research or its outcomes have been disclosed.

All quotations, figures, tables, and images included in this thesis have been appropriately cited and attributed to the original sources.

This thesis conforms to the formatting and submission guidelines set forth by Birmingham City University.

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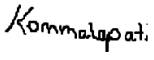
Signed:  Date: 28.08.2023

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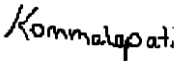
Signed:  Date: 28.08.2023

Abstract

This PhD thesis consists of three chapters.

Chapter I of this PhD thesis is a literature review that systematically analyses the existing literature on behavioural and traditional finance. It critically examines traditional finance theories' limitations in explaining market irregularities and emphasizes the rising importance of behavioural finance. It highlights how conventional theories fall short in understanding market dynamics, paving the way for behavioural finance. The chapter explores overconfidence bias, a significant cognitive bias affecting financial decision-making, and debates whether it should be analysed separately as three distinct concepts (overprecision, overplacement and overestimation) or as a unified concept of overconfidence. It concludes that while behavioural finance complements traditional finance, it cannot replace it. Integrating insights from both fields is crucial for informed investment decisions. Regarding overconfidence bias, it notes challenges in accurately measuring its various aspects but advocates for studying them under a unified concept.

Chapter II introduces a theoretical model that utilizes algebraic expressions to analyse decision-making scenarios and assess the optimality of entrepreneurs' choices under different psychological states, including rationality, overconfidence, and pessimism. This chapter pioneers the examination of investment and organizational form selection through a behavioural finance lens. It introduces a model where entrepreneurs face three choices: launching an investment project with limited liability, initiating a project with unlimited liability, or refraining from action altogether. Entrepreneurs' decisions hinge on factors like projected project performance, their level of bias towards project expectations, and tax considerations encompassing both corporate and personal income taxes. When entrepreneurs exhibit overconfidence or pessimism, scenarios of overinvestment or underinvestment arise. The model suggests that effective government policy should account for the prevalent entrepreneurial bias. If confidence diminishes to breed pessimism, tax rates (both corporate and personal) should decrease; conversely, if overconfidence prevails, tax rates should rise. The study demonstrates that a combination of corporate tax tailored for limited liability businesses and a universal personal income tax could enhance decision-making efficiency and bolster social surplus.

The aim of **Chapter III** of the thesis is to analyse how CEO characteristics, managerial overconfidence and financial factors influence investment levels in UK SMEs. The dataset in use encompasses 256 UK SMEs, spanning the years 2014 to 2019. To measure CEO overconfidence, a proxy was created based on 2421 manually gathered articles depicting CEOs. The data has been analysed using the R programming language, employing four econometric models: Generalized Method of Moments (GMM), Fixed Effects, Random Effects, and Ordinary Least Squares (OLS) regressions. The study's findings emphasize the weight of CEO behavioural biases, especially overconfidence, and their personal attributes in shaping investment choices. Notably, a positive correlation emerges between CEO overconfidence and investment rates, signifying that highly confident CEOs tend to embrace more extensive investment. Similarly, CEO's level of experience positively correlates with higher investment rates. In contrast, CEO tenure, age, and the count of directors exhibit negative relationships with investment levels. Of the economic factors considered, inflation was the sole variable that exhibited a noteworthy impact on the investment level.

Introduction

Following the groundbreaking work of Kahneman and Tversky (1979), two distinct approaches have emerged to comprehend and predict human behaviour in the context of decision-making, particularly in the fields of economics and social sciences. These approaches include the conventional rational approach and behavioural theories.

Traditional finance, also referred to as standard or academic finance, comprises a body of knowledge that explains financial decision-making based on rationality and established theories and concepts. It assumes that investors take a cautious and objective approach to their financial decisions and behave rationally, carefully considering the related risks and returns.

Behavioural finance, in turn, is a rapidly growing field of study that seeks to understand how psychological biases and cognitive limitations influence financial decision-making. By integrating insights from psychology, economics, and finance, behavioural finance aims to provide a more complete understanding of financial decision-making and to offer solutions to help individuals make better financial choices. As traditional finance assumes that investors behave rationally and objectively, the emergence of behavioural finance challenges this assumption by proposing that individuals often make decisions based on emotions, heuristics, and cognitive biases.

One such bias is overconfidence, which refers to the tendency of individuals to overestimate their knowledge, skills, and abilities. Overconfidence is a common behavioural bias that has been extensively studied in the field of behavioural finance due to its impact on financial decision-making and investment performance. Despite its potential negative consequences, overconfidence remains prevalent among investors and has been identified as a contributing factor to various financial crises (Barberis, Thaler 2003). This thesis will explore the concept of overconfidence in behavioural finance by examining its effects in entrepreneurial finance. Through a comprehensive review of existing literature and empirical evidence, this thesis will shed light on the complex relationship between overconfidence and financial decision-making, offering insights and recommendations to policymakers to improve their policies.

In this thesis, I undertook the exploration of behavioural finance through three distinct yet interconnected chapters. The linking thread throughout these chapters is the theme of overconfidence, its multifaceted dimensions, and its substantial impact on financial decision-making within

distinct contexts. The reoccurring presence of overconfidence across these chapters signifies its intrinsic connection to behavioural finance, highlighting its influence and serving as a cohesive element that ties together the diverse aspects of financial decision-making explored within the thesis. While the focus shifts from a broad perspective to a more targeted analysis, the exploration of overconfidence remains a constant. The primary objective of the thesis's first chapter is to lay a foundational framework for the ensuing sections by underlining the crucial role of behavioural biases, specifically overconfidence. Subsequent chapters aim to delve deeper into this exploration by analysing the impact of overconfidence on the process of financial decision-making, employing both theoretical models and empirical studies to comprehensively assess its influence.

The opening chapter of this thesis is a literature review that intends to illuminate the shortcomings of conventional finance theories in explaining various market irregularities, which ultimately led to the emergence of behavioural finance. While acknowledging the importance of traditional finance theories, this chapter identifies their inadequacy in addressing market anomalies and emphasizes the role of behavioural finance in bridging the gap between theory and real-world scenarios. Furthermore, this chapter will provide an in-depth analysis of the overconfidence bias, which is one of the most common biases affecting financial decision-making. Overconfidence has been studied in various research domains, resulting in some confusion and debate about its definition and measurement. This thesis aims to examine the three different approaches used to study overconfidence in psychological research, including overestimation, overplacement, and overprecision. However, it is essential to highlight that these three terms are specifically examined and discussed in Chapter 1 and are not consistently addressed in subsequent chapters. The conclusion reached in Chapter 1 suggests that, in the context of finance research, it is more appropriate to use the term overconfidence" as a unified concept encompassing overestimation, overplacement, and overprecision. As a result, the term "overconfidence" will be employed in the subsequent parts of this thesis. By reviewing the main methods of measuring overconfidence, this chapter seeks to determine whether overconfidence biases should be studied as separate constructs or as a unified concept, while also identifying potential limitations of these measures. The underlying assertion drawn from this analysis is that finance's methodologies and tools for evaluating overconfidence seem to face challenges in effectively distinguishing between the underlying psychological tendencies of overestimation, overprecision, and overplacement. Consequently, all three dimensions of overconfidence should be approached and studied within a unified framework of overconfidence.

The second chapter of this thesis[1] presents a theoretical model utilizing algebraic expressions to analyse various scenarios and assess the optimality of entrepreneurs' decisions under different psychological states, including rational, overconfident, and pessimistic. The model also incorporates the influence of organizational forms and taxes on decision-making. Through this theoretical model, this chapter aims to provide a comprehensive understanding of how different psychological biases, specifically overconfidence, can affect entrepreneurial decision-making and ultimately impact the success of the venture. By exploring the interplay between organizational forms, taxes, and psychological states, this chapter seeks to offer valuable insights for policymakers, investors, and entrepreneurs themselves to make informed decisions and enhance the likelihood of successful ventures. The model suggests that optimal government policy should take into account the expected entrepreneurial bias in the economy. If the confidence drops (pessimistic entrepreneurs), tax rates (both corporate and personal) should decrease and conversely if entrepreneurs become strongly overconfident, tax rates should increase.

Chapter three adopts an empirical approach, drawing on manually collected data from 256 SMEs based in the UK. The objective of the third chapter, covering the period from 2014 to 2019, is to examine the impact of various factors on investment decisions made by CEOs. The study will specifically explore the influence of a CEO's overconfidence, CEO's biography, including gender, age, educational background, and expertise/experience, as well as CEO incentives such as tenure and ownership. Furthermore, cognitive biases, particularly overconfidence, are considered alongside company performance indicators. An overconfidence proxy is constructed by analysing the portrayal of CEOs in the press, focusing on the keywords used to describe them. Through this analysis, each CEO is categorized as either overconfident or not confident, providing valuable insights into their behavioural tendencies and their influence on investment decisions within SMEs. By combining these different variables, which have been studied independently in previous

[1] The second chapter has been submitted as an article to the Industrial and Corporate Change Journal, a reputable publication hosted by Oxford University Press and recognized with a 3-star rating. Following a comprehensive evaluation, the article was subject to a revise and resubmit request. Despite addressing the suggested revisions and resubmitting the work, regrettably, it did not secure acceptance for publication. Subsequently, the article was submitted to the 2-star Journal of Small Business and Enterprise Development and is currently undergoing a review process.

research, a more comprehensive understanding of the factors that drive investment decisions in SMEs can be gained, given their importance to the economy. SMEs play a crucial role in the UK economy, accounting for a significant portion of employment, innovation, and economic growth (uk.gov 2021)[2]. However, despite their importance, there is very limited research studying the influence of overconfidence on the financial decision-making process among SMEs. The results clearly demonstrate a significant positive relationship between CEO overconfidence and the investment rate in SMEs.

Conducting a study in the realm of behavioural finance holds considerable value due to its capacity to provide nuanced insights into the complexities of human decision-making within financial contexts. Exploring the influence of behavioural biases, particularly overconfidence, offers a bridge between traditional economic models and the complex realities of the market. By delving into the psychological aspects that underlie financial choices, such research not only enhances our understanding of how individuals make decisions but also contributes to the refinement of financial theories and models. Furthermore, the implications extend beyond academia, as the insights gained from such studies can offer valuable guidance to policymakers, investors, entrepreneurs, and financial professionals. As behavioural finance uncovers the intricate interplay of emotions, cognitive biases, and market dynamics, its study has the potential to equip individuals and institutions with a more comprehensive toolkit for navigating the complexities of the financial landscape, ultimately fostering more informed and prudent decision-making.

The studies presented in this research make significant contributions to both academic literature and practical policymaking in the fields of entrepreneurship and investment. By empirically analysing the relationship between CEO characteristics, external factors, and investment decisions in SMEs, these studies provide novel insights into the drivers of entrepreneurial behaviour. Specifically, the identification of CEO overconfidence as a key determinant of investment rates underscores the importance of addressing behavioural biases in both entrepreneurial training and policymaking endeavours. Moreover, the proposed optimal government policy framework, which considers the expected entrepreneurial bias and advocates for targeted tax adjustments, offers guidance for policymakers seeking to stimulate investment and foster economic growth. Additionally, the studies' suggestions regarding targeted tax policies to enhance decision-making efficiency and

[2] gov.uk SME guidance available at: https://www.gov.uk/

increase social surplus present innovative approaches to address inefficiencies in the current tax system. Overall, these studies advance our understanding of the complexities of entrepreneurial decision-making and offer actionable recommendations to support SMEs and promote sustainable economic development.

To enhance current policies and practices in support of SMEs and entrepreneurship, several key recommendations emerge from the findings of the studies. Firstly, policymakers should prioritize initiatives aimed at addressing overconfidence biases among entrepreneurs by integrating behavioural finance principles into entrepreneurial training programs. Succession planning within SMEs should be emphasized to strike a balance between experienced leadership and innovative decision-making, considering the negative correlation between CEO age and investment levels. Creating an enabling environment for SMEs is essential, involving the reduction of bureaucratic hurdles, provision of access to financing and resources, and support for research and development initiatives. Tax policies should be evaluated and adjusted based on proposed optimal frameworks, aligning with entrepreneurs' confidence levels to promote investment. Measures to promote macroeconomic stability, such as sound monetary policies and controlling inflation rates, are crucial given the significance of inflation as a determinant of investment. Additionally, policymakers should prioritize enhancing data collection efforts to better understand the factors influencing investment decisions in SMEs. Lastly, fostering stakeholder collaboration among policymakers, researchers, industry experts, and entrepreneurs can ensure that policies are informed by diverse perspectives and empirical evidence, ultimately supporting SMEs in making more informed investment decisions and fostering sustainable economic development.

CHAPTER I: Unravelling overconfidence: bridging the gap between Standard and Behavioural Finance in investment decision-making

1.1. Introduction

This section reflects on traditional finance's approach to explaining financial decision-making and the growing importance of behavioural finance in explaining what traditional finance cannot.

Traditional finance (also known as standard finance or academic finance) is a body of knowledge that explains financial decisions based on rationality and the theories and concepts thought to drive them. These theories assume that investors adopt an objective and cautious approach to their financial decisions and that each investor behaves rationally, therefore in accordance with the related risks and returns.

In contrast, researchers taking a psychological approach to the subject propose that investors are often irrational when making financial decisions. This discrepancy has led to the emergence of behavioural finance since the 1980s, which aims to explain how personal, social, and psychological traits of individuals influence their financial decisions. Standard finance relies heavily on approaches such as the efficient market hypothesis and modern portfolio theory, while behavioural finance seeks to understand how psychological factors, such as behavioural biases, impact financial markets and associated decision-making.

By taking behavioural, psychological and social fields and merging them with finance and economics researchers have often found more accurate ways of explaining people's irrational and often suboptimal financial decision-making. For this reason, in recent years, behavioural finance has become increasingly influential, to the point that it now challenges traditional financial theory as being the best model on which to base financial decision making. But despite the increasing popularity of behavioural finance, it continues to receive criticism from certain groups, in particular from supporters of the efficient market hypothesis (Barberis 2021).

This chapter aims to shed light on how the assumptions of conventional finance theories fall short in explaining various market irregularities, giving rise to the development of behavioural finance. It considers the value of standard finance theories but also identifies situations in which they are inadequate, such as in the event of market anomalies. The significance of behavioural finance in bridging the gap between conventional finance theory predictions and real-world market scenarios is highlighted. This is done by using more realistic behavioural theories, such as prospect theory, in place of standard finance theories.

The chapter also takes a closer look at overconfidence bias, one of the most common biases affecting financial decision making. Overconfidence has been studied differently in different research domains, leading to confusion and debate about how best to define and measure this construct. It is useful to examine how overconfidence has been studied in psychological research, namely not as a single concept but as three separate concepts: overestimation, overplacement, and overprecision. The chapter addresses whether, in economics, overconfidence biases should be studied separately, as in psychology, or as a unified concept. This is achieved by reviewing the main methods of measuring overconfidence and identifying potential limitations of these measures.

This topic is pertinent because any gap in our comprehension of investor behaviour weakens our ability to predict financial market performance. If we neglect to look more deeply at – and therefore understand - areas of financial inconsistency, we will never be able to accurately assess the true state of any financial market. It is crucial to note that a central traditional market assumption (the absence of information asymmetry) was identified as a contributor to the Global Financial Crisis of 2007-2008 (Stiglitz 2009). Once again, this underscores the significance of this topic. Solely relying on traditional finance theories appears to hinder our making profitable and informed investing decisions.

The chapter is organised into eight sections and a conclusion. Sections 2 and 3 explore the history of both standard and behavioural finance and reflect on how their theories developed. Section 4 and 5 survey the drawbacks and limitations of both theories. Section 6 examines the three different types of overconfidence (overestimation, overprecision and overplacement) from a psychological standpoint. Sections 7 and 8 review how finance research measures overconfidence and

assesses how accurate or adequate the measures would be at quantifying the different types of overconfidence. Section 9 concludes the chapter.

1.2. Review of Standard Finance Approach

This section presents an overview of standard finance in terms of its history, key literature and theories.

Standard finance predicts financial decisions using only two concepts: risk and return. Its theories assume every individual aims to maximise return and minimise risk through each decision. It predicts that financial decisions rely on strict mathematical calculations or the pre-existing traditional financial theories. Four basic assumptions underpin traditional finance theories: that investment markets are efficient, investors are rational, that they design their portfolio on the basis of mean variance, and that predicted returns depend on perceived risk.

Traditional finance theories began to visibly emerge in the mid-nineteenth century. For instance, John Stuart Mill, in 1844, proposed the idea of *Homo economicus* - or economic man – reflecting a rational individual who strives to maximise their economic wellbeing despite operating within certain constraints. Mill's triad of underlying assumptions are perfect self-interest, perfect information and perfect rationality (John Stuart Mill, 1844). These three assumptions subsequently became central to the traditional financial model in its aim to secure equilibrium solutions through maximising the marginal utilities for individuals affected by situational constraints. Daneil Bernoulli, in 1738 and in 1954, compares expected utilities to study decision-making under risk (Daneil, Bernoulli 1738).

Statman (1999) states that standard finance is compelling because it leverages so few components to create a unified theory – its pillars being John Lintner and William Sharpe's capital asset pricing theory, arbitrage principles proposed by Merton Miller and Franco Modigliani, the option-pricing theory proposed by Fischer Black, Myron Scholes, and Robert Merton and portfolio construction principles contributed by Harry Markowitz.

Von Neumann and Morgenstern (1944) develop their "Expected Utility Theory". They propose that a rational investor will attempt to maximise his expected utility by multiplying the

weighted sum of utility values by their respective probabilities. Their theory adopts three investor categories: risk adverse, risk neutral, risk taker.

Modern Portfolio Theory began to emerge following the publication of Markowitz's paper "Portfolio Selection" in 1952 (Markowitz, 1952). Although the significance of the paper took years to be acknowledged it ultimately gained recognition and interest from academia. The theory assumes investors to be fully rational in their decisions. It also accepts that stock prices always incorporate optimum information about their values, and that prices only change as a result of reliable information. In the 1970s, finance models used rational expectations to link speculative asset prices to economic fundamentals. This led to finance being connected to and inseparable from the wider economy. Traditional finance bases itself on the four foundations of: investors being rational; markets being efficient; expected returns being a function of risk only; investor portfolios should be designed solely according to Mean-Variance Portfolio Theory rules.

In his 1952 paper, Harry Markowitz introduces a portfolio selection model, "Markowitz portfolio theory". This theory proposes that the optimal portfolio construction process involves choosing a mix of high-risk securities alongside risk-free assets – therefore both maximising the expected return and minimising the risk. The theory is a practical help in the construction of portfolios. Markowitz portfolio theory subsequently gave rise to CAPM - the Capital Asset Pricing Model.

Pioneers behind CAPM include Sharpe (1963, 1964) and Lintner (1965). Its simplicity resulted in CAPM's wide acceptance and popularity (Sharpe, 1964). Even so, many traditional theorists were not fans due to its anomalies with regards to market efficiency (Lintner, 1965). By taking into account the risk of a particular asset, CAPM determines a fitting rate of return if it is to be included in a diversified portfolio. Central to this model is the idea that investors must get compensation for market specific risk and the time value of money. It envisages the return on all individual investments and investment portfolios within the economy. The model relates the difference between the envisaged returns of any pair of assets and that of their betas, β. The risk of the asset, and consequently the sought-after return, increases as β increases.

In 1970, Eugene Fama introduced "Efficient Market Hypothesis" (EMH) another important theme for standard finance. This hypothesis assesses how news or information impacts the market and from there interprets market efficiency and expected return (Eugene Fama, 1970). Fama

proposes that beating the market is impossible as the distribution of information by financial markets is efficient. EMH is founded on the idea that a security's price or market value already reflects all information, so therefore the price the asset is trading for at any moment is an accurate value. As stocks are believed to be valued correctly, advocates of the hypothesis argue that portfolio managers or active traders cannot, over time, "outperform the market". As a result, they propose that investors should opt to own the "entire market" rather than futilely striving to achieve superior returns. Given that 60% to 80% of the time the S&P 500 stock index outperforms the overall market, the proposal is supported. Eugene Fama categorizes market efficiency into three forms. *Weak form efficiency* suggests that asset prices fully reflect all historical price information, rendering it impossible to predict future price movements using past trading data alone. *Semi-strong form efficiency* implies that asset prices reflect all publicly available information, including company announcements and economic indicators, making it difficult to consistently achieve above-average returns by trading on public information. Lastly, *strong form efficiency* asserts that asset prices reflect all information, both public and private, meaning that even insider information cannot be used to gain abnormal returns, as all relevant information is already incorporated into asset prices. (Fama, 1992).

Arbitrage Pricing Theory (APT), introduced by Stephen Ross in his 1976 paper, "The Arbitrage Theory of Capital Asset Pricing," revolutionized the field of asset pricing. Unlike the Capital Asset Pricing Model (CAPM), which relies on the single-factor market model, APT offers a multifactor approach to explain asset prices and expected returns. Ross's theory proposes that the expected return of an asset is determined by its exposure to various systematic risk factors, such as interest rate changes, inflation, and macroeconomic indicators, rather than solely by its covariance with the market portfolio. APT suggests that mispricing in securities arises from deviations between their actual prices and their theoretical values based on these risk factors. Arbitrageurs exploit these mispricings to earn riskless profits, which, in turn, lead to price adjustments that restore market efficiency. By considering multiple risk factors, APT provides a more comprehensive framework for understanding asset pricing dynamics and has become a cornerstone of modern finance theory (Stephen Ross, 1980).

Such theories, for a long time, were accepted as the ideal explanation of investor and market behaviour. However, more recently, researchers have observed how traditional theories often fail

to accurately reflect actual market conditions and investor activity. There's an emerging acceptance that standard finance theories may be founded on over-simplified assumptions. Traditional finance theories are based on how markets and investors "should" behave (i.e. in accordance with economic predictions), rather than how they "actually" behave. This precipitated the development of behavioural finance which, in notable contrast to traditional finance, allows for the existence of the irrational and biased investors.

1.3. Review of Behavioural Finance Approach

This section looks at the growing importance of behavioural finance in explaining financial decision making that traditional finance fails to explain.

The field of behavioural finance emerged academically in the late 20th century as a response to the limitations of traditional finance theory. Over the last 40 years, investor decision-making processes have become better understood because traditional financial theories have partially explained them. However, simultaneously, a problem arose because standard theories did not take account of irrational behaviour. For instance, the Efficient Market Hypothesis bases itself on the idea that market participants approach asset prices rationally, by taking into account all factors – current, future intrinsic and external. However, it was becoming evident that investors and portfolio managers may also behave irrationally, that stock markets are not always efficient and that, when designing their portfolio, investors do not always follow the mean variance rule. As the influence of psychological factors became more evident, the novel field of behavioural finance strengthened its capacity to incorporate investor psychology, bias and irrationality into its theories (Shefrin, Statman 2000).

The importance of behavioural finance became clear as its analysis of market prices and fluctuations could be used to benefit both speculation and decision-making. Neuroscience and psychology studies have already established that the human mind is a complicated thing to study. The human brain is a complex organ, and where people may sometimes be rational in their decision making, at other times, they may behave recklessly (Kahneman 2011).

In 1759, Adam Smith, a Scottish economist and moral philosopher, published his "Theory of Moral Sentiments" in which he explores morality and selfishness (Smith, 1759). Smith discusses

an “invisible hand” – alluding to a morality that instinctively guides individuals in their social, economic and financial decisions. Stressing the role of traits such as pride, shame, egotism and insecurity, Smith concludes that, in general, people make decisions that result in outcomes that advance their own interests. He finds that people love praise, therefore their decision making is sometimes determined by whether they think a decision will win them praise. They may consider the more praiseworthy decision to be the correct one (Smith, 1776).

In 1776, two decades after publishing his “Theory of Moral Sentiments”, Adam Smith follows it with “The Wealth of Nations” – one of the first descriptions of the factors that build a nation’s wealth (Smith, 1776). A decade later, Jeremy Bentham (1789) draws attention to the psychological influences on utility function. Bentham proposes that a human’s desire for happiness means they can never make a decision that is not coloured by emotions. Despite both researchers emphasising the influential role of psychology in economic behaviour, their proposals were gradually forgotten over the next century.

However, in the late nineteenth century, ideas related to behavioural finance again began to surface, particularly in the influential 1896 book, “The Crowd: A Study of the Popular Mind”, by Gustave le Bon. Throughout the twentieth century, le Bon's work gained further momentum. Selden (1912) observed that investor sentiment determined stock price movements. Simon (1955) argued that an individual's rationality is constrained by both the information available to them and their inherent cognitive limitations. The Theory of Bounded Rationality presents a more practical iteration of standard expected utility theory by factoring in human judgment limitations. Pratt (1964) explored the utility function by comparing local to global risk aversion, ultimately finding that decision-makers have more local risk aversion when they are globally more risk-averse. Pratt also linked this to a utility function that evaluates risk as being a proportion of total assets.

In the mid-twentieth century, Leon Festinger, a US psychologist, proposes the idea of “cognitive dissonance”. This refers to two cognitions being held simultaneously yet in nature or content both being in conflict (Festinger, Riecken & Schachter 1956). Internal dissonance leads to such a degree of discomfort or confusion in the person experiencing it that the person will attempt to evade it by changing their beliefs.

However, the most ground-breaking research into behavioural finance can be attributed to Israeli psychologists Daniel Kahneman and Amos Tversky (Kahneman D & Tversky A). In 1973,

Tversky and Kahneman greatly influenced the field of behavioural finance by introducing the availability heuristic. This judgmental heuristic proposes that a person evaluates the probability of an event or the frequency of classes according to how easily relevant instances come to mind ("availability"). Humans' instinctive mental default to availability heuristics produces systematic biases.

Six years later, in 1979, the same researchers disrupt the decision-science world with a paper that was – and still is - considered the most influential in the field of behavioural finance. In it, they introduce a concept of "Prospect Theory", which is designed for analysing decision-making under risk (Kahneman D & Tversky A, 1979). In it, they describe four heuristics typically employed when making decisions in the face of uncertainty: representativeness, availability, anchoring and adjustment. Prospect theory proposes that people exhibit either risk aversion or risk seeking behaviour in response to available choices or relative probability of outcomes. They may act as risk-takers in decisions where they presume gains are assured yet become risk averse in decisions with a likelihood of losses. Kahneman D & Tversky A, (1974) state that people assign value to gains and losses, search for available options (or prospects), and then rank them according to rules of thumb (heuristics). Later they evaluate their options against any reference that provides a reasonable relative basis for predicting their gains and losses. The theory says that the significance of a loss to an individual is always higher than that of a gain – even if for the same amount - because investors are typically keener to avoid a loss than make a gain (Kahneman & Tversky, 1981). This phenomenon is known as loss aversion.

In 1981, Robert J Shiller, researching stock market volatility, presents an alternative to standard financial theories (Shiller RJ, 1981). Two decades later, in his bestselling book, Irrational Exuberance (Shiller RJ, 2005), he sets out to explain US stock market fluctuations in terms of market participant behaviour. Notably, exploring the market bubble of the late 1990s, he points to the contributing factors of investor perception, psychology and culture.

In 1994 Meir Statman and Shefrin develop the "Behavioural Asset Pricing Model (BAPM)", a new pricing model that allocates investors as either being informational traders or noise traders. An information trader is effectively a rational investor who aligns with the CAPM model. In contrast, noise traders do not follow either the CAPM or traditional financial models so are irrational (Shefrin and Statman, 1994). Shefrin and Statman's "Behavioural Portfolio Theory (BPT)" follows

in the year 2000. It models how investor behavioural bias and associated risk tolerance shape how they construct their portfolios (Shefrin and Statman, 2011).

Stein (2003), in a review of capital budgeting literature identifies that managerial overconfidence may influence corporate investment decision-making. Drawing on references from psychology, he suggests that behavioural biases can lead individuals to overestimate their capabilities, therefore potentially affecting a company's investments.

In 2003, another significant contribution to behavioural finance was made by Barberis and Thaler. Their research into individual trading behaviour aimed to unravel behavioural finance applications in relation to stock market average returns. Their proposition is that behavioural finance relies on two assumptions: limits to arbitrage – meaning that it is difficult for rational traders to counter dislocations triggered by irrational traders; and psychology, which addresses deviations from rationality.

