ERASMUS UNIVERSITY ROTTERDAM

Erasmus School of Economics

Master Thesis Financial Economics

Capital structure:

A longitudinal study to the effect of growth option value on leverage

Modigliani and Miller (1958) state that the value of a firm is independent of the financial policy. Further research extensively finds evidence against this claim, and documents several firm specific characteristics influencing the capital structure. One of these characteristics is the amount of growth opportunities, a theoretical construct that is hard to measure and finds a huge amount of proxy variables related to it. This paper bridges the gap between real option theory and capital structure by studying the effect of two estimation procedures of growth option value on leverage. This paper provides evidence on the negative influence of growth option value on leverage, and documents some evidence that the amount of short term debt attenuates this negative effect. The results are based on a sample of 1,058 firms and 5,224 firm-year observations using data from NYSE and NASDAQ firms from 2011-2017.

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1. Introduction

Sixty years ago, Modigliani and Miller (1958) created a theoretical model in which they concluded that the value of a firm is independent of the way investments are financed. Nevertheless, this assertion relies under a lot of assumptions, and future research developed several theories that suggest that the financial policy of a firm does influence the value of a firm (e.g. Baker and Wurgler, 2002; Campbell and Kelly, 1994; Myers and Maljuf, 1984; Ross, 1977). Altogether these studies developed four main capital structure theories: the signalling theory, the pecking-order theory, the static trade-off theory, and the market timing theory respectively. As researchers did not achieve consensus regarding whether either one of these theories is dominant, further studies tested other factors that influence capital structure. One of these factors is the market to book ratio (MTB ratio), a variable of which its negative relation with leverage is nearly taken as given in the field of empirical corporate finance. Studies argue about the economic interpretation behind this relation and tend to assign this relation to the negative relation between leverage and growth opportunities. Growth opportunities consist of all future investments which are expected to lead to returns higher than the opportunity cost of capital, and are hard to measure directly (Modigliani and Miller, 1961). Assuming capital markets are efficient, and investors incorporate information regarding these growth opportunities in the stock price, one can estimate its value by subtracting the present value of a firm's assets in place (PVA) from the value of a firm *(V)*, leaving the present value of growth opportunities (PVGO), or growth option value. Since the MTB ratio is often used as a proxy for growth opportunities the question that follows from the negative relation between the MTB ratio and the leverage ratio is whether the growth option value negatively affects the leverage ratio. The underinvestment theory of Myers (1977) states that this negative causal relation exists since the optimal leverage ratios for firms with more growth opportunities are relatively lower, since debt financing these investments might lead to debtholders attempting to reap the benefits that follow from these investments. On the other hand, do Jensen and Meckling (1976) state that growth opportunities have a lower collateral value and are therefore more likely to be equity financed. These two theories in combination with other theories and the amount of evidence on the negative relation between leverage and proxies for growth opportunities lead to the following prediction: assets in place should be financed by debt and growth opportunities should be financed by equity. The scope of this paper is to examine whether the growth option value negatively affects the leverage ratio.

Since past literature finds the relation between several proxies for growth opportunities and the leverage ratio, there must be an economic rationale behind it that relates to economic theory. Multiple theories provide possible explanations for the existence of the causal relation, and apart from researching the relation this paper summarizes past literature regarding this matter. The reason of this is that apart from answering the main question I aim to explain the causal relation.

In addition, Mauer and Sarkar (2001) state the issuance of short-term debt can mitigate the agency costs following from the shareholder-bondholder conflict. The shareholder-bondholder conflict is more pronounced in firms with relatively many growth opportunities. The theory of Mauer and Sarkar (2001) therefore suggests an inverse relation between growth opportunities and short-term debt. Several empirical studies find some support for this claim, which leads to the sub question whether issuing more short-term debt might mitigate the negative effect of growth option value on the leverage ratio.

The growing amount of literature about the relation between capital structure and growth opportunities emphasizes the relevance of analysis to a firm`s growth option value. Thereby does Kester (1984) find that 70% to 80% of a firm`s equity value in industries with shifting demand is determined by growth opportunities. Tong et al. (2008) find that the average growth option value in their sample is 43% of the value of the firm. These findings show that a substantial amount of firm value can be contributed to growth opportunities.

Besides the MTB ratio, which was already mentioned, researches also use other proxy variables for growth opportunities such as Tobin's Q, the PE ratio, and sales-growth (Adam and Goyal, 2008). In a way, empirical literature on growth opportunities consists of two types of studies: the literature that uses proxy variables and the literature that aims to assign value to growth opportunities. Little research focuses on the latter of the two as most studies use proxy variables. Interestingly, the studies that attempt to estimate the growth option value find mixing results of the relation between growth option value and leverage. For instance, Smit et al. (2017) do find that leverage and the PVGO are positively related in their study. Long et al. (2002) also find the relation is positive for some years if they add Tobin's Q to the regression as a control variable. On the contrary, Tong et al. (2008) do find a significant negative relation between the leverage ratio and growth option value. However, these studies use leverage as a control variable in regressions with the PVGO as dependent variable. To my knowledge the literature on empirical corporate finance therefore lacks evidence on the direct negative effect of PVGO on leverage. By using two modern estimation procedures of the PVGO this paper aims to close the gap between theory and practice and contributes to the existing literature on this topic. The results of this paper are interesting for financial analysts and can be regarded as a building block for future research on this topic. I use two methods to estimate growth option value to test whether results are robust to the use of different methods. I use the model of Tong et al. (2008) and Smit et al (2017), and the model of Brealey and Myers (1981) and Kester (1984). I retrieve yearly accounting and financial data from Compustat/CRSP from the years 2011-2017, leading to an unbalanced panel data set of 1,058 firms with 5,224 firm-year observations after cleansing, and correcting for missing data. To empirically test the predictions, I use a fixed-effects panel data model in which leverage is the dependent variable and growth option value is the independent variable. I do find growth option value to have a negative influence on leverage, which supports previous theoretical and empirical implications. I find the results being robust under both models and the results are insensitive to the inclusion of inflation. I do not find sufficient evidence on the prediction that the amount of short-term debt mitigates the negative effect of growth option value on leverage, which most likely is due to the sample as it solely consists of relatively large, listed and S&P credit rated firms. Most studies that research growth opportunities use proxy variables, however since these proxy variables mostly also proxy for other theoretical constructs, the explanatory power of these variables can be questioned. Estimating the growth option value instead of using proxy variables allows me to bridge the gap between real option theory and financial policy. As empirical work on post-crisis financial policy is still in an early stage, it is interesting to have some new insights of capital structure determinants after the financial crisis. Furthermore, I aim to contribute to the capital structure puzzle by linking findings on control variables to the respective theories. The rest of this paper is organized as follows. Section 2 provides an overview of past literature regarding this topic. Section 3 forms the hypothesis. Section 4 explains the process of data gathering and describes the research design. Section 5 provides the results. Section 6 concludes

