On the Mean Reversion of Capital Structures in Valuation Methodologies

by

Claus Kjær Jørgensen
(102426)

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Supervisor: Michael E. Jacobsen

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Resumé

Formålet med denne afhandling er at undersøge den ofte anvendte antagelse i værdiansættelser at firmaers kapitalstruktur, over tid, vil bevæge sig mod et gennemsnit og derved udvise mean reversion. Ud fra et teoretisk synspunkt kan dette fænomen forklares via afbalanceringsteorien, der argumenterer for et optimalt punkt af kapitalstruktur, der balancerer mellem fordele og ulemper, som selskaber vil styre efter. Litteraturen hvad angår kapitalstruktur er generelt modsigende, med empiriske resultater der støtter forskellige teorier. Få empiriske studier har fokuseret specifikt på at teste mean reversion fænomenet i kapitalstuktur på trods af dets prævalens i praktiske anvendelser af værdiansættelse.

Denne afhandling adresserer specifikt denne antagelse ved at teste for mean reversion i kapitalstrukturer på både individuelt firma niveau samt med en paneltilgang. Jeg undersøger den empirisk baggrund for antagelsen om mean reversion og tester holdbarheden af denne antagelse ved at foretage unit root tests på selskaber fra S&P 500 indekset i tidsperioden fra 1980 til 2019. Samtidigt identificerer jeg finansielle karakteristika der differentierer sig mellem selskaberne. Derudover diskuterer jeg den nye bølge af grønne finansielle instrumenter, og disses potentielle indflydelse på kapitalstruktur i fremtiden.

Mine resultater indikerer, at antagelsen omkring mean reversion af kapitalstruktur ikke altid er holdbar. Individuelle tests indikerer en trend imod mean reversion, mens panel tests indikerer et mere blandet forhold. Karakteristika mellem selskaberne indikerer en størrelses forskel mellem grupperne, hvor de firmaer der udviser mean reversion af deres kapitalstrukturer er mindre end firmaer der ikke udviser denne tendens. Mere blandede forhold observeres omkring andre karakteristika såsom profitabilitet og værdiansættelse. Diskussionen om grøn finansiering viser en trend inden for området, som både praktiserende analytikere der arbejder med værdiansættelse og finansielle managers i selskaber bør være opmærksom på. Særligt den nemmere adgang til kapital ved påvisning af en bæredygtig agenda har potentialet til at skabe nye finansieringsmuligheder for en lang række selskaber og derved påvirke kapitalstrukturer.

Contents

1 Introduction

At the very birth of a new firm, the question of funding arises. The entrepreneur might look to her savings to fund the first few months of the new firm, or she might have pitched the idea to close family, friends, or the neighbour to secure funding for the first short while of operations. She might have gone even further and talked to the bank to get a loan to start the business, or perhaps she took on additional investors, giving up some of her equity stake in the firm she has just started, to get it off the ground. No matter the specific circumstances of the funding, the fundamental question remains: How does the firm fund its operations?

No matter what stage of the lifecycle a firm is at, whether it be just starting, or considering an IPO, the question of funding and financing the operations and new investment projects is an ever-present problem for the financial managers of the firm. Naturally, one might then ask, why is it that it is so important? What value does it create, if any? There are differing opinions on this in the literature of finance, but the basic reason as to why it is beneficial to even think about how the firm is funded, that is, what capital structure the firm has, is that the ideal combination of equity and debt can create value for the owners of a business by allowing it to pay less taxes (Modigliani & Miller, 1963). Through this measure, the capital structure of the firm directly impacts the valuation of the company. After all, if managers are to maximise shareholder wealth, then they should choose the capital structure which is the most valuable to existing shareholders of the firm. But what if there are changing market landscapes and conditions which are affecting the access and perhaps also the price of capital? New and exotic financing options such as green financial instruments might play a big role in the capital structure of firms in the future, but how should this be captured? How should one integrate the new framework for lending that sustainable finance provides? If we are not the management of the company, and we do not know what the plans are for the firm's future capital structure, how do we determine the capital structure that we will utilise in the valuation?

One commonly used approach is to utilise target capital structures based on industrial averages (Petersen et al., 2017), arguing that the current capital structure observable via book values may be different to the specific capital structure the firm might adhere to in the future. Implied within this methodology is the assumption that the firm will, over time, adjust to this capital structure, effectively arguing that the capital structure of the individual firm will be mean reverting. This assumption is precisely the primary focus of this thesis. Exploring whether firms do adjust towards a targeted capital structure and what characteristics such firms might share, compared to firms that do not exhibit this mean

reversion. Additionally, what impact the current observable trends regarding green financing might have on the future capital structure choices of firms to further progress the knowledge base within valuation and the relation to capital structures.

This thesis will proceed as follows. In the remaining part of the introduction, I will present the basic framework for capital structure and the link to the impact on valuation, my research questions, and my delimitations. Chapter 2 is dedicated to a theoretical review of capital structure literature, as well as literature regarding mean reversion and the properties of the concept, while exploring its influence on capital structure. In chapter 3, I present and provide motivations for the data selection as well as the methodological approach this thesis will take to the research questions. In chapter 4, I present my analysis of the data sample and the empirical results observed. In chapter 5, I discuss the empirical results, relate the results to previous literature, and provide interpretations of the results. In chapter 6, I discuss the implications of green financing. Chapter 7 concludes the thesis.

1.1 Basic Framework

Given the subject matter at hand is valuation and capital structure, it seems appropriate to cover any considerations of ambiguity or different interpretations there might exist of these two concepts. I will go through the main concepts and explain the link from capital structure to valuation. However, terminology within the areas of capital structure and valuation may differ within the field of academia, and so the terminology used in this specific thesis should not be viewed as a uniform way of describing the concepts, but rather merely as a guide for this specific thesis.

1.1.1 Valuation

Aswath Damodaran, one of the foremost experts on valuation (New York University, 2020), argues that valuation is more like a craft rather than an exact science. Valuation is, at its core, figuring out how much a certain company is worth, even if there is no universal truth to be found. There are several different approaches to valuation. The three main approaches are intrinsic valuation, relative valuation, and liquidation valuation (Petersen et al., 2017). While contingent claims methodologies using real options also has their utilisation, they are often difficult to navigate and the required inputs hard to obtain (ibid.). This thesis does not concern itself with the approaches of relative valuation, liquidation valuation, nor contingent claims valuation. The focus of this thesis is exclusively that of the intrinsic valuation, of which the Discounted Cash Flow (DCF) valuation method is by far the most popular among practitioners, with Economic Value Added (EVA) and

Adjusted Present Value (APV) models also having their place among the practitioners, but not to the same degree as the DCF methodology (Petersen et al., 2017).

The basis of DCF valuation rests on two main propositions: 1) for an asset to have value, the expected cash flows have to be positive at some point over the life of the asset, and 2) an asset that generates cash flows earlier in its lifespan will be worth more than an asset which generates cash flows later (Damodaran, 2000). In short, one discounts the cash flows the firm is expected to receive by the appropriate discount rate, that being the Weighted Average Cost of Capital (WACC). From this, one can derive the following formula for the value of the firm using a DCF approach (Petersen et al., 2017, p. 305):

$$\text{Enterprise Value} = \sum_{t=1}^{\infty} \frac{FCFF_t}{(1+WACC)^t} \tag{1.1}$$

where

$FCFF_t$ = the expected free cash flow (after taxes) to the firm in the period

WACC = Weighted Average cost of Capital

As per the above equation, there are two inputs in the model which directly affect the outcome of the valuation, the expected future free cash flow and the discount rate (WACC). This also implies that a higher free cash flow and a lower WACC lead to a higher valuation, while lower free cash flows and higher WACC lead to a lower valuation.

The main purpose of this thesis is not to discuss how best to estimate these two parameters to obtain as realistic a valuation as possible. However, it seems nonetheless appropriate to delve a bit further into how exactly the chosen capital structure will impact the valuation of a company, and precisely outline which of these aspects this thesis will focus on.

1.1.2 Capital Structure in Valuation

There are those who would argue that capital structure does, in fact, not directly impact valuation. The seminal works of Franco Modigliani and Merton H. Miller (M&M) in 1958 argues this exact fact. The model, however, has several restricting characteristics, such as an assumption of no taxes and no bankruptcies. Under the conditions M&M sets up, they do conclude that capital structure does not matter for the value of the company, which has been the springboard for a lot of academic attention surrounding the subject of capital structures and company valuation.

This section does not aim to delve deeply into the theories surrounding capital structure, as this will be covered in the review of existing literature on the topic. However, as

mentioned before, there are two main inputs for the DCF valuation, the cash flows and the discount rate. The choice of capital structure impacts only one of these, as the free cash flow to the firm is unaffected by the choice of leverage (Petersen et al., 2017). To see why capital structure has a direct impact on the discount rate, consider first what exactly the discount rate used in valuation is. It is an expression of the required rate of return for the investors in the firm (ibid.). This will typically be two different types (although more exotic options do exist), equity investors and debt investors, who each have a required return based upon the risk they are taking. Given that equity investors take on more risk when investing in a company, the required return to equity holder is often higher than the return required by debt investors. The discount rate can thus be expressed follows, weighing the two required returns by their share of the capital structure of the firm (Petersen et al., 2017, p. 341):

$$WACC = \frac{NIBD}{NIBD + Equity} * r_d * (1 - t) + \frac{Equity}{NIBD + Equity} * r_e \qquad (1.2)$$

where

NIBD = The market value of net interest-bearing debt

Equity = Market value of equity

r_d = Required rate of return on NIBD

r_e = Required rate of return on Equity

t = Marginal tax rate for the firm

From this, it becomes evident how exactly the capital structure of the firm impacts the valuation an analyst will arrive at, as the capital structure influences the discount rate. This causes a problem for the person performing the valuation, as it is not often that the firm being valued is traded publicly, and thus has its updated market-value based capital structure readily available. There are several ways to approach this problem when performing the valuation of the company. Petersen et al., (2017, p. 341) argues that two main approaches should be utilised: 1) utilising the capital structure of comparable firms or the average industrial capital structure, or 2) utilise the iteration method.

However, regardless of the chosen methodology, an underlying assumption of both is that the firm will, over time, move towards a targeted capital structure. The first methodology assumes that the average capital structure of the industry is the best proxy for the targeted capital structure of the individual firm, and so argues that the firm will move towards this capital structure over time. The second methodology attempts to directly

estimate this targeted capital structure for the firm, by finding the optimal capital structure through an iterative process, arguing then that the firm will move towards this optimal capital structure over time. Therefore, no matter which choice the person performing the valuation makes regarding the estimation of capital structure, embedded within the valuation will be the basic assumption that the firm will, over time, gradually move towards a targeted capital structure. The difference lies only in how this targeted capital structure is estimated, and therefore the mean reversion concept is applicable when utilising both methodologies to perform a valuation. For this reason, it seems appropriate to further analyse whether this assumption holds when comparing it to existing literature, as well as empirical results regarding the capital structure decisions of firms.

1.2 Problem formulation

This thesis attempts to test whether or whether not firms exhibit mean reverting tendencies in their capital structures over time, and as such whether it is reasonable to utilise the assumption of mean reversion to a targeted capital structure in a valuation setting, and by extension also support for either the trade-off theory or the pecking order theory (Golinelli & Bontempi, 2005).

This thesis' main objective is to provide an answer to the following question:

- *Do firms, over time, adjust their capital structures according to a targeted level of leverage, or is the observed capital structure a result of more ambiguous mechanisms?*

The above question is a rather broad one however, and I immediately delimit the problem by focusing explicitly on the assumption in valuation regarding mean reversion of capital structure. Additionally, I wish to supplement with an analysis on if firms that exhibit mean reversion differ from those that do not in terms of selected financial measures to perhaps uncover what measures or mechanisms might differ between the groups. To create a clear and concise structure of this thesis, it will focus on testing the following hypotheses:

- *Hypothesis 1: Over time, companies will tend to adjust their capital structure towards a target as predicted by trade-off theory, and will therefore exhibit a mean reversion tendency in their capital structure*

- *Hypothesis 2: Companies exhibiting mean reversion tendencies in their capital structure will differ in certain financial measures compared to companies that do not exhibit this mean reversion tendency*

These two hypotheses will be tested to create a concrete and simple basis for evaluating whether the assumption regarding targeted capital structures in valuation seems reasonable. While the first hypothesis will directly attempt to determine if the usage of the targeted capital structures assumption in valuation is reasonable, the second hypothesis will aim to both identify what might characterise a mean reverting firm, as well as attempt to provide a basis for understanding why certain firms have a mean reverting tendency in their capital structure, while others do not. Together these two hypotheses will allow for an interpretation on the reasonableness of the mean reversion assumption, as well as provide a framework for understanding what might make a firm mean reverting in its capital structure.

As mentioned in the introduction, newer green financing instruments might change the landscape of financing and therefore seem appropriate to address. This part of the thesis will focus on looking forward, with the testing of mean reversion looking at the history of capital structure. This is done in order to complement the empirical testing with forward-looking perspectives, offering insights into not only how the historical capital structure choices have taken shape, but also how they might take shape in the future, and how anyone performing valuation should take this into account. For this reason, it will be more of a discussion of trends, literature, and observations in the markets, focused on answering the following question:

- *How, if at all, will the new instruments of green financing impact the adjustments firms make to their capital structure in the future?*

Together with the two hypothesis, which will be empirically tested, this question forms the full scope of this thesis, a scope focused both on the historical adjustments of capital structure in a valuation perspective, and how the future of capital structures might be influenced by green financing. In the following section, I present the specific delimitations of the research questions as well as the two stated hypotheses.

1.3 Delimitations

While many aspects within capital structure can be interesting to look at from a valuation perspective, in order to concretely reach results which can perhaps lead to a recommendation in regards to the performance of firm valuation, certain choices must be made within the design of the study. Therefore, there are important delimitations to the empirical analysis of this thesis. First, I only consider American firms, specifically firms

which have, at some point, been a constituent of the S&P 500 from 1980 until 2019. This specific choice is motivated in the section regarding data selection.

I do not intend to test these firms regarding what financial measures might best predict their future capital structure. This thesis is only concerned with the specific aspect of mean reversion tendencies within capital structure, and what characteristics such firms might share compared with those that do not exhibit these tendencies. Another important delimitation is that I do not intend to propose a new way to identify whether or whether not a firm is mean reverting, as I will rely on the methodology of Augmented Dickey-Fuller tests, inspired by previous literature (Ahsan et al., 2016; Canarella et al., 2014; Golinelli & Bontempi, 2005). The characteristics testing of this thesis will attempt to augment the analysis of mean reversion and argue why these firms might be mean reverting, if they do indeed differ from the firms that are not mean reverting in their capital structure. Naturally, one could have also taken a more theoretical, rather than empirical, approach to the problem and questions stated above. However, it is important to emphasise that I will restrict this thesis to focus on an empirical analysis of companies, augmented with the theoretical discussion of green financing, as this aspect does not lend itself to hypothesis testing.

These delimitations are made to ensure a clear focus for the thesis. Capital structure is a subject with many different theories, and delimitations are therefore made in order to focus solely on the mean reverting aspect of capital structure, how this relates to existing theories and valuation, what explanations might lie in financial measures of the companies regarding mean reversion of capital structures, and how green financing might impact this.

2 Literature Review

In this chapter of the thesis, I will present and discuss previous literature related to capital structure. Firstly, some of the seminal work will be presented to cover the basics of the influence that capital structure has on valuation, the primary determinants of capital structure, and how the academic thinking on this subject has progressed over time. Secondly, existing literature related to mean reversion will be covered to ensure a thorough review of the concepts of mean reversion. Lastly, literature regarding mean reversion of capital structures over time will be discussed, in addition to other uses of mean reversion in the financial markets, with a specific focus on the methodologies and results these papers present. Some of these papers showcase a conclusion which points towards no-mean reversion in the capital structure of firms, while some of the papers showcase the opposite conclusion. At the end of the chapter, a table presenting some of the most influential works within the space of mean reversion of capital structures is presented to be able to easily refer to the conclusions of these papers.

2.1 Capital Structure Theories

In this section, the works of the main theories surrounding capital structure will be presented. This section seeks only to lay the foundation for the more specific literature surrounding capital structure, by explaining the competing theories and their influences on financing decisions and firm valuation.

2.1.1 Miller and Modigliani

In 1958, M&M published their landmark paper regarding the irrelevance of capital structure, under the strict assumption that the company being valued exists in a perfect capital market (Franco Modigliani & Merton H. Miller, 1958). Since then various scholars, as well as practitioners of company valuation, have sought to expand both the theoretical and the practical aspect of the influence that capital structure has on the valuation of a company. Other theories in relation to how firms adjust their capital structures to optimise value have evolved from the work of M&M, primarily the trade-off theory and the pecking order theory. In the following, the works of M&M will be briefly summarised to provide the basis for expansion of the theories, following this, the trade-off theory and pecking order theory will be reviewed. This is done to provide perspective on the subsequent literature for mean reversion of capital structure, which, interpreted in the light of these theories, showcase support for either one, as will be further discussed in section 2.4.

M&M argues that the capital structure of a firm has no influence on its valuation, using the assumptions that the firm exists in a perfect capital market. In a perfect capital market, characteristics such as no taxes and no bankruptcy makes this theory have limited implications in practice, as firms exist in markets where taxes and the risk of bankruptcy certainly are present (Franco Modigliani; Merton H. Miller, 1958). In 1963, M&M expanded upon their model to include the advantages of debt financing, and it is this work that has since evolved into the concepts of trade-off theory and pecking order theory (Modigliani & Miller, 1963). M&M (1963) argues that the value of the company is effectively made up of the value of the company without any debt, the unlevered company, to which you add the tax benefits of the debt the company has:

$$Value_{Levered} = Value_{Unlevered} + Tax\ rate * Value\ of\ Debt \qquad (2.1)$$

From this equation, it is evident how the traditional theories around capital structure showcase how the leverage level of the firm directly impacts the full value of the firm. By raising its debt, the firm will achieve infinitely higher value if the tax rate is > 0. If a firm takes on infinite debt however, the negative effects of debt will start to appear, such as the risk of bankruptcy and higher lending costs. This is the starting point for the trade-off theory.

2.1.2 Trade-off Theory

The trade-off theory builds upon the concept that minimisation of the capital costs of the firm maximises the value of the firm. This is done through a balanced perspective on the advantages and disadvantages of both debt and equity. Advantages of debt stem primarily from the incorporation of the tax shield which exists due to interest payments being deductible (Modigliani & Miller, 1963). However, naturally, the disadvantage of debt is also that this debt must be serviced, introducing an element of financial risk to the firm. The cost of these financial risks is referred to as the cost of financial distress. As such, the trade-off theory does exactly as the name implies, as the trade-offs from the advantages and disadvantages of debt are considered and balanced to arrive at the optimum leverage ratio, where the tax shield is maximised, without causing too much financial distress to the firm. A firm will, according to the trade-off theory, continue to increase its percentage of debt in the capital structure, up until the marginal tax advantage of one more unit of debt is equal to the marginal distress disadvantage of one more unit of debt (ibid.).

This theory also implies two fundamental perspectives on financial leverage: 1) an optimal level of leverage exists for any given firm and 2) that the optimal level of leverage

will vary widely from firm to firm, as each firm is in a unique situation with regards to the financial distress it can carry while exploiting the tax advantages of the debt it takes on. However, MacKay and Phillips (2005) did observe several trends within different industries. An example of this is that industries which are more dependent on what they deem "heavy assets", e.g. manufacturing firms with factories or shipping firms with ships, tend to have a higher leverage ratio. They argue that this is due to the ability of these firms to effectively post their assets as collateral for the loans, allowing the lenders to have less return requirement on the loans, leading to favourable lending terms for the companies.

Given the first fundamental perspective of the trade-off theory, that an optimum exists, one can extend from this that, given rational actors in the market, the firm will strive towards this optimum. Any deviations or fluctuations around this optimum will be temporary, and the firm will revert to the optimum leverage ratio in the long run. On this basis, the mean reverting property of financial leverage according to the trade-off theory is to be measured using the historical mean of the actual leverage ratios, rather than an estimation of the target level of leverage (Golinelli & Bontempi, 2005). This property therefore lends itself well to mean reversion tests.

There have, however, been several criticisms of the trade-off theory. Some contrary studies argue that the explanatory power of the trade-off theory is limited in relation to actual leverage decisions made by companies (de Jong et al., 2011; Rahman & Arifuzzaman, 2014). Aspects of real-world behaviour such as the time-aspect of making capital structure adjustments, asymmetrical information, the costs of either issuing debt or equity to adjust capital structures, as well as competing theories, showcase some of the weaknesses of the trade-off theory.

2.1.3 Pecking Order Theory

The other main theory which has sprung from the works of M&M in 1958 the pecking order theory, introduced by Myers and Majluf in 1984. The theory does not focus on finding the optimal leverage level firms should strive towards. Instead, it attempts to describe that companies will have different preferences when it comes to the adjustment of their capital structures, and how they raise new capital. One of the central aspects of the theory is asymmetrical information in financing decisions. This thesis will not delve deeper into the concept of asymmetrical information and its influences within finance. For a paper on this specific topic, see Myers and Majluf (1984).