In conclusion, the emergence and evolution of behavioural finance have significantly contributed to our understanding of financial decision-making processes that traditional finance theories alone fail to explain. Over the past century, various scholars and researchers have delved into the realms of psychology, economics, and finance to unravel the complexities of human behaviour in financial markets. From Adam Smith's exploration of moral sentiments to the groundbreaking work of Daniel Kahneman and Amos Tversky on prospect theory, the journey of behavioural finance has been marked by seminal discoveries and paradigm shifts. By integrating insights from psychology into economic models, behavioural finance has provided a more nuanced understanding of investor behaviour, market dynamics, and asset pricing. Moreover, the development of behavioural finance models such as the Behavioural Asset Pricing Model (BAPM) and Behavioural Portfolio Theory (BPT) has paved the way for a more comprehensive approach to portfolio construction and investment management.

1.4. Entrepreneurial Finance In The Context Of Behavioural Finance

Behavioural finance has garnered increasing attention in the realm of entrepreneurship finance and the financial decision-making processes of CEOs, as evidenced by the literature in this

field. Drawing upon a comprehensive review of relevant studies, this discussion explores key themes and findings in behavioural finance research within these contexts.

One prominent area of investigation in entrepreneurship finance is the impact of psychological biases on entrepreneurial decision-making. Studies such as Shane (2003), Cooper et al. (2018), and Simon et al. (2000) have highlighted how cognitive biases such as overconfidence, optimism, and risk aversion can significantly influence entrepreneurs' perceptions of risk and opportunity. For example, Simon et al. (2000) emphasized the bounded rationality of entrepreneurs, suggesting that decision-making is often constrained by cognitive limitations and information asymmetries, leading to deviations from traditional economic models.

Furthermore, behavioural finance research has examined the role of emotions in shaping entrepreneurial behaviour and financial decision-making. For instance, Shepherd and Patzelt (2018) explored the impact of affective states such as fear and excitement on entrepreneurs' risk perception and decision-making processes. Their findings suggest that emotional arousal can lead to heightened risk perception and impulsive decision-making, particularly in high-stakes situations.

In the context of CEO financial decision-making, behavioural finance literature has unearthed several critical insights into the complexities of executive behaviour and its impact on corporate financial outcomes. Building upon foundational works by scholars such as Malmendier and Tate (2005), Graham et al. (2009), and Baker et al. (2007), researchers have delved deeper into understanding how CEO behavioural biases shape corporate financial policies and investment strategies. For instance, Malmendier and Tate (2005) provided compelling evidence that overconfident CEOs tend to undertake riskier investment projects and pursue value-destroying acquisitions, leading to adverse consequences for firm performance. Similarly, Graham et al. (2009) shed light on the role of managerial attitudes in driving corporate actions, demonstrating how CEO characteristics such as risk preferences and optimism influence strategic decision-making processes. Moreover, Baker et al. (2007) highlighted the significance of CEOs' personal experiences and risk perceptions in shaping their strategic choices, particularly in the context of mergers and acquisitions. By integrating insights from behavioural finance, these studies offer valuable contributions to understanding the nuanced interplay between CEO behaviour, psychological biases, and

corporate financial decision-making, providing implications for both theory and practice in the field of finance and management.

Moreover, research in this area has examined the influence of social and cognitive factors on CEO decision-making. For instance, Hambrick and Mason (1984) explored the concept of managerial discretion and its implications for CEO decision-making autonomy and firm performance. Their study suggests that CEOs' personal characteristics, social networks, and cognitive biases can shape their strategic choices and influence firm outcomes.

Overall, the literature review underscores the importance of incorporating insights from behavioural finance into entrepreneurship finance and CEO decision-making processes. By understanding the psychological biases and emotional factors that influence financial decision-making, entrepreneurs and CEOs can make more informed and rational choices that enhance firm performance and value creation. Additionally, this research highlights the need for policymakers and investors to consider the behavioural aspects of decision-making when designing strategies and interventions to support entrepreneurial ventures and established firms.

1.5. The Conflict of Traditional and Behavioural Finance Theories

This section presents the conflict between traditional and behavioural finance. It also gives examples of market phenomena that can be explained by behavioural finance but not by traditional finance or vice versa.

Even though behavioural finance has gained popularity in recent times, it still faces criticism from some quarters. Typically, efficient-market hypothesis advocates are the loudest opponents of behavioural finance. Regarded as a cornerstone of contemporary financial theory, the efficient market hypothesis fails to consider irrational behaviour as it posits that the market value of any security reflects the influence of all pertinent information upon its release (Lo, 2005).

The conflict between traditional and behavioural economics theories has sparked the evolution of economic perspectives and methodologies. This ongoing debate has given rise to innovative research techniques such as choice architecture and design economics (Santos, 2011). In the scientific realm, arguments often stimulate the generation of fresh ideas and evidence to support different approaches and theories. The debate between proponents of traditional and behavioural

finance in economics is particularly intense and enduring, with opposing viewpoints and justifications for events in financial markets. These theories fundamentally clash, with efficient versus inefficient markets, rational versus irrational investors, and Homo economicus versus Homo sapiens being their primary tenets. Traditional finance sets the basic principles of economic science, while behavioural finance connects economics with psychology in a more innovative manner (Faber, 2011).

Eugene Fama, the pioneer of market efficiency theory and the most prominent critic of behavioural finance acknowledges that certain anomalies cannot be accounted for by contemporary financial theory. However, Fama also maintains that market efficiency ought not to be completely disregarded in favour of behavioural finance. Fama suggests that several anomalies identified in traditional theories might be regarded as temporary chance occurrences that are ultimately rectified with time. In his publication titled "Market Efficiency, Long-Term Returns and Behavioural Finance," (1997) Fama contends that multiple discoveries in behavioural finance appear to oppose one another and that in general behavioural finance consists of irregularities that are possible to explain by market efficiency. In his view, there is no such thing as behavioural finance and it's just a criticism of efficient markets (Fama, 1997).

At first glance, both traditional finance and behavioural finance theories have their advantages and are applicable in theoretical models. However, the challenge lies in their practical application in real financial markets, which are essentially places where buyers and sellers come together. In such markets, financial anomalies sometimes occur, rendering traditional finance theory ineffective. This is because a key element in financial markets is the human factor, which encompasses a range of emotions and decision-making processes that economics alone cannot fully explain. This is where behavioural finance has a distinct advantage over traditional finance theory, as it draws from psychology to provide more comprehensive explanations for financial market anomalies.

1.6. Market anomalies – reinforcement of the foundations of Behavioural Finance

An anomaly outside of financial markets is typically defined as an unusual or strange occurrence. However, in the investment world, an anomaly reflects a situation in which a security (or

group of securities) behaves in a manner that contradicts the idea of efficient markets i.e. one in which security prices are believed to incorporate all available information all the time. Given the relentless publication and high-speed dissemination of any new information, achieving and sustaining efficient markets is often difficult. The complexity of financial markets also renders them almost unpredictable, as was demonstrated during the global financial crisis.

Finance professionals and academics, through their attempts to identify and predict significant market fluctuations, have made market anomalies a crucial area of scientific research. Numerous market anomalies have been recognised in scholarly literature, with some being short-lived while others persist across various investment markets (Mačerinskienė, Kartašova, 2012). Any anomalies in financial markets serve to prove that efficient financial markets do not exist. To gain more knowledge about financial market anomalies, a plethora of research has been conducted. For instance, a study of stock market returns in 18 countries, by A. Agrawal and K. Tandon, finds seasonal anomalies in almost all countries (Bollerslev, Tauchen 1994). The presence of financial market anomalies is evident.

The emergence of financial market anomalies has been attributed to several factors, with investor irrationality and decisions being the primary drivers. Mačerinskienė and Kartašova (2012) have identified lack of professionalism, poor investment experience, misunderstanding and misinterpretation of information, weak focus and concentration, alongside cognitive biases such as overconfidence, the disposition effect and anchoring bias, representativeness, availability and regret aversion as the main causes of investor irrationality and resulting anomalies in financial markets.

Several concepts in finance cannot be explained by traditional finance but can be explained by behavioural finance. These include over/undervaluation, excess volatility, speculation bubbles, size effects, and calendar effects. Each concept is explored in more detail below.

1.6.1. Over- and undervaluation

Over/undervaluation refers to the difference between an asset's perceived or expected value and its actual market price. Behavioural finance suggests that investors' emotions and biases can cause them to overreact to news and events, leading to prices that deviate from their fundamental values. For example, if investors become overly optimistic about a company's prospects, they may bid up its stock price beyond what the company's actual earnings or revenue justify, resulting in

overvaluation. Conversely, if investors become overly pessimistic, they may sell off shares of a company at a price below its fundamental value, resulting in undervaluation (Wang, Chen, 2017).

1.6.2. Excess volatility

Excess volatility refers to the tendency of financial markets to experience large swings in prices that cannot be explained by changes in the underlying fundamentals of the assets being traded. Overall, the stock market behaves in a too volatile manner for it to be a result of purely rational behaviour. Also, it is sometimes host to seemingly illogical valuations. The existence of excessive volatility is strongly evidenced, including in the work of Cutler, Porterba & Summers (1989). Their research looks at the significant stock price movements and major news events (as published in the New York Times) over five decades up to the late 1980s and considers whether there is a relationship between the two. They find that although some volatility can be explained by news, a large proportion cannot. For instance, after news broke about the attack on Pearl Harbour (8th December 1941) a 4.37% drop in the US market resulted. A market impact seems inevitable on occasions of big news. Similarly, we would expect presidential elections, which always spawn a glut of frontpage headlines, to affect the market as the public react to each candidate's economic policy (and the likelihood of it coming into play). However, when Goldwater was defeated by Johnson in 1864, the stock market hardly moved – only increasing by 0.05%. This was because it was already known that Johnson was likely to win outright. In the same research Cutler, Porterba and Summers also studied the 50 largest market changes and attempted to link them to material information. In some cases, this was easy, in other cases they could find no reason for the price changes or information on why the market reacted. When the stock market slumped by 6.73% on 3rd September 1946 even the New York Times acknowledged that there was no apparent cause (Schwert, 1997).

Behavioural finance argues that such perplexing phenomena as excess volatility and price anomalies can be explained by the interference of investor emotions and biases. For instance, fear or greed may prompt investors to buy and sell based on short-term fluctuations rather than long-term trends.

1.6.3. Speculation bubbles

Irrational investor behaviour similarly underpins what are known as speculation bubbles - when the price of an asset rises rapidly and exceeds its fundamental value, only to eventually crash back down to a more realistic price. Behavioural finance suggests that speculation bubbles are driven by investor emotions and biases such as herd mentality and overconfidence. These prompt investors to buy into a hot market without fully considering the risks and potential downsides. Technology bubbles are a type of speculative bubble, for instance the dot-com boom. They can only be identified after they burst, when prices slide or crash (Hong, Stein 2002). Technology bubbles form when high values are triggered by investor enthusiasm rather than by rational economics. The dot-com boom was a bubble that began to emerge in 1995 and peaked in March 2000. It went hand in hand with massive investment in internet-based companies at a time of rapid adoption of the internet, a flood of related technologies, plentiful availability of venture capital and over-egged valuations of dot-com start-ups. The Nasdaq Composite stock market index grew 800% over that period, then dramatically fell by 78% by October 2002. From spectacular rise to spectacular crash, all gains of the bubble evaporated. Online shops such Pets.com, Webvan, Boo.com and communications companies like Worldcom were forced to close. Others had to be acquired or taken over. Some largescale corporates such as Cisco, Amazon and eBay lost huge value, but adapted and survived (Rohner, White 2011).

Curiously, after a bubble bursts, investors often display hindsight bias, claiming that they knew all along that it was a bubble and that the prices could not be sustained at such giddy heights. The question arises why they invested and retained their investment so long as to lose - sometimes huge amounts of money. This is certainly a display of irrational, not rational investor behaviour.

1.6.4. Size effects

Another phenomenon that can be explained by behavioural science but not traditional is a tendency known as size effects. Initially identified by Banz (1981), this effect posits that smaller firms—typically characterized by lower market capitalizations—tend to yield higher risk-adjusted returns than their larger counterparts over extended periods. This anomaly not only confronts the Efficient Market Hypothesis (EMH), which advocates for market rationality and the impossibility of consistently achieving superior returns without increased risk, but it also underscores the

significance of behavioural finance as a critical lens for understanding market dynamics. Behavioural finance suggests that the size effect may be attributed to the underrepresentation and undervaluation of smaller companies by analysts and investors, leading to frequent mispricings. Such mispricings present lucrative opportunities for informed investors to capitalize on the eventual market correction, thereby securing higher returns. The persistence of the size effect in empirical research highlights the intricate interplay between market efficiency, investor behaviour, and asset pricing, offering fertile ground for further investigation within the domain of financial academia (Banz, 1981).

1.6.5. Calendar effect

Behavioural finance has also allowed us to explain why financial markets may exhibit certain odd patterns or anomalies at regular times or dates. This is known as the calendar effect. The theory points to such patterns arising from irrational investor behaviour e.g. psychological bias, emotion-driven decisions, tax-related selling or bias towards certain dates or events. For instance, take the Monday effect, a market anomaly which concerns the phenomenon of lower stock values on Mondays than on other weekdays (French, 1980).

Not all theories that fall under the umbrella of the calendar effect are reliable. However, some – specifically those that use evidence backed up by statistics – may be a potentially useful guide as to when is a good time (or not) to invest. One popular calendar effect theory, the October effect, claims that the biggest stock market crashes happen in October. It's possible to collate historical records and other evidence in an attempt to shore up this theory that stocks often trade lower in October. Make, for example, a list of the market crashes in the Octobers of 1907 (Bank Panic), 1929 (Black Tuesday), 1987 (Black Monday) and 2008 (Global Financial Crisis). However, statistical evidence is not actually sufficient to support it. The question arises as to whether it could become a self-fulfilling prophecy, even in a mild way. The rational investor ought to ignore the October effect because of the lack of statistical evidence. But, as we have seen, irrational investors exist. Take a big enough cohort of irrational investors, cognizant of the theory, therefore nervous of October, and their investment behaviour as a group could ever create market ripples that grow to statistical levels over time.

1.6.6. Limitations and challenges of Behavioural Finance

The following section will look at the limits of behavioural finance. Despite behaviourists having proposed various explanatory theories and models to address anomalies in the former finance doctrine, none of the theories are sufficiently developed to unequivocally challenge the existing efficient markets model. This leads to behavioural finance often being cast under the shadow of its limitations, as explored below.

Behavioural finance, while serving as a critique of traditional finance, faces limitations in providing a comprehensive alternative framework. It challenges the assumption of rational utility-maximizing behaviour upheld by traditional finance, exposing the complexities of human biases and psychology. As noted by Lo (2005), behavioural finance effectively disproves the notion of the info-rational investor or CEO, highlighting the inadequacies of traditional finance theory. However, a key limitation lies in its failure to offer a concrete alternative theory. While behavioural science undermines traditional finance approaches, it does not propose clear alternative frameworks. Moreover, behavioural science relies on proxies rather than direct measurements, leading to inconsistencies in study results. Without easily empirically testable propositions, behavioural finance lacks the precision required to forge new theories. Investors seeking guidance for their investments cannot rely solely on the unpredictable nature of behavioural science. Instead, they require actionable insights that guide them toward optimal investment decisions. As argued by Barberis and Thaler (2003), behavioural finance illuminates the gaps in traditional finance but falls short in providing robust solutions to fill those gaps. Therefore, while behavioural finance offers valuable insights into human behaviour and decision-making, its limitations underscore the need for complementary approaches to guide investment strategies effectively.

The first limit is that behavioural finance is essentially a critique of traditional finance, but it is not an alternative. Its premise is that no individual – with all our complex human biases and intricate psychologies – is the rational utility-maximising person that traditional finance assumes investors and CEOs to be. Being correct in this regard, it is effective at disproving traditional finance theory and the idea of the info-rational investor or CEO. However, the limitation is that while behavioural science may have somewhat invalidated traditional finance approaches, it may not, itself, suffice as the alternative to it. Neither does it propose any other alternative theories. Behavioural science does not offer anything that is easily empirically tested – something

traditionally necessary if one wishes to forge a new theory. Behavioural science relies on proxies, not direct measurements and the results of studies in this field can be inconsistent. Investors cannot rely solely on the unpredictable nature of behavioural science, as their investments require guidance towards the right direction rather than solely avoiding the wrong direction. Investments cannot be based on criticisms. In essence, behavioural finance explains where traditional finance has gaps, but it cannot fill those gaps.

Another limitation of behavioural science is its potential to undermine investor confidence. Critics argue that behavioural finance tends to overemphasize the role of irrational behaviour in financial markets while underestimating the significance of rational decision-making (Thaler, 2015). Investors ideally seek definitive information to guide their decisions, such as clear indicators of profitability or lack thereof. However, such certainty about the future is often unavailable. Consequently, investors rely on probabilities, evidence-based theories, anecdotal evidence, and personal experiences, including both conscious and unconscious biases, for reassurance (Kahneman, 2011). If the individual has already subconsciously or intuitively decided they do or do not want to invest, they may unwittingly pick out only the evidence that supports that decision, but even then, rightly or wrongly, they will implement their financial decision with confidence. However, when the unpredictable factor of "behaviour" is introduced, investors become apprehensive. Behavioural finance theory acts to reduce investor confidence. It prompts investors to doubt and second-guess themselves. It is understandable therefore that investors who are exposed to behavioural finance theories report difficulty making decisions afterwards. They are thrown into doubt. They question now whether their decisions are mainly influenced by bias, not fact. With the foundation of confidence shattered, they find themselves uncertain about the validity of their "logical thought processes" (Lo, 2005).”. The challenge emerges of finding a source for objective guidance for investors, as the once dependable traditional finance theory, which they have always relied upon, is now punctured by the insights of behavioural finance theory. Their decision-making ability is suddenly stymied. Under a cloud of doubt, their investment decisions may slow even though the market is a time-sensitive thing. An unconfident investor may not be able to unravel their doubts about bias vs fact fast enough to invest before the investment opportunity has already passed.

The presence of uncertainty inevitably fosters confusion, and behavioural finance theories notably contribute to the bewilderment experienced by investors. For instance, one of its theories may conclude that investors are risk-averse, but simultaneously conclude that investors are over-confident. Behavioural finance practitioners defend these contradictory inferences by claiming that an investor will behave differently in different circumstances. However, in terms of common sense and psychology, a person who is risk-averse is unlikely to also be risk-seeking (Kamoune and Ibenrissoul 2022).

Behavioural finance is limited in its applicability to institutional investors compared to individual investors. The majority of behavioural biases identified in the field primarily pertain to individual decision-making processes and may not translate directly to institutional behaviour (Barberis, 2013). Institutional investors, such as mutual funds, pension funds, and hedge funds, represent a significant portion of the market and are typically managed by professionals who may not be as susceptible to cognitive biases as individual investors (Barberis & Thaler, 2003). These fund managers prioritize fund performance and adhere to regulatory requirements and industry standards, which can help mitigate biases. Additionally, their investment decisions are made on behalf of others rather than for personal gain, further reducing the influence of emotional biases (Thaler & Sunstein, 2008). While behavioural finance theory provides valuable insights into individual decision-making, its application to institutional behaviour remains limited.

Behavioural finance has yet to fully incorporate the influence of social status on investment decisions. While many investment decisions are made with the aim of financial profit, some are motivated by the desire to enhance social status. Investments in luxury real estate, for example, may prioritize social perception over financial returns. Despite their potential financial drawbacks, such investments can confer social status and prestige to the investor (Hoffman, 2017). However, behavioural science has largely overlooked the phenomenon of status-based investments and the underlying motivations driving them.

Behavioural finance, in its approach, tends to overlook emotions by treating them in an unemotional manner. It perceives emotions as biases or cognitive issues that simply need to be resolved, without fully acknowledging their complex and intrinsic nature. However, emotions are a part of the human experience that have evolved to be useful in keeping us safe and shepherding us away from danger and instability. An investor who shuts down their emotions, thinking it wise,

may become financially rich but miss out on a rich human experience. The ideal is for an investor to optimise their emotions, listening to them as cues or as representing instinct, but also tempering them with clinical rationality before making decisions (Kamoune and Ibenrissoul 2022).

In conclusion, the conflict between behavioural finance and traditional finance arises due to their fundamental differences in assumptions about the rationality and behaviour of market participants. While traditional finance assumes that market participants are perfectly rational and make optimal decisions based on all available information, behavioural finance recognises that human behaviour is often driven by emotions, biases, and heuristics that can lead to irrational decision-making.

The conflict between traditional finance and behavioural finance has been a long-standing debate in the financial world, with traditional finance emphasizing the rationality of investors, while behavioural finance highlights the role of psychological biases. One of the areas of disagreement is the concept of overconfidence, which refers to investors' tendency to overestimate their abilities and knowledge, leading to suboptimal investment decisions (Barberis, Thaler 2003). In this context, it is interesting to explore the three types of overconfidence: overestimation of one's own ability, overprecision in one's beliefs, and overplacement of one's self in comparison to others.

1.7. Three forms of overconfidence

This section delves into overconfidence, a frequently studied behavioural bias that stands out as both common and extensively researched. However, a notable discrepancy emerges regarding its conceptualization: while economics treats overconfidence as a singular bias, psychology recognizes it as comprising three distinct components—overestimation, overprecision, and overplacement. This raises the question of whether economists could gain insights by adopting psychology's approach, dissecting overconfidence into its constituent parts rather than treating it as a unified concept.

Overconfidence bias is a psychological phenomenon where individuals overestimate their abilities, knowledge, or the accuracy of their beliefs and predictions. This bias leads people to be more confident in their judgements than is warranted by the evidence and can result in them making decisions that are not well-informed or that may not align with reality. Overconfidence, in

recent times, has increasingly been factored into behavioural economic models to better explain certain perplexing empirical phenomena. Literature has increasingly pointed towards overconfidence as an important driver of entrepreneurial outcomes. It is now frequently examined and debated in both psychological and economic literature, albeit often using different discipline-specific approaches of method or definition. (Cooper, Woo and Dunkelberg, 2018). However, it is worth noting that overconfidence remains the same phenomenon regardless of how it is labelled or categorized. The consideration lies in determining the appropriate level of detail for studying it. In financial literature, numerous findings are frequently consolidated under the overarching concept of overconfidence.

However, psychological literature describes three distinct behavioural expressions that together form overconfidence: *overplacement*, which is when an individual believes that they are better than average, *overprecision*, where an individual is excessively certain that they know the truth, and *overestimation*, in which an individual has an inflated sense of their actual ability, performance, control over external events and chances of success (Moore and Healy, 2008).

Various research angles and techniques are used to study overconfidence in financial markets. However, usually they all assume that overconfidence is underpinned by a single psychological mechanism. Such an assumption is likely to be misguided though, because overconfidence seems not to be a unified construct. Conflicting results from different studies on overconfidence are further complicated by the inconsistent usage of the term "overconfidence" in popular discourse.

To ensure clarity, this review analyses the three types of overconfidence. While overconfidence can be examined from different perspectives, and as overconfident beliefs are inherently erroneous, it is worth asking whether, in financial research, it is appropriate to corral overestimation, overplacement, and overprecision into the single confine of overconfidence. Studies in psychology that investigate overconfidence typically focus on only one of these three types at a time.

In 2008, Moore and Healy conducted a comprehensive literature review regarding overconfidence in the area of psychology. Their analysis of 511 papers revealed that 46% of the studies focused on overestimation, 32% on overplacement, and 22% on overprecision.

To understand the differences between overestimation, overprecision and overplacement, it is necessary to analyse related research in the field of psychology and the different tests that have been performed on each concept. Below, the three aspects of overconfidence are discussed separately. The aim is to help us conclude whether it is more useful in financial research to study the three concepts of overconfidence separately, or as one. Overall, the review highlights the diverse and inconsistent nature of overconfidence and emphasises the need for a clearer understanding of this concept in order to avoid confusion and potential misinterpretation in research.

1.7.1. Overestimation

Many believe that wishful thinking is the main driver behind overestimation, particularly in the case of optimistic predictions for the future, as noted by Sharot (2011) and Taylor (1989). This view suggests that people tend to overestimate the probability or number of positive outcomes in a self-serving manner. However, this claim is fraught with issues from practical, conceptual, and empirical standpoints. Practically, it is problematic because there are numerous situations where holding inaccurate beliefs is proven to be maladaptive. Conceptually, the claim is questionable as the psychological concepts underpinning self-deception are unverified.

That wishful thinking may lead to overestimation presents an empirical challenge as the evidence for self-deception is not convincing. Firstly, distinguishing between true self-deception vs deliberate attempts at deceiving others is difficult, even with strong incentives for honest reporting, as motives to impress others cannot be eliminated (Simmons & Massey, 2012). Furthermore, research indicates that overestimation does not always depend on self-deception, as participants who are less skilled in a task may show even greater overestimation than their peers due to a lack of awareness about their knowledge gaps (Ehrlinger, Johnson, Banner, Dunning, & Kruger, 2008; Miller & Geraci, 2011).

Moreover, as empirical evidence for wishful thinking is weak, it would predict that more desirable outcomes are perceived to be more likely. However, literature reviews find that detecting any wishful thinking effect is challenging (Krizan & Windschitl, 2007), and that it may only operate under specific conditions where all outcomes are equally likely (Bar-Hillel & Budescu, 1995; Krizan & Windschitl, 2009). However, there is also evidence suggesting the opposite - that

desirability decreases the perceived likelihood of an event (Benoît, Dubra, & Moore, 2015; Vosgerau, 2010).

Contrary to the prevalent belief of psychological research being riddled with evidence regarding overestimation (Sharot, 2011), any evidenced support is actually limited or inconsistent. Notably, there are many instances in which people under-predict their performance, a likelihood of a positive future, or their probability of success (Moore & Small, 2008). For instance, when carrying out an effortless task, people are prone to underestimating their performance (Clark & Friesen, 2009). Additionally, when asked to predict their probability of surviving a bout of influenza, people significantly underestimate their likelihood of surviving (Slovic, Fischhoff, & Lichtenstein, 1984). Smokers tend to significantly underestimate their actual risk of developing lung cancer (Viscusi, 1990).

For many years, researchers have recognised that the level of difficulty of a task, or the frequency of success, has a strong impact on how individuals perceive their own performance – in other words, the "hard-easy effect", a phenomenon first explored by psychologists Lichtenstein & Fischhoff (1977). The hard-easy effect describes how people tend to be overconfident about how successful they'll be at performing difficult tasks, while underconfident about their performance on easy tasks. Efforts to explain what underpins overestimation is a challenge, as task difficulty appears to be a major influencing factor, and a simple motivational explanation cannot account for the evidence. Any such explanation would need to show that motivation exaggerates an individual's self confidence in relation to performing difficult tasks, while undermining their confidence about performing easy tasks. However, there are plausible theories which offer a better explanation of the observed evidence, without relying significantly on motivation or self-enhancement, for example the theories proffered by Erev, Wallsten, and Budescu (1994).

Two types of consistent overestimation have been identified in research. Firstly, the illusion of control, secondly the planning fallacy. An individual's penchant to overestimate the agency they have over the future and future results is the illusion of control (Presson & Benassi, 1996). However, looking more closely at the literature it seems that this result may not be as significant as previously thought, as it is often found in "chance" tasks where actual control is zero. In situations where people have no control, they can only overestimate their level of control, much like difficult tasks precipitating performance overestimations. Other research paradigms yield inconsistent

evidence for control overestimates (Charness & Gneezy, 2010; Li, 2011). For instance, certain studies that have deliberately allowed individuals significant amounts of control have found that the individuals underestimate the control they have (Gino, Sharek, & Moore, 2011).

When examining the planning fallacy, there is a consistent body of evidence that highlights a common tendency among individuals to overestimate the speed at which they can accomplish ambitious, sizable, or innovative projects (Flyvbjerg & Sunstein, 2016). Nevertheless, the literature also presents substantial instances of reversals, particularly in the context of short tasks (Halkjelsvik & Jørgensen, 2012; Roy & Christenfeld, 2008). These findings align with the concept of the hard-easy effect, where people tend to miscalculate their likelihood of success on more challenging and lengthier tasks, while overestimating their prospects for success on simpler and shorter tasks. The explanations put forth in the literature for the planning fallacy often revolve around cognitive biases such as temporal construal (the way we mentally perceive future events changes based on their temporal distance), memory biases, or the distinction between inside and outside views (Buehler & Griffin, 2015).