2. Literature review

The literature review consists of two parts, being theoretical and empirical work. First, I focus on theoretical work and then I focus on the empirical work that follows from theory. At last I give a summary, leading to implications regarding forming the hypotheses.

2.1 Theory

A huge amount of literature focuses on the capital structure, which results into it being a puzzle. I give a brief overview of the four core theories regarding financing decisions as well as describing real option theory. At last I do report and describe what implications these theories have regarding the research question.

2.1.1 Valuation of a firm

In the literature of corporate finance one can find several approaches to valuate a company. The most common approach is the discounted cash flow approach which states that the value of a firm *(V)* is equal to the present value of all future cash flows (Brealey et al., 2012).

$$V = \sum_{t-1}^{T} \frac{C_t}{(1+r)^t} \tag{1}$$

Modigliani and Miller (1961) introduce another approach to determine the value of a firm, the ‘investment opportunities approach’. This approach states that the value of a firm is equal to the value of net assets in place (PVA) and the value of growth opportunities (PVGO). They state that growth opportunities have value if the investments in assets associated with growth opportunities yield a higher return than the firm`s cost of capital. An advantage of the investment opportunities method over the discounted cash flow approach is that it focuses on the nature of true ‘growth’ by assuming that the current value of a firm consists of the value of assets in place and the present value of a firm`s growth opportunities

$$V = PVA + PVGO \tag{2}$$

There are two possible approaches to estimate the PVGO (Smit and Moraitis, 2010). On the one hand the ‘bottom up approach’ for which one must identify all the firm’s types of options and then valuate these options based on an option valuation method. On the other hand, the ‘top down’ approach states that the market value is known from financial markets and that by subtracting an estimation of the PVA from this value leaves the PVGO. In this formula the present value of net assets in place is calculated as the present value of earnings (as an annuity) and presents the value of a firm with no growth opportunities. As the abovementioned formula indicates, the higher option value leads to a higher stock price. Therefore, these firms are valuated higher by the market than what would be expected by the discounted cash flow method (Modigliani and Miller, 1961).

Following the investment opportunity approach the value of a firm consists of the net value of assets in place and the present value of growth opportunities. In the interpretation of

Modigliani and Miller (1961) the value of investment opportunities displays all future investments which are expected to yield a higher return than the opportunity costs of capital. However, the firm may choose not to exercise all investment opportunities which indicates that the value of growth opportunities is best considered as the present value of a firm`s options on future investments (Myers, 1977). One important characteristic of growth opportunities is that they can be considered as real options on assets (Smit and Trigeorgis, 2012). The future investment that is needed to buy the asset is regarded as the option price, and whether the option has value depends on the future value of the asset. Myers (1977) elaborates on the investment opportunity approach from Modigliani and Miller (1961) by stating that there is a distinction between assets which` value depends on future investments and assets which` value is independent of future investments.

Strategic adaptability is important in a changing environment for a firm anticipating to benefit from investment opportunities (Smit and Moraitis, 2010). Both these investment opportunities, and the strategic position in the market are incorporated in the stock price. Logically, the potential growth is not the same for all stocks. There are two reasons for growth companies having a higher growth option value than value firms (Sarkar, 2000). Firstly, they tend to operate in industries with higher uncertainty which leads to a higher growth option value. Secondly, these growth firms typically have more compound options (option on an option) relative to simple options, which increases the option value.

2.1.2 Capital structure

The leverage ratio is the part of capital that is financed by debt instead of equity (Ward and Price, 2006). This means that the higher the leverage ratio the more debt relatively to equity a specific firm contains. In financial literature there is an ongoing discussion about the optimal leverage ratio, since both debt and equity financing are associated with different advantages and disadvantages. Myers (2001) states there is no dominant capital structure theory and that there is no legitimate reason to expect there will ever exist one. Literature on corporate finance develops four main theories regarding the optimal capital structure: the static trade-off theory, the pecking order theory, the market timing theory, and the signalling theory. The following four paragraphs will discuss and explain these theories. At last I discuss the agency theory, which follows from the static trade-off theory which has some implication regarding optimal financial policy.

Static trade-off theory

The trade-off theory states that there is a trade-off between the costs and benefits of debt and equity (Campbell and Kelly, 1994). Tax shield on interest and having fixed financial commitments are regarded as advantages of issuing debt (Wrightsman, 1978; Chen and Steiner, 1999). Disadvantages of raising debt are bankruptcy costs, agency costs and the loss of financial flexibility (Gruber and Warner, 1977; Jensen, 1986; Gamba and Traintis, 2008). The latter is regarded as the most important determinant as firms lose the financial flexibility of funding future investments with debt when they borrow up to the maximum debt capacity. When firms trade-off these costs and benefits they can determine an optimal capital structure. Therefore, most firms' capital structures do not consist of either solely debt of equity.