The pecking order theory argues that as the degree of asymmetrical information rises, so does the costs of the financing (SC Myers et al., 2017). Firms will prefer to primarily utilise internal financing, as the costs of this financing type will be the lowest, given that the management has full access to the information. Second, firms will prefer to turn towards debt financing before turning to issuances of new equity (Eckbo, 2008). An important implication of this theory is that firms which are highly profitable will tend to require lower amounts of external financing such as debt and will therefore primarily operate through internal financing. Pecking order theory helps to explain deviations from the trade-off theory and should be a supplement to help capture the complexities of capital structure decisions by management, and how these will influence the valuation of the firm.

Contrary to the trade-off theory, the pecking order theory does not stipulate that an optimum exists for the leverage ratio, but rather that the financing decisions of firms are a consequence of several factors including management, market sentiment, and performance (SC Myers et al., 2017; Stewart Myers & Majluf, 1984). If firms do not operate towards an optimum, the leverage of a firm does not have a mean reverting property according to the pecking order theory and will instead behave more in order with a random walk pattern.

2.2 Drivers of Capital Structure

Much of the current literature regarding capital structure is dedicated to the prediction of it. That is, what characteristics of a firm are the best at determining the capital structure decisions that firm makes. These characteristics are important to identify, as they will play a central part of the second hypothesis in this thesis.

Across the vast body of literature on this subject, four primary characteristics stick out as recurring and with high explanatory power over the capital structure of the firms studied. The first characteristic is the market to book value, which has been demonstrated to be negatively associated with debt (Baker & Wurgler, 2002; Barclay et al., 2006; Frank & Goyal, 2004; Hovakimian, 2004; Jung et al., 1996; Rajan et al., 1994; C. W. Smith & Watts, 1992). The primary two reasons for this is that firms with high market-to-book ratios are likely to have a high amount of their value tied to future growth prospects, and as such not tied to current earnings, thus they are able to reduce their taxable income substantially with a relatively low amount of leverage. Secondly, these firms are likely to maintain a certain amount of financial slack, should they wish to execute on their future growth prospects. A second characteristic is profitability, documented by studies such as Titman and Wessels (1988) and Rajan et al. (1994). The argument supports primarily the pecking order theory, as it argues, again, for an inverse relationship, leading firms with higher profitability and

thus higher earnings to rely more on internal financing for its projects in the form of retained earnings. The third characteristic is simply that of size, which is found to be positively correlated with leverage (Mehran, 1992; Parsons & Titman, 2008; Titman & Wessels, 1988). Here the primary considerations for the relationship include that of reputation (Diamond, 1989) and increased access to the debt markets due to relationships (Faulkender & Petersen, 2006). The fourth characteristic is the ratio of fixed assets to total assets, also known as asset tangibility. This ratio has been empirically shown to be positively correlated with leverage (Frank & Goyal, 2004; Friend & Lang, 1988; Marsh, 1982; Rajan et al., 1994; Titman & Wessels, 1988). The primary reason for this relationship is that tangible assets, compared to their intangible counterparts, better preserve their values during defaults, and as such, the recovery rates of creditors increase (Parsons & Titman, 2008).

While the delimitations outlined that this thesis will not concern itself with the prediction of capital structure from financial characteristics, the above overview on this subject is of importance as it forms the foundation for the testing of the characteristics which will be performed in this thesis.

2.3 Mean Reversion Literature and Financial Aspects

Given the importance this thesis places on the concept of mean reversion, it seems appropriate to introduce conceptually and statistically what it is, how to interpret it, and how it has previously been used in financial literature.

2.3.1 Mean Reversion

Mean reversion, also often referred to as regression to the mean, first appeared in the book Hereditary by Francis Galton in 1869 (Galton, 1869). Here, he studied specifically how talent was carried in families, and passed on from parents to their children. He looked at several groups of exceptionally talented people, great scientists, musicians, and similar people with extraordinary abilities. One might critique the specific groupings and arbitrary evaluations of capabilities (Stigler, 1997), however, what Galton noted was that there seemed to be a decrease in the capabilities the further either up or down he went in the family tree. At the time, Galton did not have the mathematical nor argumentative concepts entirely worked out as to why this was, but he had in effect formulated the first evidence of regression towards the mean (ibid.). He would formalise the arguments in 1886, in "Regression Towards Mediocrity in Hereditary Stature", proving the argument utilising the characteristics of children in relation to their parents. If a parent, for example, were of an extreme height, this characteristic is not completely passed onto the child. Instead, the

height of the child will regress towards a mean point. Mathematically, the expression of the regression to the mean phenomenon can be derived as follows (Stigler, 1997):

> Begin with two standard normal random variables labelled *X* and *Y* with a correlation of ρ and a bivariate density:

$$f(x,y) = \frac{1}{2\pi\sqrt{1-\rho^2}}\exp - (\frac{1}{2(1-p^2)}(x^2 - 2\rho xy + y^2)) \tag{2.2}$$

> Given the conditional density of Y given X = x is found to be that of:

$$f(y|x) = \frac{f(x,y)}{f_x(x)} \tag{2.3}$$

$$= \frac{1}{2\pi\sqrt{1-\rho^2}}\exp\left(-\frac{1}{2}\left(\frac{y-\rho x}{\sqrt{1-p^2}}\right)^2\right) \tag{2.4}$$

> This is the density of a N(ρx, *1-*p^2) random variable. Therefore, the conditional expectation for the Y variable given X = x, is ρx, showing regression from *x* towards the mean of 0.

Verbally, the primary argument used throughout the literature utilises the test scores of a student taking two examinations. If the student scores exceptionally well on the first test relative to the performance of the class as a whole, the above regression and concept of mean reversion teaches us that the expected score on the second test will be worse relative to the class as a whole. If the first score happened to be low, the reverse phenomenon would be expected as we would predict a higher relative score on the second test. In this specific example, the argument is that the high score is comprised of two separate components, skill, considered a permanent component, and luck, considered a transient component. The specific contribution of these two towards the test score is, in principle, irrelevant, as the luck component is expected to not be present, as it is considered a transient component, leaving only the component of skill contributing to the score. This effectively means that the test score will now be based purely on the skill, without the luck element, leading to a net decrease in the score, leading to a regression towards the average (Stigler, 1997).

2.3.2 Financial Aspects of Mean Reversion

In terms of regression towards the mean in financial literature, the phenomenon has received significant attention, both regarding the performance of stocks, but also the performance of firms themselves. In 1933 Horace Secrist wrote a book titled The Triumph of Mediocrity in Business (Secrist, 1933). Here he argued that the primary cause of the

great depression in the United States was the mediocrity of businesses in the long term – a tendency for firms that perform well in a period to, over time, perform less well. He attributed this fact to a new economic principle he believed he had discovered. He argued that competitive pressures will inevitably dilute superior talent, with the solution being to protect superior companies from competition from less-fit companies (G. Smith, 2016). However, Secrist had in fact discovered nothing at all, and had merely been fooled by regression towards the mean, as Hotelling (1933) wrote in his review of the book.

The error Secrist committed was that he ignored the component of luck. He argues that, if a firm performs well, it must be due to how exceptional the company is. Therefore if the firm subsequently performs poorly, there must be an underlying explanation for this fact, such as competition from the less-fit companies (Secrist, 1933; G. Smith, 2016). Here however, he ignores what regression towards the mean teaches us about the components of luck and skill, as provided in the student example. The same can be argued to be true for any company, where the most successful company is more likely to have had more good luck than bad luck, and have done well, not only in relation to its peers, but also in relation to its actual capabilities. Therefore, the subsequent performances of this company will typically be closer to the average company. This is the lesson that regression towards the mean teaches us, and it does not mean that all firms will turn mediocre. This is a fallacy that, as Smith (2016) puts it "… fooled so many prominent, sophisticated people in the past and continues to do so today."

This is highlighted in this section as to showcase that I am indeed aware of the statistical fallacy of regression towards the mean, however, in specific relation to the research of this thesis, the capital structures being employed are not considered as "performance". I do not make the argument that one capital structure is superior to another, and that all firms are trending towards mediocrity, whereas this may simply be regression towards the mean. This is an important distinction I wish to make. The fallacy that fooled Horace Secrist in 1933 and can, as Stigler (2000, p. 170) notes: "can easily hoodwink the mathematically educated as the nonmathematician", is not of major concern, as there is no concrete conclusions drawn from the level of the capital structure, nor the movement of these, as being either good or bad. Were this thesis to instead focus on the specific performances of these firms as a function of e.g., their return on equity, I would be much more cautious with drawing conclusions from the trends observed, as this has fooled even Nobel Laureate Economists, such as Sharpe in 1980 and Fama and French in 2000 (G. Smith, 2016). I want to be rather clear on this subject. The observations made in these studies regarding the

financial performances of the companies are, of course, true. The firms that perform well do tend to perform less well over time, while the firms performing poorly do tend to perform better over time. However, the fallacy lies in attributing this convergence of performance to underlying economic factors, whereas it is simply a statistical regression to the mean, as also argued by Smith (2016) and Stigler (1997).

With this rather important factor of the conclusions that can actually be drawn from these types of studies regarding the performance of firms, or indeed those of stocks, and given the lack of focus on this specific element within this thesis, it does not seem appropriate to discuss the entirety of the financial literature related to performance in this sector. Rather, the remainder of this section will focus on specific literature related to mean reversion regarding the aspect of capital structure, as the conclusions and inferences that can be drawn from such papers seem more clear, whereas performance-related research is more exposed to the fallacy of regression towards the mean.

2.4 Methodological Review

Prior to delving into the concrete literature surrounding the empirical results of the mean reversion studies which are related to capital structure, it seems appropriate to provide a short overview and discussion of the main methodologies applied in these papers. The section will focus on the differences in research design, applied tests, and underlying assumptions regarding capital structure adjustments of firms. In general, much of the financial literature with a focus on mean reversion performs the tests regarding the performance of firms or stocks. As such, there is limited peer-reviewed literature on the capital structure component of mean reversion. However, the existing literature can be broadly divided into two categories: Research focused specifically on the capital structure component of mean reversion, and research which empirically tests the trade-off theory and the pecking order theory, which, as argued earlier, can effectively be viewed as tests for mean reversion within capital structure.

The paper by Golinelli and Bontempi (2005) asks the exact question of financial leverage and mean reversion. Their research focuses on a rather limited section of firms, with the focus being on Italian firms that operate within the manufacturing sector, as such, their research design does perhaps not lend itself to extrapolation to other countries nor industries. The time aspect of their study focuses on 12 years of leverage ratio data for the selected firms, a period they argue is comfortable to ensure that adjustments to financial leverage can be carried out by the firms. The primary research focus in their work relates directly to the mean reversion of the leverage ratios, as well as presentation of evidence in

favour of either the trade-off theory or the pecking order theory. Their primary testing methodology relies on the Augmented Dickey-Fuller test (ADF), testing for the presence of a unit root in the individual companies' time series. Additionally, they include a panel level test, namely the Im-Pesaran-Shin (IPS) test on their data. Mathematically, they define the concept of the trade-off theory as follows:

$$\Delta d_{it} = a_i(d_{it-1} - d_{it}^*) + \varepsilon_{it} \quad (2.5)$$

With *d* indicating the actual debt ratio, d* the target debt ratio, and ε the stochastic error term. As such, when $a_i<0$, firms will adjust towards their long-term leverage ratio target.

In a similar paper by Ahsan et al. in 2016 unit root tests are also applied to a sample of 670 listed firms in Pakistan, utilising 37 years of financial data for the tests. This research spans across 13 sectors, not limiting itself to the manufacturing sector. It does, however, not include research on individual firm unit roots, but only utilises panel data, using the Fisher-type panel unit root test. Canarella et al. (2014) utilised a similar research design in their paper looking at US firms in the time-period of 1997-2010 using panel data segmented into industries, and utilising the Fisher-type tests as well as the Phillips-Perron (PP) tests to determine unit roots.

A different methodology was applied in a paper specifically focused on the manufacturing industry of Pakistan by Qureshi (2009) using 34 years of financial data for the Pakistani manufacturing firms. Rather than a unit root test, a regression model is applied to test the relationships of various financial items on the prediction of future leverage ratios. As previously mentioned, several other works in the academic world focus on this specific hypothesis, namely what determinants are best at predicting the capital structure choices of firms, and if these support either the trade-off theory or the pecking order theory (Bontempi, 2002; Fama & French, 2002; Getzmann et al., 2010; Liu, 2011; Mukherjee & Mahakud, 2010; Ozkan, 2001). Common to all literature that fits within this specification, is their testing methodology, which revolves around regression-based testing of characteristics of a firm, and which of these characteristics act as the best determinants for the capital structure decisions of the firm, both historically and when predicting future capital structure choices.

Given the hypothesis of this thesis does not concern itself with which characteristics best describe or predict the capital structure of a firm, a more detailed review of this literature is left out having already reviewed the primary characteristics in section 2.2. Rather the focus from these studies will be on the empirical results which are of interest

due to the implications regarding evidence either supporting trade-off theory or supporting pecking order theory, and by extension mean reversion of capital structures.

An additional subset of literature which concerns itself, albeit somewhat secondary, with mean reversion of capital structure, are papers looking at the speed with which firms adjust their capital structures. Papers in this category typically test for speed of adjustment (SOA) of capital structure, utilising the framework of:

$$Expected\ leverage = rho * Null\ Leverage + (1 - rho) * Target\ Leverage \quad (2.6)$$

With rho = 1-SOA

If a firm is making instant adjustments to capital structure, the SOA will be equal to 1, leaving rho at 0, which means the equation simplifies to:

$$Expected\ leverage = Target\ Leverage \quad (2.7)$$

Conversely, when firms do not concern themselves at all with target leverage, the SOA is 0, rho will be 1, and the expected leverage of the firm is therefore left at a level of "null leverage", typically defined discretionarily by management (Iliev & Welch, 2011). As with trade-off theory and pecking order literature, the methodologies of this subset of capital structure research is not of primary concern, and as such will not be discussed further. The empirical implications are of interest however, as they may support the mean reversion hypothesis.

2.5 Empirical Evidence of Capital Structure Mean Reversion

This section will seek to present the empirical findings of the studies related to mean reversion of capital structure. Both specific papers looking at mean reversion, as well as papers looking at empirical evidence in support of either the trade-off theory or pecking order theory, will be reviewed to give a holistic picture of the current empirical findings concerning mean reversion of capital structures.

The papers by Ahsan et al. (2016) and Golinelli and Bontempi (2005) both found conflicting results regarding the mean reversion properties of capital structure. Ahsan et al. (2016) reported results of mean reversion in the leverage ratios of Pakistani firms when testing on a panel level, and testing for both short-term and long-term trends, showcasing support for the trade-off theory. However, when testing on an individual firm level, results were conflicting, as only 16% of the firms showcased short-term mean reversion and 25% showcased long-term mean reversion. Additionally, when classifying firms by profitability,

results showcased that profitable firms tended to follow the trade-off theory, and showcased mean reversion, whereas firms operating at a loss did not showcase mean reversion. Similar results were reported by Golinelli and Bontempi in their 2005 study of Italian manufacturing firms. Here, the results showcased a rejection of mean reversion in capital structure when testing at the individual company, whereas the panel-level testing showcased evidence in favour of capital structure being mean reverting.

This might showcase issues with the underlying concept of individual company testing, as is also discussed further in the methodology section, and one might make the conclusion that the empirical evidence will depend upon which test is being utilised – individual testing of firms will showcase a lack of mean reversion, whereas panel testing will showcase mean reverting properties. However, Canarella et al. (2014) show this is not the case. Utilising panel testing on American firms, they showcase first that the properties of the capital structure are mean reverting – however, they argue that the testing methodology utilised is flawed, as it relies on what is first-generation unit root tests, which are unable to account for cross-sectional dependency in the data, of which there may be several reasons why capital structure data would be, as will be discussed in section 3.4. When accounting for cross-sectional dependency in the data, utilising second-generation panel unit root tests, the evidence showcases that capital structure is not mean reverting, providing evidence, using a panel testing methodology, against the trade-off theory.

Significant bodies of research have been devoted to testing the empirical support of the capital structure theories. In a paper by Flannery and Rangan (2006), significant evidence was showcased in favour of firms pursuing a target capital structure, and as such in favour of mean reversion. Additionally, this paper showcased that the typical adjustment speed of the firm, when closing a gap to its targeted capital structure, is at more than 30% per year. Hovakimian and Li (2011) estimates much longer time, more than 10 years specifically, for a firm to adjust towards its target capital ratio. Nevertheless, they find evidence supporting a reversion towards a targeted capital structure, showcasing further empirical support for the mean reverting properties of leverage. A more balanced result is showcased by Huang and Ritter in their 2009 paper, looking at the speed of adjustment. They find evidence both in support of the pecking order theory, namely that firms act in according to equity market prices when determining funding, but also support for the trade-off theory, as they find that firms do move toward target debt ratios, generally with a half-life of adjustment of 3.7 years. Support for both trade-off and pecking order theories is also found in the work by Fama and French, (2002).

Several studies have also found empirical evidence supporting only the trade-off theory, such as Getzmann et al. (2010), which showcased that, respectively, 56% and 46% of European and US firms converge towards a target capital structure, providing further evidence for mean reversion. Additionally, they showcase, specifically, that industry effects directly influence the capital structure choices as well as adjustment speeds of firms within these industries, across both regions. Similar evidence is obtained by several papers, (Liu, 2011; Mukherjee & Mahakud, 2010; Nunkoo & Boateng, 2010; Ozkan, 2001), albeit with different results regarding the specific speed of adjustment towards the targeted capital structure.

A smaller body of research has found evidence supporting the pecking order theory. Notable papers include Lemmon et al. (2008), Hovakimian et al. (2012), and Iliev and Welch (2011). Specifically, the paper by Iliev and Welch in 2011 is of interest, as it makes the claim that much of the research showing empirical support for the trade-off theory when researching adjustment speeds of capital structure is flawed. As they write: "a number of prominent papers in the literature have estimated the average speed of adjustment (SOA) of firms' leverage ratios with estimators not designed for applications in which the dependent variable is a ratio" (Iliev & Welch, 2011). Their results showcase that non-mean reverting behaviour is a reasonable estimate for the adjustments made by firms, and so argue against the trade-off theory.

The current body of literature is in disagreement. Empirical findings of peer-reviewed literature show support for both the trade-off theory and pecking order theory, utilising several different research designs, methodologies, and samples of data. Perhaps this is also why both theories still do exist and are widely accepted within financial academia, as they both provide useful descriptors of real-world behaviour by firms, even if not all firms follow the exact teachings of either theory.

2.6 Regarding the Mathematical Limitations of Capital Structure

Two specific papers, which were not deemed appropriate to fit within the categories of the reviewed literature in the previous section, will be discussed here. They have significant implications for any research related to capital structure and empirical tests of the trade-off theory or pecking order theory, and by extension also mean reversion, and so will receive a thorough review to understand the limitations the findings place on any study concerning itself with this specific area of research.

In a paper published in 2007 looking at profitability and mean reversion of leverage ratios, Chen and Zhao make the argument that, even if a firm strictly follows the pecking order theory, empirical testing can still observe a mean reversion pattern in the capital structure of these firms. This brings into question the body of literature utilising empirical evidence of mean reversion in capital structures as support for the trade-off theory, and also the question of whether the mean reversion is simply mechanical, or the result of actual economic and financial policy decisions made by the firm. In 2007, Chen and Zhao published an additional paper focused exclusively on this concept that they named "mechanical mean reversion".

The logical argument for the mechanical mean reversion lies within the natural mathematical limitations of capital structure. Imagine a firm which is currently worth $1,000. The firm is financed by $800 of equity and $200 of debt – 80% equity financing and 20% debt financing. If this same firm issues $30 of new equity and $10 of new debt, the financing policies of this firm showcase a preference for equity – yet the mathematics dictates that the leverage ratio rises from 20% to 20.2%, post-issuance of both the new equity and new debt. The reverse is also true if the firm is financed using 80% debt and 20% equity, and issues $30 of new debt and $10 of new equity, showing a preference for debt financing, yet the leverage level of the firm will fall from 80% to 79.8%. Regardless of the financing preferences the firm displays, the capital structure will trend towards a mean – that is to say that a high leverage ratio will tend to decrease, and a low leverage ratio will tend to increase (Chen and Zhao, 2007). This brings into question the literature regarding the trade-off theory, as the empirical evidence which supports it might be due to mechanical mean reversion, rather than intended effects from firms.