Determining whether the evidence for the planning fallacy stems from motivated or self-serving overconfidence is complex, given the potential negative consequences associated with overcommitment, overscheduling, heightened stress, frustration, and eventual disappointment.

1.7.2. Overplacement

The outstanding expression of overconfidence, overplacement, is a belief that prompts a person to rate themselves (mistakenly) as better than (or more talented or skilled or knowledgeable) than others. In financial decision-making, the person may believe themselves to be "better-than-average" at knowing how to invest. Overplacement in behavioural finance can lead individuals to make investment decisions that are not well-informed or that may not align with reality, leading to suboptimal investment outcomes. This bias can result in over rating one's own abilities, a tendency to disregard important information, and a willingness to take on excessive risk (Moore, Healy 2008).

The extensive body of research supporting "better-than-average" beliefs has led numerous scholars to suggest that the phenomenon of overplacement is nearly universal (Beer & Hughes, 2010; Chamorro-Premuzic, 2013; Dunning, 2005; Sharot, 2011; Taylor, 1989). Nonetheless, a

more meticulous analysis of this body of evidence unveils certain noteworthy constraints (Harris & Hahn, 2011; Moore, 2007). Many of the studies that evaluate better-than-average beliefs employ response scales that lack precision, thereby complicating the task of comparing these beliefs with actual reality. It is unwarranted to assume bias solely based on the circumstance that more than half of respondents assert themselves to be above average (Benoît & Dubra, 2011); such a conclusion overlooks the influence of skewed distributions, where a majority will invariably position themselves above average. Harris and Hahn (2014; 2011) have provided compelling criticisms of the lax methodologies prevalent in a significant portion of the research concerning better-than-average effects, underscoring the urgency of implementing straightforward methodological enhancements.

One way to enhance the validity of measuring better-than-average beliefs is to use a more precise response scale. For example, Svenson's (1981) study of American and Swedish drivers used deciles to rate driving ability. The results found 93% of American drivers would rate themselves higher than the median. It is possible for a majority to rate above average, but statistically impossible for over half a population to rate above the median. To increase the credibility of such evidence, it's important to define clearly what it means to be a good driver or performer, as subjective definitions can lead to inconsistent results. Due to individual differences and varied standards, people can rate themselves as better than others and still be right based on their own criteria. However, this does not necessarily mean that their beliefs are objectively valid, and it's crucial to consider the potential biases that may be at play (Roy & Liersch, 2013; Dunning, Meyerowitz, & Holzberg, 1989).

One approach to mitigate ambiguity is to use specific quantifiable measures and compare participants against others in the same experiment. Some studies using this method have found evidence of overplacement (Benoît et al., 2015; Camerer & Lovallo, 1999; Williams & Gilovich, 2008). A more novel method elicits "belief distributions" with the aim to distinguish overplacement from rational information processing (Merkle & Weber, 2011). There’s a challenge though, as not many studies have focused on the methodological issue of self-selection. Hogarth and Karelaia (2012) argue that self-selection may lead to apparent overconfidence. Taking entrepreneurial entry as an example, individuals who overestimate their probability of success are more likely to enter a new market with the intention to compete. Other settings witness this same process, such

as job-seeking, course selection, athletic competition, and political candidacy (Cain, Moore, & Haran, 2015; Krawczyk & Wilamowski, 2016). Therefore, self-selection should be addressed when interpreting overplacement findings.

Studies have shown that the tendency to believe oneself to be better than average is particularly prevalent among high-ranking executives. This may be for several reasons. Firstly, highly skilled individuals may be more susceptible to this effect due to a lack of proper weighting of the comparison group, as demonstrated by Camerer and Lovallo (1999) and Kruger (1999). For instance, a CEO might be inclined to self-compare against an average manager rather than to other CEOs, leading to an overestimation of their abilities in certain areas such as investment decisions or mergers. Secondly, the effect is stronger in the case of abstractly defined outcomes as opposed to one-to-one comparisons to others (Moore and Kim, 2003). This is particularly relevant for CEOs as they rarely have a direct comparison. Additionally, according to Weinstein (1980), Kunda (1987) and Weinstein and Klein (2002) individuals incline towards being overly optimistic about their prospects, particularly in areas they believe are under their control or to which they are highly committed. For top corporate managers, this applies to both their ability to control the outcome of major strategic decisions and their strong commitment to company performance due to the relationship between their compensation and career prospects and the success of the company. As executives climb the corporate ladder, they are more likely to face decision-making environments that are conducive to biases, such as low-frequency and noisy feedback (Nisbett and Ross, 1980). Moreover, decisions at the executive top-level are somewhat of a rare event for a company. As each project comprises many unique features the meaningful comparison of any current- to past-experience is difficult.

In summary, substantial evidence supports the idea that senior corporate decision-makers are prone to overestimating their skills relative to others and of being overly optimistic about the upshots of their decisions.

1.7.3. Overprecision

Overprecision refers to an excessive confidence in one's knowledge of the truth. It is a form of overconfidence that is widespread but not well understood. The study of overprecision is limited by a small number of research paradigms, and the use of questions that people do not typically

encounter in their daily lives to assess beliefs. Recent attempts to study overprecision have employed innovative methods such as examining its impact on gambling behaviour (Andrade, 2011) and using a behavioural measure that mimics everyday decision-making (Mamassian, 2008). In situations where there is an asymmetric loss function, uncertainty often prompts individuals to move their responses to one or other side of their best guess in everyday decisions. As an example, should a person be uncertain about the balance in their bank account while also wanting to avoid bouncing an imminent direct debit, they will spend less. Similarly, if someone is uncertain about their car's width, they will naturally avoid driving too close to the kerb or any cars parked by the kerb. In all such scenarios, with less certainty comes more caution to avert risk (Busemeyer 1985).

To investigate this phenomenon, researchers have also used an approach that asks individuals to propose a confidence interval in relation to their estimates. For example, they may be asked to provide a range that has a 90% chance of containing the correct answer and only a 10% chance of being outside the correct range. Studies consistently show that hit rates within 90% confidence intervals often fall below 50%, suggesting that individuals tend to be overly precise when deciding their ranges, giving the impression of inappropriate confidence in the accuracy of their beliefs. Interestingly, this effect persists across all levels of expertise. However, a valid criticism of this method is that the average person may not be familiar with confidence intervals and may not use them in their everyday lives. This unfamiliarity may contribute to errors in judgment. Furthermore, should subjective error distributions be unimodal, with the largest amount of error being in the middle, then making the confidence interval excessively narrow will have greater consequences than making it too wide (Moore & Healy, 2008).

An alternate approach in research involves the utilization of item-confidence judgments (González-Vallejo & Bonham, 2007; Koehler, 1974). In this method, participants are requested to provide the correct answer to a question and then express their confidence level as a percentage that their response is accurate. This approach closely aligns with how individuals might naturally convey confidence in their everyday situations. Nonetheless, it comes with its set of limitations, primarily favouringfavoring the identification of overprecision. The predicament arises from the fact that this measure concentrates on the belief for which a respondent possesses the highest certainty, potentially introducing bias. To illustrate, it's akin to investigating whether the highest bidders on an online platform like eBay tend to pay more than an item's actual value; such analysis

could be skewed due to data selection. Similarly, by directing attention to the beliefs individuals assert as their most certain, researchers become more prone to discovering instances where their accuracy falls short of their declared confidence levels.

An alternative method involves a participant task that draws on Mamassian's asymmetric loss function (2008). Participants get a reward for pressing a button when a certain light in a sequence appears. Pressing the button too early or too late incurs a penalty in some cases. Based on the variability in the participants' responses, Mamassian calculates the optimal shift in responses, in light of the change in incentives. He finds that individuals shift their responses too little, which points to overprecision. Mannes and Moore (2013) extend Mamassian's paradigm to the verbal - asking participants to guess at the highest temperature for random days in the past. The results were consistent with Mamassian's findings and demonstrated a lack of shifting, indicative of overprecision.

However, the behavioural shift paradigm is subject to similar limitations as item-confidence paradigms and confidence intervals. Specifically, it only facilitates the assessment of overconfidence across a set of items while requiring researchers to make assumptions about the comparability of those items. In the case of the behavioural shift paradigm, researchers must calculate an error variance and thereafter assume that it is uniformly applicable across all items. Meanwhile, the confidence interval paradigm requires the researcher to calculate an average hit rate and assume that both accuracy and uncertainty are comparable across items. These assumptions may not hold, and they could potentially bias the conclusions drawn by researchers (Soll & Klayman, 2004).

These experimental designs encounter a constraint stemming from the difficulty of ascertaining the precise beliefs of respondents, given the researcher's inability to access the exact information contained within the respondent's mind. Moore, Carter, and Yang (2015) endeavoured to surmount this challenge by focusing on random events for which the researcher could explicitly define the genuine probability distribution. While conventional measurements of hit rate initially indicated overprecision in the outcomes, the source of this overprecision did not originate from subjective probability distributions being narrower than the actual probabilities. Contrarily, an intriguing revelation emerged—the probability distributions reported by participants were notably broader than the real distribution, and yet, they still failed to adequately encompass participants' own error margins. This perplexing result casts substantial doubt on prevalent assumptions about

overprecision and the nature of confidence in one's own knowledge, thereby prompting a demand for further comprehensive inquiry.

From the research presented above, it can be concluded that overestimation and overplacement frequently appear to be observationally equivalent. Evidence presented by Cooper, Woo, and Dunkelberg (1988) based on a survey of 3,000 entrepreneurs is incapable of distinguishing between them. Although the psychology underpinning the two is significantly different, it is the decision environment which determines what factors are actually at work. Overplacement necessitates that direct comparisons are made to a reference group which is present in established and also contested markets. In contrast, overestimation appears to apply more generally to a wider set of situations where individuals assess their own abilities. While overplacement and overestimation result in a positively biased perception of expected returns, and therefore should promote overinvestment, the effects of overprecision are uncertain.

Based on the psychological research on overestimation, overplacement, and overprecision presented in the previous section, it can be concluded that the current methods and instruments used to assess and differentiate these biases may not be accurate enough to isolate a specific bias. Biases are often intertwined and can influence each other in complex ways. They may be influenced by factors that are difficult to control or measure, such as individual differences in personality, experience, or motivation. Additionally, biases can interact with each other and with situational factors, making it difficult to isolate their effects. Thus, it can be challenging to disentangle the different biases that may be at play in a particular situation.

To determine the appropriateness of using a unified concept of overconfidence without distinguishing between its various types in financial research, it is essential to evaluate the effectiveness of the measures used to assess overconfidence and determine if they are sophisticated enough to capture its nuances and different forms, something that is explored in the following section.

1.8. Measures of overconfidence

Empirical researchers in behavioural finance face a significant challenge when studying the impact of CEO behavioural biases on their financial decision-making process. The main difficulty lies in how to accurately measure these biases and link them to the financial decisions that are

affected. As biases cannot be measured directly, it is necessary to rely on proxies. This section provides an overview of the primary proxy-based measures of CEO overconfidence and the literature which has developed them.

To establish a convincing case about the effects of any bias – in this case the impact of overconfidence on financial decisions and outcomes – empiricists must first create measures for it. To this end, four primary measures of overconfidence have been developed. These are: portfolio trading-based measures (executive stock-based compensation decisions), media-based measures (media attitude towards key executives), earnings forecasts-based measures and survey-based measures. The chapter on measures of overconfidence provides a comprehensive overview of the different approaches researchers have taken to measure overconfidence in executives.

1.8.1. Portfolio trading-based measures

Under investment-based measures CEOs can be categorised as overconfident on several premises, often using information inferred from the CEO's investment activity in their personal portfolio.

Under option-based measures Hall and Murphy (2002) assign CEOs as overconfident if they typically exercise their stock options later than other (risk-averse) CEOs. Similarly, CEOs can be identified as overconfident if they fail to exercise their options even after the stock price has risen since the grant date, or if they increase their exposure to the company's specific risk by acquiring additional stocks in the company, or if they are found to be, in more years, a net buyer of their company's stock rather than a net seller (Malmendier & Tate, 2005, 2008, 2015).

A CEO may also be deemed overconfident if they purchase their company's stock during times of negative return (Kolasinski & Li, 2013) or if their investments are deemed excessive compared to those of their peers (Ahmed & Duellman, 2011).

Duellman, Hurwitz & Sun (2015) classify the CEO as overconfident if, for the CEO's company, the residuals from any regression of total asset growth on sales growth lie within the fourth (top) quartile for the industry year.

Statman, Thorley, and Vorkink (2006) examine the correlation between high trading volume and overconfidence within the US stock market. As a proxy for the degree of overconfidence, they

propose using high past returns, pointing out that successful investments lead to an increase in overconfidence, and subsequently, a higher volume of trades. This same proxy is used by Kim and Nofsinger (2003) in their analysis of the Japanese stock market.

Sen and Tumarkin (2015) adopt an approach similar to Malmendier and Tate's and refer to it as the "Share Retainer" approach. This approach involves analysing a CEO's stock trading behaviour following the exercise of their stock options. Should a CEO keep a number of the shares which they obtained by exercising their stock options, it signals their optimism regarding their company's prospects. In this case the CEO is classed as overconfident.

1.8.2. Media-based measures

Malmendier and Tate (2005, 2008) initiate the use of media-based measures to categorise CEOs as overconfident if the language they use for media coverage (e.g. press releases) is deemed overconfident. The media-based measure compares the number of articles in the business press that use words or phrases implying overconfidence (e.g. using the terms "optimistic" or "confident") to the quantity of articles which adopt words and phrases implying caution such as "not optimistic", "prudent", "not confident" or "conservative". The CEO is deemed to be overconfident if, in the specific year, there are more articles implying overconfidence than caution. Other researchers have applied similar logic to other potential indicators of overconfidence, such as the tweets CEOs make (e.g., Lee et al., 2017).

Another example of media-based measures of overconfidence is the use of earnings conference calls. Researchers have analyzed transcripts of these calls to identify language that suggests overconfidence or underconfidence by CEOs. For example, CEOs who use more positive language about their company's future prospects or who make more optimistic projections about earnings may be deemed overconfident. On the other hand, CEOs who are more cautious in their language or who make more conservative projections may be deemed underconfident (Sah, Stough 2017).

1.8.3. Earnings forecasts-based measures

Another approach for measuring CEO overconfidence involves using executives' earnings forecasts. Lin, Hu, and Chen's (2005) approach is based on the idea that overconfident CEOs are more likely to make inaccurate and overly optimistic earnings forecasts. The logic behind this

approach is that overconfident CEOs may have a tendency to overestimate their abilities and the potential of their companies, leading them to make overly optimistic earnings forecasts. This can result in a large gap between the projected earnings and the actual earnings of the company.

In their study, Lin, Hu, and Chen (2005) compared the earnings forecasts of CEOs with the actual earnings of their companies over a period of four years. They found that CEOs who were classified as overconfident, based on their earnings forecasts, tended to overestimate their companies' earnings by a significant margin. On the other hand, CEOs who were classified as underconfident tended to underestimate their companies' earnings.

Malmendier and Tate (2008) use a similar approach to Lin, Hu, and Chen (2005) by examining the accuracy of CEOs' earnings forecasts. They find that CEOs who consistently make optimistic earnings forecasts are more likely to experience negative stock returns in the future, suggesting that their optimism was unjustified.

Similarly, Fahlenbrach and Stulz (2011) find that overconfident CEOs tend to issue more stock and make more acquisitions, which can lead to negative outcomes for shareholders. These studies highlight the potential risks associated with overconfident CEOs and suggest that measures based on earnings forecasts can be a useful tool for identifying overconfidence.

1.8.4. Survey-based measures

Crafting questionnaires aimed at inferring an individual's behavioural traits presents an alternative avenue for gauging overconfidence. Various scholars, including Ben-David, Graham, and Harvey (2008), as well as Sautner and Weber (2009), adopt this method. Ben-David and colleagues undertake a survey involving senior finance executives, presenting them with a series of inquiries concerning their predictions regarding the S&P 500 returns. The researchers posit that responses showcasing a limited range in return estimates indicate overconfidence, while those displaying overly optimistic projections of index returns signify a form of optimism.

Moore and Healy (2008) conducted a survey asking CEOs to rate their own abilities and their company's future performance relative to competitors. CEOs who rated themselves and their company's future performance higher than their competitors were deemed to be overconfident. Similarly, researchers have also used survey-based measures to assess the overconfidence of

investors and financial analysts. For example, Odean and Barber (2001) conducted a survey to measure the overconfidence of individual investors by comparing their self-assessed investment skills to their actual investment performance.

All these measures of overconfidence yield results that are always binary or discrete, meaning they simply indicate whether a CEO is overconfident or not ("0" for non-overconfident, "1" for overconfident). They do not indicate the extent of the overconfidence, or what subtype of overconfidence is at play.

1.9. Overconfidence – or overestimation, overplacement and overestimation?

Economists face the consideration of whether to maintain the perspective of overconfidence as a unified concept or to strive toward broadening their measures and proxies. This expansion would allow finance research to delineate overconfidence into its granular components, mirroring the psychological breakdown of overprecision, overplacement, and overestimation.

The measures outlined above are sophisticated enough to identify overconfidence in a broad sense. But they are not designed to measure anything more subtle, such as the three manifestations of overconfidence observed in psychological research. The current economic measures of overconfidence only produce a binary result – a CEO is either overconfident or not.

To commence, let's explore how economists could approach the measurement of the finer-grained constructs. Researchers could develop specific measures to capture these subtle aspects of overconfidence. They could then collect any pertinent data on individual investors. Thereafter they could analyse the data to investigate the relationship between these subtler forms of overconfidence against trading volume or other measurable aspects of investor behaviour. For instance, if an investor is subconsciously driven by overprecision or overestimation bias, they may be overly confident in their ability to predict the future performance of a stock or other financial asset, leading them to make predictions that are more extreme or certain than is warranted by the available information. This could lead to errors in their options predictions, which could then be used to identify and quantify the level of their overprecision or overestimation.

Or, for example, an investor who overestimates their ability to pick winning stocks may be more likely to engage in excessive trading or to take on higher levels of risk than is optimal. Similarly, an investor who overplaces themselves relative to their peers may be more likely to engage in risky or speculative investments, based on the belief that they can outperform others in the market. An investor who exhibits overprecision may be more likely to rely on their intuition or beliefs, rather than objective evidence, when making investment decisions, leading them to make suboptimal choices (Prims and Moore 2017).

The challenge lies in the fact that any of the three biases have the potential to lead to similar decision-making errors when it comes to stock purchases. Each bias could result in an investor disregarding vital information or making excessively confident or optimistic predictions about the future performance of a stock. Thus, it becomes difficult to definitively attribute each decision or outcome to a specific bias. Moreover, the academic progression from proxy to bias to effect involves numerous assumptions, making it a lengthy and uncertain process. If one focuses on specialization rather than generalization at the bias stage, it raises the question of whether the predicted effect would be less accurate and valuable.

Overconfidence is a complex construct that manifests in different ways and is influenced by a variety of factors. Personality traits, cognitive biases and environmental factors all have an effect. Measuring overconfidence accurately is already inherently challenging, before even attempting to break it down into different dimensions. Any studies or tests to isolate subcategories of overconfidence would need to be designed and tested carefully and lengthily for them to be meaningful to finance research.

For instance, consider media coverage. It may offer some insight into overplacement, overprecision or overestimation but is not a direct measure for them. Media coverage may potentially be able to indicate overplacement if it reveals individuals exhibiting excessive self-promotion or self-aggrandisement. However, what is presented to the media tends to be well curated (by the communications department if not the CEO) so signs of excess are likely to be rare (or filtered out), but broader signs more common. Therefore, media coverage cannot be relied on as a sole measure for overplacement, and other proxies would need to be found and leveraged also. Similarly, the extent to which individuals express certainty or confidence in their statements or predictions may also be reflected in media coverage. However, this would not be a reliable indication of

whether the individuals are overconfident, because confidence and accuracy may not be strongly correlated (Gao, Xu, Li and Xing 2021).

Media coverage may also provide some information on the extent to which individuals are certain or confident in their predictions or assessments (overprecision). However, this is unlikely to accurately reflect the extent to which individuals are actually overestimating the likelihood or magnitude of an outcome.

Portfolio trading-based measures of overconfidence typically involve analysing the trading patterns of investors to determine whether they exhibit excessive confidence in their abilities to predict market outcomes. While portfolio trading-based measures can offer valuable insights into the presence and impact of overconfidence in investment decision-making, they often lack the sophistication needed to differentiate between the different types of overconfidence, such as overestimation, overplacement, and overprecision. For example, if an investor exhibits overconfidence in their ability to pick winning stocks and as a result, they overweight their portfolio with those stocks, it may be difficult to determine whether this reflects overestimation of their own abilities, overplacement of their confidence in the specific stocks, or overprecision in their belief that their stock picks will outperform the market. Portfolio trading-based measures tend to focus on aggregate patterns of trading behaviour rather than on the underlying cognitive biases that may be driving that behaviour. As a result, they may not capture the nuances of different types of overconfidence.

Earnings forecasts-based measures of overconfidence are generally also not sophisticated enough to differentiate between different types of overconfidence such as overplacement, overprecision, and overestimation. This is because these measures primarily focus on the accuracy of earnings forecasts made by executives, rather than their decision-making process or beliefs about their own abilities. As a result, they may not capture the full range of cognitive biases and heuristics that can lead to overconfidence in investment decisions. Additionally, earnings forecasts-based measures may not be suitable for detecting overplacement or overprecision, as these biases relate more to the perceived accuracy of one's beliefs or estimates, rather than the accuracy of earnings forecasts (Hribar and Yang, 2016).

In summary, achieving a more granular view of overconfidence in the field of economics would likely involve great challenges and few or no benefits. The different forms of

overconfidence overlap and interact in complex ways. An investor may display overprecision (in their predictions) at the same time as overestimation (of their ability to outperform the market). Disentangling the two – or three, if there is simultaneously any possibility of overplacement - would be difficult. The only way to differentiate the nuances would be to construct a multi-dimensional test that specifically targets the different dimensions of overconfidence based on knowledge from psychological research.

A cross-discipline collaboration would be possible, but would the outcome be worthwhile? Overplacement, overprecision and overestimation may each represent a distinct cognitive phenomenon, but they all contribute to one thing, suboptimal decision-making, which may already be adequately dealt with in economics research under the umbrella term of overconfidence.

Ultimately the decision as to whether to study these biases separately or as a unified concept depends on the research question and context. Studying the biases separately could provide a more precise understanding of each one's specific effects and causes, but it would require extensive refinement and adaptation of existing measures and would perhaps introduce an unwieldy amount of complexity into research, without a corresponding advantage. Continuing to study overconfidence as a conglomerate for the purposes of finance may be perfectly adequate – while also more accurately reflecting that human biases always interact and act in concert to impact decision making. They never act in isolation.

1.10. Conclusion

This research draws on an extensive review of literature to elucidate how behavioural finance has evolved as a useful departure from traditional finance's rational decision-making focus. During the 1970s, the trend in behavioural finance shows a steady development. Earlier studies primarily focused on deviations from standard finance, where researchers discredited theories such as Arbitrage Pricing theory, Capital Asset Pricing Model, Efficient Market Hypothesis and Modern Portfolio theory, all of which assume market efficiency and rationality among individuals. However, with the advent of theories in behavioural finance, scholars have demonstrated that behavioural theories can explain the irrational behaviour of investors when they are thinking about and making investment decisions. The upward trend in publications indicates that research into behavioural biases is gaining significant momentum.

The core disparity between behavioural finance and traditional finance lies in their differing beliefs about the rationality and conduct of market participants. Traditional finance assumes that market players are rational and capable of making optimal choices based on all available information. However, behavioural finance acknowledges that human behaviour is often influenced by emotions, biases and heuristics that can lead to irrational decision-making. In contrast to traditional finance, behavioural finance provides valuable insights into the impact of investor behaviour on market inefficiencies that may be overlooked by traditional finance. Incorporating behavioural finance into investment management can help investors identify and mitigate biases, leading to more rational decisions.

It is essential to note that behavioural finance does not intend to supplant traditional finance. Anyway, it is not sufficient as an alternative. Instead, it complements traditional finance. By integrating insights from both fields, investors can acquire a comprehensive understanding of market behaviour and make better-informed investment decisions. Any conflict between behavioural finance and traditional finance does not involve choosing one approach over the other, but rather acknowledging the strengths and weaknesses – and critiques - of each and then utilising them together to achieve optimal investment outcomes.

This chapter firmly acknowledges the capacity of behavioural finance to help explain phenomena that cannot be explained by standard finance. Therefore, pursuing further research in this area, while refining finance's tools for encompassing behaviour and bias, is critical if we wish to deepen our understanding of financial complexities.

The chapter also sought to address the critical question of how to tackle the well-studied behavioural bias of overconfidence in finance. As psychology research has delved into the more nuanced and intricate aspects of overconfidence, it begs the question of whether finance research can follow suit and whether it is possible to address overconfidence at a subtler level that considers the three distinct types of overconfidence.

Overconfidence generally pertains to a person's inclination to be excessively self-assured in their beliefs, judgements, or abilities, which can manifest in diverse forms, such as overestimating one's ability to forecast the future, overestimating one's abilities in comparison to others, or overestimating the precision of one's knowledge or beliefs. Finance studies use a variety of approaches and measures with the assumption that they are all investigating overconfidence as a single

psychological concept. However, in contrast, psychological literature points to there being three distinct forms of overconfidence, namely overplacement, overprecision and overestimation.

This chapter has assessed the most commonly used measures of overconfidence in financial research to see if they could be extended to accurately capture the complexities of overestimation, overprecision and overplacement and whether it would be worth doing so. It appears that finance's methods and instruments for assessing overconfidence would not be reliably able to differentiate between the underlying psychological leanings of overestimation, overprecision and overplacement. Part of the reason is that these three biases may overlap, intertwine and influence each other in complex ways, or they may be influenced by external situational factors. However, the three biases do have one effect in common: they all inevitably lead to similar forms of suboptimal decision-making and judgment. Therefore, the conclusion of this chapter is that all three aspects of overconfidence should continue to be studied under a unified concept of overconfidence.

The existence of overconfidence subtypes, as recognised in psychological research, reminds us that overconfidence is multi-layered and does not simply refer to an investor overestimating their financial acumen, but many other aspects of themselves also. However, it appears perfectly adequate for finance's existing definition of overconfidence to remain broad and at a high level, for instance as defined by (Anderson, 2012:719) - as an investor's "inaccurate, overly positive perceptions of their abilities or knowledge". For finance, exhaustive challenges would need to be overcome to analyse it at a finer level, yet for no evident advantage.

CHAPTER II: Behavioural Biases And Financial Policies: Theoretical Implications On Business Form Choice And Taxes

2.1. Introduction

Building on the insights from the first chapter, the second chapter of this PhD thesis delves deeper into the world of real financial decisions and their relationship with behavioural biases. The conclusion drawn in the first chapter underscores the significance of viewing overconfidence as a unified concept, encompassing its sub-types such as overplacement, overestimation, and overprecision. This idea guides the exploration of practical aspects in this second chapter. A theoretical model is used to investigate how behavioural biases influence various financial choices. While the first chapter focused solely on certain aspects of overconfidence, the theoretical model introduced in the second chapter also incorporates pessimism. This inclusion enhances the ability to construct a more comprehensive model and examine diverse economic outcomes. This research encompasses areas such as making investment decisions, selecting between different business structures (like limited or unlimited companies), and addressing tax matters. By linking the theoretical foundation from the first chapter with this model in the second, the analysis reveals how these biases impact the way financial decisions are made.

This research stands as the pioneering effort in analysing the impact of entrepreneurial biases on tax policies. This subject holds considerable significance for various reasons. Primarily, while behavioural aspects of entrepreneurial decision-making have been extensively explored in fields like economics and finance, they remain relatively uncharted in the realm of theoretical literature on optimal taxation. Notable works like Fairchild (2005, 2011) and Everett and Fairchild (2015) have ventured into these areas but not extensively within the context of taxation. Secondly, recent discourse suggests that the way entrepreneurs make determinations about business structures and investments seems to align with behavioural biases, as seen in studies such as Graham, Hanlon, Shevlin, and Shroff (2017).