Pecking order theory

The pecking order theory is an opposing theory of the trade-off theory and states that companies should first use internal funds to finance a project (Myers and Majluf, 1984). When internal funds are not sufficient, the company should use debt, and as a last resort a company should raise new equity. The rationale behind this order of financing is the signal that a firm gives to the public. Using internal funds gives a signal of financial strength, and issuing debt shows that a firm easily can meet its debt obligations. At last the issuance of new equity might give a signal that the stock is overvalued.

Market timing theory

The market timing hypothesis states that firms are more likely to finance investments with equity when a firm's stock is valuated high as it would receive a higher price for issuing new shares, and more likely to raise debt as the stock is valuated low (Baker and Wurgler, 2002). Although in efficient capital markets, there is no possibility to benefit from market timing since the costs of equity and debt do not vary independently. However, when capital markets are inefficient one can benefit from timing the market.

Signalling theory

Ross (1977) develops another theory regarding the optimal capital structure of firms. The signalling theory states that a conflict might arise due to asymmetric information between managers and investors. If the manager of a firm has information that might lead to a rise in stock price if this information becomes publicly available, the manager has an incentive to send this information to investors. However, investors might question the credibility of the message of the manager. A solution to this problem is the use of (credible) signals. An example of such a signal is the issuance of additional debt, which is an indication of financial health and therefore good future performance of the stock. On the other hand, does a decrease of debt give a negative implication on the future stock price.

Agency theory

As mentioned earlier, following trade-off theory firms trade-off the different costs and benefits of both equity and debt, one type of these costs are agency costs. The principal agent theory is a common theory in economics that describes the conflict that can arise between principals and agents through different incentives, and due to this conflict, agency costs can arise. There are three forms of agency costs: monitoring costs, bonding costs and residual losses. Monitoring costs arise when principals want to monitor the actions of the agents. Bonding costs include all costs that are related to contractual obligations between principals and agents. Residual losses are the cost that arise from conflicting interests between principal and agents apart from monitoring and bonding costs.

In finance the most common principal agent problem is the conflict between shareholders (principal) and managers (agents). On the one hand shareholders want the managers to run the company in such a way that it maximizes shareholder value. On the other hand, managers want to maximize their own power or wealth and because of these two conflicting interests a conflict may arise (Jensen and Meckling, 1976).

The free-cash flow problem of Jensen (1986) is an example of such a conflict. The free cash flow is cash flow in excess of the required expenditures to expand or maintain its asset base. If managers decide to pay this excess cash flow to shareholders, shareholder value would increase. However, the decision to pay-out cash flow does decrease the manager`s power because they now have fewer resources under their control. If managers then want to invest they need to monitor the capital market, which leads to monitoring costs. Investing the excess capital would eliminate these agency costs. Thereby does investing lead to growth of the company, and company growth is positively related to the manager`s compensation. Therefore, managers have an incentive to overinvest to reap private benefits. Issuing debt can decrease this overinvestment problem, since the obliged interest payments to creditors lower the free-cash flow. The free-cash flow problem increases with listed companies since individual shareholders of these companies only hold a negligible part of the company`s shares. Therefore, it is not possible for those single shareholders to have influence on the managers if they do not behave accordingly to their interests. Thereby do agency costs arise with monitoring and the possible benefits from monitoring will not outweigh the costs

(Easterbrook, 1984).

Besides the agency conflict between shareholders and managers, another conflict can arise in a business. If a firm raises its debt relative to equity, a conflict between debtholders and shareholder might occur (Jensen and Meckling, 1976). The assets substitution problem is a problem that arises when firms are having much debt relative to equity, this incentivizes shareholders to prefer high pay-off projects regardless of the probability of success. Whenever the project succeeds, debtholders do not benefit from high pay-offs since they will only receive a fixed amount of interest. However, when the project fails, debtholders bear most of the risk. As a reason of this debtholders attempt to limit shareholders to invest in high risk projects, which increases the conflict. A second case of the agency costs associated with this conflict is the underinvestment problem of Myers (1977). Myers (1977) predicts that debtholders want to reap of benefits of firms having valuable growth opportunities. As a reason of that the shareholders are left with lower returns, leading to passing over positive net present value projects more frequently.

2.1.3 Theory on the relation between growth opportunities and leverage

All theories related to the agency theory have something in common as they all have implications for the relation between the leverage ratio and growth opportunities. To be more specific, the theories have implications for a causal relation between growth opportunities and leverage. The underinvestment problem of Myers (1977) predicts a negative effect of growth option value on leverage and, since firms consisting of relatively much debt suffer from debtholders aiming to reap benefits from growth opportunities. Logically, issuing new equity can mitigate this problem leading to the prediction that growth opportunities negatively affect leverage ratio. Jensen (1986) states that the collateral value of assets in place is higher than the collateral value of assets of growth options and therefore cause more agency costs of free cash flow. Debt can help to reduce these costs of free cash flow, which leads to the prediction that there is a positive relation between leverage and assets in place. As the collateral value of growth opportunities is lower, firms that do have relatively many growth opportunities find it harder to obtain new debt. Therefore, this theory of Jensen (1986) strengthens the belief that growth option value negatively influences the leverage ratio. Thereby does debt financing diminish financial flexibility which is undesired for firms with big investment opportunities. In addition to this Trigeorgis (1993) states that the succession of real options depends highly on the financial flexibility of a firm. Real options affect the growth option value positively and financial flexibility is negatively correlated with the leverage ratio. Barclay et al. (2006) show in their theoretical paper that the debt capacity of growth options is negative. Debt capacity is defined as the amount of additional debt that is needed to finance an additional asset. This indicated that the firm's optimal leverage ratio declines as the amount of growth opportunities rise. The static trade-off theory also suggests that growth opportunities negatively affect leverage since high growth firms suffer from costs of debt as they would lose more value in case of bankruptcy (Frank and Goyal, 2005). Brito and John (2001) model that firms having illiquid growth opportunities that are primarily debt financed will underinvest in risky project, since the concern of losing control over the firm results in the managers becoming risk averse.