Mathematically, the evidence Chen and Zhao (2007) provides is as follows:

Utilising an accounting identity where $A_t = A_{t-1} + \Delta D_t + \Delta E_t + \Delta RE_t$

Where

A_t = Asset at time *t*, D_t = Debt at time *t*, E_t = Equity at time *t*, RE_t = Retained earnings at time *t*, Δ = Difference operator

The change in leverage ratio can be expressed as:

$$Leverage\ change = \frac{D_t}{A_t} - \frac{D_{t-1}}{A_{t-1}} = \left[\left(1 - \frac{D_{t-1}}{A_{t-1}}\right)\frac{\Delta D_t}{A_t}\right] + \left[-\frac{D_{t-1}}{A_{t-1}}\frac{\Delta E_t}{A_t}\right] + \left[-\frac{D_{t-1}}{A_{t-1}}\frac{\Delta RE_t}{A_t}\right] \quad (2.8)$$

From this, the impact that debt and equity financing have on firms of different leverage levels are vastly different. Debt financing will impact lower levered firms more, whereas equity and retained earnings will impact firms with higher leverage more. This showcases the mathematical limitations of the leverage ratio. To use the example Chen and Zhao (2007) provide, assume a firm with a leverage ratio of 10%. To maintain this ratio, for every $1 of debt the firm issues, it must match that with $9 of equity or retained earnings. This will, leaving aside extreme financial ratios, lead to mean reversion of the capital structure, regardless of the preferences firms have for their financing.

This specific piece of literature has been included primarily to show the limitations in drawing inferences regarding support for capital structure theories merely from mean reversion of capital structures. As such, it, of course, also provides mathematical evidence that capital structures, mechanically, will tend to mean revert, even if this is not the product of target capital ratios of firms. Regardless, the empirical tests of mean reversion still seem prudent, as they will provide evidence of the actual behaviour of firms, even if the conclusions that are to be drawn from this evidence might not be that of support for the trade-off theory, even if the results showcase significant mean reversions of the capital structures.

In table 1 I present a summary of the empirical literature on the topic of mean reversion of capital structures. As discussed throughout this chapter, there are varying results regarding the tendencies of firms' capital structures to exhibit mean reversion tendencies. Some of ambiguous results might stem from differences in research designs or samples as discussed in section 2.4.

Authors	Golinelli & Bontempi, 2005	Ahsan et al. 2015	Chen & Zhao, 2007	Canarella et al., 2014	Iliev & Welch, 2010
Sample	Italian Manufacturing firms	Pakistani firms	US firms	US firms	US firms
Time-period	1982-1997	1973-2010	1972-2002	1997-2010	1963-2007
Testing methodology	Individual (Dickey-Fuller) and Panel (Im-Pesaran-Shin)	Individual (Dickey-Fuller) and Panel (Fisher tests)	Regression analysis	Panel (Fisher tests)	Regression analysis
Results	Non-mean reverting (individual), and mean reverting (panel)	Non-mean reverting (individual), and mean reverting (panel)	Mechanical mean reversion of capital structure	Non-mean reverting	Non-mean reverting

Table 1 - Summary of studies on mean reversion of capital structures

3 Data and Methodology

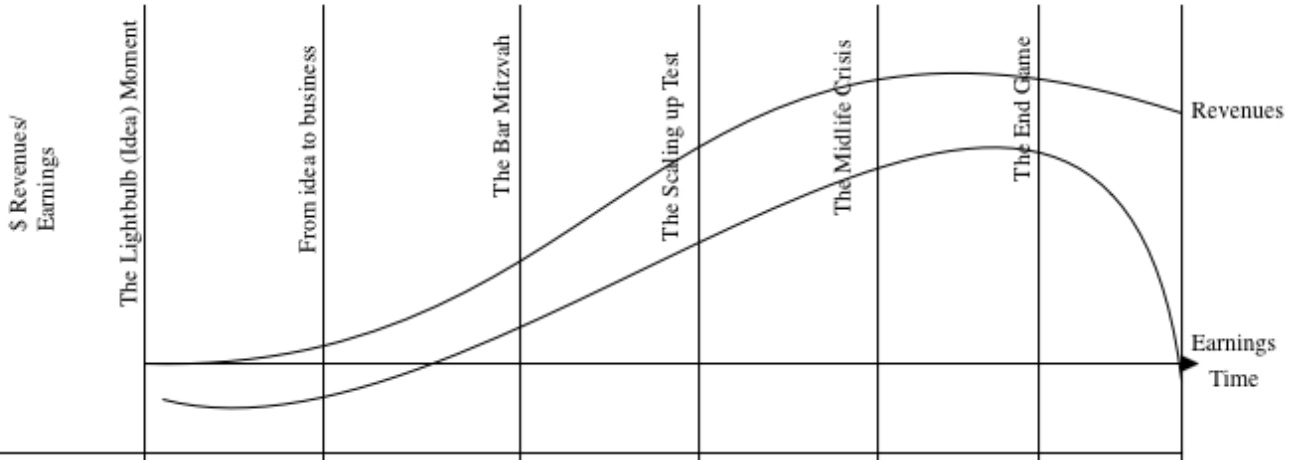
In this chapter, I describe, motivate, and discuss the chosen methodology and data selection used in the thesis. Generally, I employ research designs similar to those of Golinelli and Bontempi (2005), Ahsan et al. (2016) and Canarella et al. (2014). This means I will utilise the concept of unit root testing at both an individual firm level and panel level to determine if the capital structures exhibit mean reversion. Briefly defined, the capital structures will exhibit mean reversion if the tests reject the null hypothesis, namely that a unit root is present, and so the data does not show a systematic pattern of unpredictability, but rather a mean reverting property. Significant effort has gone into ensuring the data quality, as this directly impacts the conclusions which can be drawn from the findings. As such, the source of data and methodologies for data treatment have been researched thoroughly and will be motivated below.

A central choice of the methodology applied in the thesis is that, first, I will perform individual company tests. This is in line with the research of Golinelli and Bontempi (2005) and Ahsan et al. (2016) and thus not performing the individual company tests would not allow for direct comparisons with parts of the results that they obtain. Second, to allow further comparisons, including with the results of Canarella et al. (2014) I will also perform panel level tests. This will allow for more general comparisons to the existing empirical results of capital structure literature.

In the following section, I will first describe and discuss the data selection process. Second, I will describe the testing methodology utilised in the thesis for both mean reversion and characteristics. Third, the choices of several parameters of the utilised tests will be described, and how these contribute to strengthening the robustness of the performed tests. Finally, the differences between individual firm testing and panel level testing will be reviewed.

3.1 Data Selection

When studying capital structure, I would posit that two main considerations regarding the specific firms being studied must be considered. What this means is, there is little use in studying the capital structure choices of a hobby-firm, which is not necessarily driven by rationale actors in the markets. Additionally, there is little reasoning to study firms which are not making active capital structure choices, due to limitations of cash-flow or similar. Damodaran (2015), fits this narrative into the corporate lifecycle.



Growth Stage	*Stage 1 Start-up*	*Stage 2 Young Growth*	*Stage 3: High Growth*	*Stage 4 Mature Growth*	*Stage 5 Mature Stable*	*Stage 6 Decline*
Operating Cashflow to Equity	Negative	Negative	Small +'ve -> Big Positive	Big, growing Positive	Big, stable Positive	Declining
Reinvestment	High	High	High, but dropping	High, approaching average	Low	Negative (Divesting)
Debt	No debt	No debt	Low debt	Medium debt	High debt	Retiring debt

Illustration 1 – Corporate Lifecycle (Aswath Damodaran, 2018)

He argues that, not until firms reach what he describes as the Scaling-up Test (3rd from the left in illustration 1), does the firm begin to consider debt financing, due to the limitations this naturally places on the firm's development in the early years. Debt needs to be serviced, and stable cash flows might not exist for the firm yet. As such, I will argue that one main consideration when wanting to study capital structure choices, will be that the firms must be mature and have the capability to borrow and make decisions regarding financing.

Second, I would also argue that, while not strictly necessary to study capital structure, designing the study around the data of publicly traded firms will significantly increase the strength of the results. First, when looking at publicly traded firms, updated values will be

more readily available. While the specific market value of debt might still not be obtainable, the market value of equity certainly is, and since market values will reflect the true opportunity costs of investors, capital structure studies should primarily focus on market value data (Petersen et al., 2017, p. 341). Second, firms rarely disclose much surrounding their capital structure, particularly if the firms are privately held. As such, the data quality for studies focusing on private firms will, from an outside-in perspective, be worse than when looking at available market data for publicly traded firms (ibid.).

These two considerations, focusing on firms which are mature and capable of making financing decisions, and which are publicly traded, naturally narrows the field of possible firms which can be studied. For this thesis, I have selected to base the sample of data on the S&P 500 index. There are several reasons for this. Firstly, the S&P 500 consists purely of American firms, which will help to ensure that the reporting and accounting standards of the firms do not differ, which could bias the results. All firms will be subject to the same regulations regarding disclosing of debt and equity, and as such no wrong conclusions will be drawn based upon conflicting data between the firms. Secondly, the S&P is a "large-cap" index. What this means is that for a firm to be adopted into the index, the market capitalisation, as of today, must be at least USD 8.2 billion, ensuring the firms are capable of making financing choices. Additionally, the firms must have significant trading volume, ensuring up-to-date available market-determined pricing for its stock (S&P, 2019). Lastly, the firms of the S&P 500 are spread across a multitude of different industries, allowing for panel-segmentation of the data by industry for further testing of mean reversion tendencies within specific industries. From this, I argue that the S&P 500 fulfils the two main considerations regarding data selection for capital structure studies, and so it has been chosen for the purpose of this thesis. Other indices could have been chosen, but the data availability of the S&P 500 is practically unmatched among other major indices.

3.1.1 Construction and Preparation of the Data

In this subsection, I will go through and outline the concrete steps taken to construct the dataset, as well as any preparations made in order to make the data more robust, so that any conclusions drawn from testing are less spurious.

As mentioned, the dataset will be based upon the S&P 500. However, firms exit and enter the S&P 500 almost every year, presenting an apparent problem. If a firm is dropped from the S&P 500, it is not necessarily because it fails to meet the requirements of selection to the index (S&P, 2019). As firms are selected to the index by a committee which attempts to most accurately portray the industries which represent the economy of the United States,

the choice by the committee to exclude a firm from the index in order to select another one may in fact be due to shifts in the economy which are outside of the firm's control. Naturally, it may also be because the firm has failed to meet the criteria, or perhaps the firm has even gone bankrupt. Regardless, the data selected for this thesis will not be based upon a "rolling" S&P 500 index. This is to combat the potential biases of the selection committee influencing the data, and also to avoid survival bias in the data, as the probability of bankruptcy certainly, most likely at least, will have a significant impact on the financing decisions of a firm, and as such, these are still of interest to study in a mean reversion perspective. This means that if a firm has, during the chosen study period, been a part of the S&P 500 index, it will be considered part of the dataset. With the selection of the firms which will participate in the study complete, the data gathering can be described. I will extract quarterly capital structure from Wharton Research Data Services (WRDS), also referred to as COMPUSTAT regarding each firm. COMPUSTAT has strategically been chosen as the database, as it allows for more direct comparisons with the previous mean reversion study of Canarella et al. (2014) who also utilises COMPUSTAT as the data source.

In relation to the second hypothesis regarding the characteristics of the firms which exhibit mean reversion in their capital structure, data must also be gathered in order to test this hypothesis. Based on the literature, four characteristics have been identified as those most relevant regarding capital structure. Of course, any characteristic of a firm, whether it be growth, profitability, number of employees, or tenure of the management, could be argued as influencing capital structure. As previously mentioned, this thesis does not concern itself with the prediction of capital structure, but rather regarding the mean reversion nature of leverage. Therefore, I will rely upon the previous literature regarding this subject and consider the characteristics and parameters this body of literature has identified as those most relevant for studying capital structure. For this reason, in addition to the capital structure data, I will also gather the market to book values, fixed assets, intangible assets, financial assets, total assets, profitability, and revenue. These represent the four characteristics identified in section 2.2, with revenue being a proxy for the size of the firm. This data is gathered from the COMPUSTAT database on a quarterly basis, as this ensures the most up-to-date financial info at each time interval. For profitability, the measure of Earnings Before Interest Taxes Depreciation and Amortisation (EBITDA) has been chosen. The literature does not specify which profitability measure is necessarily the most accurate, but the EBITDA margin is naturally the most close to what one can consider "true" operating profits, and is not influenced by differences in accounting principles of

depreciation or similar (Petersen et al., 2017). For the measure of tangible assets to total assets, this specific value is not available in COMPUSTAT. Therefore, it will be calculated by subtracting the value of intangible and financial assets from the total asset base of the firm, leaving only the value of the tangible assets on the balance sheet. Unfortunately, the asset level data is not available further back than 1998, and so for the tangible asset ratio testing, no considerations will be given to the period prior to 1998. All data points of the four different parameters have been converted to the same calendar-year twelve-month basis, with the fiscal year ending on the 31st of March in any given year. This is done to greater enhance comparability between firms which might have different fiscal year endings, and so will allow for specific comparison in any given year, and will not bias the estimates to favour firms ending their fiscal year at a different date than others.

The period chosen for the study is 1980-2019. This has been chosen for three primary reasons. Firstly, in a paper in 2016, Arltová and Fedorová argued that the Augmented Dickey-Fuller test does not perform particularly well with a low number of observations. Specifically, they defined the time-series of observations in intervals, showcasing that the ADF test is most appropriate for datasets with observations greater than 50. As the data available is quarterly due to the quarterly reporting structure of financial data, this rules out any shorter time-periods. Arguably, one could have designed the data around monthly observations, even daily, as the firms are traded on the stock exchange. However, the noise levels in daily trading operations are generally rather high (Antoniou & Vorlow, 2005), and so are likely to cause more harm than good for the validity of the results. As new financial items are only released once a quarter, this is the most up-to-date available information at each quarter, and so will be the basis of data for the study. 50 observations in quarterly data results in 12.5 years of data being the minimum acceptable for the utilisation of the chosen methodology. To account for firms entering the index late, and also to cover several important market events in US history such as Black Monday (1987), the Dot-com bubble (2000), and the financial crisis of 2007-08, a time-period three times the recommended length seemed appropriate to allow the test results to be considered robust, and not cherry-picking of a particularly bullish or bearish time-period within the American markets. This also results in any firm which does not have >12.5 years of data available being excluded from the tests. While this may bias the results, it is necessary to ensure the validity of the tests, and is also in keeping with existing literature on the subject, which rarely, if ever, concerns itself with time-periods shorter than 13 years (Ahsan et al., 2016; Canarella et al., 2014; Golinelli & Bontempi, 2005). Additional exclusions from the data include financial firms which is also in keeping with existing literature (ibid.).

The final consideration for the preparation of the dataset is the handling of outliers. In the case of this thesis, that is extreme leverage ratios of firms. The motivation regarding the treatment of outliers in capital structure is rather clear. If a firm has an extreme leverage ratio, say that of 12:1 (so the debt is 12, while equity is 1), it seems unlikely that this is due to concrete financing decisions made by the firm. Rather, it might be because its stock price has been reduced significantly by the market (which one could argue *is* due to the decisions of the firm), and so this might bias the estimates of the firm's capital structure, and so also might bias the data overall as to exhibit more mean reversion tendencies, as the firms will, naturally, look to lower the capital structure from an unsustainable level. Generally, two main approaches to dealing with outliers exist in the literature, namely trimming the data or winsorizing the data. No exact consensus exists within the current literature, and both methods can prove useful for dealing with outliers. For this reason, both methodologies are analysed in this thesis, and results utilising trimming at the 5% and 95% level as well as winsorizing at the 5% and 95% level will be shown. The percentiles are based upon the entire data series for the individual companies, and so are not biased by industrial averages. The 5% level has been chosen in accordance with existing literature on mean reversion of capital structure, as to greater enhance comparability between studies (Canarella et al., 2014). A different level could certainly have been chosen, but the 5% level provides a good balance between the removal and replacement of values, while maintaining the general integrity level of the data. One issue which must be considered however, is if the two datasets provide different results, which one should carry the most weight. No clear argument can be made in favour of one or the other, as they are both directly influencing the dataset, and so may cause biases. One study by Bieniek (2016) did however find that the bias of winsorized data seems to be smaller than that of trimmed data. He argues that this is because the removal of data points, rather than replacement, leads to less power of analysis, and so creates additional bias in the trimmed dataset. For this reason, should the analysis of the trimmed and winsorized datasets carry significantly different results, more weight will be placed on the winsorized dataset when attempting to draw inferences and conclusions from the empirical results obtained in this thesis.

With the above considerations, the final dataset consists of 771 firms, spanning 10 industries as per GICS classification, with an average of 25 firm years per firm in the data sample. The specific data extracted, along with definitions, calculations, and treatment of the data is summarised in table 2.

Variable	Description	Calculation and definitions	Data Preparation
Capital structure	Individual firm Capitalisation Ratio	Total Debt as a fraction of the sum of Total Debt, Common/Ordinary Equity and Preferred Stock	Trim and winsorization at 5th and 95th percentiles
Size	Individual firm revenue	Net revenue calculated as per US GAAP	Annualisation set to the 31st of March each year
Profitability	EBITDA margin	Calculated as Earnings before interest, taxes, depreciation, and amortization as a percentage of revenue	Annualisation set to the 31st of March each year
Valuation	Market-to-Book Value	Calculated as Market Capitalisation divided by Total Book Value. Total book value calculated as Total Assets – Total Liabilities	No treatment, reflects latest data as per 31st of March each year
Tangibility of Assets	Tangible Asset Ratio (TAR)	Calculated as Financial Assets and Intangible Assets subtracted from Total Assets	No treatment, reflects latest data as per 31st of March each year

Table 2 - Summarisation of data sample definitions

3.2 Testing Methodology

In order to test for mean reversion in a time series, one must understand the precise meaning of what mean reversion is not. A series of data which does not exhibit mean reversion, is said to be non-stationary, defined as containing a unit root. The tests of these are based on a model for the first-order autoregressive process developed by George Box and Gwilym Jenkins (1970). The simplest autoregressive process is given by (Davidson & MacKinnon, 2003):

$$y_t = (\beta - 1)y_{t-1} + \sigma\varepsilon_t \quad (3.1)$$

Where ε_t is given as white noise with a variance of 1. When $\beta = 1$, this model is defined as having a unit root and will follow a random walk process (ibid.). Graphically, the difference can be depicted as shown in illustration 2.

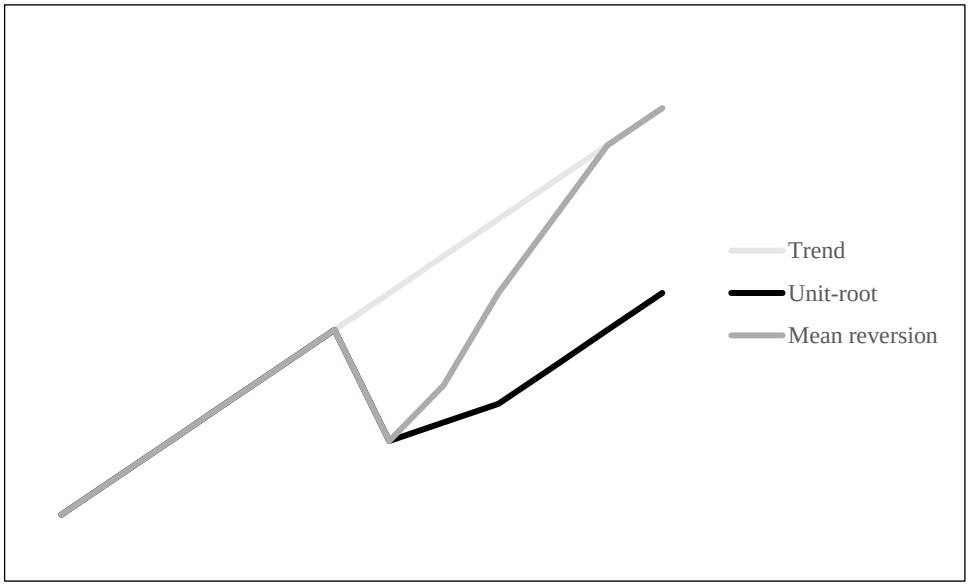


Illustration 2 - Showcase of unit root contra mean reverting behaviour

Here, when the time series drifts away from its mean values, a series displaying a unit root does not converge back to the mean value again, but instead follows a random walk for its future values. As such, the time series exhibits non-stationarity and cannot be considered mean reverting. If we subtract y_t from both sides of equation 3.1 we get

$$\Delta y_t = (\beta - 1) y_{t-1} + \sigma \varepsilon_t \tag{3.2}$$

And as such, to test for the null hypothesis, which under this specific scheme of testing is considered as the time series displaying a unit root, we can simply test that the coefficient given in equation 3.2 as y_{t-1} is equal to 0.