Analysing the choice of business forms, behavioural biases, and taxation holds substantial value due to its far-reaching implications in the realm of financial decision-making. The selection of business structures plays a pivotal role in shaping the operational framework of companies,

impacting their risk exposure, liability, and potential for growth. Examining behavioural biases sheds light on the human element inherent in decision-making processes, uncovering how cognitive tendencies influence choices and outcomes. Furthermore, taxation policies wield a significant influence on economic activities and incentives, affecting resource allocation and overall economic efficiency. By delving into these intertwined aspects, this analysis provides insights into the intricate interplay between psychological factors, structural choices, and policy dynamics, contributing to a holistic understanding of the complex financial landscape.

The model considers a scenario in which entrepreneurs with investment ideas must select between two organizational forms: limited liability and unlimited liability. In the case of the latter, the outcome of bankruptcy entails the owner's obligation to liquidate personal assets. This scenario is framed within the context of information asymmetry, wherein lenders possess incomplete knowledge about the qualities of projects, a concept elaborated on by Stiglitz and Weiss (1981), De Mezza and Webb (1987). Furthermore, the entrepreneurs themselves introduce bias into the equation, which manifests as either overvaluation (for overconfident entrepreneurs) or undervaluation (among pessimistic entrepreneurs) of the actual quality of their ideas.

In the model, the parameter epsilon (ε) is utilized to capture the spectrum of entrepreneurial biases, spanning from overconfidence to pessimism, and establishing a baseline of rationality. Rational entrepreneurs are modelled with an epsilon (ε) value of zero ($\varepsilon = 0$), signifying a balanced and unbiased evaluation of their venture's prospects, where decisions are made in alignment with objective probabilities and realistic risk-return assessments. Conversely, overconfident entrepreneurs are represented by an epsilon (ε) value greater than zero ($\varepsilon > 0$), capturing their propensity to overestimate success probabilities and underplay risks, often resulting in aggressive investment and elevated risk-taking. Pessimistic entrepreneurs, characterized by an epsilon (ε) value less than zero ($\varepsilon < 0$), embody a conservative bias, underestimating success chances and giving undue weight to potential risks, which can lead to missed opportunities. This parameterization allows the model to quantitatively analyse how varying degrees of bias - rooted in overconfidence, pessimism, or rationality - affect entrepreneurial decision-making and venture outcomes.

This analysis in the chapter covers a wide range of scenarios, thus thoroughly examining the optimality of entrepreneurs' choices. The comprehensive analysis spans various scenarios, providing a nuanced examination of the optimality of entrepreneurs' choices, considering both their

inherent bias and the informational limitations stemming from the asymmetry between entrepreneurs and lenders. When entrepreneurs are unbiased and information symmetry exists between lenders and entrepreneurs (where both have equivalent knowledge about project qualities), entrepreneurial decision-making aligns with social optimality. In this context, projects with positive net present values are pursued, while those with negative values are discarded.

The study progresses to examine cases involving overconfident and/or pessimistic entrepreneurs. Due to information asymmetry, entrepreneurs of lower quality might exploit favourable credit conditions, creating an adverse selection scenario that pushes higher quality entrepreneurs out of the market. With overconfident entrepreneurs, overinvestment occurs, leading to an excess of lower quality projects. Pessimistic entrepreneurs confront a balance between capitalizing on good credit conditions and undervaluing their project quality, which determines whether overinvestment or underinvestment prevails. The outcome hinges on various parameters, including the extent of entrepreneurial bias.

The utilization of a theoretical model offers the advantage of encompassing a wide array of diverse aspects. In the context of this study, it enables the examination of the effects related to business structure, taxation, as well as behavioural biases. Conducting an empirical study that involves business structures would pose challenges due to the constrained presence of unlimited liability companies within the UK market and the inherent difficulties associated with data collection.

The research illustrates how tailored government taxation policies can incentivize entrepreneurs. A well-calibrated corporate tax curbs the inclination of limited liability entrepreneurs to overinvest. Personal income tax does not alter the incentives for entrepreneurs with limited liability, but it does impact those with unlimited liability. This is due to incomplete loss offset (as per Becker and Fuest (2007)) and the bias exhibited by entrepreneurs in the model.

The rest of the chapter is organized as follows. Section 3 presents the basic model, its main results, a variation of the model with asymmetric information between entrepreneurs and lenders as well as analyses the case with overconfident, pessimistic entrepreneurs and taxes. Section 4 presents the model's implications and its consistency with empire call evidence as well as discusses the model's robustness and extensions and Section 5 concludes.

2.2. Literature review

2.2.1 Entrepreneurial Investments and Debt Financing Under Asymmetric Information

The phenomenon of asymmetric risk allocation between owners and debt holders in investments has significant implications for the lending behaviour of financial institutions, particularly in the context of start-up firms. Stiglitz and Weiss (1981) highlight the potential for credit rationing when debt holders bear the brunt of investment failures, leading to decreased incentive for lenders to extend loans, especially when the quality of investment projects is challenging to discern. This credit rationing phenomenon reflects the difficulty in achieving an equilibrium for bank loans, even when firms possess positive net-present value (NPV) projects. However, De Mezza and Webb (1987) present an alternative perspective, suggesting that lenders' inability to fully ascertain borrowers' characteristics can result in excessive investment levels compared to socially efficient levels, deviating from the predictions of the Stiglitz-Weiss model. Bonnette et al. (2016) further argue against the high prevalence of credit rationing, lending support to the realism of De Meza and Webb's model, which serves as a foundational framework. Additionally, the integration of asymmetric information with behavioural biases adds complexity to the understanding of lending dynamics.

Furthermore, Bester (1985, 1987) analyses the role of collateral in dealing with problems of adverse selection and moral hazard issues inherent in lending. It is shown that instead of raising interest rates, lenders my use collateral as a mechanism for self-selection and incentive mechanism. Bester's analysis highlights how collateral, in the presence of ex ante private information, can serve as a means for lenders to differentiate between loan applicants with otherwise similar observable characteristics, thereby addressing informational asymmetries through signalling mechanisms. This underscores the multifaceted nature of lending dynamics, where considerations of risk allocation, information asymmetry, and behavioural biases intersect to shape lending decisions and outcomes in financial markets. Bester's analysis of collateral's role in mitigating adverse selection and moral hazard is intricately linked to the article's exploration of tax policy, investment

decisions, and entrepreneurial behaviour. By examining collateral as a signalling and sorting mechanism in the lending market, Bester's work underlines the significance of alternative strategies beyond interest rate adjustments to address information asymmetries—paralleling the article's investigation into how tax adjustments can serve as a response to entrepreneurial biases.

In contrast, Antelo (2016) investigates optimal corporate income taxes for companies with private information about its potential profitability and production level selection. If a signalling equilibrium exists, the government obtains more information about businesses than it would in the case of a pooling equilibrium. However, if this is the case, some firms may exit the market so a pooling equilibrium can provide more revenue to the government. Antelo (2016) argues that the government can maximize its tax revenue by not forcing an information disclosure. Antelo suggests that the government can maximize tax revenue by allowing a pooling equilibrium, where firms are not forced into information disclosure, contrasting with the model discussed in this chapter by not directly addressing entrepreneurial bias or the combination of corporate and personal taxes in decision-making.

The model presented in Antelo's work (2016) is perhaps the most similar to the one described in the chapter. This model involves asymmetric information, corporate income tax, and entrepreneurs determining production decisions (termed as investment decisions in the chapter). Both the model discussed in the chapter as well as Antelo’s model offer insights into optimal taxation and organizational decision-making but from different angles: one emphasizing the behavioural aspects of entrepreneurial decisions and their implications for tax policy, and the other on information asymmetry's role in tax optimization without a focus on entrepreneurial biases. The inclusion of behavioural biases into the model discussed in this chapter represents a significant contribution to the existing literature. This addition not only broadens the scope of analysis but also enriches our understanding of the interplay between psychological factors and economic decision-making, offering a more comprehensive framework for evaluating tax policy implications.

While both Antelo's and the chapter's models offer insights into optimal taxation and organizational decision-making, the inclusion of behavioural biases in the chapter's model represents a significant contribution to the literature. By integrating psychological factors into economic decision-making, the chapter enriches our understanding of the interplay between behaviour and tax policy implications.

2.2.2. Taxes and the Choice of Business Form

Horvath and Woywode (2005) analyse an entrepreneur's choice between a limited liability firm and an unlimited liability firm when debt financing is used. They argue that the benefit of limited liability appears as a concave function of investment volume and the investors' wealth.

Building on this foundational understanding of liability preferences, Becker and Fuest (2007) and Miglo (2007) delve deeper into the nuances of investment decisions and the choice of organizational form under conditions of imperfect loss offset and information asymmetry**.** Becker and Fuest (2007) show that under symmetric information and debt financing, risk-neutral individuals with limited (un-limited) loss offset options would be more likely to choose a company with (without) limited liability. They highlight how asymmetric information can exacerbate overinvestment, suggesting taxation as a moderating force. Expanding on this complexity, Miglo (2007) considers entrepreneurs' private insights into both project success probabilities and future earnings, revealing a landscape where both over and underinvestment can occur, thereby challenging the notion of a one-size-fits-all tax policy for limited liability companies.

Further refining the discourse, Ewert and Niemann (2012) analyse the influence of asymmetrical taxation on organizational choice, underscoring limited liability's role in encouraging riskier investments, which can be tempered by targeted taxation strategies. This discussion on taxation continues with Blaufus and Mantei (2014), who argue that while taxes do not sway the organizational form choice in risk-free investments, they become a crucial factor when investments are fraught with risk, emphasizing the differential impacts of debt payments under various liability structures.

In contrast to these studies, the present chapter pioneers an exploration of behavioural biases and their interplay with organizational form choice and taxation policy in an environment typically assumed to have perfect information. This novel approach unveils that, similar to Blaufus and Mantei (2014), taxes have no influence on organizational form choice for risk-free investments but play a significant role under risk—a perspective that resonates with our findings, especially for risk-averse entrepreneurs.

Echoing Ewert and Niemann (2012), this chapter also confirms that limited liability can significantly influence entrepreneurs' risk appetite, yet it diverges by incorporating the effects of

entrepreneurial bias on investment decisions, thereby enriching the academic conversation with a fresh lens on the intricacies of organizational form and taxation.

2.2.3. Behavioural Finance, Investment and Debt Finance

Fairchild's research provides valuable insights into the interplay between managerial overconfidence and its impact on financial decision-making within organizations. In Fairchild (2007), the analysis focuses on the effects of managerial overconfidence on financing decisions and firm value, particularly in the presence of moral hazard problems. This study highlights how an overconfident manager's underestimation of financial distress costs can lead to biased estimations of debt costs, while also exploring how debt can influence the incentive to provide effort. The implications of entrepreneurial bias on equilibrium outcomes are examined, revealing the potential for discrepancies between perceived and actual debt value. Furthermore, the investigation delves into the ramifications of this bias on business form selection and taxation strategy, considering scenarios of asymmetric information between bankers and entrepreneurs.

Building on these findings, Fairchild (2005) further explores the combined effects of managerial overconfidence, asymmetric information, and moral hazard problems on financing decisions. This study underscores the detrimental impact of overconfidence in an asymmetric information model, where it induces excessive, welfare-reducing debt. However, it also highlights instances where managerial overconfidence may not necessarily harm shareholders, particularly under moral hazard problems.

Within the chapter, alignment is observed with Fairchild (2005, 2007) in recognizing that outcomes involving decision-makers driven by irrational biases may not inherently be worse than those involving rational actors. Attention is directed towards the process undertaken by start-up firms in opting for an organizational structure and shaping their investment endeavours. Moreover, an examination is conducted into the effects of these biases on governmental tax strategies. It's notable that this aspect remains unexplored within the literature on behavioural finance. Differing from Fairchild (2005), the analysis also encompasses scenarios involving both pessimistic and risk-averse entrepreneurs; in fact, in cases where entrepreneurs exhibit both risk aversion and pessimism, asymmetric information can be beneficial, leading to more undertaken projects compared to situations with symmetric information.

In conjunction with the extensive literature reviewed, it is imperative to incorporate foundational theories that underpin the comprehension of organizational behaviour and decision-making amidst uncertainty. The Grossman, Hart, and Holmström theory (1986), fundamental in contract theory and organizational economics, offers critical insights into the optimal allocation of decision-making authority within firms and the design of incentive systems. Central to their framework is the acknowledgment of incomplete contracts and asymmetric information, which highlight the challenges in specifying all possible contingencies in contractual agreements. The theory emphasizes the importance of ownership and control rights as mechanisms to align incentives and mitigate agency problems within organizations. Owners, or residual claimants, are vested with decision-making authority to maximize firm value, thus resolving conflicts of interest between different stakeholders. Additionally, the theory underscores the role of incentive structures, such as performance-based compensation, in motivating agents to act in the best interest of the organization. By integrating these principles, the Grossman, Hart, and Holmström theory provides a comprehensive understanding of organizational behaviour under uncertainty, offering insights into the design of optimal organizational structures and incentive systems.

2.3. Model

In the theoretical model of Chapter 2, "pessimism" is favoured over "underconfidence" to precisely capture individuals' tendencies toward anticipating negative outcomes. While "underconfidence" addresses issues related to self-confidence, "pessimism" encompasses a broader spectrum of cognitive biases and attitudes toward future events. Unlike "underconfidence," which focuses primarily on individuals' beliefs in their own abilities or judgments, "pessimism" extends to their overall outlook on the future. It involves anticipating negative outcomes or expecting unfavourable circumstances, irrespective of one's confidence (Seligman, 2007). This broader perspective allows for a more comprehensive understanding of how individuals perceive and respond to uncertain or risky situations. In essence, while "underconfidence" addresses one aspect of cognitive bias, "pessimism" captures a wider range of negative anticipations and their implications for decision-making and behaviour.

Consider a firm with an investment idea/project. The project costs B and generates earnings

αB with probability p and 0 otherwise, $\alpha > 1$.[3] The firm has initial capital K, $K < B$. The firm belongs to an entrepreneur who owns 100% of the firm's equity. The entrepreneur can undertake the project by investing available funds K and by issuing debt in the amount of $B - K$.[4] The entrepreneur should also decide whether to organize the firm with limited liability or unlimited liability. If the latter is the case and the firm is bankrupt, the entrepreneur will be forced to sell his personal assets to cover the debt. It is assumed that the entrepreneur's personal wealth is greater than B so he will be able to pay its debt back entirely.[5] Everybody is risk neutral and the risk-free interest rate is normalized to zero. In addition, the entrepreneur is biased (overconfident or pessimistic), i.e. he thinks that the project can generate profit $(\alpha + \varepsilon) B$ where ε measures the degree of the entrepreneur's bias. $\varepsilon > 0$ means that the entrepreneur is overconfident, $\varepsilon < 0$ means that the entrepreneur is pessimistic and $\varepsilon = 0$ means that the entrepreneur is unbiased (rational).

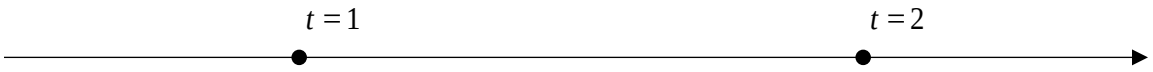
The project has positive NPV if:

$$\alpha p > 1 \qquad (1)$$

In this case the expected earnings from the project exceed the investment cost:

$$p\alpha B > B \qquad (2)$$

The timing of events is present in Figure 1.



[3] In Section 4, the model robustness with regard to different assumptions made is discussed.
[4] External equity is not considered. More comments are provided in Section 4.
[5] We will discuss this assumption in Section 4.

A firm with initial amount of cash K and an investment project that costs B selects its organizational form and decides whether to issue debt $B - K$

Earnings from the project are realized If the firm is one with limited liability and earnings are less than the face value of debt F the firm is bankrupt If the firm is one with unlimited liability and earnings are less than the face value of debt F the entrepreneur sells his assets

Figure 1. The sequence of events.

The analysis begins by considering the case with rational entrepreneurs ($\varepsilon = 0$) and symmetric information, where all parties possess the same information and all variables are publicly known. The model is solved using backward induction. First, the decision to undertake the project is analyzed for both limited and unlimited liability firms, followed by an examination of the choice of organizational form.

The decision to undertake the project.

First, consider the firm with limited liability. If the project is undertaken, the entrepreneur's profit equals $W = p(\alpha B - F)$ if $\alpha B > F$ and 0 otherwise, where F is the face value of debt. This means that if income from the project is not sufficient to cover the debt, the firm goes bankrupt and the entrepreneur gets nothing from the project. Otherwise, the entrepreneur gets the difference between the project's earnings and the payment to the debtholders. From the lender's point of view, the expected payoff should cover the amount of investment/loan:

$D = pF$, which implies that $F = D/p$. So

$$W = p(\alpha B - D/p) \tag{3}$$

If the project is not undertaken, the entrepreneur's profit equals K.

Lemma 1. *The project is undertaken if and only if $\alpha > 1/p$.*

Proof. The project is undertaken if (3) is greater than K. Since $D = B - K$, this condition can be written as $p(\alpha B - (B - K)/p) > K$. This is equivalent to $\alpha pB > B$ or $\alpha > 1/p$.

Now consider the firm with unlimited liability. The entrepreneur's profit if the project is

undertaken equals the expected profit from the project minus the payment to the debtholders. Since the entrepreneur's wealth is large enough, debt is risk-free for lenders in the case of unlimited liability. This means that the face value of debt equals D and the entrepreneur's earnings equal: $W = p\alpha B - D = p\alpha B - (B - K)$. This is the same expression as (3) so the solution is the same as it is for the case with limited liability (Lemma 1).

Comparing the result of Lemma 1 with (1) one can notice that when an entrepreneur is rational, his firm's investment policy is optimal, i.e. only socially profitable projects will be undertaken.

The choice of organizational form

Let us now turn to the decision about organizational form.

Proposition 1. *Under symmetric information and rational entrepreneurs, the choice of organizational form is irrelevant.*

Proof. As follows from the discussion above, the entrepreneur's profit is the same regardless of the company type.

The result is not surprising. In a world without any market imperfections and assuming that entrepreneurs are rational, decision-making is socially optimal, and the choice of organizational form is irrelevant. Overall, the results in Section 3 are consistent with the spirit of classical literature on firm financial decision-making in a perfect market such as capital structure irrelevance of Modigliani and Miller (1958).

2.3.1. Asymmetric Information

Now assume that the lenders do not know p.

The decision to undertake the project.

First, consider the firm with limited liability. If the project is undertaken, the entrepreneur's profit equals $W = p(\alpha B - F)$ *if* $\alpha B > F$ and 0 otherwise. From a lender's point of view, the expected payoff should cover the amount of investment/loan: $D = p^*F$ where p^* is the average probability of success among entrepreneurs who decide to invest. It implies that $F = D/p^*$. So

$$W = p\,(\alpha B - D/p^*) \tag{4}$$

If the project is not undertaken, the entrepreneur's profit equals K.

Lemma 2. *The project is undertaken if and only if*

$$p > \frac{K}{\alpha B - \frac{B-K}{p^*}} \tag{5}$$

Proof. The project is undertaken if and only if $p(\alpha B - D/p^*) > K$ or $p(\alpha B - (B-K)/p^*) > K$. It's interesting to compare this result with Lemma 1. When lenders know the probability of success, the interest rate is fair from the entrepreneur's point of view and the decision-making about the investment is significantly simplified and essentially comes down to seeing if the project has a positive NPV or not (Lemma 1). When lenders are uncertain about the probability of success, the decision-making depends on more factors (Lemma 2). Subsequently, entrepreneurial decision-making is analyzed from an efficiency perspective under the presence of asymmetric information.

Lemma 3. $\frac{K}{\alpha B - \frac{B-K}{p^*}} < \frac{1}{\alpha} < p^*$

Proof. Since p^* is the average probability of success among entrepreneurs who undertake the project, Lemma 2 implies $p^* > \frac{K}{\alpha B - \frac{B-K}{p^*}}$. It can be rewritten as $\frac{1}{\alpha} < p^*$. Now consider $\frac{K}{\alpha B - \frac{B-K}{p^*}} < \frac{1}{\alpha}$. This is equation to $\frac{1}{\alpha} < p^*$ as well.

Lemma 3 is crucial to obtain the following result.

Proposition 2. *Under asymmetric information, entrepreneurs with limited liability overinvest.*

Proof. Socially efficient projects are determined by (1). However, entrepreneurs invest according to (5). If p is such that $\frac{K}{\alpha B - \frac{B-K}{p^*}} < p < \frac{1}{a}$, the entrepreneur invests in a project with negative NPV.

Under asymmetric information, interest rates do not perfectly reflect the real quality of every single project. As a result, some bad quality entrepreneurs can benefit from this situation and start

running their projects even if their projects are socially not desirable (for a further analysis of borrowing and investments under asymmetric information that involve rational entre- pruners see, for example, Stieglitz and Weiss (1981), DeMezza and Webb (1987) and Blaufus and Mantei (2014)). Finally note that firms with unlimited liability are not affected by asymmetric information because for banks the debt is essentially risk-free. In Section 5, potential model extensions are discussed, considering situations where asymmetric information could also impact unlimited liability firms.

The choice of organizational form

Proposition 3. *Under asymmetric information and rational entrepreneurs, entrepreneurs select unlimited liability.*

Proof. Consider a firm with unlimited liability. The entrepreneur's earnings equal: $W = p\alpha B - D = p\alpha B - (B - K)$. Under limited liability they are equal to $p(\alpha B - (B - K)/p^*)$. Comparing these expressions leads to the following. If

$$p > p^* \tag{6}$$

the entrepreneur will select unlimited liability. But this also means that p* cannot be the average performance of firms that select limited liability since p < p* for all firms with limited liability. So no equilibrium exists where a firm selects limited liability.

The result is not surprising. As was mentioned previously, in the world with asymmetric information the cost of asymmetric information puts limited liability form in disadvantage compared to unlimited liability.

2.3.2. Overconfident and pessimistic entrepreneurs

Now suppose that the entrepreneur is biased (overconfident or pessimistic), i.e. he thinks that the project can generate profit $(\alpha + \varepsilon) B$. ε measures the degree of the entrepreneur's bias.[6]

First, consider the firm with limited liability. If the project is undertaken, then, objectively, the entrepreneur's profit equals $W = p(\alpha B - F)$ if $\alpha B > F$ and 0 otherwise, where $F = D/p^*$. The entrepreneur, however, thinks that it is $p((\alpha + \varepsilon)B - F)$. If the project is not undertaken, the entrepreneur's

[6] We assume that entrepreneurs are homogenous in terms of the value of ε. An interpretation is that the degree of the entrepreneur's bias is related to, for example, the state of the economy.

profit equals *K*.

Lemma 4. *The project is undertaken if and only if*

$$p > \frac{K}{(\alpha + \varepsilon)B - \frac{B-K}{p*}} \qquad (7)$$

Proof. Similar to Lemma 2.

Lemma 5. $\frac{K}{(\alpha+\varepsilon)B - \frac{B-K}{p*}} < \frac{1}{(\alpha+\varepsilon)} < p*$

Proof. Similar to Lemma 3.

Proposition 4. *1) If $\varepsilon \geq \varepsilon^*$ (overconfident entrepreneurs), entrepreneurs with limited liability overinvest. 2) If $\varepsilon < \varepsilon^*$ (pessimistic entrepreneurs), entrepreneurs with limited liability underinvest. 3) $\varepsilon^* < 0$.*

Proof. Socially efficient projects are determined by (1). However, entrepreneurs invest according to (7). Let ε* be the value of ε such that the right side of (7) equals that of (1). There is $\frac{K}{(\alpha+\varepsilon)B - \frac{B-K}{p*}} = \frac{1}{\alpha}$ which implies that:

$$\varepsilon* = \frac{K\left(\alpha + \frac{1}{p*}\right)}{B} - \alpha + \frac{1}{p*} \qquad (8)$$

If ε > ε*, the right side of (1) is greater than that of (7). This means that if p is such that $\frac{K}{(\alpha+\varepsilon)B - \frac{B-K}{p*}} < p < \frac{1}{\alpha}$ the entrepreneur invests in a project with negative NPV. If ε < ε*, the right side of (1) is less than that of (7). It means that if p is such that $\frac{K}{(\alpha+\varepsilon)B - \frac{B-K}{p*}} > p > \frac{1}{\alpha}$ the entrepreneur passes up an investment opportunity with positive NPV. Finally, it follows from Lemma 5 that $\frac{K}{(\alpha+\varepsilon)B - \frac{B-K}{p*}} = \frac{1}{\alpha} < \frac{1}{\alpha+\varepsilon*}$ which implies that ε* < 0.

The interpretation of Proposition 4 is as follows. Pessimistic entrepreneurs (ε < 0) with a low chance of success are facing a trade-off between the cost of investing in a low-quality project and the benefits from advantageous market conditions for debt financing (low interest rate from low-quality entrepreneur point of view). That is why some pessimistic entrepreneurs still overinvest

although the majority of them underinvest. Overconfident entrepreneurs always overinvest.

Now consider the firm with unlimited liability.

Lemma 6. *The project is undertaken if and only if*

$$1/p < \alpha + \varepsilon \qquad (9)$$

Proof. The project is undertaken if $K < p(\alpha + \varepsilon)(K + D) - D = p(\alpha+\varepsilon)B - (B - K)$. This is equivalent to $B < p(\alpha + \varepsilon)B$ or $1/p < \alpha + \varepsilon$.

Corollary 1. *Overconfident/pessimistic entrepreneurs with unlimited liability overinvest/underinvest.*

Proof. Socially efficient projects are determined by (1). However, overconfident entrepreneurs invest according to (9). If $\varepsilon > 0$ and α is such that $1/p - \varepsilon < \alpha < 1/p$, the entrepreneur invests in a project with a negative NPV. If $\varepsilon < 0$ and α is such that $1/p - \varepsilon > \alpha > 1/p$, the entrepreneur passes up an investment opportunity with a positive NPV.

The choice of organizational form

Under asymmetric information and biased entrepreneurs, entrepreneurs select unlimited liability. Consider a firm with unlimited liability. The entrepreneur's earnings equal: $W = p\alpha B - D = p(\alpha + \varepsilon) B - (B - K)$. Under limited liability, they are equal to $p((\alpha+\varepsilon)B - (B - K)/p^*)$: Comparing these expressions leads to the same conclusion as in Proposition 3.

2.3.3. Taxes

In this section, an analysis is conducted to determine whether the government can enhance firms' incentives through the implementation of various taxes. Initially, the focus is on examining the effects of a corporate income tax imposed on firms with limited liability.

Corporate income tax

Let *tc* denote the corporate income tax rate. If the project is undertaken, the entrepreneur's

earnings equal: $W = p(\alpha(K+D) - F - tc\,(\alpha B - B - (F - D)))$ if $\alpha\,(K + D) > F$ and 0 otherwise. This means that the firm's income equals earnings (αB) minus cost (B) and furthermore, interest on debt (the amount of interest equals $F - D$) reduces corporate income under taxation so the total amount of tax equals $tc(\alpha(K + D) - B - (F - D))$. As before, the debt value satisfies the following condition: $D = p^*F$, where p^* is the average probability of success among entrepreneurs who selected limited liability.

The entrepreneur, however, expects:

$W = p((\alpha + \varepsilon)B - (B - K)/p^* - t_c((\alpha + \varepsilon)B - B - (F - (B - K)))$ if $(\alpha + \varepsilon)B > (B - K)/p^*$ [7]

Lemma 7. *The project is undertaken if and only if*

$$p > \frac{K}{(1 - tc)\left((\alpha + \varepsilon)B - \frac{B - K}{p*}\right) + tc\,K} \qquad (10)$$

Proof. If the project is undertaken, the entrepreneur's earnings equal $p(((\alpha+\varepsilon)B - D = p^*) - (B - D))(1 - tc) - (1 - p)(B - D) = p(((\alpha+\varepsilon)B - (B - K) = p^*) - K)(1 - tc) - (1 - p)K$. If the project is not undertaken, the earnings equal K. The proof follows from the comparison of these expressions. The presence of a corporate tax definitely affects the decision-making by entrepreneurs. If (10) and (7) are compared, it can be noticed that the conditions determining the thresholds separating entrepreneurs who elected to invest and entrepreneurs who elected not to are different and this difference depends on the corporate tax rate.