On the contrary, the models of Mauer and Sarkar (2001) and Childs et al. (2005) state that agency costs decrease as the maturity of debt decreases, which implies that short term debt mitigates the agency problem and thereby lead to a decrease in agency costs. The issuance of short-term debt thus can mitigate both the under- and overinvestment problem. This theory would suggest that short term debt has an inverse relation with growth opportunities.

2.2 Empirical research

This section elaborates on the past literature regarding capital policy and growth opportunities. First, I give an overview of past empirical research on capital structure. Then I discuss previous work regarding the relation between leverage and growth opportunities. At last I focus on how past literature attempted to measure growth opportunities.

2.2.1 Determinants of capital structure: Empirical tests of the theories

Early work documents a relation between financial policy and the industry in which a firm competes. Schwartz and Aronson (1967) show that there are significant differences of capital structures between industries in their sample from 1923-1962. They also find that leverage ratios within industries are quite similar. A few years later Scott (1972) finds support for this finding in his sample consisting of 77 firms in the year 1969. Ferri and Jones (1979) do find some evidence that there is a relation between industry and the leverage ratio but find that this relation is less strong than suggested by previous literature. Thereby they find that the leverage ratio is related to size of a firm. An exception is the research by Remmers et al. (1974), who do not find evidence that the industry is a determinant of the leverage ratio in their sample consisting of non-US firms in nine different industries in the period 1965-1966. In more recent work Hall, Hutchinson and Michaelas (2000) find that both long term and short-term debt differs significantly between industries. Their sample consists of 3500 small and midcap companies from the UK. Thereby they do find a negative significant relation between short term debt and firm growth.

The four capital structure theories result into several studies testing its explanatory power. Masulus and Korwar (1986) and Aquith and Mullins (1986) give empirical support for the market timing hypothesis as they find that firms are more likely to issue equity after their stock price has increased. Baker and Wurgler (2002) investigate whether equity market timing matters when firms determine their financial policy. In this paper the authors use the MTB ratio as a proxy for market timing options. In this research they do find a significant negative relation between the leverage ratio and the MTB ratio. For this they give an explanation from a market timing point of view as firms that have a high valuation have an incentive to raise (overvalued) equity instead of debt. Although the four main capital structure theories have conflicting characteristics there are also some similarities between them. Fama and French (2002) test some of these similarities and find for instance that leverage is positively correlated with firm size, an empirical prediction of both the pecking order theory and static trade-off theory. On the other hand, they also find that leverage is negatively correlated with profitability, which is in line with the pecking order theory but contradicts the trade-off model. In addition to this Frank and Goyal (2003) do some empirical tests on whether the pecking theory holds for public companies in the US in the period 1971 to 1998. First, they find that firms extensively use external financing since internal funds mostly are not sufficient. Second, they do not find that debt financing dominates equity financing. Both findings do not match the predictions of the pecking order theory. In small samples Frank and Goyal (2003) do find some support for the pecking order theory, especially for big firms, but declines over time and equity become more important. When firms have a deficit of fund flows, meaning that there are no internal funds available, the pecking order theory expects the firm to issue debt. When firms follow this expectation, it is likely that they follow the pecking order theory (Myers and Shyam-Sunde, 1999). In their study Myers and Shyam-Sunde (1999) find some evidence on firms using the pecking order theory to finance their investments. Thereby they do not gain empirical support of firms using the target debt ratio, which is an implication of the static trade-off theory. Kayhan and Titman (2004) state that long term debt follows the trade-off theory. Flannery and Rangan (2006) and Lemmon et al. (2008) support the theory that firms have target capital ratios, one of the implications of the trade-off theory. Mahajan and Tartaroglu (2008) also find results in line with the trade-off theory. Jung et al. (1996) research which theoretical capital structure model best explains financial policy. They compare the agency model, pecking-order model, and the market timing model. They find that two type of firms finance investments with equity: firms with a lot of growth opportunities, and firms with few growth opportunities and no limited ability to borrow. Without the presence of agency costs, it is not probable that the latter firm would issue equity, and therefore they conclude that the agency model has some explanatory power in the cross-sectional variation of capital structure. Jung et al. (1996) do not find empirical support for the market-timing theory as firms do not seem to issue equity when their stock is overvalued. The finding of Jung et al. (1996) is in line with earlier work of Harris and Raviv (1991) and Smith and Watts (1992) who state that the agency model has strong explanatory power in the cross-sectional variation of the leverage ratio. The results of Aivazian et al. (2003) document empirical support for the discipling role of debt, an implication that follows from the agency theory as financial crises most likely affect a firm's financial policy, Harrison and Widjaja (2014) research the validity of the trade-off theory, pecking order theory, and the market-timing theory during after crisis years. Bamhra et al (2010) document that firms anticipating economic crises tend to act more conservatively in their financing decisions. This suggest they would use more internal funding instead of external funding, a finding that gets empirical support from Campello et al. (2010), who research financial constrained firms in crisis years. Harrison and Widjaja (2014) do find empirical evidence for a negative effect of the MTB ratio on leverage in both the pre-crisis as the post-crisis period, they allocate this negative effect to the market timing hypothesis, which is in line with Baker and Wurgler (2002). In addition, they do find a positive coefficient for size before the crisis, which is in line the static trade-off theory. However, the coefficient switches sign after crisis, indicating that after the credit-crisis larger firms have relatively less debt and smaller firms relatively more debt.