It is on the basis of this concept that the Augmented Dickey-Fuller test is built, mathematically derived as such (Cheung & La, 1995):

Let x_t be a time series and derive from an Autoregressive(k) representation:

$$\Delta x_t = \mu + \gamma t + \alpha x_{t-1} + \sum_{j=1}^{k-1} \beta_j \Delta x_{t-j} + u_t \tag{3.3}$$

Where Δ is the difference operator and u_t is given as white noise, equivalent to ε_t in equation 3.2. The logic of the test is relatively simple and utilises a lagged-level principle. That is, if the lagged level of the series (x_{t-1}) provides no useful information in predicting the change in the series, then the data is characterised by a unit root, and so will follow a random walk. Contrary, if the series is, in fact, mean-reverting, then the lagged level will provide certain relevant information in terms of predicting the next level of change in the

data-series, and so the series cannot be characterised as a random walk, and so does not contain a unit root.

Applying this specifically to the framework of capital structure, we again consider the literature regarding the subject. The trade-off hypothesis supposes that any deviations from the optimal debt ratio will be transitory in nature, and as such firms will move towards the target in the long run. This indicates the non-existence of a unit root, and therefore we can utilise unit root testing for this hypothesis. Let $d_{i,t}$ signify the debt ratio of firm i (with i = 1….N), at the time of t (with t = 1….T). If the capital structure of a firm (d_{it}) is mean reverting towards an optimal debt ratio (d^*_i), this implies a stationary process for the firm, given by (Canarella et al., 2014):

$$d_{it} = d_i^* + \partial_{it} \tag{3.4}$$

Where

$$\partial_{it} = \sum_{j=1}^{k-1} \beta_{ij} \partial_{t-j} + \varepsilon_t \tag{3.5}$$

Jointly these two equations form the following stationary autoregressive process

$$d_{it} = a + \sum_{j=1}^{k-1} \beta_{ij} \partial_{t-j} + \varepsilon_t \tag{3.6}$$

Which can also be given equivalently by the Augmented Dickey-Fuller representation:

$$\Delta d_{it} = a_i + \rho_i d_{it-1} + \sum_{j=1}^{k-1} a_{ij} \Delta d_{it-j} + \varepsilon_{it} \tag{3.7}$$

Solving equation 3.7 for $\rho_i = 0$ reduces to the specifications of the unit root test as in equation 3.8.

$$\Delta d_{it} = a_i + \sum_{j=1}^{k-1} a_{ij} \Delta d_{it-j} + \varepsilon_{it} \tag{3.8}$$

Equation 3.8 has a significant implication which can now be explained in broader detail and context, given the mathematical foundation has been laid out. The equation implies that when a shock occurs of ε_{it} at the time of t, the capital structure of the firm will change in the long run. Precisely, the debt ratio of the firm will change by $(1 - \sum_{j=1}^{k} a_{ij})$, indicating a permanent change to the capital structure. A permanent change to the capital

structure necessarily implies that the leverage ratio changes of the firm will not be transitory, and so will stay in place. This notion is inconsistent with the theories of the trade-off hypothesis, suggesting that the firm will revert to its optimal level. As such, when performing the Augmented Dickey-Fuller test, the null hypothesis H_0 is: $\rho_i = 0$ for all i, indicating a unit root in the debt ratio. The alternative hypothesis, H_1: $\rho_i < 1$ for some i, the debt ratio does not contain a unit root, and so will respond to the shock with a mean reverting property, and deviations from the optimal capital structure will be transitory.

The Augmented Dickey-Fuller test has been chosen as the methodology of this thesis for two primary reasons. First, it is the most simple and also most widely-used test for unit roots (Davidson & MacKinnon, 2003), giving it significant empirical support as a solid methodology to use for unit root testing, and is therefore highly applicable and appropriate to use within literature focused specifically on mean reversion. The primary alternative to the ADF tests is the Phillips-Perron test, which follows a similar logic of testing. However, literature has shown that when comparing the robustness of the ADF to the Phillips-Perron test, the ADF is superior in finite samples (Davidson & MacKinnon, 2003; Ng & Perron, 1995; Schwert, 1989). Second, in the existing literature regarding capital structure mean reversion, the ADF is the primary testing methodology of choice, likely given the above-mentioned reasons. Utilising the ADF in this thesis allows for direct comparability of results, as different testing methodologies will not play a role in the empirical results stemming from the data, and so will not be influencing any interpretations or conclusions which may come from these.

3.2.1 Testing of Financial Characteristics

As argued in the introduction, to increase the practical usability of the research performed in this thesis, I will go beyond the existing literature and also attempt to identify if any specific characteristics are present in the firms which exhibit mean reversion tendencies. In this subsection, I will briefly outline the process for these tests.

One advantage that the individual firm testing possesses is that it allows for individual identification of the firms which exhibit mean reverting properties in their capital structure. This is particularly advantageous when wishing to further analyse these firms in an attempt to document if and how they differ from the firms which do not exhibit mean reversion tendencies in their capital structure. For these tests, the firms which exhibit mean reversion properties will be grouped by industry, as will the firms which do not exhibit mean reversion properties. This will allow for concrete comparisons of these two groups, both

across industries and intra-industry, and potentially showcase significant differences in the parameters between the groups.

There are several approaches which can be taken to identify the differences between two groups, the most obvious and widely used methodology being a t-test. An argument could certainly also be made for running individual regressions in an attempt to predict the capital structure of both the mean-reverting group and the non-mean reverting group in the sample, and see the differences in how significant the parameters chosen are in prediction across both groups. However, as this thesis is specifically not focused on the prediction of capital structure, even regarding the firms which exhibit mean reversion, this methodology will not be considered, but could be an interesting point of further research. Rather, this thesis focuses on identifying if characteristics shared among the group of firms which exhibit mean reversion, and the group of firms which do not, are significantly different. This test will allow for interpretation in relation to valuation when choosing the future capital structure of the firm being valued, while potentially enhancing the understanding of why certain firms adjust their capital structures differently from others.

For this type of argumentative logic, the two-tailed t-test seems the most appropriate test to perform, as it will indicate either a rejection or non-rejection of the null hypothesis that there are no significant differences between the two groups. The specific variation of the t-test performed will be the Welch t-test, as it allows for differences in the variance of the two groups. The variance has been tested using an F-test and showed that the variance between the respective groups is significantly different, hence the Welch t-test has been chosen as it is the most appropriate (Welch, 1947).

The Welch t-test defines the statistic *t* by:

$$t = \frac{\overline{X_1} - \overline{X_2}}{\sqrt{\frac{s_1^2}{N_1} + \frac{s_2^2}{N_2}}} \tag{3.9}$$

Where $\overline{X}_j$, s_j, and N_j are the jth sample mean, sample standard deviation, and sample size (Welch, 1947).

This specific method allows for rejection or non-rejection of the null hypothesis that there is no significant difference between the values of the two groups, and so fits nicely in regards to the second stated hypothesis of this thesis, and will allow for relatively simple interpretations of the tests.

3.3 Parameter Selection for Testing

When performing the ADF test, there are two main parameters to consider, aside from the data and above-mentioned considerations of the general model. These two parameters are especially important to increase the relative strength of the ADF test, as compared to its alternatives, and to increase the robustness of the results extracted from the test.

The first is the specific case that one wishes to test utilising the ADF methodology. Generally, the three cases of testing, which implies different restrictions to the fitting of the model, are: 1) Random walk without drift, 2) random walk with drift or 3) random walk with or without drift (STATA, 2013). For the purposes of this thesis, I will utilise case three, random walk with or without drift. This is the least restrictive of the three cases, and allows for the introduction of a trend term, which the other cases do not. The specific reason for the trend term is apparent when performing simple regressions of the overall data for capital structure, which shows a clear upward trend (see appendix 1 for regression and graphs). While this is not the focus of this thesis, it is nevertheless interesting to observe the clear increase in overall leverage level over time within the data sample, and it is certainly an observation that warrants the inclusion of the trend term in the fitting of the model.

The second parameter which one must consider is the length of the lags. Given that the ADF includes lags, it allows for a higher-order autoregressive process, one of the strengths of the test. However, the determination of the specific lag parameter is not necessarily easy, and there is no uniform way to determine the optimal number of lags for the given model. One methodology which has been used in previous literature is the Akaike Information Criterion (AIC) to determine the optimal number of lags. The AIC is effectively an estimator of the relative quality of a statistical model for a certain set of data (Bozdogan, 1987) measuring the value of the model as:

$$AIC = 2k - 2\ln(\hat{L}) \tag{3.10}$$

Where

k = the number of estimated parameters in the model

$\hat{L}$ = the likelihood function for the model

The preferred model will be the one with the lowest AIC value, meaning AIC rewards models regarding their goodness of fit parameter, while penalising functions that exhibit risks of overfitting due to a high number of estimate parameters. The AIC will be utilised

to choose the optimal number of lags for the ADF testing throughout this thesis. For a more in-depth discussion of the usage of AIC in model selection, see Bozdogan (1987).

3.4 Individual and Panel Testing

An observation which was made during the literature review was the difference in exploring individual firm data sets and exploring panel data sets. The primary difference between the two is how the data is organised, and such also how the unit root tests can utilise the data. When utilising purely the time-series aspect of the firms, that is individual testing, the data will be organised as per table 3.

Time	**Firm 1**	**Firm 2**	**Firm 3**
t	X_1	X_2	X_3
t+1	Y_1	Y_2	Y_3
t+2	Z_1	Z_2	Z_3

Table 3 - Individual data

Panel data however is organised by individual groups. This requires panel data to both specify the specific group, using subscript *i*, as well as the time variable, using subscript *t*, as shown in table 4.

Group	**Time-period**	**Notation**
1	1	Y_{11}
1	2	Y_{12}
1	T	Y_{1T}
⋮	⋮	⋮
N	1	Y_{N1}
N	2	Y_{N2}
N	T	Y_{NT}

Table 4 - Panel data

The primary advantages of utilising panel data in unit root testing is that this specific data format is capable of exploiting both the time dimension as well as the cross-section dimension of the data. This will lead to a greater power when performing unit root tests, as

well as greater efficiency when compared to time series unit root tests (Baltagi, 2005; Canarella et al., 2014; Levin et al., 2002).

One key issue to address when using panel unit root tests is the assumptions made regarding cross-section independence. Some tests utilising panel data assume cross-sectional independence in the data set, an assumption that seems unrealistic given the focus area of this thesis. There are several reasons why cross-sectional dependence may exist between firms in a given industry. Firms which share an industry are effectively exposed to the same market conditions. When a shock hits the industry, the firms will likely be impacted in much the same way. Even broader, some market factors impact even firms outside of the specific industry, such as the monetary policy employed where the firm is located. If the interest rate is raised, this will increase the cost of borrowing for the firm, which will influence the cost of capital, which might directly influence the firm's financing decisions (Bokpin, 2009; Frank & Goyal, 2009). Previous studies have also found empirical evidence that observations regarding firms and industries tend to be cross-correlated (Bernier & Mouelhi, 2012; Breitung & Pesaran, 2005; Chan et al., 2001). To handle this specific problem, I will employ what is known as second-generation unit root panel tests, which do allow for cross-sectional dependence by imposing a common factor structure. These tests still build on the foundational framework of the ADF test, and so still share the null hypothesis of a unit root, and perform, in effect, the same testing, but modified in the way specified above.

Another issue of concern is that of the data structure itself. When discussing panel data, one can group the data into two types: balanced and unbalanced panels. The panel shown in table 4 is a balanced panel, as each group has the same number of observations. Conversely, an unbalanced panel is one in which some of the groups are missing observations, creating a panel where not every observation is filled in for each and every group. This presents a problem, as certain panel data models only provide valid results when testing on a balanced panel of data. As discussed in the data selection section, I include firms which enter the S&P 500 index later than the 1980s, as not to cherry-pick older and longer-surviving firms. This by default leads to an unbalanced panel of data, as these firms will have no observations to include prior to their entrance into the index. Therefore, the model for the panel unit root testing also must fulfil the criteria that a balanced panel is not necessary to reach valid results.

Based upon literature regarding the advantages and disadvantages of the different models which fulfil both of the above criteria (Baltagi, 2005; Maddala & Wu, 1999), I have

chosen to perform the Fisher test. The Fisher type ADF test fulfils both criteria in that it allows for cross-sectional dependence and does not require a balanced panel of data. Additionally, it is the implemented model of testing by both Ahsan et al. (2016) and Canarella et al. (2014), allowing for greater comparability with the results of these two empirical pieces of literature, as differences in testing methodology will not bias the interpretations which can be made from the results presented in this thesis.

Regarding the sorting of the data into panels, the existing literature groups the firms by industrial classification. As mentioned, the tests I will perform are capable of handling the dependency issues these groupings will create, and so I do not consider this issue a particular worry of this data grouping. Therefore, I will also be performing the panel wide tests on groups segmented by industrial classification, utilising the GICS classification. GICS has been chosen for its greater identification and classification capabilities compared with alternatives such as the SIC system.

4 Empirical Results

In this chapter, I will present the findings of the analysis carried out as described in the methodology section. The chapter will proceed as follows. In section 4.1, I will present the results of the mean reversion testing, with descriptive statistics in section 4.1.1, individual firm testing in section 4.1.2, and panel-level testing in section 4.1.3. Following this, in section 4.2, I will present the results of the testing of the characteristics, with descriptive statistics in section 4.2.1 and testing results in section 4.2.2 and 4.2.3.

4.1 Mean Reversion Testing

In this subsection, I will present both the descriptive statistics for the data set on which the mean reversion testing is performed and the results of the mean reversion tests. Regarding the data for the testing of mean reversion, the data of both the trimmed dataset and the winsorized dataset are presented as to better relate these to the results in the sections to follow.

4.1.1 Descriptive Statistics

In table 5, I present the descriptive statistics for the final trimmed dataset, and in table 6, I present the descriptive statistics for the final winsorized dataset. All inputs are from COMPUSTAT, and the procedure for the preparation of the dataset is described in the methodology section.

Industry	# firms	Observations	Mean	Median	10th percentile	90th percentile	Variation	Std. dev
Overall	771	80,096	0.342	0.321	0.017	0.619	0.108	0.328
Communication services	41	3,788	0.483	0.427	0.139	0.868	0.119	0.346
Consumer discretionary	133	13,928	0.331	0.299	0.025	0.631	0.068	0.261
Consumer staples	64	7,166	0.382	0.346	0.077	0.665	0.078	0.280
Energy	64	6,428	0.382	0.353	0.147	0.604	0.082	0.286
Healthcare	94	9,248	0.265	0.229	0.004	0.545	0.058	0.242
Industrials	127	13,898	0.367	0.326	0.035	0.663	0.221	0.470
Information technology	121	11,915	0.179	0.116	0.000	0.422	0.097	0.311
Materials	68	6,959	0.383	0.360	0.135	0.633	0.054	0.232
Real estate	2	239	0.435	0.428	0.327	0.565	0.007	0.084
Utilities	57	6,527	0.515	0.501	0.417	0.623	0.009	0.093

Table 5 - Descriptive statistics of final trimmed dataset of the leverage ratios

Industry	# firms	Observations	Mean	Median	10th percentile	90th percentile	Variation	Std. dev
Overall	771	87,001	0.352	0.325	0.019	0.639	0.157	0.396
Communication services	41	4,129	0.488	0.428	0.122	0.883	0.128	0.357
Consumer discretionary	133	15,154	0.339	0.302	0.026	0.655	0.085	0.291
Consumer staples	64	7,817	0.390	0.348	0.074	0.689	0.087	0.296
Energy	64	7,037	0.392	0.354	0.142	0.621	0.150	0.387
Healthcare	94	10,021	0.274	0.233	0.005	0.562	0.067	0.258
Industrials	127	15,090	0.378	0.328	0.034	0.675	0.362	0.602
Information technology	121	12,731	0.195	0.124	0.000	0.452	0.162	0.402
Materials	68	7,595	0.389	0.361	0.132	0.650	0.063	0.251
Real estate	2	262	0.437	0.429	0.324	0.576	0.009	0.092
Utilities	57	7,165	0.517	0.501	0.413	0.632	0.010	0.097

Table 6 - Descriptive statistics of final winsorized dataset of the leverage ratios

As shown, there are differences between the industries in terms of the number of firms included, as well as the values of the capital structure, their percentiles, as well as standard deviations. This is to be expected, as literature has previously showcased empirical evidence supporting industry as a factor in the capital structure choices of a firm. None of the industries showcase a particularly worrying overweight of firms, and all industries, apart from the Real Estate industry, contain enough firms to consider the power of the panel level testing to be strong, particularly with the number of observations within each industry. As the Real Estate industry only contains two firms, concerns regarding the validity of the testing, due to the small sample, are certainly warranted. For this reason, little weight will be placed on the results regarding the panel level testing of the Real Estate industry, when drawing final conclusions from the testing results of this thesis.

The industry with the most firms present is the Consumer Discretionary industry, followed by Industrials, and Healthcare. Generally, the means and medians of the capital structure of the different industries seem quite close in the 0.2 – 0.4 range, with Information Technology being the lowest average leverage ratio, and Utilities having the highest average leverage ratio. There is quite a big difference in the variation of the leverage ratio between industries, with the Industrials and Communication Services showing a higher level of variance in the data. This is, however, not a particularly big concern, and the inclusion of these metrics is to ensure a good impression of the dataset, and that a dataset with a low variance has not been cherry-picked as to support a certain hypothesis.

The remainder of this chapter focuses on the findings, which will form the basis for the evaluation of the hypotheses stated in the introduction. Testing for mean reversion, I have

performed ADF tests on an individual firm level, and Fisher type ADF tests on a panel level of the data, with the panel grouping being defined by industrial classification to enhance comparability with previous studies.

4.1.2 Individual Firm Results

As it is not feasible to report the individual testing for all the firms, I present below in figure 1 and figure 2 the distribution of the ADF tests' Z-scores for both the trimmed dataset and the winsorized dataset, respectively. For reference of the output from an individual test, please refer to appendix 2. All tests utilise a lag variable of 1 as chosen by AIC. The output of the ADF test focuses purely on the left side of the distribution, and as such, to be significant, the Z-score has to be below the critical value. In below figures, the vertical line inserted indicates the critical values of 10% and 5% (the left most indicates 5%), with the histogram being divided into buckets reflecting the specific difference at these significance levels. Note the slight difference in critical value across the two tests due to differences in the data preparation methods outlined previously.

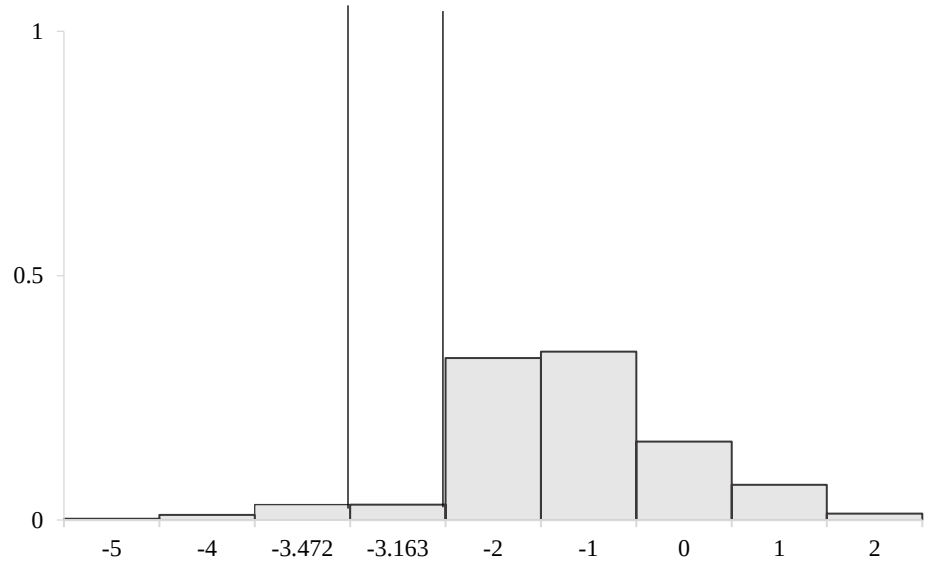


Figure 1 - Trimmed ADF Z-scores

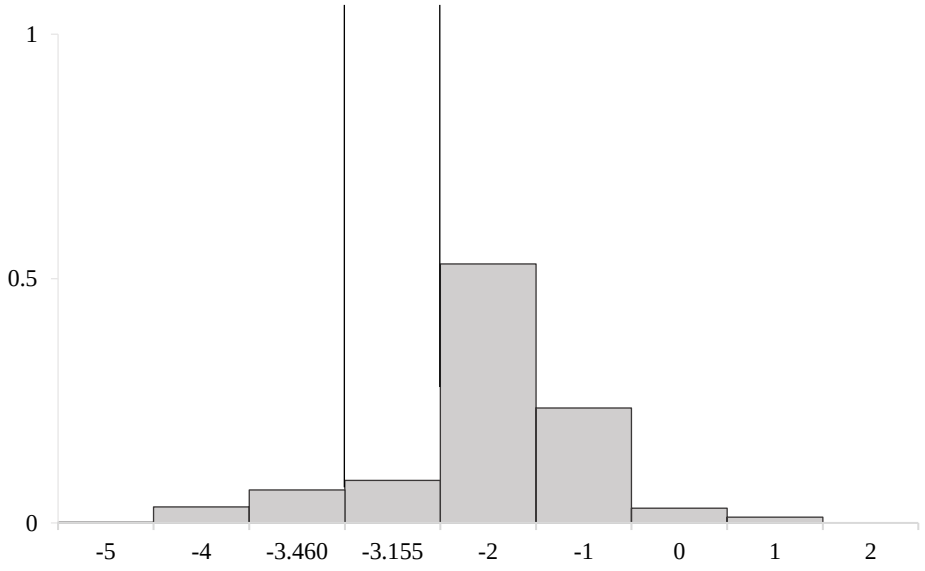


Figure 2 - Winsorized ADF Z-scores

In the testing of the trimmed data, the null hypothesis that there is a unit root, and so the data acts more according to a random walk and does not exhibit mean reversion, is rejected in only 57 cases at the 10% level, equivalent to about 7% of the firms exhibiting mean reversion tendencies. At the 5% level of significance, this drops to 35 cases, or about 4.5% of the cases. When looking at the data which has been prepared using winsorizing instead of trimming, at the 10% significance level, 147 cases showcase a rejection of the unit root null hypothesis, equivalent to about 19% of the cases. At the 5% level, this drops to 83 cases or about 10.7% of the observations rejecting the unit root null.