Proposition 5. *If*

$$tc = \frac{B(\alpha + \varepsilon) - K\alpha - \frac{B - K}{p*}}{B(\alpha + \varepsilon) - K - \frac{B - K}{p*}} \qquad (11)$$

entrepreneurs make optimal decisions.

Proof. The socially optimal decision is determined by (1). Entrepreneurs make their decisions

[7] Note that $(\alpha + \varepsilon)B - B - (F - (B - K)) = (\alpha + \varepsilon)B - B - ((B - K)/p^* - (B - K)) = (\alpha+\varepsilon)B - B/p^* + K/p^* - K > 0$ because by Lemma 5 $(\alpha+\varepsilon)p^* > 1$. This result holds for the case with taxes.

according to (10). So, if the right side of (10) equals $\frac{1}{\alpha}$ the entrepreneurs' decisions will be optimal. So $\frac{K}{(1+tc)(((\alpha+\varepsilon)B-\frac{B-K}{p^*}+tcK} = \frac{1}{\alpha}$ which implies Proposition 5.

Corollary 2. *The optimal tax rate is positively correlated with ε, α and B and negatively correlated with K.*

Proof. It follows from the analysis of the derivatives of the right side of (11) with respect to the corresponding variables.

The interpretation of Corollary 2 is as follows. When entrepreneurs become more overconfident, the level of overinvestment increases, and the government should optimally increase the corporate tax rate. If the personal wealth of the entrepreneurs increases, there is more incentive to select unlimited liability. This implies that less entrepreneurs select limited liability and the extent of the overinvestment problem is reduced so the government should reduce the corporate income tax. Higher earnings from investments create more incentive for overinvestment so the tax rate should be reduced.

Now consider the choice between limited and unlimited liability. Proposition 3 holds for the case with corporate tax. The reason is that the tax reduces the income of the entrepreneurs with limited liability without affecting the income of unlimited liability firms. So, condition (6) will be converted into one where p is still greater than p * (except that p should be even farther from p * to accept limited liability). Again, it means that there is no equilibrium where entrepreneurs take limited liability. As a result, entrepreneurs will select unlimited liability, which will lead to non-optimal decisions according to Corollary 1.

Combining corporate income tax and personal income tax.

Consider an economy with both corporate income tax and personal income tax. The conditions below determine the entrepreneur's choice in terms of investment and the choice of organizational form.

Let *t* denote the personal income tax rate. The entrepreneur's earnings in case a limited liability business form is chosen and investment is made equals *W = p(αB - (B - K)=p* - tc(αB - B - (F - (B*

*- K)))(1 - t) if αB > (B - K)=p** and 0 otherwise. The entrepreneur however expects *W = p((α+ε)B-(B-K)=p*-tc((α+ε)B-B-((B-K)=p*-(B-K)))(1-t) if (α + ε)B > (B - K)=p** and 0 otherwise. If the project is not undertaken, his earnings equal *K(1 - t)*. So, the choice between investing with limited liability and not investing at all is determined by the comparison of these expressions and it will be the same condition as in Lemma 6 because *(1 - t)* will be cancelled on both sides of the comparison.

Now consider the choice between investing with unlimited liability and not investing at all. It will be demonstrated that the personal income tax, in and of itself, does not alter the incentives of entrepreneurs when compared to the scenario without any tax, as shown in Lemma 5. Nevertheless, it will also be illustrated that this tax plays a crucial role when there is an imperfect loss offset for unlimited liability firms. The entrepreneur's earnings if the project is undertaken are *pα (K +D) (1-t) - D+ Dt- Dx = pαB (1- t)-(B-K) (1-t+x)*. Note that x = 0 would mean a perfect loss offset. The entrepreneur believes, however, that they are *p(α + ε)(K + D)(1 - t) - D + Dt - Dx = p(α + ε)B(1 - t) - (B - K)(1 - t + x)*. If the project is not undertaken, the entrepreneur's earnings equal *K* (1 - *t*).

Lemma 8. *The project is undertaken if and only if*

$$p > \frac{B(1 - t + x) - Kx}{(\alpha + \varepsilon)\, B\, (1 - t)} \qquad (12)$$

Proof. As follows from the above analysis the entrepreneur invests if *p(α+ ε)B(1 - t) - (B - K)(1 - t + x) > K(1 - t)*. This condition implies (12). Note that if *x* = 0 (perfect loss offset), condition (12) becomes *p* > 1 α+ε, which is equivalent to the one in Lemma 6.

Proposition 6. *If*

$$t = \frac{\varepsilon B - (B - K) - x\alpha}{\varepsilon B} \qquad (13)$$

entrepreneurs make optimal decisions.

Proof. Indeed, it follows from the comparison of the left sides of (1) and (12), that if *(α+ε)B(1-t)K(1-t)+(B-K)(1-t+x) = α*, the entrepreneur's decision-making is socially optimal. This implies that t = $\frac{\varepsilon B - (B-K) x\alpha}{\varepsilon B}$.

Corollary 3. *Optimal tax rate is positively correlated with K and ε and negatively correlated with α, B and x.*

Proof. It follows from the analysis of the derivatives of the right side of (13) with respect to the corresponding variables.

The interpretation of Corollary 3 is as follows. When entrepreneurs become more overconfident, the level of overinvestment increases because more entrepreneurs undertake their projects. The government should optimally increase the tax rate because it will have a bigger effect on earnings from projects because the option of not undertaking a project is not affected by the entrepreneur's overconfidence. If the personal wealth of entrepreneurs increases, there is more incentive to be passive (not invest). Increasing the tax rate reduces the incentive to stay passive since it affects the value proportionally while in the case the project is undertaken earnings are less affected by the tax rate increase because of the imperfect loss offset. Finally, higher earnings from investments create more incentive for investing. This in turn creates more ground for overinvesting. The tax rate should be reduced since it will have a stronger effect on the desire not to invest because of the imperfect loss offset.

The Corollary 2 and 3 suggest that the optimal tax rate should respond differently to varying degrees of entrepreneurial bias, distinguishing between overconfidence and pessimism. A positive correlation with overconfidence bias implies that as overconfidence among entrepreneurs increases, so does the optimal tax rate. This indicates that policymakers may view higher tax rates as a means to counteract potentially risky investment behavior associated with overconfidence, thereby promoting economic stability. Conversely, a negative correlation with pessimism bias suggests that as pessimism among entrepreneurs intensifies, the optimal tax rate tends to decrease. In this scenario, policymakers might opt for lower tax rates to incentivize investment and stimulate economic activity, mitigating the effects of widespread caution and risk aversion. Thus, the optimal tax rate serves as a tool to address the nuances of entrepreneurial behavior, aiming to strike a balance between fostering economic growth and mitigating potential market disruptions.

To address the fluctuating levels of entrepreneurial overconfidence, a progressive tax system can be instrumental. By closely monitoring market trends in entrepreneurial behaviour, policymakers can gauge the prevailing levels of overconfidence through economic indicators and surveys.

Implementing a progressive tax structure that dynamically adjusts tax rates in response to observed market trends offers a flexible approach. For instance, if there's a notable increase in overall entrepreneurial overconfidence, the government could consider raising tax rates to mitigate the potential risks associated with overinvestment. Moreover, targeted tax adjustments can be employed to incentivize desired behaviours, such as offering tax incentives to encourage more cautious investment decisions during periods of heightened overconfidence. This approach necessitates policy flexibility, allowing for periodic reviews and adjustments to tax rates based on ongoing assessments of entrepreneurial behaviour and its impact on the economy. Such adaptive tax policies can better align with the evolving dynamics of entrepreneurial activity, fostering economic stability and growth.

Now consider the choice between limited liability and unlimited liability.

Proposition 7. *Limited liability is selected if and only if*

$$p < p = \frac{B - K\,(1 + t + x)}{(1 + t)((1 - tc)\dfrac{B - K}{p*} + tc\,((\alpha + \varepsilon)B + K\,\left(\dfrac{1}{p*} - 1\right))} \qquad (14)$$

Proof. Recall that the entrepreneur's expectations about earnings in the case that the project is undertaken and a limited liability firm is selected are: *W = p((α+ε)B-(B-K)=p*- tc((α+ε)B-B-((B-K)=p*-(B-K)))(1-t)*. In case of unlimited liability these are *p(α + ε)B(1 - t) - (B - K)(1 - t + x)*. Comparing these two expressions leads to the following condition: the entrepreneur selects limited liability if and only if

(B-K)(1-t+x) > p((B-K)=p+tc((α+ε)B-B-((B-K)=p*-(B-K)))(1-t)*

This condition implies (14).

Proposition 8. *An optimal tax policy can be implemented using the tax rates determined by Propositions 5 and 6.*

Proof. The personal tax rate can be established using (13). Now with regard to the corporate tax rate, there are two cases. First suppose $\bar{p} \geq 1/a$. A connection between p^* and $\bar{p}$ can be made using (14). For example, if p is uniformly distributed p* equals $(\bar{p} + 1/\alpha) = 2$ because as implied by Proposition 7, all entrepreneurs with $1/\alpha \leq p \leq \bar{p}$ select limited liability. This will eliminate p^* from equation (11) and condition (14). The analysis reduces to a system of two equations with two variables (*tc* and

p). The second case is when $\bar{p}$ < 1/a. In this case no entrepreneur will select a project with limited liability.

Below a numerical example is provided. Suppose α = 2, *B* = 2, *K* = 1, ε = 1, *x* = 0.5. Projects are uniformly distributed with support [0; 1]. Socially efficient projects are determined by the following condition: $p > 1/\alpha = 0.5$. Then from (13) there is *t* = 0.5. Two cases are possible. First suppose $\bar{p}$ > 0.5. Then firms with p < 0.5 will not invest. Firms with $0.5 < p < \bar{p}$ will undertake projects with limited liability. Firms with $p > \bar{p}$ will undertake projects with unlimited liability. So, there is $p^* = (\bar{p}+1/a) = 2$. Using this in (11), we get: $tc = \frac{2\bar{p}}{10\bar{p}+1}$. Similarly (14) can be rewritten as: $\bar{p} = \frac{2}{5tc + 4/(2\bar{p}+1)}$. Solving these two equations gives us: $\bar{p} = 0.8713$, tc = 0.17 and $p^* = 0.6685$. This is a solution because it was assumed that $\bar{p} > 0.5$. The analysis of the case with $\bar{p} < 0.5$ is omitted for brevity.

2.4. The model implications, robustness and extensions.

2.4.1. Implications

The chapter argues that the optimal tax policy should take into account the observed behavioral bias of entrepreneurs. If the confidence drops (pessimistic entrepreneurs), tax rates (both corporate and personal) should decrease and conversely if entrepreneurs become strongly overconfident, tax rates should increase. It also implies that if the tax policy does not consider the extent of entrepreneurial overconfidence, usually an equilibrium will result in non-optimal decision-making by entrepreneurs. If entrepreneurs are pessimistic and tax rates are too high, underinvestment will occur and the tax advantage of debt will not be used in the case of limited liability firms, i.e. too many unlimited liability firms will be created. Graham et al (2017) observe that currently entrepreneurs underinvest and do not fully use the advantages of debt related to taxes. This is consistent with one of the previously discussed cases where taxes, which are too high, do not reflect the entrepreneurial bias, as the entrepreneurs are too pessimistic. The model also predicts that optimal tax rates should depend on the average size and income of businesses, and the degree of loss offset imperfections for unlimited liability entrepreneurs.

The key takeaway from this chapter underscores the importance of considering the behavioural biases exhibited by entrepreneurs when crafting an optimal tax policy. If the confidence drops (pessimistic entrepreneurs), tax rates (both corporate and personal) should decrease and conversely if

entrepreneurs become strongly overconfident, tax rates should increase. It also implies that if the tax policy does not take into account the extent of entrepreneurial overconfidence, usually an equilibrium will result in non-optimal decision-making by entrepreneurs. If entrepreneurs are pessimistic and tax rates are too high, underinvestment will occur and the tax advantage of debt will not be used in the case of limited liability firms, i.e. too many unlimited liability firms will be created.

2.4.2. Model extensions and robustness.

The purpose of this section is to discuss potential extensions and avenues for future research based on the model presented in the preceding sections. The section begins by proposing extensions to the model, such as allowing entrepreneurs to select debt levels and pay dividends, as well as considering personal borrowing by entrepreneurs. It then discusses the possibility of introducing outside equity financing into the model and explores the implications of heterogeneity in entrepreneurial biases. Additionally, the section examines the role of asymmetric information in various aspects of the model and suggests directions for further exploration, such as analysing asymmetric information regarding variables other than the probability of firm success. Finally, the section addresses the assumption of entrepreneurs' initial wealth and suggests that future research could explore scenarios where entrepreneurs do not have sufficient wealth to cover losses. The section aims to show evidence that the results of the model are robust as well as stimulate further inquiry and refinement of the model by identifying potential areas for expansion and investigation.

Selecting debt level. The model can be extended by allowing entrepreneurs to select the debt level and pay dividends using the initially available funds. Indeed, consider the firm with limited liability. Let $K = K_1 + K_2$, where K_1 is the amount of internal funds invested in the projects, which is determined by the entrepreneur and K_2 is the amount of non-invested funds (dividends). There is $D = B - K_1$. If the project is undertaken, the entrepreneur's profit equals $W = p(\alpha B - F) + K_2$ if $\alpha B > F$ and K_2 otherwise, where $F = D/p$. So the project is undertaken if $p(\alpha B - F) + K_2$ is greater than K. This condition can be written as $p(\alpha B - D/p) + K - (B - D) > K$. This is equivalent to $\alpha pB > B$ or $\alpha > 1/p$, which is the same as (1). A similar argument can be made for the case with unlimited liability. While minor changes may occur in the model's solution, based on the current observations, the main intuitions are expected to remain unchanged.

One can further extend the model by allowing K_2 to be negative (personal borrowing by

entrepreneurs) and assuming, for example, that personal and business borrowing conditions are different. This is a possible direction for future research.

Outside equity. Most firms analyzed by empirical literature related to the topic face the choice between internal funds and debt (an exception is Blaufus et al (2014)). One of the reasons for this seems to be that the basic ideas related to issuing debt (debt overhang, edibility etc.) are quite different for equity issues (Harris and Raviv (1991)). In this case if external equity is possible then it will not have a tax advantage compared to financing with debt (in terms of corporate income tax deductions) and, on the other hand, it will be subject to asymmetric information problems. So, a simple introduction of equity finance will not affect the model's results. One can further extend the model by introducing some advantages to equity financing (for example, extending the model the two periods and introducing an additional debt overhang problem in the second period which could create an advantage of using outside equity). This is a possible direction for future research.

Heterogeneity with regard to the value of ε. In sections 2.3.1 *Asymmetric Information*, which addresses asymmetric information, the assumption is made that entrepreneurs are homogeneous in terms of their bias level, following a similar approach as observed in Fairchild (2005). As was previously mentioned, the idea behind it is that the primary source of bias is market conditions. A natural question though is whether the results stand if one considers a case with heterogeneity of entrepreneurs with regard to their level of bias. One can consider an extension where, for example $\varepsilon = \varepsilon_1 + \varepsilon_2$, where ε_1 is a common factor for all entrepreneurs and ε_2 is an entrepreneur's specific factor of bias. The analysis shows that most conclusions remain the same. In conditions (10), (12), and (14) there is a function $p(\varepsilon)$ which determines a threshold for an entrepreneur's decision-making. Interestingly, the signs of the inequalities (conditions) in (10), (12), and (14) do not change which makes most of the solution similar to this basic case. So, if the government cannot only observe ε_1 but ε_2 as well, a perfect solution would be achieved by introducing a corporate income tax and a personal tax (asymmetric in this case). If ε_2 is not observable, a more complex taxation system arises in equilibrium while the main qualitative intuitions remain very similar. For example, the government should take behavioral biases into account so the optimal tax will have to depend on ε_1. Asymmetric information exists regarding other variables. One promising direction for future research is to analyze the case when asymmetric information exists regarding not only the probability of firm success but also for other variables like, for example, the value of project return (α) (in the spirit of Stieglitz and

Weiss (1981)). This is an interesting direction for future research. Two points are worth mentioning though. The main result of this chapter, that the entrepreneurial bias should be considered by the government when planning its tax policy, will not be affected. Quantitatively, the results may change though. Secondly, the importance of asymmetric information regarding the probability of success is crucial since this variable is not observable. However, the level of earnings can be observed. By collecting information about firm earnings, the government can improve its knowledge of the different parameters about each company. If one considers a multiperiod environment (similar to Antelo (2016)), the importance of asymmetric information regarding the level of earnings diminishes over time.

Entrepreneur's initial wealth. The assumption that the entrepreneur has sufficient wealth to cover losses in case of unlimited liability strongly simplifies calculations (a similar approach is used in Becker and Fuest (2007) and Miglo (2007)). If the entrepreneur does not have sufficient wealth, an unlimited liability contract could be interpreted as a limited liability contract (since the entrepreneur's loss is limited, i.e. it is less than the amount borrowed in the case that the project fails which to some extent contradicts the spirit of an unlimited liability contract). In general, this direction is a potential line for future research.

2.5. Conclusion

This chapter is the first to analyze the simultaneous choice of investment and organizational form using a behavioral finance approach. A model is considered in which entrepreneurs have three options: to initiate an investment project using a limited liability business form, to initiate a project with unlimited liability, or to refrain from taking any action. The entrepreneurs' decisions depend on several factors including the expected performance of projects, the degree of entrepreneurial bias with regard to project expectations, and taxes. Both corporate income taxes, applied to firms with limited liability, and personal income taxes are considered in the analysis. When entrepreneurs are rational, the choice of investment and organizational form is irrelevant in most cases. However, when entrepreneurs are overconfident/pessimistic, overinvestment/underinvestment occurs. The model suggests that optimal government policy should take into account the expected entrepreneurial bias in the economy. If confidence drops to the point where entrepreneurs become pessimistic, tax rates (both corporate and personal) should decrease and conversely if entrepreneurs become strongly

overconfident, tax rates should increase. Graham et al (2017) observe that currently entrepreneurs underinvest and do no fully use the tax advantages of debt. This is consistent with one of the previously discussed cases where taxes, which are too high, do not reflect the entrepreneurial bias, as the entrepreneurs are too pessimistic. It is demonstrated that combining a corporate tax specifically for limited liability businesses and a universal personal income tax can enhance the efficiency of decision-making and contribute to an increase in social surplus. The model also generates some suggestions regarding the link between optimal tax rates and some other factors such as the average size and income of businesses, and also the degree of loss offset imperfections for unlimited liability entrepreneurs. Most of the results are new and have not yet been tested.

The upcoming third chapter's findings echo the implications drawn from the discussed theoretical model, particularly the positive correlation between CEO overconfidence and investment rates. This alignment emphasizes the necessity of incorporating behavioral finance insights not only into theoretical models but also into empirical studies of real-world economic behavior. The empirical analysis will be undertaken in the forthcoming chapter.

CHAPTER III: Empirical analysis of CEO's personal characteristics and overconfidence on investment decisions in SMEs in the UK.

3.1. Introduction

In the forthcoming third chapter of this thesis, a comprehensive analysis will be undertaken to explore the impact of Chief Executive Officer (CEO) overconfidence and their distinctive attributes, alongside other economic and firm-related factors on investment level. Expanding upon the theoretical foundation laid in the second chapter, Chapters 2 and 3 share a common focus: examining the impact of overconfidence on investment levels and investigating how taxes influence financial decision-making. Additionally, in Chapter 3, the empirical analysis is enhanced by integrating additional layers of complexity. This includes the incorporation of CEO characteristics, firm-specific factors, and microeconomic variables. By delving into real-world data and considering the intricate interplay between CEO's overconfidence, varying characteristics, and broader economic and firm-specific elements, this chapter aims to provide an understanding of how these factors collectively shape investment decisions.

Corporate investment decisions and actions are usually assumed to be explainable using agency theory (Jensen & Meckling, 1976), asymmetric information theory (Myers & Majluf, 1984) and/or other traditional corporate finance theories. Indeed, to date, empirical studies have tended to find that the key determinants underpinning corporate investment patterns are cash flow, profitability, growth opportunities and financial leverage. However, corporate finance literature also asserts that chief executive officers (CEOs) are central to making the decisions that dictate their company's financial strategy (Jensen & Meckling, 1976). It is beyond doubt that any decision a person makes in life will naturally be shaped by their cognitive biases. This raises the question of whether corporate financial decisions are not just being influenced by the rational, as traditionally thought, but also by the irrational – in other words, CEO personality and cognitive bias such as overconfidence. The acknowledgment of behavioural biases in corporate decision-making reflects a paradigm shift in understanding how individuals navigate complex financial environments.

Instead of strictly adhering to rational models of decision-making, researchers now recognize the importance of incorporating insights from psychology and behavioural economics to develop a more nuanced understanding of managerial behaviour (Barberis & Thaler, 2003; Loewenstein et al., 2001). By acknowledging the role of behavioural biases, scholars can better explain observed phenomena such as herding behaviour, market bubbles, and deviations from efficient market outcomes. Behavioural studies assume that managers are not fully rational or objective, and that instead they bring personal psychological biases, such as overconfidence, into their decision-making (Fairchild, 2005, 2007; Baker & Wurgler, 2013; Ben Mohamed, Fairchild, & Bouri, 2014). The overconfidence bias can lead managers to make overly optimistic assessments of investment opportunities, underestimate risks, and engage in excessive risk-taking behaviour (Kahneman & Lovallo, 1993; Daniel et al., 1998).

These academic findings point to a need to look more closely at how CEO bias affects financial decisions – so we can better understand how a CEO's personal traits and background can affect such things as investment level, corporate capital structure, performance and the payment of dividends (Baker & Wurgler, 2002; Malmendier & Tate, 2005a). Interestingly, research finds that general demographics reflect the likely social and psychological characteristics of a CEO. For example, there are indications that younger CEOs are more aggressive investors (Prendergast & Stole, 1996), in contrast to older CEOs who tend to be risk-averse and resistant to using new information and techniques when constructing investment strategies (Hambrick & Mason, 1984).

Aside from age, other useful characteristics include gender, tenure, education and professional background (Hambrick, 2007). For instance, short-tenured CEOs are likely to make risky investments and to react quickly to use new information (Hirshleifer, 1993), whereas CEOs who have longer tenure err towards risk-aversion and conservative choices (Audia, Locke, & Smith, 2000; Grimm & Smith, 1991). Hu & Liu (2015) show that the longer a CEO's career has been, therefore the stronger their social connections, the less likely they are to be swayed by external borrowing constraints.

In terms of education, CEOs with formal financial training are better equipped to choose optimum investment alternatives because they have the knowledge and tools they need to understand market trends and conditions (Malmendier & Tate, 2005b). The growing importance of female leadership across the world is indicated by the increasing number of female CEOs. Female CEOs

have been widely studied on account of their unique pattern of characteristics, including risk aversion, conservative decision making, efficient monitoring and lower confidence compared to their male counterparts (Barua et al., 2010; Chen et al., 2016; Huang & Kisgen, 2013; Johnson & Powell, 1994; Ullah et al., 2019). Because gender appears to strongly sway the nature of corporate decisions, this chapter also explores how gender may affect investment level.

While certain studies have revealed both direct and indirect relationships connecting CEO characteristics to investment choices, other studies have found no significant correlation between these factors. The presence of inconsistent results in the existing body of knowledge regarding the relationship between a CEO's personal characteristics, behavioural biases and investment decisions is a significant motivation for this study.

Research consistently underscores the pivotal role of internal cash flow as a primary determinant, with positive cash flows facilitating investment while negative ones constrain spending (Fazzari et al., 1988; Cleary, 1999). Additionally, firm profitability emerges as a critical factor influencing investment decisions, with profitable firms more inclined to pursue new projects and expansion opportunities (Cooper & Nyborg, 2006; Hovakimian et al., 2004). Growth opportunities represent another significant driver of investment, with firms actively investing to capitalize on promising prospects (Titman & Wessels, 1988; Bond & Cummins, 2004). Financial leverage, or the degree of debt financing, also affects investment choices, as high debt levels may restrict investment due to increased financial risk (Faulkender & Petersen, 2006; Rajan & Zingales, 1995). Moreover, economic uncertainty and risk play a substantial role, prompting firms to exercise caution and potentially delay investments in uncertain environments (Bloom et al., 2007; Pindyck, 1991). Industry characteristics further influence investment decisions, with industries experiencing high growth or technological change witnessing heightened investment activity (Hall, 1987; McDonald & Siegel, 1986). Notably, managerial traits, including overconfidence and behavioural biases, exert significant influence, potentially leading to suboptimal investment outcomes (Malmendier & Tate, 2005; Graham et al., 2009).

The empirical validation of these relationships has typically been limited to large companies, because for large companies CEO data is more readily accessible than for small companies. In contrast, minimal research has been done into Small Medium Enterprises (SMEs) in the UK because of the hard accessibility or lack of data. This research gap needs to be filled because SMEs

comprise 99% of UK businesses (uk.gov 2021)[8]. They contribute hugely to the economic stability and growth of the UK, and to employment and job creation. With SMEs being a foundation stone of the UK's economic health, it would be an oversight to continue neglecting them academically. Research will lead to a better understanding of SMEs and what drives them, so CEOs, stakeholders and policymakers can then make more informed choices of how to grow and manage them. These conclusions are supported by research conducted by reputable organizations and institutions, including reports from the Federation of Small Businesses (FSB)[9] and government bodies such as the Department for Business, Energy & Industrial Strategy (BEIS)[10] and the Office for National Statistics (ONS)[11]. Academic studies, international organizations and country-specific analyses further corroborate the critical role of SMEs in the UK economy.

The empirical validation of these relationships has typically been limited to large companies, because for large companies CEO data is more readily accessible than for small companies. In contrast, minimal research has been done into Small Medium Enterprises (SMEs) in the UK because of the hard accessibility or lack of data. This research gap needs to be filled because SMEs comprise 99% of UK businesses (uk.gov 2021)[12]. They contribute hugely to the economic stability and growth of the UK, and to employment and job creation. With SMEs being a foundation stone of the UK's economic health, it would be an oversight to continue neglecting them academically. Research will lead to a better understanding of SMEs and what drives them, so CEOs, stakeholders and policymakers can then make more informed choices of how to grow and manage them.

Taking into account the importance of SMEs and the corresponding research gap that has been identified[13], this chapter sets out to study the influence of a CEO biography (gender, age, educational background and expertise/experience) and CEO incentives (tenure and ownership), cognitive biases such as overconfidence, company's performance indicators as well as economic factors on CEO's investment decisions, within SMEs in the UK. The aim is to address the research gap by integrating the different types of variables that have been predominantly analysed independently in previous studies.

[8] [12] [13]gov.uk SME guidance available at: https://www.gov.uk/
[9] https://www.fsb.org.uk/
[10] https://www.gov.uk/government/organisations/department-for-business-energy-and-industrial-strategy
[11] https://www.ons.gov.uk/

The study's dataset comprises 256 UK SMEs representing diverse industries and spanning the timeframe of 2014-2019. Financial data was sourced from the FAME online database and the gov.uk website, while CEO-specific information was manually collected from the companies' official websites and Companies House. The overconfidence proxy was constructed using 2421 manually gathered articles that portrayed CEOs. These articles were sourced from both company websites and prominent British newspapers. It's noteworthy that this dataset has never been analysed before.

The chapter is organized as follows: Section 2 presents the theoretical background and hypothesis development. In Section 3, the methodology is outlined, including details about the data collection process. Section 4 and 5 presents statistical models and tests used for analysis. Section 6 shows empirical findings, discusses their implications, and provides recommendations for future research.

3.2. Literature review

Behavioural finance is a growing field that tries to explain how people make economic decisions. It combines psychology, economics, and finance to understand why people's choices do not always follow traditional economic theories. This field has gained traction because the usual idea of rational investors in efficient markets does not explain many real-world situations. Behavioural finance looks at how people actually behave, both on their own and in groups, to find better explanations. For instance, it helps us understand why markets sometimes do not work as efficiently as they should.