Flannery and Rangan (2006) do some empirical tests on the trade-off theory, to be more specific they attempt to measure the amount of time it takes a firm to reach the optimal leverage ratio. They conclude that it takes approximately five years to eliminate half of the difference between the target and actual leverage ratio. Since this is such a short amount of time, Flannery and Rangan (2006) state that it is not likely that the cross-sectional variation between capital structures is explained by firms converging to a long run leverage ratio. Then Flannery and Rangan (2006) choose to run regressions with firm specific variables, which decreases the adjustment time substantially. This indicates that capital structures somehow are determined by factors that are stable over time. In a comparable study on capital structures Lemmon et al. (2008) also add firm fixed-effects to the regressions and find that leverage ratios are more stable over time than suggested by previous work. In their study the leverage ratio remains steady when controlling for earlier determined capital determinants.

Hovakimian and Li (2011), however, argue that adding firm fixed effects might cause a 'look-ahead[1]' bias in the time of adjustment. The papers of both Flannery and Rangan (2006) and Lemmon et al. (2008) raise the question what this missing factor related to.

2.2.2 Leverage and growth opportunities

The question that Flannery and Rangan (2006) and Lemmon et al. (2008) left unanswered is what the stable firm-specific factor is related to. Theory leads to the prediction that growth opportunities are related to this stable factor (Ogden and Wu, 2012). This section summarizes the past literature on the relation between growth opportunities and leverage.

Both Bradley et al. (1984) and Long and Malitz (1985) find that industries that tend to have more growth opportunities are also having lower leverage ratios. Smith and Watts (1992), and Barclay et al. (1995) investigate the relation between leverage and growth opportunities and both find this relation is significantly negative. They use the MTB ratio as a proxy for growth opportunities. Rajan and Zingales (1995) also use the MTB ratio as a proxy for growth opportunities and elaborate on earlier work. They find that the relation between the leverage ratio and growth opportunities is negative for all G-7 countries.

Gaver and Gaver (1992) document growth firms having significantly lower leverage ratios than non-growth firms. In their study they rank all firms in four quartiles based on several proxies for growth opportunities, the highest quartile being growth firms and the lowest quartile being non-growth firms.

Aivazan et al. (2003) find a negative relation between investments and leverage. To be more specific, this negative effect is stronger for firms with a low Tobin`s Q (in their study a proxy for growth opportunities). This finding supports earlier work from McConnell and Servaes (1995) who show that the value of a firm has a negative relation with leverage when the firm has a high Tobin's Q and a positive relation with leverage for firms with a low Tobin's Q. Consistent with the latter two papers is the study of Lang et al. (1996) who also find that the negative relation between investment and leverage only holds for firms with a low Tobin's Q. Lang et al. (1996) find a robust negative relation between growth opportunities and leverage within and between industries. In their study they use several proxies for growth: PE ratio, sales growth, MTB ratio, and Tobin's Q. Baker and Wurgler (2002) and Mahajan and Tartaroglu (2008) also find a negative relation between the leverage

[1] The look-ahead bias occurs due to the use of information that would not have been known during the period in which the sample lies. Therefore the results of the study might be biased.

ratio and MTB ratio in their studies. Hutson and Hogan (2004) research the capital structure of small and midcap technology-based firms in the Irish software industry. They find that technology-based firms, associated with more growth opportunities, are more likely to be equity financed. Chen and Zhao (2006) take the debate on the relation between the MTB ratio and leverage to a new level by stating that this relation is not robust. They find that the relation is not monotonic, but U-shaped which is skewed to the right. In their sample, which they separate into three parts based on market cap they find that the relation between the MTB ratio and leverage is positive for the small cap and midcap group. Over the whole sample they do find a negative relation, which indicates that this relation is driven by a small part of the sample from the large cap group. Ogden and Wu (2013) that the relation between the MTB ratio and leverage might not be linear after all. In their research they hypothesize that the relation between the MTB ratio and the leverage ratio is convex. They find that the explanatory power of their models highly increases when they replace the MTB ratio for the inversed exponential function of the MTB ratio as a determinant of leverage.

The studies of Hovakimian (2004) and Hovakimian et al. (2004) both show a significantly negative relation between the leverage ratio and growth opportunities in their studies to the target capital structure. Both studies use the MTB ratio to proxy for growth opportunities. Kayhan and Titman (2004) find similar results on the relation between the leverage ratio and MTB ratio. Frank and Goyal (2004) support this claim and document that once a firm has a high MTB ratio, the firm tends to reduce its debt the next year, although they did not find that additional issuance of equity follows from a high MTB ratio, indicating there is no causal relation between the MTB ratio and leverage.

A significant amount of literature on transaction costs researches the relation between investment types and the capital structure. Williamson (1988) states that the assets characteristics determine the way a project is financed. He states that assets that can be redeployed are financed by debt and assets that cannot be redeployed are financed by equity. Titman and Wessels (1988) find that the leverage ratio is negatively related to a firm's uniqueness. In their research they base uniqueness on three categories, being R&D expenditures, selling expenses and what fraction of employees voluntary leaves their job. Since uniqueness is based on a firm's R&D expenditures, and R&D investments lead to non-redeployable assets, O'Brien (2003) hypothesizes that investments in R&D cannot be used as collateral for debt. This is in line with the underlying theories from Myers (1977) and Jensen (1986). R&D investments are the type of investments associated with growth opportunities, and as a logical consequence previous research exhibits a positive relation between R&D expenditures and the growth option value (Mitchell and Hamilton, 1988; Long et al., 2002; Ho et al., 2006). Several researchers study the effect of debt financing of R&D, with mixing results. For instance, Bradley et al. (1984) find a negative relation between leverage and R&D expenditures, but Szewczyk et al. (1996) on the other hand find that the abnormal returns achieved by R&D expenditures have a positive relation with the leverage ratio. Acs and Isberg (1996) state that the impact of both leverage and R&D expenditures on growth opportunities depend on the size of a firm. Vicente-Lorente (2001) concludes that R&D expenditures tend to be financed by equity since R&D investments especially create intangible assets, which have a relatively low collateral value. In addition, Ho et al. (2006) state that agency problems arise most easily in R&D projects relative to other investment projects. Debtholders anticipate on this and will demand a premium if a firm wants to borrow money for a R&D project. Thereby does information asymmetry between debtholders and managers lead to debtholders to exaggerate the risks of the project, which also leads to the debtholders demanding a premium. Therefore, agency costs and information asymmetry both make it relatively unattractive to finance R&D projects with debt. Ho et al. (2006) also document that the ability of a firm to obtain growth opportunities from R&D investments negatively depend on the leverage ratio. They also find that size is positively related to a firm's ability to obtain growth opportunities from R&D expenditures, but these advantages disappear as the leverage ratio of these firms increases. Even more striking is their finding that, given that a firm has a high leverage ratio, small firms achieve more growth opportunities than large firms.