This testing primarily showcases support for the existence of a unit root in the capital structure of the companies, as I cannot, in the majority of the tests, reject the unit root null hypothesis, and so cannot argue that the firms have mean reverting tendencies within their capital structures. Rather that they seem to exhibit behaviour more in accordance with random walk. When looking at the industrial distribution of these firms as in figure 3 and 4, it seems to be the result that no particular industry has a large number of mean reverting firms compared to the other industries. In the trimmed dataset, the industry with the largest proportion of firms with a mean reverting capital structure is the Information Technology sector with 15.7% of the firms showcasing mean reversion. This is followed by Healthcare (8.5%), Consumer Discretionary (8.3%), and Consumer Staples (7.8%). Neither of these industries however showcase particularly strong tendencies regarding mean reversion of capital structures, as the percentages all remain below 20%, with nine out of ten industries below 10%. When looking at the dataset which has been winsorized rather than trimmed,

more industries showcase a higher percentage of the firms exhibiting mean reversion, as was expected given the results of the individual firm testing showcased in figures 1 and 2. Disregarding the real estate industry, as it only contains two firms, the industry with the largest proportion of firms exhibiting mean reversion in their capital structure is the Healthcare industry with 27.6% of the firms showing mean reversion tendencies. This is followed by Materials (25%), Consumer Discretionary (21.1%), and Consumer Staples (20.3%). Certain observations regarding the industries will be touched upon additionally when comparing the characteristics of the firms in section 4.2.

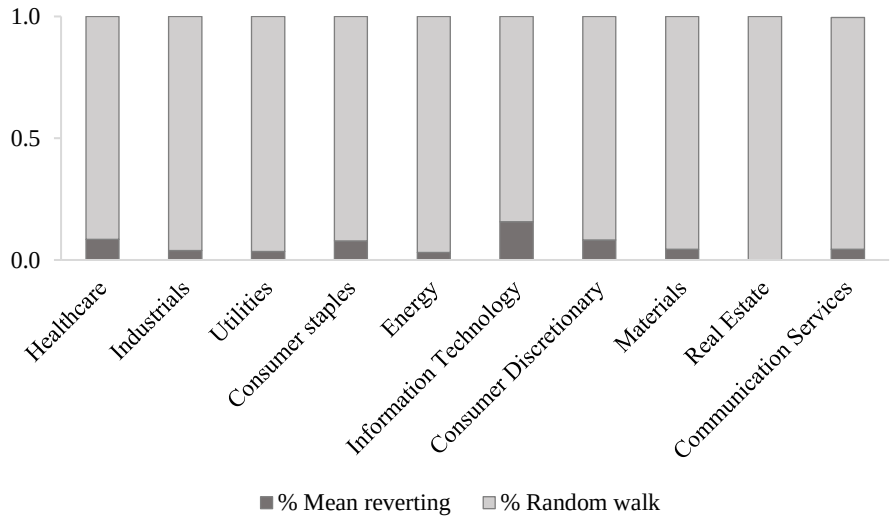


Figure 3 - Industrial Distribution Trimmed Data

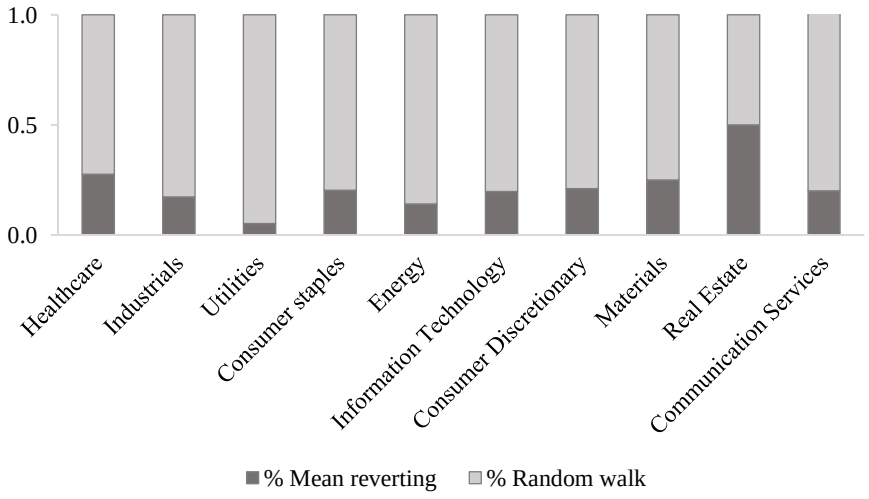


Figure 4 - Industrial Distribution Winsorized Data

From the individual firm testing, it seems that the majority of the results do not showcase support for the trade-off theory, as the number of firms which exhibit mean reversion in their capital structure across the period is smaller than the number of firms which exhibit random walk tendencies in their capital structure. Both when looking at the trimmed dataset and the winsorized dataset, the unit root null cannot be strongly rejected across any industries, as the proportion of firms exhibiting a unit root is significantly larger than the number of firms which can reject this unit root null, and thus exhibit mean reversion.

An important observation, however, is the difference in the results regarding the two datasets. While neither provide enough evidence to showcase significant support for the mean reversion of capital structure, the winsorized dataset has more firms exhibiting mean reversion tendencies. As was argued in the methodology section, I will place more emphasis on the winsorized data, as it is likely to contain less bias than the trimmed version of the dataset. However, even the winsorized dataset does not provide clear evidence to support the trade-off theory and support a result which indicates mean reversion in the capital structure of firms, generally.

4.1.3 Panel Results

In order to exploit both the cross-sectional and time-series variability in the data, one must utilise a panel test as argued in the methodology section. I utilise the Fisher-type ADF test, as it fulfils the criteria outlined in section 3 and is deemed the most appropriate test for the panel data of this thesis.

In below table 7, I report the values of the P test statistic and the Z test statistic for the Fisher type ADF test on the trimmed panels segmented by industrial affiliation, with the corresponding P-values reported below their respective statistical measures. In table 8, the same results for the winsorized dataset is presented. For reference of the output from a panel level test, please refer to appendix 3. The P statistic is computed using the chi-square test and is distributed as a chi-square distribution utilising 2N degrees of freedom (Canarella et al., 2014):

$$P = -2\sum_{i=1}^{N} \ln (p_i) \tag{4.1}$$

Where p_i is the p-value of the test statistic in the cross-sectional unit i.

The Z-test statistic is the inverse normal statistic, is distributed as a standard normal distribution (ibid.):

$$Z = \frac{1}{\sqrt{N}} \sum_{i=1}^{N} \Phi^{-1}(p_i) \tag{4.2}$$

The choice of these two specific test statistics rests on the research performed by Choi (2001). Using simulations, he suggests that the inverse normal Z statistic is, in fact, the result that offers the best trade-off between the size and the power of the test. However, when the number of panels is finite, as is the case with the data being examined in this thesis, the inverse Chi-square P test is also applicable. For this reason, both results have been included below, as they are both deemed to be relevant results for the data analysed in this thesis.

In the below tests, I utilise a lag of 1 as chosen by AIC, and to account for contemporaneous correlation, I utilise demeaned data. This refers to subtracting the cross-sectional means from the observed data, a strategy when performing panel unit root tests suggested by Levin et al. (2002) and Im et al. (2003). This strategy is highly applicable in the case of capital structure testing, as it is meant to control for situations where disturbances caused to the data might be correlated across the defined units. As argued earlier, this is most likely the case for companies which operate within the same industry, and as such this methodological recommendation has been carried forward into the tests performed in this thesis.

Industry affiliation	**Fisher type ADF tests**	
	P	Z
Communication services	91.2590	0.4662
	0.2269	0.6795
Consumer discretionary	270.8876	3.4278
	0.4054	0.9997
Consumer staples	137.3977	2.4138
	0.2693	0.9921
Energy	137.0405	-0.4352
	0.2364	0.3317
Industrials	250.0852	2.4169
	0.3141	0.9922
Healthcare	167.1434	-0.1153
	0.4605	0.4541
Information technology	274.0697	-0.4496
	0.0246**	0.3265
Materials	130.2291	0.9085
	0.4778	0.8182
Real estate	4.1346	0.2380
	0.3881	0.5940
Utilities	93.4368	2.4484
	0.8397	0.9928

*Table 7 - Fisher type ADF tests for trimmed dataset * denotes significance at the 1% level, ** denotes significance at the 5% level*

Industry affiliation	Fisher type ADF tests	
	P	Z
Communication services	62.1000	1.8105
	0.9503	0.9649
Consumer discretionary	300.2360	-0.7603
	0.073**	0.2236
Consumer staples	121.3293	0.7963
	0.6490	0.7871
Energy	281.0937	-7.3901
	0.0000*	0.0000*
Industrials	442.7982	-4.8721
	0.0000*	0.0000*
Healthcare	282.1202	-3.8537
	0.0000*	0.0001*
Information technology	345.7933	-3.6153
	0.0000*	0.0001*
Materials	150.4611	-0.9201
	0.1569	0.1787
Real estate	1.8127	0.6179
	0.7702	0.7317
Utilities	104.9637	0.9336
	0.6684	0.8248

*Table 8 - Fisher type ADF tests for winsorized dataset * denotes significance at the 1% level, ** denotes significance at the 5% level*

The results of the panel testing are mixed depending on which dataset is used. Using the trimmed dataset, results are in-line with individual firm testing, whereas the winsorized dataset differs from the individual firm testing, where the null hypothesis of a unit root presence was rarely rejected. In the panel testing, based on the trimmed data, the unit root null is only rejected at a 5% significance in one industry, Information Technology. In the other industries, the p-value does not reach any traditional level of significance, except for the Communication Services industry, which does near a 20% significance level. Regardless, this panel testing seems to provide empirical evidence against the trade-off hypothesis, as the unit root null is unable to be rejected in the majority of the cases, and so the capital structure decisions of the firms in these industries more resemble a random walk rather than any return to a targeted capital structure.

When looking at the winsorized data, the results differ from both the individual firm testing, as well as the panel testing of the trimmed dataset. The unit root null is rejected in

5 industries at a 5% significance level or below utilising the P-test statistic (Consumer Discretionary, Energy, Industrials, Healthcare, Information Technology), and in 4 industries utilising the Z-test statistic (Energy, Industrials, Healthcare, Information Technology). The Materials industry does also near a 10% significance level but is not considered significant in neither the P-test statistic nor the Z-test statistic. This result of panel-testing is more in-line with the trade-off theory, indicating that firms, at least in the specified industries, do adjust their leverage ratio towards a targeted capital structure, and that shocks which those industries occur affecting the capital structure, will only have a transitory effect on the financing decisions the firms make, and they will, over time, revert to their targeted capital structure.

An interesting observation regarding the panel-level data, is that it does not necessarily correspond to the identified industries which have the highest number of firms with mean reverting properties in the individual test. For example, the industry which was identified with the second most firms exhibiting mean reversion in their leverage in the individual firm testing based on winsorized data was the Materials industry. When testing the panel data, the null hypothesis of a unit root cannot be rejected, and so the Materials industry does not appear to exhibit mean reversion tendencies when analysing the panel data. Of course, when testing the individual firms, the proportion of firms in the Materials industry showcasing mean reversion was far from the majority, but this does not have to be the case for the panel test to be able to reject the unit root null, as showcased in Healthcare industry, which had 27.6% of the firms in the individual test showcasing mean reversion, and has the unit root null rejected in the panel test at a 1% significance level in both the P-test statistic and the Z-test statistic.

This raises the question of which results are the most trustworthy, the individual firm testing or the panel-level testing? An important note here, of course, is that regardless of which method is chosen and results are relied upon, a complete rejection of the first hypothesis of this thesis seems unfeasible. The results are mixed, even when utilising panel-level data, although the panel-level tests based on winsorized data do showcase more support for mean reversion, and as such for the trade-off theory. Regardless, previous literature makes the claim that the panel framework of testing for unit roots carries significantly greater power than simply testing the individual time-series of the data (Golinelli & Bontempi, 2005). They argue that, if conflicting results do arise from the two testing methodologies, one should put more trust in the results provided by the panel-level testing, as they will have greater power. As this thesis does not attempt to devise precisely

which of these methodologies carry the greatest power, and which results should be trusted more, it will rely upon the recommendations of these previous studies, and as such, when concluding upon the stated hypotheses, will put more weight on the results provided by the panel level tests, rather than the individual testing of the capital structure of firms.

4.2 Characteristics Testing

The previous section focused on the empirical results regarding mean reversion and showcased that several firms do exhibit mean reversion. However, it also showcased that there is a significant number of firms in the sample which do not exhibit mean reversion of their capital structures. This might lead to the question of whether or whether not there is a difference between these two groups, as the second hypothesis of this thesis states. Based on the winsorized dataset, as it is likely to contain less bias as argued previously, the firms have been divided into two groups, mean reverting and non-mean reverting. These groups were tested for significant differences in the main drivers of capital structure as per the literature reviewed in section 2.2.

4.2.1 Descriptive Statistics

In table 9, I present the descriptive statistics for the mean revering firms, and in table 10 I present the same statistics for the non-mean reverting firms in regard to all parameters of the characteristics data. All inputs are from COMPUSTAT, and the procedure for the preparation of the dataset is described in the methodology section.

Industry	# firms	Mean revenue	Mean EBITDA-%	Mean M/B	Mean TAR
Overall	147	12,366	15.7%	2.96x	0.82
Healthcare	26	16,090	-4.1%	5.14x	0.71
Industrials	22	19,829	16.7%	3.35x	0.80
Utilities	3	5,748	17.4%	1.25x	0.95
Consumer Staples	13	14,558	13.5%	5.28x	0.72
Energy	9	13,975	23.5%	1.69x	0.94
Information Technology	24	7,036	16.9%	3.52x	0.77
Consumer Discretionary	28	12,375	14.3%	3.28x	0.86
Materials	17	10,992	17.5%	2.35x	0.86
Real Estate	1	1,778	17.8%	0.70x	1.00
Communication Services	4	21,279	23.3%	3.00x	0.55

Table 9 - Descriptive statistics of characteristics of mean reverting firms

Industry	# firms	Mean revenue	Mean EBITDA-%	Mean M/B	Mean TAR
Overall	624	21,049	15.8%	3.15x	0.81
Healthcare	68	18,092	-9.6%	4.96x	0.67
Industrials	105	16,894	14.8%	3.07x	0.74
Utilities	54	13,015	28.3%	1.13x	0.95
Consumer Staples	51	46,480	13.5%	4.36x	0.71
Energy	55	30,015	25.4%	1.93x	0.94
Information Technology	97	14,034	18.0%	5.10x	0.77
Consumer Discretionary	105	17,395	10.0%	3.48x	0.86
Materials	51	9,702	15.4%	2.76x	0.83
Real Estate	1	17,976	15.6%	1.64x	0.97
Communication Services	37	26,885	27.0%	3.07x	0.64

Table 10 - Descriptive statistics of characteristics of non-mean reverting firms

The above tables showcase the average revenue, EBITDA-%, Market to Book value, and Tangible asset ratio of the two groups. Simply looking at the overall average for the two groups, one cannot identify a clear and concise difference across EBITDA-%, Market to Book value, and Tangible asset ratio, although the mean-reverting firms seem to have slightly lower market to book values than the non-mean reverting firms. The only measure in which a difference manifests itself when dividing the firms into these groups, is the revenue. The mean reverting firms seem to have lower revenue than the non-mean reverting firms, perhaps indicating a size relationship between mean reversion and non-mean reversion of the capital structure of the firms.

However, based on the descriptive statistics, several differences do seem to manifest themselves intra-industry between the groups. As an example, the utility industry firms which exhibit mean reversion average an EBITDA-% of 17.4%, with the firms not exhibiting mean reversion averaging an EBITDA-% of 28.3%. On the basis of this, it seems appropriate to test for differences in the characteristics of the two groups both across the industries as well as intra-industry, in an attempt to identify any trends or mechanisms which might help increase understanding of why certain firms adjust towards a target while others do not.

4.2.2 Characteristics Results

The testing performed in this section attempts to identify whether any characteristics trends exist within the two groups, namely firms which exhibit mean reversion in their capital structure as identified in the individual firm testing, and those that do not. In table 11 I report the result of the t-test across industries. Here, the whole groups have been analysed based on the parameters chosen, and so no industrial classification has been taken

into account in this test. I report the degrees of freedom, t-test statistic, the critical t-value of the chosen test, and the p-value showcasing if the result is significant or not.

Across industries	df	t-stat	t critical (two tail)	P-value two-tail
Revenue	14	-2.2053	2.1448	0.0447**
EBITDA-%	16	-0.0389	2.1199	0.9694
M/B	18	-0.3042	2.1009	0.7645
TAR	18	0.1661	2.1009	0.8699

*Table 11 - Empirical results across industries of characteristics testing. ** denotes significance at the 5% level*

The results showcase little significance between the two groups across industries. Out of the four parameters tested, only the revenue parameter showcases significance at a 5% level. This result indicates that there is a significant difference between mean reverting firms and non-mean reverting firms when looking at their revenue, and by proxy, the size of the firms, with the firms exhibiting mean reversion tendencies in their capital structure being significantly smaller than the firms not exhibiting mean reversion of the capital structure.

However, to further augment the results, the tests were also performed at the industry level, maintaining the two groups, but assigning each firm to its respective industry. As each parameter is tested within each industry, I present below four tables, each pertaining to the testing of one parameter across all industries. I report the degrees of freedom, t-test statistic, the critical t-value, and the p-value. In table 12, I report the results for the revenue parameter, in table 13 I report the results for the EBITDA-% parameter, in table 14 I report the results for the M/B parameter, and in table 15 I report the results of the tangible asset ratio parameter.