Behavioural finance is now a part of mainstream finance. One underlying assumption of is that the information structure and the characteristics of market participants systematically influence individuals' investment decisions as well as market outcomes. The choices individuals make are not fully rational. Instead, our brains often take shortcuts and are influenced by emotions when processing information. This affects how people make financial decisions, sometimes leading them to behave in ways that seem irrational. They might not always follow the usual ideas of avoiding risks, and they can make mistakes in their predictions that are quite predictable (Baker and Nofsinger, 2010).

Finance scholars are inclined to disagree about what influences are the key drivers shaping financial decision-making. Existing literature on corporate investment establishes that cash flow, company size, profitability, sales and leverage are key determinants of overall corporate investment strategy (Aivazian, Ying, & Hubbard, & Peterson, 1988; La Cava, 2005; Rajakumar, 2005; Tokuoka, 2012). However, research into behavioural corporate finance finds that a manager's personal characteristics such as age, tenure length, financial education, career experience are also key influences on corporate finance decisions (Bertrand & Schoar, 2003; Hambrick & Mason, 1984; Hu & Liu, 2015; Malmendier & Tate, 2005b).

In an effort to more fully understand financial problematics, contemporary research has turned to exploring how human behaviour influences financial decision-making, rather than relying purely on analysing financial datasets. This research has highlighted questions over the relevance of the rationality hypothesis in decision-making. Researchers have started to look more closely at the human factor and, in particular, the way in which human bias affects financial decision-making.

The research shows that behavioral traits of individual managers, in particular overconfidence, can distort corporate investment decisions (Malmendier and Tate 2005, Heaton 2002, Campbell 2011). The unique contribution of this chapter lies in its combination of overconfidence among CEOs of UK SMEs and its influence on investment levels. The study's focus on overconfidence among SMEs is unprecedented due to limitations in data collection for SMEs and difficulties in building a reliable overconfidence proxy. This research adopts a complementary approach by integrating the aforementioned financial and behavioural factors into a single study. The analysis focuses on examining the impact of CEOs' characteristics, including their overconfidence, along with financial and economic factors on a firm's investment decisions.

This literature review finds that the CEO's behaviour and personal characteristics as well as company-specific or microeconomic factors, all might have key roles in decisions on corporate investment. Drawing on the reviewed theories, this study tries to extend previous works on behavioural corporate finance by examining the interaction between investment level and various CEO characteristics such as education, experience, tenure, ownership, age, and gender in the existence of managerial overconfidence among SMEs in the UK. Key firm determinants of overall corporate investment strategy, as well as macroeconomic factors, are also controlled for in the analysis.

The relationship between a CEO's personal characteristics and investment decisions has been the subject of research, yielding in some cases varying and inconsistent findings. Some studies have demonstrated both direct and indirect relationships, highlighting the influence of CEO characteristics on investment choices. However, contrasting these findings, other studies have failed to find a significant correlation between these factors. The existence of these inconsistent results within the existing literature has served as a primary motivation for undertaking this study.

In the subsequent section, a comprehensive literature review is provided for each independent variable utilized in the study. Drawing upon the existing research, hypotheses are formulated to guide the analysis. It is worth noting that the control variables, encompassing firm-specific and microeconomic factors, do not have explicitly constructed hypotheses based on the literature.

3.2.1. CEO’s overconfidence and investment level

Some empirical research on the relationship between CEO overconfidence and investment level has provided findings suggesting that overconfident CEOs tend to engage in more aggressive investment activities.

For example, a study by Malmendier and Tate (2005) examined the investment level of overconfident CEOs and found that firms led by overconfident CEOs exhibited higher levels of investment spending compared to firms led by less overconfident CEOs. Similarly, a study by Li and Tang (2010) found that overconfident CEOs were more likely to undertake acquisitions and engage in riskier investment projects.

Researchers like Lin, Hu, and Chen (2005), as well as Huang, Jiang, Liu, and Zhang (2011), and Campbell, Jhonson, Rutherford, & Stanley (2011), conducted practical tests to examine how managerial overconfidence affects the connection between investment and cash flow. Their findings suggest that when managers are overly confident, it can lead to stronger sensitivity between investment and cash flow. This phenomenon helps clarify why companies might struggle to attain the best investment plans and why their value in the market might not reach its optimal level.

In a study by Heaton (2002), a basic corporate finance model is used to make theoretical predictions. It suggests that managers with an optimistic outlook may view external financing as expensive. This is because, due to their bias towards optimism, they believe that stock markets do not fully appreciate the value of their company's shares. The study proposes that the presence and amount of internal cash flow will affect a company's investment decisions. This situation can lead to imbalances in the company's investment strategy: if there's a substantial internal cash flow, it might lead to excessive investments, while insufficient cash flow might result in underinvestment issues.

Gervais, Heaton, and Odean's (2011) study delves into the intricate relationship between CEO overconfidence and capital budgeting decisions. Through their investigation, they shed light on the significant impact that overconfidence among CEOs can have on the allocation of capital within firms. Their findings indicate that overconfident CEOs exhibit a propensity towards more aggressive investment strategies, resulting in heightened levels of capital expenditures. However,

while this approach may initially appear bold, it carries the risk of potentially negative consequences for firm performance.

Hirshleifer (2001) has provided empirical evidence suggesting that overconfident CEOs exhibit a propensity for increased investment activities. Graham, Harvey, and Puri (2013) found that firms with overconfident CEOs tend to have higher capital expenditures and investment rates compared to those with less overconfident leaders. Furthermore, research by Gibbons and Murphy (1992) and Finkelstein and Hambrick (1996) has explored the implications of overconfidence on corporate decision-making, including investment choices. Gibbons and Murphy (1992) found that overconfident managers may exhibit a tendency to pursue riskier investment projects, potentially leading to suboptimal outcomes for the firm. Similarly, Finkelstein and Hambrick (1996) suggested that overconfident CEOs may be more likely to pursue aggressive growth strategies, including excessive investment, which can impact firm performance. Overall, the literature supports the hypothesis that overconfidence among CEOs is positively associated with higher investment levels within firms.

Based on the findings from previous studies, the following hypothesis is proposed:

Hypothesis 1: **Overconfident CEOs of SMEs tend to overinvest; therefore, overconfidence is significantly positively related to the investment level.**

3.2.2. CEO's gender and investment level

Research into cognitive psychology and management consistently highlights the influence of a CEO's gender on various aspects of leadership style, effectiveness, communication skills, conservatism, aggressiveness, risk aversion, and decision-making. Notably, empirical studies examining the relationship between CEO gender and investment level have revealed a significant relation between the two. A substantial body of literature explores gender differences in investment choices.

Lundberg et al. (1994) suggest that men tend to display higher overconfidence, especially in traditionally masculine domains like the financial industry. Estes and Hosseini (1988), through an experiment involving over 1,300 individuals, provide evidence of women exhibiting lower confidence in making investment decisions compared to men. Supporting these findings, Barber and

Odean (2001) identify substantial gender disparities in overconfidence, with men engaging in 45% more active trading than women, resulting in a reduction of nearly one percentage point in their net annual returns. In terms of risk aversion, Powell and Ansic (1997) observe that women tend to exhibit lower levels of risk-seeking behaviour than men.

Likewise, Olsen and Cox (2001) suggest that female investors show a greater inclination to consider risk attributes, particularly concerning potential losses and uncertainty, compared to men. In a related context, Li et al. (2013) discover that female sell-side analysts tend to exhibit a stronger tendency towards risk aversion in their recommendations. Pompian and Longo (2004) also note gender-related disparities, with women adopting a realistic and pessimistic approach, displaying lower risk tolerance, while men often demonstrate overconfidence, unrealistic expectations, and higher risk tolerance.

Furthermore, additional literature suggests that women are generally less overconfident than men (Barber & Odean, 2001; Deaux & Farris, 1977; Lenney, 1977; Lundeberg, Fox, & Punccohar, 1994) and more risk-averse (Arch, 1993; Bernasek & Shwiff, 2001; Byrnes, Miller, & Schafer, 1999; Eckel & Grossman, 2008; Jianakoplos & Bemasek, 1998; Sundén & Surette, 1998). These behavioural differences between men and women seem to lead to significant divergences in investment and financing decisions. Specifically, female CEOs, compared to their male counterparts, tend to invest less and utilize less debt when establishing their company's capital structure

The proposed hypothesis is:

Hypothesis 2: Male CEOs are less risk averse than women and invest more.

3.2.3. CEO’s age and investment level

Previous empirical and theoretical studies yield contradictory evidence regarding how a CEO’s age influences their financing decisions. Some literature finds that younger CEOs incline towards risk-aversion because they feel greater career concern - an anxiety which may prompt excessive investment conservatism (Eaton & Rosen, 1983; Hirshleifer & Thakor, 1992; Holmström, 1999; Scharfstein & Stein, 1990). Similarly, younger CEOs, anxious to impress, may be keenly aware that they have little track record and reputation compared to their older cohorts.

This again can incline younger CEOs towards avoiding risky or innovative investment opportunities (Zwiebel, 1995).

In contrast, other strands of research find that more youthful CEOs can be risk lovers, with higher energy levels and a tendency to make riskier investments and more maverick decisions than older managers (Li et al., 2014; Roberts & Rosenberg, 2006; Serfling, 2014). The managerial signalling model developed by Prendergast and Stole (1996) reveals how younger managers may commit to risky and aggressive investment strategies in an effort to signal to the market that they are of superior quality and talent. Younger managers may over-believe in themselves – therefore indulging in exaggerated investment to appear knowledgeable, confident and superior.

Older CEOs are arguably more risk-averse, which is evident in their tendency to make less risky financial decisions. Their safer investment style helps preserve their career and the familiarity of the status quo, so ensuring them a quieter life. However, Bertrand & Schoar (2003) and Serfling (2014) find that by avoiding risky investment projects, a more mature CEO may negatively impact their company's investment strategy. Furthermore, older managers may be reluctant to alter their historic investment style lest it signals to others that their former investment method was not as effective as it should have been (Bertrand & Schoar, 2003; Eaton & Rosen, 1983; Li et al., 2014; Serfling, 2014).

Based on the arguments above, the following hypotheses are proposed:

Hypothesis 3: Corporate investment declines as the age of the CEO increases.

3.2.4. CEO's ownership and investment level

Agency theory asserts that if a manager owns substantial shares in their company, their priorities and interests become more aligned with those of external shareholders (Jensen & Meckling, 1976). A number of empirical studies conclude that company performance is positively linked to the degree of managerial ownership (Chung & Pruitt, 1996; Morek, Nakamura, & Shivdasani, 2000; Palia & Lichtenberg, 1999).

Agrawal & Mandelker (1987) show that the level of stock and share options held by a CEO influences the decisions they make on their company's financing and investment. They conclude that CEO shareholding can significantly reduce agency problems. Similarly, Malmendier & Tate

(2005) also argue that higher shareholding among management leads to reduced agency problems. It is based on their finding that in companies where managers have higher ownership, a smaller investment-to-cash flow sensitivity results.

In contrast, another strand of research finds that managers with significant shareholdings - hence high control rights - may become resistant to internal and external governance mechanisms (Fama & Jensen, 1983; Morck, Shleifer, & Vishny, 1988; Shleifer & Vishny, 1997; Stulz, 1988). In the same vein, another argument proposes that high managerial ownership may over-empower management therefore creating agency problems (DeAngelo, 1985). Managers with overly high voting power tend to push decisions and actions in a direction that is advantageous to themselves while neglecting the interests of external shareholders.

Becht, Bolton, & Roell (2003) postulate that stock options can allow CEOs to enrich themselves at the expense of shareholders. Hence, an overly financially self-interested management team can reduce company performance. Agency problems across managers and shareholders can affect the management's investment decisions, resulting in either overinvestment or underinvestment. In some cases, managers may squander investment into negative net present value projects because it will put them in control of more assets, therefore allowing them more private benefit (Jensen, 1986). Another term for this is empire-building. Higher share ownership can encourage CEOs to be overconfident and aggressive, therefore more inclined to overinvest.

Conversely, Aggarwal & Samwick (2006) claim that managers may avoid investing in value-added projects because it would commit them to investing more time to oversee the investment projects. The drain on their time is perceived as a private cost, caused by their spending more.

Due to the contradictory research results, the following hypotheses are proposed:

Hypothesis 4: Higher ownership can encourage CEOs to be overconfident therefore more inclined to overinvest.

Hypothesis 5: Managers with high ownership may avoid investing because it would commit them to investing more time to oversee the investment projects.

3.2.5. CEO's tenure and investment level

Research into the link between CEO tenure-length and corporate investment falls into two groups. One group argues that shorter-tenure CEOs have less power, professional knowledge, and organisational familiarity than their older counterparts. It follows that short-tenured CEOs err towards safer (less-risky) investment projects than CEOs who have longer tenure (Finkelstein & Hambrick, 1996; Hermalin & Weisbach, 1991; Mezghanni, 2010; Miller & Shamsie, 2001; Richard, Wu, & Chadwick, 2009).

However, the second group finds that CEOs with short tenure invest more aggressively than those with longer tenure. This is likely because short-tenured CEOs are more experimental and curious about innovation and dynamic change, underpinned by the ambition and drive to achieve short-term outcomes that strengthen their reputation in the company. Such literature also argues that CEOs with longer tenure are risk-averse and that they have often fallen behind knowledge-wise in the rapidly evolving business environment. In such cases, they are less able to level up the firm's investment if internal funds are insufficient (Finkelstein & Hambrick, 1996; Gibbons & Murphy, 1992; Graham, Harvey, & Puri, 2013; Hambrick, Geletkanycz, & Fredrickson, 1993; Hambrick & Mason, 1984; Hirshleifer, 1993; Miller, 1991; Miller & Shamsie, 2001).

Based on these arguments, the empirical investigation aims to determine the influence of CEO tenure on corporate investment. In relation to this, the following hypotheses are proposed:

Hypothesis 6: Short-tenured CEOs, driven to achieve short-term outcomes, are more likely to invest aggressively than long-tenured CEOs.
Hypothesis 7: Due to lack of knowledge and organisational familiarity, short-tenured CEOs tend to invest less.

3.2.6. CEO's education and investment level

Research shows that a CEO's educational background colours their decision-making (Becker, 1970; Dollinger, 1984; Gunz & Jalland, 1996; Schroder, Driver, & Struefert, 1967). In particular, CEOs who have benefited from a financial education are less prone to irrational behaviour when it comes to making financial investment decisions for their companies. This is because they have

gained a deeper experience and understanding of financial markets and macroeconomic fundamentals (Ben Mohamed et al., 2014; Malmendier & Tate, 2005b). Their more rational and informed behaviour allows financially educated CEOs to raise external capital more cost-effectively which, by extension, reduces the average cost of capital.

Malmendier and Tate (2005) conducted a study that found a positive relationship between CEO education and a firm's investment level. They discovered that CEOs with formal financial training, such as degrees in finance or related fields, were more likely to engage in higher levels of investment spending. Their education equipped them with the necessary knowledge and expertise to make informed investment choices, resulting in more aggressive investment strategies.

Finkelstein & Hambrick (1996) observed that CEOs with advanced education tend to be more inclined towards risk-taking. Bertrand & Schoar (2003) discovered that CEOs holding an MBA degree tend to be more assertive, and this is linked with higher capital spending and debt levels. When opportunities for growth are substantial, executives with MBAs often invest excessively. Over the span of a decade, Smith, Smith & Verner (2006) noted a rise in the proportion of CEOs with elevated education levels. They also highlighted that a CEO's educational background significantly influences a company's decision in appointing them.

In contrast, other studies have presented mixed or contrasting results regarding the relationship between CEO education and investment level. For instance, Zona, Zattoni, and Minichilli (2013) found no significant relationship between CEO education and a firm's investment decisions. Their study suggested that factors other than formal education, such as experience and industry-specific knowledge, might play a more prominent role in shaping investment decision-making.

Based on the above, the following hypotheses are proposed:

Hypothesis 8: CEOs with higher educational level are more prone to take risk which results in higher investment levels.

Hypothesis 9: There is no relation between educational level and investment level.

3.2.7. CEO's professional experience and investment level

Another cohort of literature concludes that CEOs with longer career experience tend to invest more than those with shorter career experience, even when firms' internal funds are limited. This might be related to their having had time to develop a strong social network during their career, coupled with having gained more experience and expertise in designing and carrying out investment strategies (Geletkanycz & Boyd 2011; Granovetter, 1985; Haynes & Hillman, 2010; Hillman & Dalziel, 2003; Holmstrom & Costa, 1986; Nahapiet & Ghoshal, 1998; Scharfstein & Stein, 1990; Virany, Tushman, & Romanelli, 1992).

A study by Hoberg and Phillips (2010) found that CEOs with greater industry-specific experience are more likely to pursue investment opportunities and allocate more resources towards capital expenditures. Similarly, a study by Li et al. (2014) showed that CEOs with broader functional experience, such as finance or operations, exhibit higher levels of investment.

In addition, managers with a long career path behind them have learned better how to adeptly obtain the exact information they need to identify optimum investment avenues (Granovetter, 1973).

Based on these findings, it is hypothesized that:

Hypothesis 10: CEOs with longer career experience invest more than those with shorter career experience.

3.2.8. CEO's characteristics, overconfidence and investment level among SMEs

In their study, Mohamed at al. (2014) take into account a comprehensive range of factors, including CEO traits, CEO overconfidence, and investment levels. They investigate how these factors interact with investment cash flow sensitivity, considering scenarios with and without managerial optimism. The findings underscore that the financial education of CEOs, their ownership stakes, and their optimistic tendencies collectively contribute to explaining deviations in a company's investment strategy due to their influence on the relationship between investment and cash

flow. Similar to other researchers in the same field, Mohamed et al. (2014) analyse a dataset of major U.S. corporations.

Research by Ben Mohamed et al. (2014) and Hu and Liu (2015) have studied the dynamic between cash flow and a CEO's financial education, age, career experience, tenure and ownership. They contend that investment cash flow sensitivity is affected by these personal characteristics. Based on these findings, it is hypothesized that the personal attributes of a CEO influence the cash flow sensitivity of investments.

While papers from various countries are available, research specifically addressing investment levels within UK SMEs remains noticeably scarce. Below, some results from research conducted in countries other than the UK have been presented.

In the study conducted by Betzer et al. (2022), the relationship between managerial overconfidence and investment policies within small and medium-sized German firms is thoroughly examined. Utilizing a distinctive panel dataset, the research probes into the influence of overconfident managers on investment choices and their resulting consequences. The study's findings unveil a trend where managers displaying overconfidence exhibit a propensity for increased investment levels, particularly favouring expansion-oriented investments.

In their study, Lamptey, Marsidi, and Ladime (2021) delve into a significant theoretical dimension by examining the influence of managerial overconfidence bias on working capital management within Small and Medium-sized Enterprises (SMEs) in Malesia. By investigating the intricate relationship between overconfidence and the handling of working capital, the research brings to light a crucial factor that shapes managerial decision-making in SMEs. The study suggests that overconfident SME managers tend to overestimate sales growth and underestimate cash flow volatility, leading to heightened inventory investments for potential returns, particularly if personal or external capital is readily available.

3.2.9. Firm specific factors

This research incorporates ten economic and firm-specific factors that are known to influence investment levels. These factors have been selected as control variables based on previous

literature on the determinants of investment level, allowing for the consideration of various indicators related to a company's activities and economic situation.

Liquidity level of a company is often emphasized in the literature as they determine investment opportunities. For example, Erel et al. (2017) found that companies with higher liquidity can increase investment without relying heavily on external capital markets.

Another key indicator reflecting a company's activity is its *level of debt.* Gebauer et al. (2018) study levels of corporate debt and investment in Europe. Their calculations reveal a threshold: when debt is too high, it distorts investments - on account of higher risk and financing costs. This threshold is reached when the debt- to-asset ratio of a company becomes 80–85%. At this point, a noticeable decline of investment occurs.

The influence of profitability on a company's investment decisions is examined while accounting for the income factor, particularly *EBITDA*, as emphasized by Davis (2018). This perspective underscores that a decline in profitability can exert adverse effects on a company's choices regarding investments. Furthermore, this analysis extends to encompass the *Return on Total Assets (ROTA)* Ratio. ROTA provides insights into the efficiency with which a company employs its assets to generate profits. By controlling for both EBITDA and ROTA, a comprehensive understanding is achieved regarding how variations in profitability impact a company's investment strategies.

The influence of *firm size* on investment decisions is captured by including the total assets variable, an approach adopted by accounting standards like Generally Accepted Accounting Principles (GAAP) and other researchers (Barth et al., 2016; Spiceland et al., 2019). Total assets represent all the resources owned by a company, encompassing both tangible and intangible assets. Tangible assets include physical items like cash, inventory, property, and equipment, while intangible assets comprise items such as patents, trademarks, and goodwill.

Waseem et al. (2011) Julio and Gala (2016) found that smaller firms tend to exhibit higher levels of investment compared to larger firms, suggesting distinct investment patterns between different-sized companies. Total assets serve as a widely recognized measure of firm size, encompassing important determinants such as growth potential, financial stability, and investment opportunities.

Firm age is also recognized as a factor that can affect investment. Older firms might have more established market positions, well-developed organizational structures, and potentially more conservative investment strategies. In contrast, younger firms might be more focused on growth opportunities and could be more willing to take risks to expand their market presence. Additionally, the life cycle stage of the firm can influence the investment levels, as companies in different stages may have different growth prospects and financial constraints (Adelino, Robinson 2014).

The number of directors on a company's board is considered to have an impact on the investment level. The composition and characteristics of the board of directors can influence decision-making processes, governance practices, and ultimately, the investment decisions of a firm. A larger board with more directors may lead to more diverse perspectives, knowledge, and expertise. This diversity can enhance the quality of discussions and deliberations on investment decisions, potentially leading to more informed and robust investment choices. Too many directors may lead to information overload, communication challenges, and decision-making delays. Conversely, a smaller board may have a more streamlined decision-making process, enabling faster and more decisive action on investment opportunities (Faleye, Hoitash, and Hoitash (2011). Furthermore, a study by Yermack (1996) found a U-shaped relationship between board size and investment. The findings indicated that investment levels initially increase with board size up to a certain point, after which they decline. This suggests that there may be an optimal board size that maximizes investment effectiveness.

3.2.10. Macroeconomic factors

To ensure a comprehensive analysis, this research incorporates macroeconomic factors such as *GDP growth, inflation, corporate tax rate* and *interest rates* as control variables. These variables are included to account for their potential influence on investment levels and to better isolate the effects of other independent variables under investigation.

GDP growth, which measures the rate of economic expansion, provides valuable insights into the overall health and prospects of an economy. Higher GDP growth rates are generally associated with increased consumer demand, business opportunities, and market expansion. Studies, such as Barro (1991), have found a positive correlation between GDP growth and investment rates, suggesting that robust economic growth creates a conducive environment for investment.

Inflation refers to the general increase in prices over time. Moderate inflation can be beneficial for investment because it indicates a growing economy. However, high and unpredictable inflation can erode the purchasing power of consumers and lead to uncertainty in the business environment. Cecchetti and Kashyap (1996) analyse the relationship between inflation and business investment using data from various countries. These studies suggest that inflation can have a dampening effect on investment levels. Higher inflation rates and inflation uncertainty tend to reduce investment, primarily due to increased uncertainty, higher borrowing costs, and the erosion of real returns on investments.

Interest rates, reflecting the cost of borrowing and the return on investment, also play a significant role in investment level. Research by Gürkaynak, Sack, and Swanson (2005) suggests a negative relationship between interest rates and investment. Higher interest rates tend to dampen investment activity as they raise borrowing costs, making investments more expensive. Conversely, lower interest rates can stimulate investment by reducing the cost of capital, making borrowing more affordable for firms and encouraging investment in various projects.

The relationship between the *corporate tax rate* and investment level has been extensively studied in the field of economics. Numerous empirical studies have investigated how changes in the corporate tax rate influence a company's investment decisions. A study of Ohrn, E. (2018) examined the effect of corporate tax reforms on investment level. The researcher found that reductions in the corporate tax rate led to an increase in investment by these firms. The findings suggest that a lower tax burden incentivizes companies to allocate more resources towards investment, as it improves their profitability and expected returns.

By considering these factors as control variables, this research aims to shed light on the relationship between CEO personal characteristics and investment decisions, contributing to a better understanding of the underlying dynamics.

3.3. Data and Methodology

This chapter provides an overview of the key components of the study, including the sample, variables utilized in the panel regression model, data sources, and the methodology employed.

3.3.1. Data sample

The data set consists of 256 SMEs in the UK covering the period of 2014-2019. Only small and medium British, non-listed companies meeting the criteria as per the UK's definition of SME on gov.uk[14] have been used. The definition of an SME encompasses companies with a turnover of under 50 million pounds and fewer than 250 employees. The sample consists of companies from various industries and has been downloaded from an online database FAME. Appendix 1 provides a detailed breakdown of the industries included in the study, along with their respective percentage representation.

The selection of SMEs for this research is motivated by the scarcity of studies focusing on SMEs compared to larger corporations. The sample encompasses companies from diverse industries and was obtained from the FAME online database. It's noteworthy that the sample period, extending up to 2019, represents the most recent available data in FAME at the time of analysis. Moreover, due to the specific timeframe within which companies are required to provide their financial information, only data up to two years prior to the commencement of the analysis could be incorporated for evaluation.

To ensure the sample's relevance, filters were applied during the search process. Below, a stepwise selection procedure for the final sample has been presented:

1. Initially, a total of 25,678 companies were retrieved from the FAME database covering the period of 2014-2019.
2. Additionally, to ensure data reliability and completeness, companies with missing or incomplete financial data for any year within the period of 2014-2019 were excluded from the sample. This was necessary for cases where data was unavailable due to the non-existence of the companies during the research time scope. After applying the data completeness filter, 11,345 companies remained in the dataset.

[14] gov.uk SME guidance available at: https://www.gov.uk/

3. The dataset was filtered to include only companies classified as Small and Medium Enterprises (SMEs) according to the UK government's definition on gov.uk, resulting in 5,345 companies remaining in the dataset.
4. Following the SME classification filter and exclusion of micro-companies, 3,234 companies remained in the dataset. The definition of a micro entity, as per the UK government's guidelines, is a company with a turnover of £632,000 or less and 10 employees or less.[15]
5. After applying the data completeness filter, the dataset was further refined to exclude outliers or extreme values that could skew the analysis. This refinement resulted in 2,587 companies remaining in the dataset.
6. Furthermore, companies with significant changes in ownership, mergers, or acquisitions during the study period were excluded to maintain consistency in the sample. After this refinement, 1,145 companies remained in the dataset.
7. Only companies incorporated before January 2014 were included in the sample. This criterion ensured the inclusion of companies with a certain operational history needed for the analysis. This refinement resulted in 611 companies remaining in the dataset.
8. Only companies with available names of CEOs were included in the dataset to ensure consistency in the analysis of CEO-related variables. This step resulted in 267 companies remaining in the dataset.
9. Finally, after completing all filtering and refinement steps, adjustments were made to ensure that the final sample size reached 256 UK SMEs for analysis.

It should be noted that education and professional experience information for the CEOs was not available in the FAME database. Therefore, this data had to be collected manually from other sources, such as Companies House or the company's official websites.

In line with the approach taken by Malmendier and Tate (2005 b) to measure CEO overconfidence, the study employed a similar method. Overconfidence was assessed by systematically analysing press articles that referenced the CEOs. The focus was on articles available in freely accessible online newspapers. To gather information on the CEOs, press releases from various

[15] Definition as per gov.uk SME guidance available at: https://www.gov.uk/

sources were collected manually. These sources included the company's website, mainstream newspapers, and local publications.

Macroeconomic data, including inflation rate, GDP growth, interest rate, and corporate tax rate, were sourced from the gov.uk website, ensuring the use of reliable and authoritative information.

The panel regression models are run to investigate the impact of CEO characteristics, overconfidence, firm specific and economic factors on investment policy. The sample includes cross-sectional data with time-series data. The financial data for the sample of companies, sourced from FAME, is input to the R software for analysis.