2.2.3 Proxies for growth opportunities

Despite the relation between growth opportunities and leverage has been researched extensively, there is no consensus on how to measure them. Most literature therefore uses proxy variables, below I will point out and discuss several of these proxies including the advantages and disadvantages of its use as proxy variables.

Undoubtedly, the most widely used proxy for growth opportunities is the MTB ratio. The MTB ratio is equal to the market value of a firm divided by the book value of a firm. Since the nominator is a proxy for both assets in place and growth opportunities, and the denominator being a proxy for the value of assets in place, the MTB ratio is regarded as a proxy for growth opportunities. The advantage of the use of the MTB ratio is that it is directly observable, and it can be retrieved from databases, and it suffices no estimations or calculations. However, for instance Erickson and Whited (2000) state that this ratio is a noisy proxy, and Adam and Goyal (2008) state that the MTB ratio is not perfect serving as a proxy for growth opportunities. First, it serves as a proxy for other theoretical constructs, for instance corporate performance and market-timing. Thereby a problem arises when firms have a negative MTB ratio, which more specifically means that one must drop these specific firms from their sample (Adam and Goyal, 2008). At last does the issue of reverse causality arise since leverage itself also leads to lower MTB ratios, since firms that do have higher leverage ratios are valuated lower by the market, leading to a lower MTB ratio (Adam and Goyal, 2008). Another widely used measure of growth opportunities is Tobin's Q (e.g., McConnell and Servaes, 1995; Lang et al., 1996; Aivazian, Ge and Qui, 2005). Tobin's q is defined as the market value of assets divided by the book value of total assets. Adam and Goyal (2008) state that Tobin's Q is the best proxy for growth opportunities as it contains most information regarding the nature of growth opportunities. Perfect and Wiles (1994) find a correlation coefficient of 0.96 between Tobin's Q and the MTB ratio, and therefore these two proxies can be regarded as closely related. However, using Tobin's Q as a proxy for growth has limitations, since this measure also carries information on current assets next to growth opportunities (Papanikolaou and Kogan, 2012). The fact that one must estimate both the replacement value of assets and the market value of debt are regarded as two caveats of using this proxy. Kogan (2012) therefore use a completely different measure and use the Beta of IST (investment specific technology) stock returns. In the study Kogan (2012) creates a portfolio (IMC portfolio) which takes long positions in investment firms, and a short position in firms that sell consumption goods. Then they compare the return of the IMC portfolio with the stock returns of the firms. Firms with more growth opportunities are expected to have a higher correlation with the IMC portfolio.

Some papers use the PE ratio as a proxy for growth opportunities, but Long et al. (2002) state that this ratio includes different risk levels and different efficiency gains. Another problem with using the PE ratio as a proxy for growth opportunities arises when earnings are lower or equal to zero. Thereby it serves as a proxy for other variables such as a measure of risk and an indicator of earnings growth, and market timing (Penman, 1996).

Smith and Watts (1992) use the ratio of book value of assets to the value of a firm. The book value of assets is a proxy for the value of assets in place, and the value of the firm is defined as the market value of equity plus total book debt. They acknowledge this ratio most likely suffers from measurement errors for firms having many long-term assets, since the book value consists of the historical costs minus depreciation.

Gaver and Gaver (1992) recognize the difficulties around choosing the right proxy for growth opportunities, and apart from using proxies used by earlier related studies they introduce a new proxy: the number of growth funds that select a specific stock. Rationale behind this variable serving as a proxy for growth opportunities is that mutual fund managers are expected to have private information regarding growth opportunities and therefore their trading activity might proxy for potential growth opportunities. Baker (1993) considers the use of this proxy a clever one, however it has some caveats. Gaver and Gaver (1992) acknowledge this and state that growth funds mostly do not hold small firms as the expected returns do not outweigh transaction costs on these investments. Therefore, this variable is most likely biased towards large firms. Baker (1993) points out a more fundamental problem of this proxy, stating that growth funds invest based on the potential market value of equity growth of a firm rather than considering whether a firm grows.

One can argue whether leverage might serve as a proxy for growth opportunities (Adam and Goyal, 2008). To deal with this endogeneity issue, Lang et al. (1996) separate business activities into two parts: core and non-core activities. They find that the effect of leverage on growth opportunities does not vary between the core and non-core activities. One would expect leverage to have a bigger impact on the core-activities, if leverage is a proxy for growth opportunities. Therefore, their results indicate that leverage may not be regarded as a proxy for growth opportunities.