Industry	df	t-stat	t critical (two tail)	P-value two-tail
Healthcare	75	-0.4701	1.9921	0.6397
Industrials	74	0.8079	1.9925	0.4218
Utilities	59	-3.8144	2.0010	0.0003*
Consumer Staples	43	-4.3202	2.0167	0.0001*
Energy	54	-3.2375	2.0049	0.0021*
Information Technology	50	-2.8285	2.0086	0.0067*
Consumer Discretionary	70	-1.6854	1.9944	0.0964***
Materials	72	0.6532	1.9935	0.5157
Real Estate	39	-6.0390	2.0227	0.0000*
Communication Services	71	-1.1343	1.9939	0.2605

*Table 12 - Empirical results intra-industry of the revenue parameter. * denotes significance at the 1% level, *** denotes significance at the 10% level*

Industry	df	t-stat	t critical (two tail)	P-value two-tail
Healthcare	74	0.5789	1.9925	0.5644
Industrials	51	2.6458	2.0076	0.0108**
Utilities	57	-10.2392	2.0025	0.0000*
Consumer Staples	72	0.0602	1.9935	0.9521
Energy	74	-1.1823	1.9925	0.2409
Information Technology	76	-0.9598	1.9917	0.3402
Consumer Discretionary	44	4.3449	2.0154	0.0001*
Materials	57	2.6485	2.0025	0.0104**
Real Estate	76	1.8047	1.9917	0.0751***
Communication Services	76	-5.1914	1.9917	0.0000

*Table 13 - Empirical results intra-industry of the EBITDA-% parameter. * denotes significance at the 1% level, ** denotes significance at the 5% level, *** denotes significance at the 10% level*

Industry	df	t-stat	t critical (two tail)	P-value two-tail
Healthcare	76	0.4176	1.9917	0.6774
Industrials	70	0.8300	1.9944	0.4093
Utilities	73	1.8017	1.9930	0.0757***
Consumer Staples	65	1.6320	1.9971	0.1075
Energy	76	-1.7226	1.9917	0.0890**
Information Technology	66	-3.4245	1.9966	0.0011*
Consumer Discretionary	70	-0.7481	1.9944	0.4569
Materials	53	-1.7598	2.0057	0.0842***
Real Estate	73	-6.5641	1.9930	0.0000*
Communication Services	35	-2.8009	2.0301	0.0082*

*Table 14 - Empirical results intra-industry of the M/B parameter. * denotes significance at the 1% level, ** denotes significance at the 5% level, *** denotes significance at the 10% level*

Industry	df	t-stat	t critical (two tail)	P-value two-tail
Healthcare	36	1.0092	2.0281	0.3196
Industrials	33	3.0469	2.0345	0.0045*
Utilities	20	-0.8659	2.0860	0.3968
Consumer Staples	34	0.3329	2.0322	0.7413
Energy	32	0.8481	2.0369	0.4027
Information Technology	35	0.0349	2.0301	0.9723
Consumer Discretionary	34	0.5712	2.0322	0.5716
Materials	34	2.1278	2.0322	0.0407**
Real Estate	18	3.0094	2.1009	0.0075*
Communication Services	35	-2.8009	2.0301	0.0082*

*Table 15 - Empirical results intra-industry of the TAR parameter. * denotes significance at the 1% level, ** denotes significance at the 5% level*

The above tables portray several of the parameters showcase significant differences between the mean-reverting group and non-mean reverting group intra-industry. Below figure 5 summarises the number of significant observations for each parameter across all the tests at the 1%, 5%, and 10% significance levels:

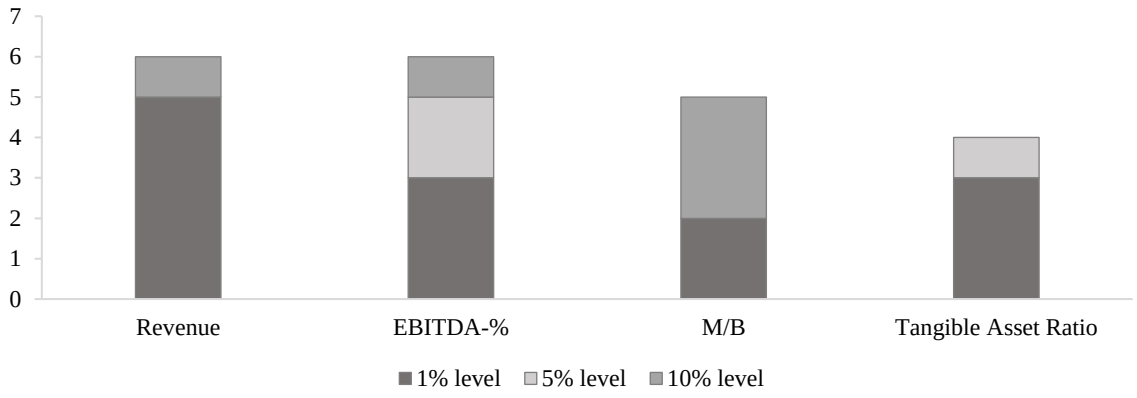


Figure 5 – Summary of significant characteristics observations

When looking at the 1% significance level, the revenue parameter showcases the most cases of significant differences, in-line with the across-industry testing, where the revenue parameter was the only parameter showcasing significance at any level. However, in this intra-industry testing, all four variables showcase that there are significant differences between the two groups, with the revenue and EBITDA variables showcasing the most significant differences when looking at the 1% and 5% significance levels, with the market to book value showing more significant differences at the 10% level. The tangible asset ratio also showcases significant differences at both the 1% and 5% level, but not to the same extent as the revenue and EBITDA parameters.

Below figure 6 showcases in which industries which parameters exhibit significant differences. Note here that the figure does not differentiate between significance levels, but has its cut-off at the 10% significance level for inclusion in the figure:

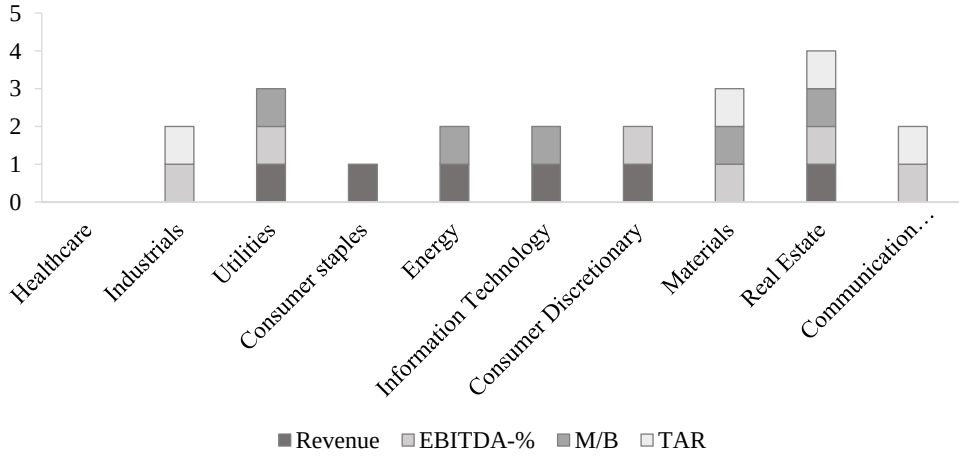


Figure 6 – Summary of significant characteristics observations across industries

Observable in figure 6 is the fact that all industries, except the Healthcare industry, has some significant difference between the two groups. While the Real Estate industry is significant at all parameters, this is likely due to the sample size, and so not much weight should be given to this result as previously explained, and it will also not be discussed further below. Apart from Consumer Staples and Healthcare, all industries in fact showcase a significant difference between the two groups regarding at least two-parameters in the testing. From these results, it seems apparent that there is some level of difference when looking at these four parameters of the firms, between the group of firms which exhibit mean reversion in their capital structure and the firms which do not showcase such behaviour, with revenue and EBITDA-% being the parameters which showcase the most significant differences.

Regarding the revenue differences between the two groups, the firms with mean reversion tendencies in their capital structure have significantly smaller revenues than the firms that do not showcase mean reversion, in-line with the overall across-industry testing. When looking at the EBITDA-% parameter, the result is slightly more mixed. Communication Services and Utilities show a significant difference, with the mean-reverting groups having a significantly lower EBITDA-% compared to the non-mean reverting groups. This result is not the case in the Industrials, Consumer Discretionary, or Materials industries, where the opposite is true – namely that the mean reverting groups have a higher EBITDA-% compared to the non-mean reverting group. In terms of the M/B parameter, the results are again mixed. In the Utilities industry, the mean reverting group is valued slightly higher on M/B basis than the non-mean reverting group. This is not the case in the Energy industry, Information Technology, or Materials industry, where the non-mean reverting group showcase a higher M/B valuation than the mean reverting group. The final parameter, the tangible asset ratio, showcases mixed results as well. In the Communication Services industry, the TAR of the mean reverting group is lower than the non-mean reverting group, while the opposite holds true in the Industrials and Materials industries.

From this it seems that, apart from revenue which has a uniform result across all industries, the specific relationship between the parameters and whether the firm is mean-reverting or not depends on which industry this firm operates within. While the M/B parameter is almost uniform as the revenue parameter, apart from the Utilities industry which showcases the opposite relationship as the other industries, the results of the two remaining parameters are mixed, and so no distinctive conclusions can be drawn at an

across-industry level. This observation is, of course, in-line with the across-industry testing performed at the beginning of this section and is likely the explanation for the lack of significant difference between the two groups at an overall level. To extract concrete interpretations, one must look at the specific industry of the firm and how the firm compares to its industrial peers. This makes sense, as industry has in previous literature shown to be highly influential, not only in terms of capital structure, but also the other parameters tested in this section. It does not seem as though I can reject the second hypothesis of this thesis. Rather the evidence points towards significant differences existing between mean-reverting and non-mean reverting firms, at least when comparing select financial characteristics.

4.2.3 Robustness Testing Across Time

The above characteristics testing showcased differences across the entire time-period between the mean reverting and non-mean reverting firms. A natural question might be if this is related to the fact that the testing is across the entire period – perhaps the tangible asset ratio relevance is due to it becoming more prevalent in recent times, or perhaps the relevance of the revenue parameter is due to significant differences in the past, which have become less significant in more recent times. In order to robustness check, as well as test if these characteristics differences have changed as time has passed, the same characteristics tests will be performed across four selected time-periods. These time-periods are 2018 – 2009, 2008 – 1999, 1998 – 1989, and 1988 – 1980. These periods are each 10 years, apart from the last period which is a 9-year period. While many different approaches could be taken, such as selecting around crises, simply using a set parameter of 10 years seems less selective and provides a less biased base for the testing.

A significant number of tests have been performed to create a full basis for the results. Each industry has been tested four times, and as such it might be difficult to properly sum-up the results in a similarly simple way as was the case in the previous section. The below figure 7 attempts to summarise the overall results. The figure showcases the four periods and the respective number of significant differences between any given group of mean reverting and non-mean reverting firms. The significance level criterion for inclusion is 10% for the showcased results.

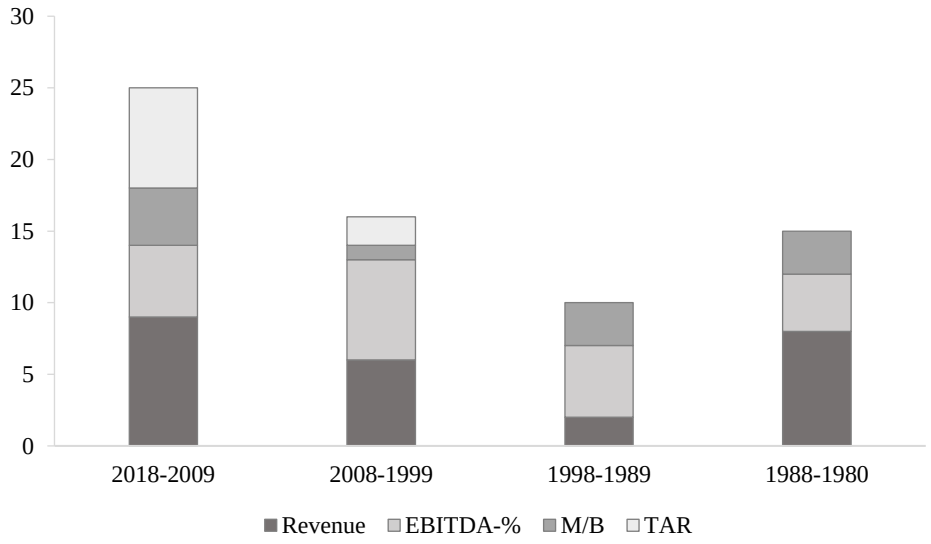


Figure 7 - Summary of significant characteristics observations across industries and time

The above figure showcases several interesting results. Firstly, it appears that no matter which time-period is selected for the testing of the characteristics, there will be significant differences in the financial characteristics chosen between the mean-reverting and non-mean reverting firms. This provides a good robustness check for the hypothesis that there are indeed significant differences between these two groups, and the results obtained in section 4.2.2 are not simply due to the testing being performed across the entire time period of the sample. While the time-period consisting of the years 2009-2018 accounts for approximately 38% of the observations, the remaining time-periods account for approximately 24%, 15%, and 22%, for the periods 2008-1999, 1998-1989, and 1988-1980, respectively, showing a reasonable representation of significant differences across all periods. Secondly, it appears that the size parameter was as important between 1980 and 1988 as it is today, that is the period of 2009 to 2018. In the periods between, the significance of the size characteristic is lower, albeit still present. This showcases that the size characteristic has maintained its significance, although perhaps for different reasons, as will be discussed in section 5.3. Thirdly, the TAR characteristic sees a sharp increase from 1999-2008 to the period of 2009-2018, showcasing that the firms which are mean reverting and those that are not perhaps adjusted their asset base significantly different when exposed to the shock of the financial crisis of 2007-08, and from this point diverged in their TAR. A final observation of the above result is that the profitability characteristic being tested, namely the EBITDA-%, has remained relatively stable across the entire period, showcasing that the differences between the mean reverting and non-mean

reverting firms regarding the profitability levels of the firms, seems to be relatively uniform, regardless of which time-period is chosen for the analysis.

When looking at the industrial level, similar results are obtained as were shown in section 4.2.2. The results for the individual industries across time are showcased below in figure 8, having its cut-off for inclusion at the 10% significance level as previous figures:

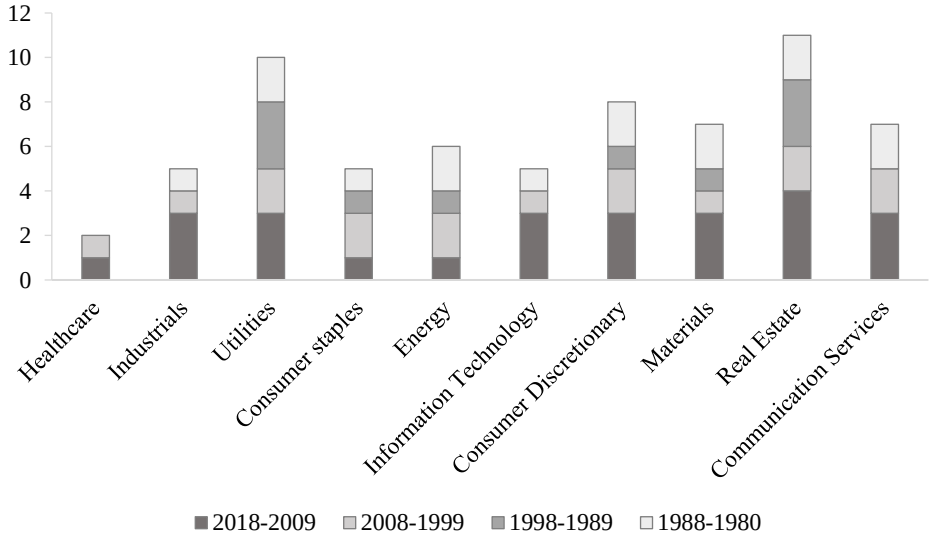


Figure 8 - Summary of significant characteristics observations across industries and time

From the above figure, it seems that, even when looking at the individual industries, significant differences in the characteristics can be observed regardless of the time period. The results do not showcase any significant overweight on any specific time period. As mentioned previously however, the period of 2009-2018 make up approximately 38% of the significant observations. This is rather interesting, as it might showcase that the differences between the mean reverting and non-mean reverting firms are growing bigger, and thus more significant, in more recent times. Regardless, this check provides additional support for the conclusion that the differences are relatively consistent across time-periods, and the previously obtained results are not simply due to differences only appearing in the later years, nor is it due to significant differences being present in the past, which have since then disappeared. The differences between mean reverting and non-mean reverting firms can be observed regardless of which time-period is chosen, showing that these differences are somewhat stable across time.

5 Discussion of Results

In this chapter, I will first relate the empirical findings to my stated hypothesis of the thesis. Following this, I will relate the results to existing capital structure literature, after which I suggest explanations for and provide interpretations of the empirical results. In addition, I will discuss limitations of the results and implications for practitioners of valuation, before finally suggesting ideas to further the research in this specific field.

5.1 Relation to Hypotheses

Given the results section showcased differing results, it seems appropriate to briefly relate these results to the stated hypotheses of this thesis, prior to delving into relations to existing literature and interpretations.

The first hypothesis of this thesis stated:

- *Hypothesis 1: Over time, companies will tend to adjust their capital structure towards a target as predicted by trade-off theory, and will therefore exhibit a mean reversion tendency in their capital structure*

As mentioned in the results section, the empirical evidence regarding this hypothesis in this thesis is mixed. The most convincing results for a non-rejection of the hypothesis stems from the panel-level testing, while the most convincing results for a rejection of the hypothesis stems from the individual testing. While more weight is placed on the panel-level testing due to its superior qualities, even here the result was not completely in favour of the hypothesis, but at the same time not strong enough to warrant a complete rejection. The evidence points towards a rather ambiguous conclusion, but I do not feel comfortable rejecting the first hypothesis of this thesis given the empirical evidence found, despite a rather strong case being made for rejection by the individual firm testing.

The second hypothesis of this thesis stated:

- *Hypothesis 2: Companies exhibiting mean reversion tendencies in their capital structure will differ in certain financial measures compared to companies that do not exhibit this mean reversion tendency*

My results indicate that there are differences between companies which exhibit mean reversion in their capital structures and those that do not. Particularly size seems to be a differentiator, remaining the largest differentiator between the two groups across the entire time period. Other characteristics such as profitability, valuation, and tangible asset ratio

also differ between the two groups across the entire period, but to a lesser extent. Based on this evidence, I do not believe I can reject the second hypothesis, as the evidence points towards significant differences in the financial characteristics of the two groups. This result helps showcase and enhance an understanding of the differences between these two groups of firms and will aid in the interpretations of why certain firms behave as per trade-off theory in a mean reverting manner, whereas others do not exhibit this mean reversion of their capital structure.

5.2 Relation to Previous Literature

The focus of this subsection is to relate the empirical results found in this thesis to the existing literature on the topic. In the literature review in chapter 2, several aspects of previous literature related to capital structures were reviewed and discussed, including the methodological approaches of previous literature focused on the mean reversion of capital structure.

Looking specifically at the methodologies of these previous papers, several differences are important to highlight. Firstly, the data sample used in all previous literature is different from the data used in this thesis. The closest comparison is the study of Canarella et al. (2014), however, even here the data used differs in the chosen time-period, as well as the selection criterion of the firms. I believe that the data selection is critical in the relation of the results obtained in this thesis, as the tests of financial characteristics in section 4.2 clearly show that there seems to be significant differences between the firms that exhibit mean reversion of their capital structures, and those that do not. Naturally, if one then obtains a sample in which the majority of the firms would be in a category which exhibits mean reversion, different results will arise than if one had a sample containing only firms containing characteristics predicted to not be mean reverting, as per the results of the testing of the characteristics.

Regardless of differences in samples, which will be touched upon again shortly, it also seems appropriate to point out the similarities between this thesis and the previous studies, allowing for comparisons of results. All the previous studies which approach the mean reversion problem of capital structure from an empirical point of view (Ahsan et al., 2016; Canarella et al., 2014; Golinelli & Bontempi, 2005), all utilise the unit root testing methodology to test for mean reversion of the capital structure in their sample of firms. Ahsan et al. and Golinelli and Bontempi both perform individual firm tests as well as panel tests, whereas Canarella et al. solely performs panel tests of the data. These features of the studies allow for relatively direct comparison with the results of this thesis, as the same

testing methodology has been applied, meaning no biases will arise due to one testing methodology favouring a certain dataset or similar issues. One issue, however, is the age of the Golinelli and Bontempi paper, published in 2005. The second-generation tests, which can account for cross-section dependence, were not developed until 2007, and so the results of this paper might be influenced by the specific unit root test used (Canarella et al., 2014).

As discussed in section 2.5, the results of these papers were mixed. Individual testing from both Ahsan et al. and Golinelli and Bontempi were not able to reject the presence of a unit root in the data, and so showcase support for the pecking order theory, rather than the trade-off theory, thereby implying that firms do not adjust towards a target capital structure, and therefore capital structure will not be mean reverting. When testing individually, Ahsan et al. specifically find that only 12% of firms are mean reverting, and Golinelli and Bontempi find that 20% of the firms are. These results seem aligned with the results in this thesis from the winsorized dataset of this thesis, as showcased in section 4.1.2, where mean reversion was found in approximately 19% of the firms at a 10% significance level. This is an interesting observation, as it ties in with the consensus of the previous literature that limited mean reversion can be found when testing the firms individually. This finding seems to be quite general with Golinelli and Bontempi looking at Italian firms, Ahsan et al. at Pakistani firms, and this thesis at American firms with similar results. This further supports the need for panel-level testing to utilise cross-sectional and time-series variability in the data for the potential rejection of the unit root null hypothesis in the testing.

As the panel level testing has more explanatory power compared to the individual firm testing, greater attention must be paid to the results of these tests as previously argued. The results in this thesis differ from the previous literature, in that previous panel testing mostly argue that they find evidence in favour of the trade-off theory when panel testing, and by extension, they find evidence of mean reversion in the capital structure of firms. The testing performed in this thesis has obtained more mixed results. While there is certainly an argument that more evidence in favour of mean reversion was obtained from the panel testing compared with the individual testing, even the panel testing does not reject the presence of a unit root across all the industries, as is the case in the previous literature. Focusing first on Golinelli and Bontempi (2005), a clear problem for the relation to the results in this thesis is the sample. Their paper focuses exclusively on Italian manufacturing firms in a period from 1982-1995. This presents significant issues, as the market forces affecting the capital structure choices of the two samples might be vastly different, as they

are exposed to completely different regulatory regimes and markets. Additionally, the period is different. The period is naturally shorter, as the paper was published in 2005, but this excludes significant shocks to the markets such as the dotcom bubble or the 2007-08 financial crisis. While these two differences might be significant, given the results of the characteristics testing of this thesis, showcasing a significant difference in size between the mean reversion and non-mean reversion groups, I believe the size of the samples might also be an issue of comparison. Golinelli and Bontempi look at 5,079 firms, compared to the sample of 771 in this thesis. While one might argue that a larger data sample is better, it has been showcased that size of firms have a significant influence on capital structure (Mehran, 1992; Parsons & Titman, 2008; Titman & Wessels, 1988), and as shown in section 4.2.2, there is a significant difference in the size of the firms when considering mean reversion

As this thesis focuses on the S&P 500, which are the biggest firms in the US, by logical extension, if more firms from the US were to be included in the sample, this would be smaller firms. Naturally, this also means that the paper by Golinelli and Bontempi must include a significant number of smaller firms. Given that the results from section 4.2.2 show that firms which exhibit mean reversion are significantly smaller than those that exhibit random walk, I would argue that the inclusion of smaller firms is a potential cause for the differences in the results obtained. The firms showcasing mean reversion are significantly smaller than those that do not, and so by including more smaller firms, which one must do to increase the sample size, this would potentially introduce more mean reverting firms, and so push the results more towards a rejection of the unit root null. Even if the current understanding of why some firms are mean reverting in their capital structure is limited, the results in this thesis showcase that size is likely an explanatory factor, and so a sample of differently sized firms might very well reach a different empirical result from the testing.