The model presented in the chapter shares similarities with Malmendier and Tate's (2005 b) approach to measuring CEO overconfidence, although they employ different methodologies. While Malmendier and Tate (2005 b) utilize two distinct approaches—CEO stock and options holdings, as well as press releases—as proxies for overconfidence, the chapter focuses on analyzing press releases. In the "revealed beliefs" argument, Malmendier and Tate infer CEOs' beliefs about future company performance from their personal portfolio transactions, utilizing detailed information from a panel dataset on Forbes 500 companies. They identify CEOs holding options beyond rational thresholds and compare their actions to those who exercise options rationally, checking for signs of inside information driving trading decisions. Alternatively, the chapter examines how outsiders perceive CEOs through press articles, constructing an indicator based on the frequency of terms such as 'confident' and 'optimistic'. This measure of CEO confidence correlates significantly with portfolio measures utilized in the chapter's analysis. While the Malmendier and Tate paper delves into how CEO overconfidence influences corporate investment behavior, specifically its impact on cash flow sensitivity, the chapter focuses on analyzing the impact of overconfidence on investment levels, without addressing cash flow sensitivity.

Despite these methodological differences, both models aim to capture CEO overconfidence's influence on corporate decision-making using firm-level data. However, there are notable distinctions between the two. Malmendier and Tate concentrate on large U.S. corporations from 1980 to 1994, while the chapter focuses on UK SMEs from 2014 to 2019. Additionally, Malmendier and Tate investigate investment distortions, whereas the chapter examines the relationship between CEO overconfidence and investment rates among SMEs.

3.3.2. Dependent variable

The investment rate is the dependent variable in the model. Similarly, to Malmendier and Tate (2005) and Campbell (2011), this chapter defines investment rate as the capital expenditure (CapEx) divided by the value of property, plant and equipment (PPE).

Capital expenditures (CapEx) represent the money a company allocates for obtaining, improving, and upkeeping tangible assets like real estate, facilities, machinery, technology, or tools. CapEx is frequently directed toward launching fresh initiatives or ventures within a company. For instance, it can involve buying new machinery or constructing a fresh facility. This financial investment serves to expand a company's activities or contribute to its future financial gains. The CapEx to PPE ratio shows how much money a company invests in relation to the fixed assets that are already in possession of the company. In the analysis, the ratio has been converted into percentage to make it more comparable across the entire sample.

3.3.3. Independent variables

The study considers the following two groups of CEO characteristics: CEO biography, which includes gender, age, educational background, expertise/experience and overconfidence, and CEO incentives, which encompass tenure and ownership.

Gender is represented as a binary variable, taking the value of one if the CEO is male and zero otherwise. *Age* is a continuous variable indicating the numerical age of the CEO. The *educational background* is captured through a dummy variable that indicates the highest level of education attained by the CEO. In the regression model, the education level variable takes a value of one if the CEO has a higher education degree and zero otherwise. While data about the educational background, including whether the CEO has financial, technical, or other types of education, was collected, this variable was not included in the analysis. The decision to exclude the CEO's financial education variable was made after determining that, although financial education may influence financial decision-making, its effect could be largely captured by the CEO's overall education level. Furthermore, it was observed that each CEO possessing financial education also had a high degree. Including the financial education variable in the regression model might introduce multicollinearity issues or unnecessarily complicate the analysis without substantially enhancing the explanatory power of the model. The dummy variable for *experience* is defined as one if the CEO

has financial experience and zero otherwise. *Tenure* represents the number of years since the CEO was appointed to the position. *Ownership* is measured as the ratio of the number of shares owned by the CEO to the total outstanding shares.

Following Malmendier and Tate (2005b), the *overconfidence* is measured by use of key-words used in newspapers portraying the CEOs. The analysis involves examining the frequency of specific words in articles related to each CEO and sample year. Words of interest include: (a) 'confident' / 'confidence' and (b) 'optimism' / 'optimistic'. These are followed by other examples such as (e) 'cautious', 'conservative', 'frugal', 'practical', 'reliable' or 'steady'. The basic list of key words is extended using common synonyms, as found in the Oxford English dictionary.

The resulting 2421 articles portraying CEOs are then analyzed by means of ATLAS.ti. To ensure that the program does not pick random words from the articles that do not refer to the CEO's characteristic, to determine whether the adjectives are negated - and to further check the context - each article is also checked manually. The outcome of the analysis is the identification of articles the CEO is either (c) 'not confident' or (d) 'not optimistic'.

The number of articles that portray a particular CEO as being confident and optimistic is then compared to the number that suggest the CEO is the opposite – unconfident, not optimistic or displaying typically unconfident attributes, such as being cautious, conservative, frugal, practical or steady. The CEO is classified as overconfident *if* $a + b > c + d + e$. The CEO is not classified if no articles mention them. An indicator variable (dummy variable) is constructed, taking a value of one if CEOs are classified as overconfident and zero otherwise.

Subsequently, the CEO-level data is merged with the financial data sourced from FAME, as well as the data manually collected from online sources.

3.3.4. Control variables

The factors known to affect firm investment are controlled for in the analysis. These factors include firm financial indicators such as: *debt-to-equity ratio* measured by dividing total liabilities by total assets and deducting total liabilities, *liquidity* measured by dividing current assets by current liabilities, *income (EBITDA)* calculated by dividing earnings before interest and tax, depreciation and amortization by total revenue and *return on total assets* (*ROTA)* measured by dividing

net income by total assets. The analysis includes controls for *firm size*, which is measured by total assets, as well as the *number of directors* and *company age*. Furthermore, the research takes into account various economic factors, including the *interest rate, inflation, GDP growth*, and *corporate tax rate.*

3.3.5. Summary of all variables used in the study

The summarized list of all variables used in the study is presented below:

Variable	Definition/Measure
Dependent variable:	
Investment rate	The capital expenditure divided by the value of property, plant and equipment.
Independent variables:	
Overconfidence	The portray of CEOs in online newspapers based on keywords.
Tenure	The number of years held in the position of CEO.
Age	Numerical value
Education	If a CEO has higher education, the dummy variable equals 1, 0 otherwise
Experience	Number of years
Gender	Fame or male, dummy variable takes the value of 1 if male, 0 otherwise
Ownership	The number of shares owned by a CEO to total shares outstanding
Firm's control variables:	Current assets divided by current liabilities
Liquidity ratio	
Debt to equity ratio	Current and long-term liabilities divided by total assets – (current liabilities +long term liabilities)
EBITDA margin	Earnings before interest and tax + depreciation + amortization divided by total revenue
Firm's age	Number of years since incorporation date
Firm's size	Total assets
Director's count	Number of directors
Return on total assets (ROTA)	Net Income /Total Assets
Economic control variables:	Corporate tax rate in %
Tax rate	Average inflation rate for a given year in %
Inflation	Average GDP growth for a given year in %
GDP growth	Average interest rate for a given year in %
Interest rate	

Table 3.1: List of variables

In the analysis, two key statistical techniques were employed to prepare the data for examination: logarithmic transformation and standardization. The logarithmic transformation proved useful for dealing with variables that spanned several orders of magnitude or exhibited high skewness. By applying the logarithm function to each data point, variance was stabilized across the dataset and its conformity to a normal distribution was enhanced, facilitating the application of various statistical tests and models. Additionally, standardization, or Z-score normalization, was used to adjust each variable to have a mean of zero and a standard deviation of one. This process

was crucial in ensuring that features with differing original scales, such as for example age or assets, contributed equally to the analysis without being disproportionately influenced by their scale or distribution. Together, these transformations refined the dataset, making it more suitable for sophisticated analytical techniques.

3.4. Research models

In this chapter of the PhD thesis, a collection of statistical models will be applied to investigate the hypotheses. These models offer distinct approaches to analysing the data and evaluating the research hypotheses. The four primary statistical models that will be utilized are POLS (Pooled Ordinary Least Squares), Random Effect, Fixed Effect, and GMM (Generalized Method of Moments). By incorporating this array of models, a comprehensive understanding of the data relationships will be sought, leading to insightful conclusions from the analysis.

The initial step in this process involves presenting the theoretical framework. Subsequently, the chapter will showcase the model outputs alongside the corresponding statistical tests, facilitating the identification of the optimal model for accurately fitting the data.

To enhance the usability and understandability of the data, as well as to fulfil prerequisites for specific statistical tests or models, two methods were utilized to transform numerical variables spanning a wide range. For variables containing only positive values and displaying significant skewness, a logarithmic transformation was applied. This adjustment helps reduce skewness and makes data patterns easier to interpret. Alternatively, when dealing with variables encompassing both positive and negative values, a scaling process was implemented. This process involved centralizing the variables by subtracting their mean and then dividing them by their respective standard deviations.

3.4.1. POLS (Pooled Ordinary Least Squares)

The data on different units in pooling model which expressed by formula (2) are pooled together with no assumption on individual differences:

$$y_{it} = \beta_0 + \beta_1 x_{1it} + \cdots + \beta_k x_{kit} + u_{it} \quad (2)$$

Where: y_{it} - explained variable of the i-th observation at time *t*; x_{kit} – k-th predictor of the *i*-th observation at time *t*; u_{it} – error coefficient of the *i*-th observation at time *t*; β_0 – model intercept (reference level); β_1..., β_k – model coefficients[16].

3.4.2. Fixed Effect Model

In a fixed effect model, each subject has their own individual characteristics that may have an additional influence on the dependent variable. The fixed effect eliminates the influence of these time-invariant characteristics so that we can assess the net effect of the predictors on the outcome variable. The designed fixed-effects model included an individual constant αi to control for the individual and time-varying characteristics t. In contrast, the slope coefficients β_1, ..., β_k were constant for all individuals (see formula 3).

$$y_{it} = \alpha_i + \beta_1 x_{1it} + \cdots + \beta_k x_{kit} + u_{it} \quad (3)$$

For the two-sided error component model, equation (3) additionally accounts for the individual invariant time effect μ_t.

3.4.3. Random Effect Model

The random effects model is suitable for panel data where confounding variables may be intercorrelated between time and between individuals. In the random effects model, the difference between the constants was adjusted for the error terms of the individuals. The advantage of using a random effects model was the elimination of heteroscedasticity. The random effects model implemented was based on the assumption that the effects specific to all individuals were distributed according to an unknown probability distribution around a common mean (see formula 4). Moreover, the common mean was invariant across all time periods.

$$y_{it} = \alpha + X'_{it}\beta + u_{it}, i \in \{1, \dots, N\}, t \in \{1, \dots, T\} \quad (4)$$

$$u_{it} = \mu_i + \varepsilon_{i,t},$$

$$\mu_i \sim \mathbb{N}(0, \sigma_\mu^2);$$

[16] are the same for all unit (do not have *i* or t subscript).

$$\varepsilon_{i,t} \sim \mathbb{N}(0, \sigma_{\varepsilon}^2);$$

Where: u_t - error component; μ_i - random component; $\varepsilon_{i,t}$ – idiosyncratic disturbance; $\sigma_{\mu}^2 -$ error variance of each specific random component; $\sigma_{\varepsilon}^2 -$ idiosyncratic error component.

The selection of the more appropriate estimator was based on the results of testing the error component models on Error Component Models.

3.4.4. Generalised Method of Moments (GMM)

Fitting of panel data in terms of the dynamic model (when one of the regressors is the lagged dependent variable) was performed using the Generalized Method of Moments (GMM) estimation procedure.

A general representation of a two-way dynamic panel data model was presented in equation (5):

$$\mathrm{y_{it}} = \alpha \cdot y_{it-1} + \mathrm{X}_{it} \cdot \beta + \mu_{\mathrm{i}} + \lambda_{\mathrm{t}} + \varepsilon_{\mathrm{it}}, \quad (5),$$

where: i – the individual dimension (i = 1, ..., N), t – the time dimension (t = *1*, ..., T), $\mathrm{y_{it}}$ – the dependent variable, y_{it-1} – the lagged dependent variable, X_{it} – a matrix of exogenous or predetermined regressors, α and β – the parameters to be estimated; μ_{i} – the unobserved time-invariant individual-specific effect; λ_{t} – the unobserved time effect; $\varepsilon_{\mathrm{it}}$– the idiosyncratic error term.

The model specified a two-way effects model that included both individual-specific effects (μ_{i}) and time effects (λ_{t}). This allows for the control for time-invariant unobserved individual characteristics and common time-specific factors that could potentially correlate with the regressors.

The two-step GMM estimator was obtained as follows: in the first step, model estimation was performed using the one-step GMM estimator with an identity matrix as the weighting matrix, next the model was re-estimated using the GMM estimator with the optimal weighting matrix, which was the inverse of the variance-covariance matrix of the moment conditions estimated in the first step.

The Hansen-Sargan test was performed to assess the validity of the overidentifying restrictions (Sargan, 1958), (Hayashi, 2000, chapter 5). Correlation of a variable with its own lagged values was conducted by autocorrelation test (Box, 1970), (Woolbridge, 2010, chapter 12).

The joint significance of the time dummy variables and model coefficients was tested by the Wald test (Wald, 1943), (Green, 2003, chapter 4).

3.5. Statistical tests

The specification of panel models presents a challenge often tied to the presence or absence of individual effects—necessitating the accommodation of unobserved heterogeneity. In the majority of instances, it's unwise to disregard individual heterogeneity entirely. This raises the question of whether we can assume this heterogeneity remains uncorrelated with explanatory variables (leading to the use of random effects), or if it's better to adjust for (transform) individual effects with fixed effects. Consequently, diagnostics encompass tests for individual effects via both approaches and Hausman-type tests to determine the appropriate method (Croissant et al., 2019).

After estimating the within model, the nested ordinary least squares (OLS) model, and the two-way effect model, a three-step pairwise test was performed. This commenced by testing the absence of individual effects using the F-test for both individual and time effects, comparing the nested OLS model with the within model. Additionally, a comparison was made between the nested OLS model and the two-way effect model to assess the absence of individual and time effects. Lastly, the individual and two-way effect model was compared to the within model to examine the absence of time effects while allowing for the presence of individual effects.

The selection of the more effective estimator between pooled and random models involved testing individual and time effects. This was carried out using the Lagrange FF multiplier test for panel models, along with the Breusch and Pagan test (Breusch and Pagan, 1980), which implements Lagrange multiplier tests for individual and/or temporal effects based on pooled model results. The null hypothesis of the Breusch and Pagan test posits zero variances between units, implying no significant difference between units (i.e., no panel effect).

The decision between fixed and random effects specifications relied on Hausman-type tests (Hausman, 1978), comparing both estimators under the assumption (H0) of no significant

difference. This essentially examines whether unique errors (ui) are correlated with the regressors; the null hypothesis assumes they are not. If this assumption is not rejected, the more efficient random effects estimator is chosen.

Regarding cross-sectional dependence, Baltagi (2007) highlighted its significance in macro panels with lengthy time series. As the dataset under consideration is not a macro panel, cross-sectional dependence testing was omitted. Similarly, serial correlation tests are not applicable to micro panels, being more suited for macro panels with extended time series.

To assess heteroscedasticity, the Breusch-Pagan test (Breusch & Pagan, 1979) was employed. This test examines heteroscedasticity in a linear regression model, assuming normally distributed error terms. It investigates whether the variance of regression errors is dependent on independent variable values. If the test yields significance (indicating heteroskedasticity), the interpretation of model effects relies on the covariance matrix, employing the heteroskedasticity-consistent covariance estimator white2 of type H3 (Zeileis 2004). Significance of coefficients was estimated using z-Wald tests.

Multicollinearity assessment within the regression model was conducted using estimated Generalized Variance Inflation Factors (GVIF). GVIF quantifies variance inflation in regression coefficients due to collinearity among predictor variables. A GVIF value exceeding 1.0 implies multicollinearity, with values surpassing 5.0 being deemed problematic (Belsley, 1980).

3.6. Empirical results

3.6.1. Descriptive statistics of CEO characteristics

Table 3.2 presents the descriptive statistics for all variables in the analysis, indicating that 41% of all CEOs are categorized as overconfident. The level of overconfidence fluctuates around 30% throughout the study period from 2015 to 2019.

Consistent with previous research findings, the majority of CEOs in the sample are male, accounting for approximately 95% of the total. The age of CEOs in the sample ranges from 22 to 82 years, with an average age of approximately 51 years. Among the age brackets, around 43% of

CEOs fall within the 51-60 years range, while only 10% are younger than 30 years old. The sample indicates that 41% of CEOs tend to be overconfident.

When examining the educational background of CEOs, the largest proportion (67%) holds a bachelor's degree, followed by 26% with a master's degree, and only 2% with a PhD. Notably, a significant portion (52%) of CEOs possess educational qualifications in the fields of finance, accounting, or economics, while technical education such as engineering is less common, accounting for 33% of the sample. CEOs with expertise in accounting or finance represent 16% of the firms, whereas approximately 12% have a technical background. Furthermore, the majority of CEOs (70%) possess experience in areas unrelated to finance or technical fields.

Moving on to CEO incentives, tenure and ownership are examined. The average CEO tenure for UK SMEs is approximately 10 years, with a maximum tenure of 40 years. In terms of ownership, CEOs hold an average ownership stake of around 8% in their respective companies.

Most SMEs (71%) fall within the smaller size category (assets up to 100k GBP), reflecting the typical SME structure in the UK which leans towards micro and small enterprises. The director count further supports this, with 92% having between 0 and 5 directors, aligning with governance structures suited to smaller, less complex businesses.

The age distribution indicates a relatively mature SME landscape, with only 24% of firms being in the 0-10 year range. The majority of the firms (57%) are between 11 and 40 years old, suggesting established businesses with potentially more resilience to market fluctuations and economic cycles.

Liquidity ratios, which measure a firm's ability to meet its short-term obligations, show a significant concentration in the lower range, with 63% of firms maintaining a liquidity ratio between 0 and 1.5%. This suggests a generally conservative approach to liquidity among UK SMEs, possibly indicative of a cautious strategy in managing working capital amidst economic uncertainties during the period. Only a small fraction (2%) maintained liquidity ratios above 5%, highlighting a risk-averse tendency in liquidity management.

The distribution of EBITDA margins shows a positive skew towards higher profitability, with 54% of the firms reporting margins between 11% and 20%. This indicates a healthy operating

performance across a majority of the SMEs, potentially reflecting effective cost management strategies and solid market positioning in their respective sectors.

Debt to equity ratios varied, with a majority (64%) of SMEs having a ratio below 1. This underlines a conservative financing structure where equity tends to dominate the capital structure, minimizing insolvency risks and enhancing financial stability. The remaining 36% with a ratio above 1 suggests a higher leverage, which could be indicative of either growth-focused strategies involving significant borrowings or potential financial stress.

ROTA figures show that a significant number of firms (46%) had returns between 5% and 10%, signifying moderate asset efficiency. The substantial proportion of firms with a ROTA above 10% (31%) reflects a segment of highly effective firms in utilizing their assets to generate earnings, highlighting operational excellence.

The control variables of tax rate, interest rate, inflation, and GDP provide contextual macroeconomic conditions influencing these metrics. These factors would have impacted the financial and operational outcomes for SMEs during the period and need to be considered when interpreting the observed trends. Throughout the period from 2014 to 2019, the corporate tax rate in the UK remained relatively stable, fluctuating within the range of 19% to 21%. Conversely, the interest rate saw an upward trend, starting at 0.25% in 2015 and gradually increasing to 0.75% by 2019. The average inflation rate was 1.74%. This level of inflation is generally considered low, indicating a stable cost environment which can help SMEs maintain consistent pricing and cost management strategies without sudden adjustments. The mean GDP was 2.35 trillion GBP.

Variable	**Percentage**	**Mean**	**Min**	**Max**
Overconfident CEOs	41%			
Gender				
Percentage of male CEOs (%)	95%			
Age		51	22	82
Percentage of CEOs who are:				
- less than 30 years old	10%			
- 31-50 years old	24%			
- 51-60 years old	43%			
- more than 60 years old	23%			
CEO's ownership		8%	0%	100%

CEO's tenure		10	3 months	40 years
- **0-10**	19%			
- **11-20**	13%			
- **21-30**	66%			
- **31-40**	2%			
Educational level				
- Below bachelor	5%			
- Bachelor	67%			
- Master	26%			
- PhD	2%			
Educational background:				
- Bachelor finance	31%			
- Bachelor technical	24%			
- Bachelor other	14%			
- Master finance	21%			
- Master technical	8%			
- Master other	1%			
- PhD finance	0%			
- PhD technical	1%			
- PhD other	0%			
Experience background:				
- Finance	16%			
- Technical	12%			
- General management /Other	70%			
Experience yrs:				
- 0-10	56%			
- 11-20	32%			
- 21-30	12%			
- 31-40	2%			
Firm specific variables:				
Liquidity ratio:				
- 0-1.5%	63%			
- 1.5%-5%	35%			
- 5% +	2%			
EBITDA Margin				
- 0 – 5%	11%			
- 5% -10%	35%			
- 11%-20%	54%			
Debt to Equity Ratio				
- Below 1	64%			
- Above 1	36%			
Firm's age				
- 0-10	24%			
- 11-20	26%			
- 21-40	31%			
- 40+	19%			

Return on Total Assets (ROTA)				
- 0-5%	23%			
- 5%-10%	46%			
- 10% +	31%			
Firm's Size (total assets)				
- 0-100k GBP	71%			
- 100k-500K GBP	16%			
- 500K GBP +	13%			
Director's count:				
- **0-5**	92%			
- **5-10**	5%			
- **10+**	3%			
Control variables:				
- Tax rate		19.6%	19%	21%
- Interest rate		0.50%	0.50%	0.25%
- Inflation		1.74%	0.20%	3.10%
- GDP		2.35 trillion GDP	2.23 trillion GDP	2.42 trillion GDP

Table 3.2: Descriptive statistics of CEO characteristics

3.6.2. Model results: FEM, REM and POLS

This following section delves into the outcomes yielded by the implemented regression models. The results of fitting a multivariate panel regression model examining the effects of the independent variable, the firm's and the economic control variables on the dependent variable (based on the inventory in table 3.1) for linear models (fixed effect, POLS, random effect) and GMM are presented in table 3.3.

Variables	**Investment rate**		
	FEM[17]	*POLS*	*REM*
Overconfidence [yes]	**0.446*****	**0.423*****	**0.431*****
	(0.016)	(0.015)	(0.015)
Gender [men]	-	**0.069****	**0.069***
	-	(0.030)	(0.037)
Age	**-0.175*****	**-0.246*****	**-0.224*****
	(0.039)	(0.033)	(0.034)
Ownership [%]	-	-0.0005	-0.0005

[17]In a fixed-effects regression model, the estimated coefficients for time-invariant categorical variables, such as gender, education level, or ownership status, were not provided. This is because these variables were absorbed by the individual-specific intercept term in the fixed-effects estimation process. This is a limitation that arises from the goal of these models to eliminate unobserved time-invariant entity-specific effects.

The variables *interest rate* and *tax rate* have been removed due to low variability of the factors (tax and interest rate remained stable in the period 2014-2019).

Variables	**Investment rate**		
	FEM[17]	*POLS*	*REM*
	-	(0.0003)	(0.0004)
Tenure	**-0.025*****	**-0.030*****	**-0.028*****
	(0.007)	(0.006)	(0.006)
Education [Master]		-0.008	-0.007
		(0.014)	(0.017)
Higher education		0.021	0.019
		(0.036)	(0.047)
Experience [yrs]	**0.022**	**0.030*****	**0.028****
	(0.014)	(0.011)	(0.011)
Firm's size	-0.003	0.002	0.003
	(0.022)	(0.008)	(0.009)
Liquidity ratio	-0.014	0.011	0.008
	(0.019)	(0.010)	(0.011)
EBITDA margin	-0.013	-0.001	-0.003
	(0.012)	(0.008)	(0.009)
Debt to equity ratio	0.125	0.0003	0.022
	(0.125)	(0.072)	(0.080)
Inflation	**1.718****	**1.525****	**1.525****
	(0.751)	(0.726)	(0.692)
GDP	-0.171*	-0.136	-0.139
	(0.098)	(0.088)	(0.085)
Director's count	**-0.051***	**-0.026****	**-0.028***
	(0.029)	(0.013)	(0.015)
ROTA	0.007	0.001	0.003
	(0.008)	(0.007)	(0.007)
Firm's age	-0.030	**-0.018***	-0.017
	(0.041)	(0.009)	(0.011)
Observations	1,536	1,536	1,536
R^2	0.532	0.584	0.566
$R^2_{adj.}$	0.432	0.578	0.560
F Statistic	86.411*** (*df* = 13; 987)	97.492*** (*df* = 17; 1182)	1,544.256***

Note: $^{*}p<0.100$; $^{**}p<0.005$; $^{***}p<0.010$

Table 3.3: Regression models: POLS (Pooled Ordinary Least Squares); FEM (Fixed Effect Model); REM (Random Effects Model)

With striking similarity in results across the three employed models—Pooled Ordinary Least Squares (POLS), Fixed Effects (FE), and Random Effects (RE)—consistent patterns emerge,

illuminating the relationship between various factors and the investment level. Notably, factors such as overconfidence, experience, and inflation consistently exhibit a positive influence on the investment level within all models. Conversely, variables such as age, tenure, and the number of directors consistently show a negative influence on the investment level across all three models. While these robust trends provide valuable insights, the selection of the most suitable model demands careful consideration. The intricacies of the data's structure, the implications of individual and group-specific effects, and the presence of heteroscedasticity necessitate an optimal modeling approach. To address this, the subsequent section will delve into the process of identifying the model that best fits the data, ensuring that the final analytical framework accurately captures the multifaceted dynamics of investment behavior.

In order to ascertain the most suitable statistical model for the analysis, a series of pivotal tests were conducted to assess the presence of distinct effects and underlying assumptions within the dataset. These tests were crucial in discerning the appropriate model that could accurately capture the nuances of the data.

The first test, the F-test comparing the Pooled Model and Within Model, yielded compelling evidence for rejecting the null hypothesis of no individual effects. This finding implied the existence of substantial individual or group-specific effects within the model, thereby necessitating their incorporation into subsequent analysis to avoid any potential bias.

Continuing the investigation, the Breusch-Pagan Lagrange multiplier test was employed to contrast the Pooled Model against the Random Model. The substantial chi-square statistic and the p-value below 0.001 signaled the rejection of the null hypothesis proposing zero variances across entities. This discovery underscored the Random Effects Model's superiority, highlighting its adeptness in accommodating the substantial variations in outcomes among different companies.

Similarly, the results of the Hausman test, which compared the Fixed Model with the Random Model, revealed an insignificant chi-square statistic and a p-value of 0.657. This outcome advocated in favor of the Random Effects Model, which proved more effective in managing unobserved, company-specific effects, without introducing any potential biases.

Lastly, the Breusch-Pagan test uncovered heteroscedasticity within the model, indicating the importance of employing robust standard errors for reliable inference.

In light of this holistic assessment of results, the Random Effects Model emerged as the most fitting choice, capable of effectively addressing the intricate interplay of individual effects, variance discrepancies, and underlying assumptions. This selection reaffirms its appropriateness for the subsequent analysis, ensuring a robust and accurate exploration of the dataset's dynamics.

3.6.3. Results of the adjustment of the final model – Random Effect Model

The multivariate random effects panel model designed to examine the influence of 17 independent and control variables (as listed in Table 3.1) on the investment rate showed considerable explanatory power. It explained a substantial amount of the variation in the dependent variable, as indicated by an R-squared (R^2) value of 0.57. This means that the model explained 57% of the variability in the investment rate. Moreover, the adjusted R-squared value (R^2adj) compensating for the number of predictors in the model was also substantial at 0.56, confirming the robustness of the model even after adjusting for the set of variables included.

The idiosyncratic variance value was 0.09, with a standard deviation of 0.30. This represented the variance within each individual or group in panel data due to factors not included in model. The share of the total variance attributed to the idiosyncratic component was 79.5%. This indicated that a substantial part of the variation in model dependent variable was caused by time-varying factors not captured in the model, or by random noise. The share of the total variance attributed to the individual component was 20.5%. This suggested that a smaller portion of the variation in investment rate was due to differences between groups.

The theta value of 0.37 expressed that within-group variation was more prevalent than between-group variation in studied data.