2.2.4 Measuring growth opportunities

Although many researches study the relation between leverage and growth opportunities by using proxy variables that can be retrieved from databases, few of them attempt to assign a value to growth opportunities. As stated earlier, the papers of Brealy and Myers (1981) and Kester (1984) are first studies to assign a value to growth opportunities by estimating the growth option value (the KBM model). The growth option value estimates the present value of growth opportunities. In this approach there is a smaller gap between real options theory and practice, since it directly calculates the growth option value as suggested by theory. Kester (1984) shows that the importance of growth options can be recognized by subtracting the total market value from the capitalized value of the firms' current earnings stream. The KBM model discounts earnings per share (EPS) as an annuity using the cost of equity as the discount rate and uses the outcome a proxy for present value of assets in place. Then this value is subtracted from the market cap. This difference leads to an estimation of the growth option value. He showed that for most firms in his sample at least 50% of company value can be contributed to growth options. Kester does not find significant differences in growth option value between small and big firms. He does find a significantly higher value of growth options for technological firms. Bevan et al. (2002) attempt to test the validity of the model of the KBM model. They conclude that the KBM model needs to be refined since it cannot cope with inflation, and after correction for inflation the credibility of the results drops. Since the inclusion of inflation leads to an increase of the value of assets in place, the growth option value significantly drops, emphasizing the model is highly sensitive to the inclusion of inflation. Several papers use a similar approach (Strebel, 1983; Chung and Charoenwong, 1991; Alessandri et al., 2002; Brealey et al., 2000 Tong and Reuer, 2006; Tong, Reuer and Peng, 2008; Smit et al., 2017). The method of Tong, Reuer and Peng (the TRP model) uses a slightly different approach than the KBM model. The TRP model does not focus solely on EPS as a proxy for assets in place but separates the value of assets in place into a value of economic profit (PVEP) and a value for capital invested (CI).

As suggested by theory, industries involved with higher uncertainty tend to have greater growth opportunities. Smit et al. (2017) aim to test this assertion and make a distinction between two types of uncertainty: transactional uncertainty and economic uncertainty. In their empirical research they find that these two types of uncertainty have two conflicting effects. On the one hand, as mentioned in earlier literature, economic uncertainty has a positive relation with the present value of growth options, but transactional uncertainty has a negative relation with the present value of growth opportunities.

However little research is available on the relation between leverage and the growth option value, there are some studies that have interesting findings on this matter. For instance, Long et al. (2002) who use the calculation method of the growth option value in which assets in place are calculated as an annuity do find some mixed results on the relation between leverage and the growth option value. In some years they find a significant positive relation between leverage and the PVGO when they include Tobin's Q into the regression. Contrary to expectations, the study of Smit et al. (2017) that uses a comparable method to calculate the growth option value to that of Long et al. (2002) do find a positive relation between leverage and growth option value. This relation tends to be driven by firms operating in developing countries, as they are having lower growth option value and lower borrowing capacity. These firms are likely to have a lower PVGO and limited resources to issue debt. Tong et al. (2008) do find support for a negative relation between leverage and the PVGO. However, they define leverage as total long-term debt divided by total equity, meaning that they ignore the short-term debt component. The studies of Long et al. (2002) and Smit et al. (2017) both define leverage as total debt divided by equity.

2.2.5 Growth opportunities, leverage, and short-term debt

Literature on the relation between growth opportunities and the use of short-term debt is relatively scarce but has some results that are worth noting. Since theory suggests that the agency costs might be lowered by using short term debt, Parrino and Weisbach (1999) attempt to empirically research this assertion. In their study they use a Monte Carlo simulation approach[2] to estimate the magnitude of the stockholder-bondholder conflict. Their estimations suggest that the agency costs of debt do really exist across firms, although they are not substantial enough that they would outweigh the tax shield of debt.

Hall et al. (2000) did not find a significant relation between growth and long-term debt. They did find a positive relation between growth and short-term debt, as suggested by theory. Hall et al. (2000) define growth as the increase in sales of the past three years. Johnson (2003) finds that the negative relation between the leverage ratio and growth opportunities is six times weaker for firms having all short-term debt than for firms having all long-term debt. This finding gives more reason to belief that agency costs decrease with issuing short-term debt. These findings shine some new light on the relation between growth opportunities and financial policy as these findings raise the question why there is such a negative relation between leverage and growth opportunities if firms can issue short-term debt to decrease the agency costs. Researchers widely document a negative relation between leverage and growth opportunities, which indicates that issuing short-term debt somehow is not the ultimate solution to the underinvestment problem. One rationale is that short-term debt has a positive relation with bankruptcy costs. As increasing short-term debt above optimal levels brings a risk of inefficient liquidation. The risk of inefficient liquidation increases the costs of bankruptcy and following the trade-off theory this risk reduces the optimal leverage ratio. One can conclude that firms trade off the agency costs and the costs following from the risk of inefficient liquidation (liquidity risk). Johnson (2003) finds strong evidence that the liquidity effect of firms with unrated debt is stronger than for firms with rated debt. For these unrated firms the effect of the liquidity risk cancels out the weakening effect of the

[2] Monte Carlo simulations model the probability of several outcomes in a process that would not have been predicted easily by using random variables. This method of simulation is used in forecasting models to understand the impact of risk and uncertainty (Mahadevan, 1997)

underinvestment problem, therefore leverage does not increase for unrated firms as they choose short term debt to reduce agency costs. For firms with rated debt Johnson (2003) finds the opposite, meaning that the net effect of issuing short term on leverage is positive. On the other hand, the effect of liquidity risk outweighs the attenuation effect which leads to a net decrease in leverage. This is an explanation to the documented negative relation between leverage and growth opportunities, even when firms issue more short-term debt to reduce agency costs. Over the whole sample Johnson (2003) finds that leverage and maturity are positively related, which is in line with the results of Barclay and Smith (1995) and Stohs and Mauer (1996).