One might very well argue that the same logic can be extended to the paper of Canarella et al. (2014). However, as discussed in the literature review, here evidence is found against mean reversion, despite a larger sample than presented in this thesis. One reason for the difference between these results, despite large sample sizes, is the second-generation tests applied by Canarella et al. (2014) which are more robust as they can account for cross-section dependence between variables, as discussed in the methodology section. As the results of Canarella et al. are more in-line with the results of this thesis, a question might be why Canarella et al. does not find evidence in support of mean reversion, with the

inclusion of a larger sample of firms. A question might certainly be asked of the analysis period of the paper. The period which is analysed is from 1997-2010, a period containing two financial crises, namely the dotcom bubble and the financial crisis of 2008. These are both major shocks to the financial environment and will present significant challenges for any firm. Given the literature regarding the adjustment speed of capital structures varies, one might question whether enough time is present in the study for firms to adjust their capital structures in light of the shocks they face from the aforementioned crises of the sample period. Hovakimian and Li (2011) estimated that more than 10 years are necessary for a firm to adjust its capital structure. The period of the study by Canarella et al. is 13 years and includes two major shocks to the entire financial market, perhaps not allowing for enough adjustment time for the firms regarding their capital structure. This might explain why, despite a larger sample and the inclusion of more, relatively, smaller firms, they do not find evidence supporting the mean reversion of capital structures in firms.

From the above discussion, it seems perhaps more problematic than initially anticipated to directly compare the results of the previous literature regarding mean reversion of capital structure to the results of this thesis. While the methodologies are similar, and certain results are shared, the differences in data sampling make it problematic to draw direct comparisons. I do not believe this in any way invalidates the results of this thesis, as they are, in fact, in line with much of the previous literature on the topic, both regarding individual firm testing as shown in Ahsan et al. (2016) and Golinelli and Bontempi (2005), as well as the panel level testing of Canarella et al. (2014). I believe rather that the above discussion highlights that choices made in the different studies, as well as this thesis, might be impacting the results which are found, and so one should exercise caution when drawing direct parallels between the studies, despite similarities in the achieved results. The motivations for the delimitations and choices regarding sample selection in this thesis have been laid out in section 3.1.

5.3 Interpretations

In this subsection, I will focus on interpretations of the results. While the previous section focused much on the literature regarding capital structure mean reversion, this section will dive more deeply into potential theoretical explanations for the observed results, and how the established capital structure theories fit into the results of this thesis.

The individual firm testing showcased a rather clear rejection of the notion that firms exhibit mean reversion. Neither the winsorized nor the trimmed dataset exhibited mean reversion of capital structures in more than 20% of the firms tested, and so, while some

firms do seem to have a targeted capital structure and will adjust towards this, the majority of the firms do not. Looking at this in the light of classical capital structure theory, this provides more support for the pecking order, rather than the trade-off theory. If the trade-off theory were to be the most applicable to the real-world behaviour of firms, we would observe more firms with mean reversion, as they adjust their capital structure towards the target. Rather, we see that most firms exhibit random walk in their capital structure adjustments, more in line with pecking order theory. The reason this more so supports the pecking order theory, is that pecking order does not argue for a set optimal capital structure, as the trade-off theory does. Rather it argues that the capital structure choices of firms will depend on many factors, such as profitability, market valuation of the firm, and accessibility of debt. Firms will tend to only borrow if the right market conditions are present for it, leading to more random walk behaviour in the capital structure, as the capital structure adjustments are not made consistently towards a set target, but rather depend on the surrounding structure and performance of the firm, which may deviate across a longer period of time.

In relation to the panel testing, the interpretations get a bit more ambivalent. The trimmed dataset showcased a rejection of the mean reversion hypothesis of this thesis, whereas the winsorized dataset showcased stronger support for the hypothesis of mean reversion. This is an interesting observation when considering the framework of classical capital structure theory. As predicted by trade-off theory, several industries do have their firms adjust their capital structure around a target, and so exhibit mean reversion, whereas other industries more exhibit random walk. Industry has previously been shown to be a large influencer of capital structure, and it is also one of the reasons why I perform the panel level tests with a second-generation ADF test as discussed in the methodology section. The framework of the firms in the industries are different. As an example, the energy sector is exposed to much different risks and market forces, compared with the consumer sector, which might be impacting how they adjust their capital structure across a long period of time. The energy sector might have more clear advantages from a set policy on capital structure due to its reliance on external market forces such as oil prices posing too great of a risk to taking on too much debt, even if it were perhaps the best for the firm, if interest rates, as an example, are low (SC Myers et al., 2017; Stewart Myers & Majluf, 1984; Shyam-Sunder & C. Myers, 1999). Conversely, the consumer staples industry does not face such an external obstacle, but might more freely adjust its capital structure as the pecking order theory suggests, mixing between internal financing, debt, and equity when most appropriate for the firm given its market situation. This exact discussion of

interpretations in favour of either the trade-off theory or the pecking order theory appears many times throughout the literature of capital structure, and is in-tune with the previous results, showcasing support for one, but evidence against the other. I would argue that the results of this thesis more-so provide results supporting the trade-off theory when testing on a panel level, and against it when testing on an individual level. As was argued in the results section, more emphasis is placed on the panel level testing, but even so, the results are ambiguous, as not every industry showcased mean reversion of the capital structure of the firms in the panel tests. Perhaps the most reasonable interpretation of the results of this thesis in relation to classical capital structure theory, is that it depends. Both the trade-off theory and pecking order theory have an explanatory factor in the actual capital structure decisions made by firms, being able to explain a portion of the choices made. It therefore seems to depend on the industry, and as such also the external market forces of these industries, which theory holds the most explanatory power over the adjustments made to the capital structure of the firms within those industries. Afterall, it would be peculiar if this thesis were the first to provide a clear and succinct answer to which theory is superior, and so it seems appropriate that evidence is found supporting both.

Another interesting discussion can be had regarding the characteristics testing performed in section 4.2 of this thesis. The results here showcased significant differences between the group with mean reversion of capital structure and the group which exhibited random walk. In relation to the size of the firms, where revenue was the variable, a relationship was established where the firms which exhibited mean reversion were shown to be smaller than the firms exhibiting random walk. This is an interesting observation, particularly in the light of the literature regarding the drivers of capital structure. An argument can certainly be made that it is likely that the smaller firms, those exhibiting mean reversion of their capital structure, does not have the same access to the equity and debt markets as the larger firms, a characteristic described by Diamond (1989) as relationships and reputation. Larger firms are more likely to have relationships in banks or regulatory bodies that can affect their capabilities to adjust their capital structure most optimally, borrowing when it is favourable and issuing equity when it is favourable, as predicted by the pecking order theory. Therefore, these firms will simply adjust their capital structure as it befalls them the most attractive in that given moment, not being bound to a targeted capital structure. Reversely, the smaller firms may not have this level of access to the capital markets, and so might be more restrictive in their capital structure policies, adhering more to a targeted leverage level, even if they may wish to be more or less levered, depending on the market conditions. This was also the argument made by Faulkender and

Petersen (2006), when they established that a positive correlation between the size of the firm and the leverage was likely due to the increased access the larger firms have to the debt markets. Even if all the firms tested have equal access to the capital markets, as they are still, relatively, large firms, they might very well not have access to the capital markets on equal conditions. The larger the firm the more likely it is that the firm will be able to access cheaper capital due to its size, reputation, and other operations perhaps involving the same capital providers, again giving the larger firms the opportunity to adjust their capital structure as they please, taking full advantage of whichever capital proves the most opportune at the time.

It seems a likely interpretation of the results obtained in this thesis that the smaller firms do not have the same access to the capital markets as the larger firms, or at the very least not equal access, and so resort to a targeted capital structure, rather than taking full advantage of market timings. An alternative is that perhaps the smaller firms are simply more conservative in their capital structure policies, and would rather adhere to a set target of leverage, rather than utilise the current market situation to determine their leverage level, which might lead to more borrowing than the firm would like, or perhaps under borrowing and not taking full advantage of the tax benefits. A counterargument to this discussion would be that all the firms in the sample of this thesis are rather large – after all, they were at some point part of the S&P 500. While this is true and certainly a valid argument, size is, of course, relative, and there is still a significant size gap between the biggest and smallest firms within the industries. Therefore, while the criticism is certainly true that this thesis mainly concerns itself with large and established firms, the motivation for this has been clearly laid out in the methodology section, and I do not consider this to be a problem regarding the interpretations of the size characteristics of the two groups.

Moving on to the other characteristics tested in section 4.2, the observation was that no clear relationship could be established across all industries in regards to profitability, utilising EBITDA, valuation, utilising market-to-book, or the tangibility of the assets, using the tangible asset ratio. Regarding EBITDA, some industries showcased that the mean reversion group were less profitable. It can be hard to relate this directly to established capital structure theory. While the pecking order theory stipulates that a more profitable firm will tend to rely more on internal financing, rather than debt, it does not argue whether this firm will have a mean reverting tendency in its capital structure. At the same time, in other industries, the opposing relationship is found between the EBITDA-% and the differences between the mean reverting and non-mean reverting groups. From this, no clear

interpretations can be made on the impact the profitability measure has on the mean reversion of capital structure, as it seems to largely depend on the individual industry. Regarding the valuation parameter, the results were also mixed, albeit less so than the profitability measure. An argument can even be made for the removal of the utilities industry due to its significant regulatory differences from the other industries (Ahsan et al., 2016; Canarella et al., 2014), and if this is considered, then the valuation parameter is one-sided in its relationship, namely that the mean reverting group is valued lower than the non-mean reverting group. This seems to provide evidence against the trade-off theory, as it supports the concept of financial slack – that the firms will not borrow to their ability as predicted by trade-off theory, as the firm wishes to maintain a certain amount of manoeuvrability in regards to its capital structure, should the firm wish to, in the future, execute certain projects, which it might not be able to if it borrows in accordance with trade-off theory, and balanced around a certain targeted capital structure. The final characteristic tested, the tangible asset ratio, showcased mixed results, however, it was also the parameter with the least number of significant differences between the two groups across all industries. Given that the results were again mixed, it seems hard to draw direct conclusions regarding the TAR's explanatory power over which firms are mean reverting and which are not. It seems to likely that the TAR plays a role in the determination of the capital structure of the firm, as argued in previous literature, but it seems less likely that it plays a role in determining whether the firm adheres to a targeted capital structure as predicted by trade-off theory, or whether it more follows a random walk and adheres to pecking order theory.

Regarding the slight variation in the significance of the characteristics over time, I believe the primary take-away is that the difference between the mean-reverting and non-mean reverting firms persist across time, and so, for example, the size difference between the two groups is not due to larger firms having significantly more capital market access in previous years, which might not be the case anymore. Clearly, the size differences between the two groups persists across the entire period and is not due to the conditions of a specific time-period influencing the results. The same can be argued for both the EBITDA-% and M/B characteristics, as they are also present across the four different time-periods. Regarding the TAR characteristic, there is a clear increase in the latest period. As explained in section 3.1, the data of this characteristic was not available prior to 1999, and so it may be difficult to interpret the results across a longer period. Nonetheless it seems prudent to comment regarding the significant increase from the two periods where the data is available. One reason could be due to the shock incurred by the financial crisis of 2008,

which might manifest itself in the financial data of the firms in the final period of the study. As such, it appears that the firms have diverged significantly in their TAR after the crisis, as opposed to previously, where it appears, they were relatively similar. Perhaps this is due to issuers of capital demanding a higher TAR for lending, leaving the firms which are easily able to adjust such a metric by perhaps acquiring more tangible assets in a position to adjust this, diverging significantly from the firms which are unable to make such adjustments. Regarding the individual proportions of significant characteristics across the time-period, it seems appropriate to briefly touch upon the increase in the last period. Firstly, it is partly made up by the significant increase in the TAR, which might be, at least partly, explained by a lack of data in prior periods. If the TAR is removed from the results, the proportion of significant results in the final period drops from approximately 38% to 32%, more in-line with the previous periods, albeit still slightly higher. Secondly, as with the TAR ratio, it seems likely that the financial crisis has had an influence on this time-period. The firms appear to be slightly more diverged in this period than the other periods, likely showing the different impacts the crisis has had on the two different groups of firms. One interpretation could certainly be that the smaller firms were affected differently, perhaps more so than the larger firms, causing a greater divide in the size and valuation between the firms, as supported by the results in figures 5 and 7. However, the EBITDA-% significance results are lower in this period than previous periods, showcasing that this interpretation might not necessarily extend to the characteristic of profitability. Regardless, the interpretation of these results point towards that a robust result was obtained in section 4.2.2, and a further discussion of the individual proportions of significant characteristics across time seems redundant, as it will be repeating much of the discussion which already appears in this chapter.

Overall, the interpretations made in this section of the thesis provide evidence supporting both the trade-off theory and pecking order theory of capital structure. While the mean reversion is not present in individual testing, supporting pecking order theory, it is present in panel testing. With panel testing having greater power, this seems the more reliable result, although it is not entirely one-sided as previously discussed. The characteristics testing provides interesting insights into what might be setting the mean reversion and non-mean reversion firms apart, with the primary factor likely being the size of the firms and thus potentially the access to the capital markets or the price of the capital. It also seems that profitability and valuation play a role in setting the two groups apart, it is less clear however what exact cause-and-effect relationship these characteristics have. Additionally, the research regarding the differences between the mean-reverting and non-

mean reverting firms showcase interesting interpretations of the results regarding financial differences between the two groups being a key explanatory variable as to why certain firms act according to trade-off theory, whereas others act as per pecking order theory.

While other research has focused greatly on if firms exhibit mean reversion and how this provides support for traditional capital structure theories, the results and interpretations laid out in this thesis enhance the understanding of why certain firms are mean reverting while others are not, rather than only providing empirical support for a specific capital structure theory. While it might still be tough to identify a mean reverting firm based on financial characteristics given a significant portion of the results are mixed, the interpretations allow for additional insight into the behaviour of the firms, opening further avenues for research. Additionally, it allows a practitioner to build an argument around the utilised assumption of mean reversion in a valuation, based on the financial characteristics of the individual firm and industry, rather than blindly utilising the assumption.

5.4 Limitations

At the beginning of this thesis, certain clear delimitations were set out to narrow the scope of the thesis. These delimitations and methodological choices made throughout the thesis also introduce limitations to the results. Firstly, it may be hard to generalise the results of the thesis outside of the US. The capital structure measure is based on a similar calculation methodology for all firms, with all firms following the same classification scheme in their financial disclosures. Introducing another scheme, such as IFRS, might introduce different measures of financial items, and thus results might not be directly comparable. Secondly, the choice of data source and financial measure of capital structure is similar to that of previous studies which focus on this specific subject, however, the data sample is significantly different. The period studied in this thesis is significantly longer than other papers in order to accommodate for a full adjustment of the capital structure by the firms, as this period can be quite long as argued in certain literature. Lastly, given the choice to focus on the S&P 500, this has perhaps introduced a certain bias towards firms which are larger and well-established. This is both positive and negative, as previously argued throughout the paper. It does however introduce a potential issue when generalising towards a broader spectrum of firms. Despite this, the sample seems adequate given that the S&P 500 makes up approximately 80% of the available traded firms in the US (DowJones, 2020). The data requirements concerning the time-period has also lead to a drop of a significant number of firms from the total available data, a choice which has been

made to ensure the validity of the test results given the chosen unit root testing methodology.

5.5 Implications for Practitioners and Future Research Avenues

Performing valuation is important to many functions of the capital market. While several methods for valuation exist, the discounted cash flow is the most utilised (Petersen et al., 2017), and it not only has its influence when M&A deals are performed, but also when IPO's are made, equity research is published, and tax related matters are to be settled. Therefore, the ability to accurately value a company benefits society as a whole, as it helps to facilitate a more efficient deployment of the capital available in the markets. An accurate as well as unbiased valuation requires that one can identify the correct discount rate, of which the capital structure is an essential piece of the puzzle. I have attempted to showcase that the commonly utilised methodology in DCF valuations of simply choosing a targeted capital structure, based on the assumption that the capital structure of firms is mean reverting, is not entirely as simple, and many factors, particularly size, are likely to play a role in how firms adjust their capital structure. Specifically, I would posit that this assumption potentially does not hold true in a lot of valuations and requires further argumentation and research prior to being applied.

This makes the research in this thesis more important. A practitioner looking to value a company might well wish to look at some of the financial characteristics tested in this thesis for the company being valued, comparing these to the industrial averages, in an attempt to identify how the firm performs in relation to its industrial peers. This might help a practitioner identify whether the firm is more or less likely to be mean reverting, with especially the metric of size seeming important. While it can still be hard to identify a mean reverting firm specifically, the results and interpretations at least allow for considerations in light of the company being valued, and a practitioner can attempt to build argument either for or against mean reversion based on the results and interpretations presented in this thesis.

Naturally, one could also consider an alternative to the DCF valuation, where the capital structure expectations are more precisely laid out, rather than being an assumption in the underlying model. Models such as Leveraged Buyout models specifically model the capital structure, and are often used in situations where private equity firms takeover a firm, making significant changes to its capital structure over the holding period, in order to then sell it again. These models more specifically spell out the assumptions regarding capital structure, rather than simply adhering to an assumption of a targeted capital structure. Of

course, one could also perform a DCF valuation with several different discount rates, each accounting for any change which might occur in the capital structure. There is inherently nothing wrong with this from a practical nor theoretical standpoint, although it is a much less used method when performing valuation among practitioners (Petersen et al., 2017).

An interesting topic for further research into this space would perhaps be to attempt to use financial characteristics to predict the capital structure movements of both mean reverting firms, as well as non-mean reverting firms. If certain characteristics are much better at prediction in the mean reverting firms, these characteristics might better help explain the adjustments these firms make to their capital structure, and might further enhance the understanding of capital structure theories, with the same of course also being true for the non-mean reverting firms. I have in this thesis considered four main characteristics identified by literature as being important determinants of capital structure, and showcased that these characteristics, by and large, differ significantly between mean reverting and non-mean reverting firms, and so a good starting point would naturally be to test these characteristics explanatory powers in relation to capital structure adjustments made by the two groups of firms.

6 Discussion of Green Financing Impact

In this chapter, I will extend the research and the observed results from the empirical analysis performed in the previous sections of the thesis, and attempt to provide a perspective focused less on empirical results, and more on a discussion of the future impacts the green financing trends might have on the capital markets, specifically, the capital structure of firms. Given the discussion will be focused on an attempt to discern what might occur in the future, little empirical evidence will be reviewed or discussed, and I will focus more on the theoretical impact green financing might have.

6.1 Context of Green Financing

When considering the aspect of green financing, it seems natural to first explain the concept which will be the focus of the discussion, as one can generally consider two aspects of the same concept. Firstly, one can consider the actual projects or operations part of green financing. That is the windfarms, solar farms, green infrastructure, or similar types of projects that firms undertake to contribute towards sustainability goals, such as the UN Sustainable Development Goals. Secondly, one can consider the capital provided to support these projects. Of course, the actual capital itself does not necessarily differ from that of traditional capital, but the structure, terms, price, and usability of the capital does. An example of this is the financial instrument green bonds, a way for the issuer of the bond to raise money specifically towards a sustainable project. It is, however, generally considered a "standard bond", but with a green feature, in that the money will typically be earmarked for a certain project or certain purpose, which is related to achieving a sustainability goal (Climatebonds, 2020; Landberg et al., 2019).

This discussion will focus on the second consideration of the concept, that is, the issuer aspect of green financing, as this is the aspect which will more naturally be able to extend and compliment the observed results of this thesis. While the other aspect is also of interest, discussions regarding this aspect would focus more on actual firm operations, how they might be adjusted or changed to fit a green financing perspective, but this is not the focus of this thesis. Rather, I wish to discuss how the green financing instruments and need for green financing might influence issuer decisions regarding capital, and thereby also directly influencing the capital structure of the firms, leading, ultimately, to an influence on the valuation of the firm.