Every coefficient in the model significantly deviated from zero, as evidenced by a chi-square (χ^2) value of 1565.56 with 17 degrees of freedom and a $p < 0.001$.

Assessment of multicollinearity in the regression model was performed using estimated Generalized Variance Inflation Factors (GVIF), which quantified the inflation of variance in the estimated regression coefficients due to collinearity among predictor variables. A GVIF value greater than 1.0 indicated the presence of multicollinearity with GVIF values greater than 5.0 considered as problematic (Belsley, 1980).

The results of fitting the final model can be found in Table 3.4

Variable	*Random effect model*	*GVIF*
Overconfidence [yes]	**0.431 (0.016)*** **	1.34
Gender [men]	**0.069 (0.033)** **	1.08
Age	**-0.223 (0.038)*** **	2.22
Ownership [%]	-0.0005 (0.0004)	1.05
Tenure	**-0.028 (0.006)*** **	1.20
Higher education	0.025 (0.055)	1.10
Experience [yrs]	**0.028 (0.012)** **	1.94
Firm's size	0.003 (0.001)	1.53
Liquidity ratio	0.008 (0.012)	1.24
EBITDA margin	-0.0003 (0.010)	1.44
Debt to equity ratio	0.022 (0.087)	1.28
Inflation	**1.525 (0.701)** **	1.30
GDP	-0.139 (0.085)	1.33
Director's count	-0.028 (0.015)*	1.08
ROTA	0.003 (0.012)	1.21
Firm's age	-0.017 (0.011)	1.13
Constant	**1.098 (0.177)*** **	-

Note: $^{*}p<0.100$; $^{**}p<0.005$; $^{***}p<0.010$

Table 3.4: The results of fitting the multivariate model with random effects in terms of robust estimation of the covariance matrix with generalized variance inflation factors (GVIFs)

The results in Table 3.4 show that factors such as overconfidence, gender, age, tenure, and inflation had significant effects on the investment rate.

Factors that showed an additional relationship with the investment rate included: the over-confidence (an overconfident CEO was associated with a 0.431 percentage point increase in the investment rate, other predictors being equal[18]), male sex (a male CEO was associated with a 0.069 percentage point increase in the investment rate relative to a female CEO), experience (a 1.0

[18] Here and hereafter

increase in experience was associated with a 0.028 percentage point increase in the investment rate) and inflation (a one percentage point increase in inflation is associated with a 1.525 percentage point increase in the investment rate).

Factors with identified negative effects included: age (a 1.0 increase in age was associated with a 0.223 percentage point decrease in the investment rate) and tenure (a 1.0 increase in tenure was associated with a 0.028 percentage point decrease in the investment rate).

All GVIF values were relatively close to 1.0 and well below the threshold of 5.0, indicating that there was likely no concerning multicollinearity among the predictor variables in the random effects panel model. This suggests that the final model did not suffer from severe multicollinearity, and the estimates of the coefficients were reliable.

When comparing the coefficients obtained in univariate analyses only the effect of overconfidence in the multivariate model varied by less than 20%. Incorporating additional control variables into the model alongside other exploratory variables altered the estimated effects of the variables 'tenure' and 'experience'. This suggests that these additional variables absorbed some of the explanatory power of 'tenure' and 'experience'. Additionally, the newly introduced variables acted as confounders, influencing the relationship between the independent and dependent variables.

3.6.4. Generalised Method of Moments Model (GMM)

The utilization of the Generalized Method of Moments (GMM) model in the analysis comes as a valuable step following the exploration of the Random Effects (RE), Fixed Effects (FE), and Pooled Ordinary Least Squares (POLS) models. While these initial models provide insights into the relationships between variables and the investment level, the GMM model offers additional advantages in handling potential endogeneity and autocorrelation issues that might be present in the data. GMM addresses these concerns by utilizing moments that are derived from the underlying economic theory to construct estimators, resulting in efficient and consistent parameter estimates even when standard assumptions are violated. Therefore, incorporating the GMM model contributes to refining the analysis by accounting for potential biases and providing robust

parameter estimates that enhance the overall understanding of the factors influencing the investment level. Table 3.5 presents the model output for GMM[19].

Variables	*Investment rate*
Investment rate (lag 1)	**-0.176** ** **(0.088)**
Investment rate (lag 2)	0.010 (0.053)
Overconfidence [yes]	**0.480** *** **(0.036)**
Overconfidence [yes] (lag 1)	**0.106** *** **(0.040)**
Age	**-0.199** *** **(0.070)**
Tenure	**-0.025** ***(0.009)**
Tenure (lag1)	0.001 (0.008)
Experience [yrs]	**0.044** **(0.020)**
Experience [yrs] (lag1)	-0.003(0.019)
Firm's size	-0.051 (0.050)
Firm's size (lag 1)	0.006 (0.035)
Liquidity ratio	-0.010 (0.032)
Liquidity ratio (lag1)	-0.008 (0.033)
EBITDA margin	0.030 (0.033)
EBITDA margin (lag1)	0.001 (0.012)
Debt to equity ratio	0.282 (0.233)
Debt to equity ratio (lag 1)	0.164 (0.225)
Director's count	-0.027 (0.043)
ROTA	-0.008 (0.022)
ROTA (lag 1)	**-0.019** ***(0.006)**
Firm's age	-0.045 (0.068)
GMM Diagnostic Tests:	
Sargan Test: *Test Statistic: chi^2 = 5.772854, P-value: 0.56651*	
Tests for Autocorrelation*: Test Statistic: -0.995186, P-value: 0.31965*	
Wald Test: *Test Statistic: chi^2 = 723.005, P-value: 0.00000000000000022*	
No of observations: 1536	
*Note *p<0.100; **p<0.005; ***p<0.010*	

Table 3.5: Results of the Generalised Method of Moments model (GMM)

[19] In the GMM regression model, the estimated coefficients for time-invariant categorical variables, such as gender, education level, or ownership status, were not provided. This is because these variables were absorbed by the individual-specific intercept term in the fixed-effects estimation process.

The GMM model output provides insightful findings regarding the relationship between various variables and the investment level. Several factors exhibit statistically significant correlation with the investment level. Notably, the lagged investment rate (Investment rate lag 1) demonstrates a negative coefficient of -0.176, although it should be noted that the confidence interval (0.088) for this coefficient is relatively wide, potentially indicating some uncertainty in its impact. Overconfidence, both in the current period and the previous one, showcases a positive influence on the investment level, with coefficients of 0.480 and 0.106 respectively. The CEO's age displays a significant negative relationship with the investment level, with a coefficient of -0.199, suggesting that older CEOs are associated with lower investment levels. Similarly, CEO tenure exhibits a negative coefficient of -0.025, implying that longer-tenured CEOs tend to have lower investment levels. On the other hand, CEO experience demonstrates a positive coefficient of 0.044, indicating that greater CEO experience is linked to higher investment levels. Lastly, the scaled Return on Total Assets (ROTA) from the previous period (lag 1) shows a negative coefficient of -0.019, which suggests that higher past ROTA is associated with lower current investment levels. These results underscore the intricate interplay between CEO characteristics and economic indicators in influencing investment decisions, offering valuable insights for further analysis and decision-making processes.

The Generalized Method of Moments (GMM) analysis presents results that align closely with those obtained from the Pooled Ordinary Least Squares (POLS), Random Effects (RM), and Fixed Effects (FM) models. The observed patterns and relationships between the independent variables and the investment level remain consistent across these diverse methodologies.

Having analyzed the relationships between various factors and the investment level through different models, the subsequent section delves into a robustness check. This step aims to further solidify the validity and reliability of our findings by subjecting them to additional tests and considerations.

The Sargan test statistic was χ^2 (7)= of 5.77 and the associated p-value was 0.57. Since the p-value was greater than conventional significance levels (e.g., 0.05), we fail to reject the null hypothesis. This means that we did not have sufficient evidence to claim that the instruments were invalid. Therefore, based on the Sargan test, we can conclude that the instruments used in the GMM model appear to be valid.

In the case provided, the autocorrelation test for lag 1 yields a test statistic of -4.27 and an associated p-value of <0.001.

Given that the p-value was substantially less than conventional significance levels (such as 0.05), we have strong evidence to reject the null hypothesis. This implied that there was statistically significant autocorrelation in the residuals of lag 1 in the model. In the context of a Generalized Method of Moments (GMM) model, the presence of autocorrelation in the residuals could indicated that the model is misspecified or that the moment conditions used by the GMM estimator were not fully met.

On the contrary the absence of significant autocorrelation in the residuals at lag 2 (a test statistic of -0.99 and an associated p=0.321), suggested that the model does not violate the no-autocorrelation assumption for this particular lag length. This result supports of the validity of the moment conditions being used by the GMM estimator at this lag order.

In addition, the significant result of Wald test for coefficients χ^2 (21) = 784.86 and a p <0.001, indicated that at least one of the coefficients in the model is significantly different from zero. Furthermore, the non-significant result of Wald test for time dummies χ^2 (3) = 0.70 and a p =0.876, implied that there was no sufficient evidence to claim that the time dummy variables were significantly different from zero in the GMM model. Hence, the time dummies do not appear to have a significant effect on the dependent variable.

3.6.5. Conclusion

The upcoming section delves into a critical aspect of the analysis: hypothesis testing. This section will compare the initial hypotheses formulated based on existing theories and expectations with the outcomes obtained from the extensive statistical modeling and empirical investigation. By examining how these hypotheses were tested and subsequently proven or disproven through rigorous analysis, valuable insights are gained into the alignment between theory and reality.

The below table summarises the hypotheses testing:

Hypothesis	*Explanatory variable*	*Expected relation*	*Observed relation*	*Hypothesis accepted?*
H1	Overconfidence	+	+	Yes

Hypothesis	*Explanatory variable*	*Expected relation*	*Observed relation*	*Hypothesis accepted?*
H2	Gender (M)	-	N	No
H3	Age	-	+	Yes
H4	Ownership	+	N	No
H5	Ownership	-	N	No
H6	Tenure	+	+	Yes
H7	Tenure	-	+	No
H8	Education	+	N	No
H9	Education	N	N	Yes
H10	Experience	+	+	Yes

Table 3.6: Hypotheses testing: expected and observed relations.
'+' = positive relation, '-' = negative relation, 'N'- no relation.

The results of this study offer significant contributions to the existing literature on the determinants of investment policies among SMEs in the UK and the role that CEOs play in investment decisions. No other study has explored the effect of CEO characteristics, including CEO biography (gender, age, educational background, and expertise/experience), CEO incentives (tenure and ownership), psychological biases (overconfidence), and financial factors among CEOs of SMEs in the UK. Therefore, this research fills a gap in the existing literature by examining these factors and their impact on investment decisions within the context of UK SMEs.

The purpose of the analysis was to test the following hypotheses:

Hypothesis 1: Overconfident CEOs of SMEs tend to overinvest; therefore, overconfidence is significantly positively associated with the level of investment.

The results clearly demonstrate a significant positive relation between CEO overconfidence and the investment rate in SMEs. Overconfident CEOs exhibited an investment rate that was 42-48% higher (depending on the statistical model used) than those without overconfidence. This finding suggests that overconfident CEOs are more inclined to take risks and invest more aggressively in their businesses. This aligns with previous research highlighting the role of overconfidence in entrepreneurial decision-making. Hypothesis I is found to be in accordance with the findings of previous studies by Malmendier and Tate (2005), Lin, Hu, and Chen (2005), Huang, Jiang,

Liu, and Zhang (2011), Campbell, Jhonson, Rutherford, & Stanley (2011), and Heaton (2002). These studies also observed a positive relationship.

Hypothesis 2: Male CEOs are less risk averse than women and invest more.

Gender also exhibited some level of statistical significance in the applied models; however, due to the limitation of the dataset, particularly the low representation of female CEOs, the true effect of gender on the investment level could not be adequately assessed. The small number of female CEOs (5%) in the sample hinders a comprehensive understanding of the gender effect on investment decisions. As a result, caution should be exercised when interpreting the significance of gender-related findings, and further research with a more balanced gender distribution within the CEO population would be beneficial to draw more conclusive insights. However, despite this limited representation, some interesting observations were noted in both the POLS and RE models. These models indicated a significant positive relationship between male gender and the level of investment.

Hypothesis 3: Corporate investment declines as the age of the CEO increases.

The analysis revealed a statistically significant negative relationship between the age of CEOs and the investment level. Specifically, for every additional year of age for the CEO, the investment rate is expected to decrease by approximately 18-24%. This finding implies that as CEOs grow older, they tend to adopt a more conservative approach to investment decisions. It suggests that with increasing age, CEOs may prioritize cautious investment choices, possibly due to their heightened awareness of potential risks and a preference for established and proven strategies over riskier alternatives. It's important to note that this interpretation assumes that all other factors affecting investment decisions remain constant. This statistically significant negative relationship between the age of CEOs and the investment level aligns seamlessly with the established findings of previous research, including studies by Li et al. (2014), Roberts & Rosenberg (2006), and Bertrand & Schoar (2003) and Serfling (2014), as well as the observations presented by Eaton & Rosen (1983).

Hypothesis 4: Higher ownership can encourage CEOs to be overconfident therefore more inclined to overinvest.

Hypothesis 5: Managers with high ownership may avoid investing because it would commit them to investing more time to oversee the investment projects.

The analysis revealed that the data did not provide substantial evidence to support the validity of Hypotheses 6 and 7, as no relationship was found between the level of ownership and investment. As a result, these hypotheses can be rejected due to the lack of empirical confirmation. These findings suggest that these factors may not play a substantial role in shaping investment decisions in SMEs.

Hypothesis 6: Short-tenured CEOs, driven to achieve short-term outcomes, are more likely to invest aggressively than long-tenured CEOs.

Hypothesis 7: Due to lack of knowledge and organizational familiarity, short-tenured CEOs tend to invest less.

The analysis revealed a significant negative relationship between CEO tenure and the investment rate in SMEs. As CEO tenure increased, the investment rate decreased by 3% for each additional year. This finding suggests that longer-tenured CEOs tend to be more cautious and conservative in their investment decisions. It is possible that experienced CEOs prioritize stability and efficiency overgrowth, leading to lower investment levels. H8 is consistent with the findings from previous studies, including Finkelstein & Hambrick, 1996; Gibbons & Murphy, 1992; Graham, Harvey, & Puri, 2013; Hambrick, Geletkanycz, & Fredrickson, 1993; Hambrick & Mason, 1984; Hirshleifer, 1993; Miller, 1991; Miller & Shamsie, 2001).

Hypothesis 8: CEOs with higher educational level are more prone to take risk which results in higher investment levels.

Hypothesis 9: There is no relation between educational level and investment level.

The analysis conducted using various models revealed no significant relationship between the education level of the CEO and the investment level. As a result, Hypothesis 10 can be reasonably rejected due to the lack of empirical support. Conversely, Hypothesis 11 holds true, as the data and models did not provide evidence to reject it. Zona, Zattoni, and Minichilli (2013) also did not find any relationship in a similar study to this one.

Hypothesis 10: CEOs with longer career experience invest more than those with shorter career experience.

The study uncovered a statistically significant positive link between CEO experience and the investment rate in SMEs. The analysis demonstrated that, with each additional year of CEO

experience, the investment rate experienced an increase of approximately 3-4%. This finding implies that CEOs with extensive experience might be more inclined to pursue a proactive investment strategy. This behaviour could be attributed to their deeper understanding of the market dynamics and an increased comfort level with taking calculated risks. Alternatively, their extensive experience may lead them to recognize opportunities that align with proven strategies, resulting in a higher investment rate. Hypothesis 12 is supported by the outcomes of the three statistical models, all of which consistently demonstrate a positive relationship between CEO experience and the investment level. This alignment with the research findings of Geletkanycz and Boyd (2011), Granovetter (1985), Haynes and Hillman (2010), Hillman and Dalziel (2003), Holmstrom and Costa (1986), Nahapiet and Ghoshal (1998), Scharfstein and Stein (1990), and Virany, Tushman, and Romanelli (1992) further strengthens the credibility of this conclusion.

The number of directors also displayed a significant negative influence in the statistical models. More specifically, the results indicate that for every additional director within the firm, the investment rate is anticipated to decrease by approximately 3-5%. This finding suggests that a higher number of directors might lead to a more conservative approach to investment decision, possibly due to increased deliberation and cautious decision-making processes within a larger decision-making body.

Other CEO-specific factors such as level of education, ownership level did not show any significant results. These findings suggest that these factors may not play a substantial role in shaping investment decisions in SMEs.

Shifting the focus from CEO-specific factors, the analysis explored several other factors, including firm's size, liquidity ratio, ROTA, EBITDA, debt to equity ratio, inflation, GDP and firm‘s age. Among all these variables, only inflation showed a statistically significant result. The growth of investment level is highly dependent on the increase of inflation. Other macroeconomic of firm specific factors do not explain the variance in the investment rate.

The findings of this study hold several implications for policy makers and entrepreneurs alike. Firstly, the significant positive relationship observed between CEO overconfidence and investment rates suggests that policy interventions and entrepreneurial training programs should focus on addressing overconfidence biases to ensure more prudent investment decisions. Additionally, the negative correlation between CEO age and investment level underscores the importance

of succession planning within SMEs to ensure a balance between experienced leadership and innovative decision-making. Moreover, the lack of substantial evidence supporting the influence of CEO ownership and educational background on investment decisions suggests that policies aimed at incentivizing ownership or promoting higher education among CEOs may not directly influence the investment. Instead, policymakers should concentrate on creating an enabling environment that encourages responsible financial decision-making while providing adequate support and resources for SMEs to thrive. Furthermore, the significance of inflation as a determinant of investment underscores the importance of macroeconomic stability and monetary policy measures in fostering an environment conducive to investment growth. Overall, these insights can guide policymakers in crafting targeted interventions to support SMEs and foster sustainable economic development. For entrepreneurs, understanding the nuances of CEO characteristics and external factors influencing investment decisions can inform strategic planning and decision-making processes, ultimately enhancing the resilience and growth prospects of their ventures in a dynamic business landscape.

It is important to note that the sample of 256 companies included in this study represents only a small proportion of all small and medium-sized enterprises (SMEs) in the UK. This sample may not fully represent the diversity and complexity of the SME landscape. A larger sample size would provide a more comprehensive understanding of the relationships between CEO characteristics and the investment rate in SMEs. The research focused solely on SMEs, and the findings may not be generalizable to larger corporations. Additionally, the study relied on self-reported data, which could introduce bias or measurement errors. While the limited sample size is a potential limitation, it is worth considering the trade-off between data availability and the scope of analysis. Despite the smaller sample, this study aims to provide valuable insights by exploring a range of important variables and their relationships. The findings derived from this sample can still contribute to the existing body of knowledge and offer valuable implications for understanding the relationship between CEO characteristics and investment decisions.

It is important to acknowledge that future studies with larger sample sizes may further enhance our understanding of the topic. Nonetheless, this study's methodology and careful selection process for the sample help mitigate the limitations associated with data availability for SMEs, ensuring the rigor and validity of the findings within the scope of this research. Further research

could delve into the underlying mechanisms that drive these relationships, providing a more comprehensive understanding of investment level in SMEs. Further research in this field can build upon the current study's findings and address several avenues for exploration. Firstly, it would be beneficial to conduct longitudinal studies to examine the long-term effects of CEO characteristics on investment level in SMEs. This would provide insights into the dynamics of these relationships and whether they evolve over time. Additionally, exploring the mediating mechanisms through which CEO overconfidence influences investment decisions could offer a deeper understanding of the underlying processes at play. Furthermore, investigating the potential moderating effects of external factors, such as industry characteristics or regulatory environments could enhance our understanding of the contextual factors that shape investment. Lastly, expanding the research scope to include a broader range of SMEs would contribute to a more comprehensive understanding of the factors influencing investment decisions in SMEs.

In conclusion, regardless of the limitations, the findings of this study contribute to the existing literature on investment level in SMEs, specifically highlighting the significance of behavioural biases and CEO characteristics. The research addresses a gap by comprehensively examining the impact of CEO attributes, psychological biases, and financial factors on investment choices in the context of UK SMEs. By shedding light on the role of CEO characteristics and external factors, the study provides practical insights for entrepreneurs, managers, and policymakers aiming to optimize investment strategies in the dynamic landscape of small and medium-sized enterprises.

Conclusion

The conclusion drawn from the comprehensive analysis across the three chapters of the thesis underscores the significant influence of behavioural finance, particularly managerial overconfidence, on corporate investment decision-making.

Chapter one establishes the groundwork by highlighting the evolution of behavioural finance as a critical response to the inadequacies of traditional finance, emphasizing the importance of acknowledging human irrationalities in financial decision-making. This chapter concludes that behavioural finance does not seek to replace traditional finance but rather complements it, suggesting an integrated approach for a more holistic understanding of market behaviours and investment decisions. The exploration of overconfidence in finance, despite its multifaceted nature in psychology, suggests a pragmatic approach to treating it as a unified concept, acknowledging the practical challenges and potential lack of added value in separating it further within the financial research domain.

Chapter two delves into the implications of entrepreneurial overconfidence on tax policy and investment decisions, proposing that optimal tax policies should consider the behavioural biases among entrepreneurs. The model proposed advocates for a government policy approach that incorporates the anticipated entrepreneurial bias within the economy. It suggests that in instances where confidence diminishes, leading entrepreneurs to adopt a pessimistic outlook, there should be a reduction in both corporate and personal tax rates. Conversely, if entrepreneurs exhibit excessive overconfidence, tax rates should be adjusted upwards. Moreover, the model suggests that a combination of a targeted corporate tax for limited liability businesses alongside a universal personal income tax could optimize decision-making efficiency and contribute to an overall increase in social surplus. This holistic approach acknowledges the intricacies of entrepreneurial behaviour and aims to create a policy environment aiming to maximize economic outcomes while mitigating the adverse effects of both excessive pessimism and overconfidence. This chapter posits that recognizing the influence of overconfidence can lead to more effective tax policies that encourage optimal investment behaviours, mitigating the risks of under or overinvestment driven by misaligned tax structures.

Chapter three, through empirical analysis, demonstrates the tangible impact of CEO characteristics, particularly overconfidence, on investment decisions in SMEs. It provides evidence of the positive correlation between overconfident CEOs and higher investment rates. CEO tenure exhibits a noteworthy negative correlation with SME investment, contrasting with the positive association found between CEO experience and investment levels. Additionally, the age of CEOs demonstrates a statistically significant negative impact on investment, while the presence of a higher number of directors is also linked to decreased investment rates, as indicated by the statistical models. However, certain CEO-specific factors such as educational attainment and ownership levels does not yield significant findings. Shifting focus to other pertinent variables, including firm size, liquidity ratios, Return on Total Assets (ROTA), Taxes, EBITDA, debt-to-equity ratios, inflation, GDP growth, and firm age, only inflation emerges as a statistically significant determinant. Importantly, the chapter puts forward several recommendations for future research, including conducting longitudinal studies to examine the long-term effects of CEO characteristics on investment levels in SMEs and exploring the mediating mechanisms through which CEO overconfidence influences investment decisions. Furthermore, it suggests investigating the potential moderating effects of external factors such as industry characteristics or regulatory environments on investment decisions.

The empirical analysis conducted in the thesis acknowledges specific limitations, including its focus solely on SMEs within the UK, potentially limiting the generalizability of findings to larger corporations or firms in different geographical regions. Additionally, the reliance on proxy measures for overconfidence and the use of a sample of 256 companies, which, while comprehensive, may not fully represent the diversity of the SME landscape, are noted as constraints to the study's breadth. The methodology's dependence on self-reported data and manual data collection for CEO characteristics also introduces the possibility of bias or measurement error, highlighting the need for future research to consider employing alternative methodologies.

The theoretical model introduced in Chapter II likely operates under simplified assumptions to ensure tractability, potentially overlooking the complexities of real-world decision-making scenarios and leading to discrepancies between theoretical predictions and actual outcomes. While the model focuses on specific factors such as projected project performance and tax considerations, it may neglect other influential determinants like market dynamics, regulatory environment, and

socio-cultural factors. Additionally, the model's inability to fully incorporate the heterogeneity among entrepreneurs, encompassing diverse characteristics, motivations, and risk preferences, may restrict its relevance and applicability across different entrepreneurial contexts.

Future research endeavours could delve into the underlying mechanisms that drive the relationships identified, thereby enhancing our understanding of investment levels in Small and Medium-sized Enterprises (SMEs). Building upon the present study's findings, several avenues for exploration emerge. Firstly, longitudinal studies could be conducted to investigate the enduring effects of CEO characteristics on investment levels in SMEs, shedding light on the dynamics and potential evolution of these relationships over time. Moreover, probing into the mediating mechanisms through which CEO overconfidence influences investment decisions could yield deeper insights into the underlying processes. Additionally, exploring the moderating effects of external factors, such as industry characteristics or regulatory environments, may offer valuable insights into the contextual factors shaping investment behaviours. Lastly, broadening the scope of research to encompass a wider array of SMEs would contribute to a more comprehensive understanding of the diverse factors influencing investment decisions within this crucial sector of the economy.

The section on potential extensions and avenues for further research within the theoretical model includes considerations of debt levels, dividend policies, and personal borrowing by entrepreneurs, present opportunities to deepen our understanding of how financial decisions interact with entrepreneurial behaviour. Moreover, the discussion on introducing outside equity financing into the model highlights the importance of incorporating external sources of funding and their implications for entrepreneurial choices. Exploring the implications of heterogeneity in entrepreneurial biases opens avenues for investigating how individual differences shape decision-making processes and outcomes. The examination of asymmetric information, particularly beyond the probability of firm success, suggests a broadening of the model's scope to encompass additional dimensions of uncertainty and risk. Furthermore, the suggestion to explore scenarios where entrepreneurs lack sufficient wealth to cover losses underscores the need to consider the financial constraints and resource limitations that entrepreneurs may face in real-world settings. Overall, these potential avenues for further research provide a compelling framework for advancing our understanding of entrepreneurial decision-making under various financial and informational constraints.

In summary, the thesis contributes significantly to the understanding of the role of behavioural finance, especially managerial overconfidence, in shaping corporate investment decisions. By bridging the gap between traditional and behavioural finance, it offers a comprehensive overview that advances academic knowledge and provides practical insights for enhancing corporate governance and investment strategies. Future research in this domain promises to further illuminate the complexities of financial decision-making, paving the way for more informed and effective policies and practices, with an emphasis on the detailed recommendations and mindful of the study's acknowledged limitations.

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Appendix I

Industry (based on SIC Codes clasification available at gov.uk)	% in the data sample
Accommodation And Food Service Activities	5%
Administrative And Support Service Activities	10%
Construction	7%
Financial And Insurance Activities	5%
Human Health And Social Work Activities	4%
Information And Communication	8%
Manufacturing	16%
Mining And Quarrying	5%
Other Service Activities	4%
Professional, Scientific And Technical Activities	5%
Real Estate Activities	5%
Transportation And Storage	6%
Water Supply; Sewerage, Waste Management And Remediation Activities	5%
Wholesale And Retail Trade; Repair Of Motor Vehicles And Motorcycles	14%

Appendix II

Predictor	**Investment rate**		
	β	*95% CI*[1]	*p*
(Intercept)	0.25	0.23, 0.28	**<0.001**
Overconfidence	0.49	0.46, 0.52	**<0.001**

[1] 95% CI – Confidence Interval 95%

Predictor	**Investment rate**			
	β	*SE*	*z*	*p*
(Intercept)	0.69	0.02	43.80	**<0.001**
Tenure	-0.02	0.00	-16.59	**<0.001**

[1] SE – the standard error; z – z-test statistic

Predictor	**Investment rate**			
	β	*SE*	*z*	*p*
(Intercept)	0.71	0.02	33.91	**<0.001**
Career experience	-0.01	0.00	-11.58	**<0.001**

[1] SE – the standard error; z – z-test statistic

Predictor	**Investment rate**			
	β	*SE*	*z*	*p*
(Intercept)	0.405	0.023	17.17	**<0.001**
Overconfidence	0.430	0.016	26.81	**<0.001**
Tenure	-0.008	<0.001	-7.60	**<0.001**

Predictor	**Investment rate**			
	β	*SE*	*z*	*p*
Career experience	-0.003	0.001	-3.72	**<0.001**

[1] SE – the standard error; z – z-test statistic