6.2 Green Financing Trends

The story of green financing extends back to 2007, when a group of Swedish pension funds were looking for a way to invest in projects which would help the climate (Worldbank, 2019). The World Bank issued the first green bond a year later, and the instruments for green financing were under way. Since then, several different types of bonds and other measures of capital have found its way under the green financing label. The largest instrument is still the green bonds, but newer and more sophisticated instruments have also seen more utilisation recently (ibid.). For example, the French food giant Danone has incorporated an adjustment mechanism into a €2 billion credit facility revolving around certain sustainability criteria. If Danone outperforms the goals regarding sustainability, the company will receive a discount to its coupon payments on the credit facility, and if it underperforms, it will instead pay a premium (European Commission, 2019). A similar mechanism has been implemented by Finnish firm Stora Enso, where part of the pricing of a new credit facility will be based around the ability of the company to reduce greenhouse gas emissions from production. These are just two examples of recent newer ways to issue green financing, which is changing the flow of capital to companies.

A significant force in the space of green financing is the recently agreed upon European Green Deal (LuxembourgForFinance, 2019) and the ambitions regarding the Paris agreement. The Green Deal stipulates that there is an investment gap of €180 billion, per year, going towards 2030, if the European Union is to meet its targets in accordance with the Paris agreement. The EU has stated that the scale of this investment is beyond the capacity of the public sector, and it will require private capital to achieve the goals, where it foresees that the financial sector will play a key role in re-orienting investments towards more sustainable technologies and towards businesses which aim to achieve sustainability goals that will contribute towards reaching the climate goals (European Commission, 2020). This is an essential trend within green financing, as it showcases a clear necessity for moving more capital into the hands of firms which are willing to commit to certain sustainability targets, and perhaps to firms which are willing to shift business models towards more climate friendly models, which will, in turn, allow them access to the capital needed to finance these operations. This is an interesting perspective, both from an operational and strategical standpoint of the firms, which I will not touch upon further as previously discussed, but also from a financial, funding, and capital structure standpoint. An additional example of this shift towards sustainability friendly funding is the Dutch Bank ING, which has recently announced that it will be assessing its $600 billion loan portfolio based upon climate impact (Financial Times, 2019) putting additional pressure on

the clients of the bank to conform towards sustainability targets, or risk an increase in prices or perhaps a loss of future funding (Hook, 2018; ING, 2018; Minnock, 2018; Times, 2018). Clearly both lenders and users of capital need to focus on the area of sustainability in their business, or risk seeing significant changes to the flow of capital they can expect in the future, as this capital will either be more expensive to acquire if they do not conform to sustainability targets, or perhaps not even be available, as the capital will instead have been diverted towards other firms with projects that are contributing towards reaching certain sustainability and climate goals. This is precisely the point that makes the discussion interesting from a capital structure perspective. If firms have a need to need to conform towards these measures of sustainability, how will this impact the capital structure of the companies and the opportunities these companies have to adjust their capital structure and funding strategies in the future. Changes will be required, and to it seems prudent to further discuss the potential impact these trends within green financing might have on the capital structure adjustments of firms.

6.3 Impact on Capital Structure

Given that the area of green financing is still, relative to other forms of funding, new, the practical implementations are still few and far between compared to other means of capital. For this reason, the discussion in this section will be theoretical and will attempt to enhance the previous discussions of adjustments to capital structure.

Naturally, one aspect one might consider is that more and more firms will need to adjust their operations to fit into the category of sustainability if they wish to achieve future funding. As seen in the example from the previous section, some firms are already doing this and are receiving preferential treatment in the sense that their funding is cheaper, should they achieve their goals. If we assume that firms can alter their business without causing major disruptions, and so are able to work towards these sustainability targets, it seems natural that the attractive characteristics of green financial instruments would lead firms to adjust their funding towards such sources. If the aim of the firm is truly to maximise shareholder value, then this can be achieved in part by lowering the cost of capital, leading to more projects being undertaken which are positive from a return perspective, but perhaps also for the environment. If the green financing alternatives are cheaper than traditional financing due to the push from regulators to move capital towards green projects, it seems a logical extension that firms will move more towards this mean of financing, rather than traditional loan capital. However, this is based on a perhaps unrealistic assumption that the firms can simply readjust their focus towards more sustainable projects. Given the likely

costs involved with such a reorientation of the business focus, the question of whether transitioning to green finance alternatives is truly value creating in a purely neoclassical economical way is more ambiguous. This presents an interesting conundrum for firms and governments alike. The EU, for example, wants to achieve significant sustainability goals by 2030 to fulfil its part of the Paris agreement, but getting private capital mobilised into these sustainability goals will certainly take time. It seems unlikely, given how long it generally takes firms to adjust their capital structures, that firms will simply change to a sustainability focus in a short period of time, in order to take advantage of the benefits that green financing offers. If we consider some of the actual implementations of alternative measures of green financing as described in the previous section, these measures might give us an insight into how firms will adjust towards green financing alternatives in the future.

Danone might currently be one of the best examples of a larger firm exploring alternative means of green financing, beyond issuing green bonds, as a significant number of larger firms have certainly done, which will be touched upon later (Flammer, 2018). The credit facility agreement Danone has entered into with BNP Paribas is of particular interest as it signifies the movement beyond green bonds and into green credit (Avery, 2018). From a pure capital structure perspective, it does not move much. Given that it is not a loan which will be issued, but rather a credit facility with green criteria tied to its pricing, the impact on the capital structure will depend on how much of the credit facility is drawn. An interesting aspect however is that, much likely regular credit ratings are used to determine the pricing of loans or bonds issued by corporations, Danone and BNP will utilise an Environmental, Social, and Governance (ESG) rating agency to determine the sustainability performance (Avery, 2018; Danone, 2018). This introduces a measure for firms which perhaps are not at investment grade-level according to Moody's or S&P to access cheap and available capital through their ESG ratings. This might lead to an increase in smaller and early-stage firms accessing loan capital through these measures, rather than traditional loan capital, which they would be unable to access due to its pricing in traditional terms due to their credit ratings. Likely, this will result in more green financing credit or loans being issued to both larger and smaller firms which, by traditional measures, perhaps are not investment-grade and so will pay a premium on their loan capital. These firms might now be able to access cheap capital due to their sustainability agendas and ESG ratings. This seems to have the potential to push leverage levels up, but in a way that is new to the capital markets. Rather than the leverage levels and risks tied to the capital being directly linked to the performance of the firms, that is, the firm's ability to generate cash flows from

projects to pay back both principle and interest on the loan capital, the risks are instead now also tied to the firms abilities to maintain a sustainable course and contribute to reaching sustainability goals. This constitutes a fundamental switch of mentality from the capital providers, as they will no longer be able to directly discern based on fundamentals of the financial situation the firm is in, whether or whether not lending will be a profitable business.

The instrument of green bonds is certainly more influential and widespread than other green financial instruments as of this time. A significant number of companies have issued green bonds to finance sustainable projects, such as Apple issuing green bonds to finance a transition from traditional to renewable energy (Wuerthele, 2019). While the rise in green bond issuances is obvious to anyone looking at the data (Landberg et al., 2019; Reichelt, 2010) a fundamental issue still remains. Green bonds are typically issued with a "use of proceeds" structure, that is, the funds are earmarked for certain projects which they aim to finance, compared to the credit facilities which are simply issued to the firm on a general level, against a certain sustainability target. This naturally means that for a green bond to be issued by a firm, it must have a set project which it intends to use this funding for. While one could argue that, given the investment gap present in order to reach the Paris agreement, projects should be plentiful, that is not necessarily true for all firms, and would, again, require a significant shift of the business focus. If Apple were to fund more of its operations using green bonds, it would need to shift from the technology business to the renewable energy business, and the same is true for any firm which is not directly involved in the supply chain of sustainability projects, applying a natural limitation to this specific green financing instrument, likely leading to a less drastic change in the funding measures compared with the alternative instruments discussed.

From the above discussion it does not appear conclusive that firms will necessarily shift towards green financing, at the very least not fast. While green financing has its benefits and can be cheaper than traditional capital, this is not necessarily the case if the criteria of issuance are still that of traditional credit ratings, as it typically is regarding green bonds (Giugale, 2018). Green bonds also often require specific projects for the financing, where more traditional loans with sustainability covenants will allow the firm to focus more on its core business, while enhancing its financial structure through meeting sustainability targets. While green bonds currently are the primary green financing instrument, estimates suggest that the green loans market will grow significantly faster, due to being quicker and easier to arrange, while providing greater flexibility for the issuers and the capital users,

while still progressing towards sustainability targets. This seems likely to be capable of pushing the capital structure of firms more towards a levered state due to the favourable terms firms can obtain in green financing, with the eventual pricing being determined by the firms capability to meet sustainability targets.

6.4 Impact on Empirical Results of the Thesis

Looking ahead, a natural question to consider might be if the trends observable within green financing might influence the empirical results obtained in this thesis. It seems perhaps unlikely however, that it will necessarily have a mean-reverting effect. There is nothing inherently mean reverting about the green financial instruments, and so it seems difficult to coherently bring together an argument for why this trend might make firms more mean reverting in their capital structure. Despite this, it seems likely that it might influence the level of leverage, which firms gain access to capital, and perhaps also change certain characteristics regarding the firms, as observed in section 4.2, indirectly leading to a change in whether or whether not a firm is mean reverting.

I would posit that the green finance trend is likely to lead to a higher level of leverage, particularly because the debt may be less risky, both from the issuer point of view, given its typically ties to a specific project, or direct ties to ESG performances. Given the risk is lower and the pricing typically offers a premium for issuers (Gianfrate & Peri, 2019) it seems a natural conclusion that this debt instrument might be utilised more in the future, as it grows in acceptance and availability to firms. This might also directly influence which firms get access to the capital. As previously discussed, perhaps the smaller firms are not mean reverting in their capital structure, because the pricing of the capital available to them is significantly different from the prices the larger firms can obtain. While their credit rating will not necessarily change, if they can implement measures to further their sustainability agenda, this will open opportunities to obtain green loan financing at favourable prices compared to traditional capital. The loan financing will not tie down the firm to committing to specific projects, but rather focus on furthering their sustainability agenda. It seems likely that this will lead to smaller and currently less levered firms to gain greater access to loan capital, and thus lead to a higher level of leverage among these firms.

An argument might be made that we might also a shift in which firms are mean reverting and which are not regarding the size characteristic. If more and more smaller firms gain access to capital at competitive prices, as they are perhaps more easily able to fit their business around shifting to a sustainable agenda due to increased manoeuvrability and flexibility, this will likely lead to more and more smaller firms being non-mean reverting,

as they are now able to adjust their capital more freely more as a larger firm as discussed in section 5.3, due to the limitations of pricing and access being lifted. For this reason, it does not seem impossible that the significant difference in sizing between the mean reverting and non-mean reverting groups observed in section 4.2.2 and 4.2.3 might become smaller, or perhaps even disappear in the future, as smaller firms adjust their capital structures around sustainable agendas, and thus gain the same access to cheaper loan financing as the larger firms have due to their stronger credit ratings, relationships, and generally broader operations. It is exactly this difference that also makes it more difficult for the larger firms to shift their operational focus to better be able to take advantage of these loan mechanism, although that is a discussion focused around speed of adaptation related to organisational size, which I will not comment further on, despite it being an interesting metric to view in relation to the speed of change regarding the green financing trends. Regarding individual industries, naturally, some industries are better prepared for this adaptation of green instruments than others. The oil companies will likely have a hard time obtaining green loan financing related to sustainability measures, as exhibited when the oil firm Repsol attempted to issue a green bond but was denied an ESG rating (Banahan, 2019; Brown, 2017; Whiley, 2017). This might push certain industries towards a more mean reverting behaviour as they have less access to loan capital, while in other industries it is unlikely to have a large effect due to the nature of the business operations not necessarily lending itself to sustainable agendas in the same way as others. Reversely one could perhaps argue that these industries are more likely to be able to gain advantages from green financing, as their environmental impact from becoming more sustainable is perhaps greater than other firms working towards sustainability targets, and so the incentives to convert these industries to a more green agenda may be greater.

As this discussion revolves around a prediction of the future, a clear inference regarding the behaviour of firms considering green financing instruments becoming available is hard to obtain. However, it seems likely that the green financing loan market might impact the results obtained in this thesis regarding the general mean reverting characteristics of smaller firms, allowing these firms to better adjust their capital structure due to the greater availability of cheaper financing, potentially leading to less firms exhibiting mean reversion tendencies, and the significant size difference between mean reverting and non-mean reverting firms potentially shrinking or disappearing, as the structure of the financial markets currently enabling this discrepancy changes due to the green financing products introduced to the market.

7 Conclusion

This thesis has addressed the issue of mean reversion in capital structure and future influences of green financing instruments. This is of importance due to the impact capital structure has on valuation, and the assumption of mean reversion often being taken for granted when performing valuation of companies. I have examined the empirical accuracy of the mean reversion assumption, and addressed characteristics differences between firms which exhibit mean reversion and those firms that do not, while discussing the future impact green financing instruments might have on adjustments to capital structures.

Two main hypotheses were formed at the beginning of the thesis. The first hypothesis addressed the assumption of mean reversion, with the hypothesis being that firms will revert to a targeted capital structure and exhibit mean reversion as predicted by trade-off theory. My results showcase that this is certainly not a universal truth. While I do not feel comfortable concretely rejecting the hypothesis, as some firms do exhibit mean reversion, both individual firm testing and panel-level testing did not show concrete evidence that all firms adjust towards a target capital structure. Panel level testing showcased the most support for mean reversion, and being the strongest test, this carries the most weight in the conclusion. However, even the results of these tests also showcased that several industries did not exhibit mean reversion of firms' capital structures, and so the first hypothesis cannot be rejected. At the same time it is certainly not an affirmation of the hypothesis, and I would caution strongly against utilising this assumption of target capital structure mean reversion in valuation settings, as it seems to be dependent on several characteristics of the firms.

Regarding the second hypothesis, this addresses the characteristics of the firms exhibiting mean reversion and those that do not exhibit mean reversion, with the hypothesis being that there will be a difference in financial metrics between these two groups. Across all industries apart from one, at least one of the financial metrics showcased a significant difference between the two groups, with several industries having several financial metrics as significantly different. The characteristic of size seemed to be the most different, with profitability and valuation following. This result was tested for the entire period, as well as four different subperiods to account for differences across time and to robustness test the result, with the results remaining relatively consistent across time. In general, more differences in the metrics can be observed in recent times compared with prior periods. This result does not warrant a rejection of the second hypothesis, and I conclude that significant differences exist between mean reverting and non-mean reverting firms when looking at financial characteristics, particularly when comparing the size of the companies

within the two groups. This is important as it enhances the understanding of capital structure behaviour, showcasing a distinct difference in size between the mean reversion and non-mean reversion firms, allowing for interpretations in relation to the adjustments made to capital structure. While it can be hard to identify a specific mean reverting firm, this result showcases that, while the mean reversion assumption may not be entirely appropriate to utilise, a practitioner can look to financial characteristics to help understand and build an argument for whether the firm being valued is more likely to adjust towards a target or more likely to exhibit a random walk pattern of its capital structure.

On the basis of the empirical results and discussion of the hypotheses provided in this thesis, the research question provided seems hard to provide a definitive answer to. Some firms do adjust their capital structures according to a targeted level of leverage, while others seem to adjust according to more ambiguous mechanisms, potentially caused by differences in the financial characteristics of the firms, warranting additional research.

Finally, the thesis addresses the topic of green financing instruments appearing in the market and the push finance greener operations. The question asked in the introduction is whether or whether not green financing will impact the adjustments the firms make to their capital structure. As this is not a hypothesis, the discussion was mostly theoretically focused. From this discussion, it seems likely that green financing instruments will impact the adjustments, but it will probably take a while. The most immediate impact potentially stems from credit facilities and loans tied to sustainability targets, enabling the capital structure choices to also create value through lower interest or principal payments if the firm reaches sustainability targets. Additionally, it will likely lead to smaller and lower credit rated firms being granted capital due to the criteria for lending not only being based on traditional financial metrics but also environmental ratings.

Based on my findings, I would firstly caution against the utilisation of a targeted capital structure in valuation. While it is certainly a convenient way to treat the area of capital structure, it seems an unreasonable assumption to simply use blindly. Rather, one should look to certain financial characteristics to better understand if the firm is likely to exhibit mean reversion of its capital structure, with the most obvious metric being size, indicating that the firms exhibiting mean reversion are smaller than those that do not. Additionally, I would suggest that both analysts and managers of firms consider the value creating properties of green financing instruments, as it is likely to have an impact on the financing levels and access to finance in the future, impacting both capital structure adjustments as well as valuations of firms going forward.

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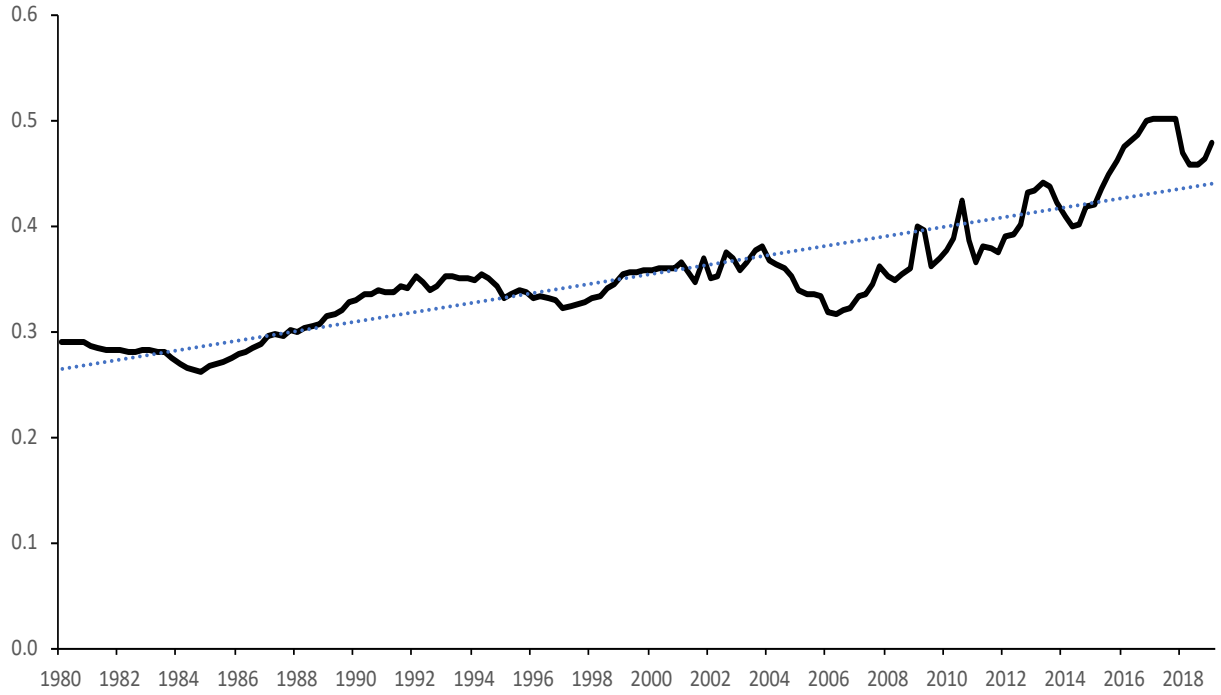
Appendices

Appendix 1 – Trend of capital structure

Regression regarding inclusion of time trend parameter in ADF tests. Below is both regression output and graph indicating an upward time trend of capital structure for the firms in the sample

Regression Statistics	
Multiple R	0.88697
R Square	0.78671
Adjusted R Square	0.78533
Standard Error	0.02679
Observations	156

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.263642319	0.004352275	60.58	0.00000	0.25504445	0.27224019	0.255044453	0.272240186
Time	0.001135291	4.76344E-05	23.83	0.00000	0.00104119	0.00122939	0.00104119	0.001229392



Appendix 2 – Individual company test result example

Example of individual company test performed using STATA's dfuller command.

Augmented Dickey-Fuller test for unit root Number of obs = 133

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-2.643	-4.029	-3.446	-3.146

MacKinnon approximate p-value for Z(t) = 0.2604

D.boeingco	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
boeingco						
L1.	-.1068872	.0404389	-2.64	0.009	-.1868964	-.0268779
LD.	.0003032	.0882244	0.00	0.997	-.1742509	.1748573
_trend	.0006399	.0002373	2.70	0.008	.0001705	.0011093
_cons	-.0079353	.0105174	-0.75	0.452	-.0287442	.0128736

Appendix 3 – Panel level test result example

Example of panel level test performed using STATA's panel level unit root test (here, Healthcare industry)

		Statistic	p-value
Inverse chi-squared(188)	P	282.1202	0.0000
Inverse normal	Z	-3.8537	0.0001
Inverse logit t(474)	L*	-4.2156	0.0000
Modified inv. chi-squared	Pm	4.8539	0.0000

P statistic requires number of panels to be finite.
Other statistics are suitable for finite or infinite number of panels.