2.3 Summary

There is not much consensus on which of capital structure theory holds, as there does not seem to be one dominant theory that describes financial policies. Researchers find several capital determinants that cannot be explained by either of these theories. Myers (2001) states that there is no dominant financial policy theory and that there is no rationale behind believing there will be one.

Theory predicts growth opportunities to be a negative determinant of corporate leverage. Empirical literature on corporate finance extensively researches this relation, finding less linearity than theory suggests. Financial literature finds a negative relation between leverage and growth opportunities, but as some argue that leverage might proxy for growth opportunities the challenge is not to find whether there is a relation, but whether growth option value does cause lower leverage ratios. The theories from Myers (1977) and Myers and Majluf (1984) state that a firm target leverage ratio are determined by a trade-off between the costs and benefits of growth opportunities and assets in place. To be more specific, a firm should use relatively more leverage to finance assets in place and less leverage to finance growth opportunities. Therefore, a firm is more likely to choose equity over debt as the value of a firm changes through a rise in growth opportunities. The free-cash flow theory of Jensen (1986) emphasizes this relation as it states that the collateral value of growth opportunities is lower than that of assets in place, leading to a lower borrowing capacity for firms with more growth opportunities. Other theories suggest that also short-term debt relative to long term debt might lower agency costs, and therefore suggest that the negative relation between leverage and growth opportunities can be attenuated using relatively more short-term debt (Mauer and Sarkar, 2001). However, empirical work on the latter assertion is less elaborate and does not find as much consensus as the negative relation between growth opportunities and leverage. Therefore, it is a challenge to test whether short term debt indeed does mitigate the negative effect of growth option value on leverage.

3. Hypotheses development

This section briefly summarizes past literature and forms the two hypotheses.

3.1 Hypothesis 1: Leverage and growth option value

According to the underinvestment problem of Myers (1977) firms should finance growth opportunities with equity. Several other theories support this claim (Jensen, 1986; Trigeorgis, 1993; Barclay, Smith and Morellec, 2006). Also, empirical studies put focus on the causal relation between growth opportunities and capital structure (e.g. Smith and Watts, 1992; Barclay, Smith and Watts, 1995; Rajan and Zingales, 1995; Aivazan, Ge and Qui, 2003; Kayhan and Titman, 2004). This leads to the following prediction (in alternative form):

> **Hypothesis 1:** The growth option value negatively influences the leverage ratio of a particular firm

3.2 Hypothesis 2: Agency costs and short-term debt

Mauer and Sarkar (2001) and Childs et al. (2005) state in their models that agency costs decrease when the maturity of debt decreases. This theory suggests that short term debt is negatively related to growth opportunities. Empirical findings on this topic, however have some mixing results. Hall, Hutchinson and Michaelas (2000) do not find a significant negative relation between short term debt and growth. On the contrary, Johnson (2003) does find that the relation between growth opportunities and leverage becomes six times weaker for firms having all short-term debt compared to firms having all long-term debt. Therefore, my second hypothesis is as follows (in alternative form):

> **Hypothesis 2:** Short-term debt mitigates the negative effect of growth option value on leverage

4. Data and methods

First, this section describes the process of data gathering, cleansing to be able to conduct this research. Second, this section describes the research design of this study.

4.1 Data

This section explains the process of gathering and using the data to be able to answer the research question. It starts by describing the process of data gathering and cleansing the data. In addition, this section addresses the process of variable creation, and adds a brief description of the data. This section completes with the deliberate description of the research design.

4.1.1 Gathering and cleansing main data

Since no database directly provides an estimate of the present value of growth opportunities data is required to be able to estimate it. I use data from the two US indices NASDAQ and NYSE of the years 2011-2017 to avoid the crisis years, since operating in crisis years significantly affects borrowing opportunities and corporate investment (Almeida et al., 2009; Duchin et al., 2010). In total 6,475 stocks are listed on both of these exchanges and the initial dataset consists of 45,325 firm-year observations. Because the dataset consists of multiple observations of multiple firms over time it is considered a panel data set, a type of data I discuss in more detail in the following sections. To be able to calculate the growth option value I retrieve both financial and accounting data from a merged dataset of Compustat/CRSP which I can acquire from Wharton Research Database System (WRDS). These financial and accounting data include total assets, current liabilities, accounts payable, EBIT, net income, depreciation and amortization, long term liabilities, debt in current liabilities (which consists of short-term debt and long-term debt due to in one year), long-term debt, deferred taxes[3], shares outstanding, book value per share, and closing price. From this data I can directly calculate financial ratios such as the PE ratio, the MTB ratio, the Solvency ratio, and the short-term debt ratio (which is defined as short-term debt divided by long term debt). Since the calculation of the latter is only possible for firms having at least some debt, firms that are all equity financed are not included in the sample.

I also gather additional data such as company tickers and SIC codes from this dataset. One criterium that I set is that firms that lack an S&P issuer credit rating (ICR) are excluded

[3] The calculation of the PVGO requires data from 2010-2017 for this variable

from the sample. I set this criterium since the ICR is required to be able to estimate the default spread, which is necessary to estimate the cost of debt. When a firm lacks data on a specific variable in a given year I exclude the corresponding firm-year observation from the sample.

The last step of data cleansing consists of excluding firms that do have a leverage ratio of zero. After correcting for missing data, the unbalanced panel data set consists of 1,058 S&P credit rated firms and 5,254 firm-year observations that compete in 289 different industries based on four-digit SIC codes. The average amount of observations per firm is five, with a maximum and minimum of seven and one respectively.

4.1.2 Creation of variables

In the following paragraphs I state the creations of the two variables PVGO and PVGOK.

PVGO

The methods used in studies to the relation between leverage and growth opportunities lack a variable that assigns value to growth opportunities, since most papers use proxy variables. As mentioned before, Brealy and Myers and Kester (1984) were the first to attempt to estimate the growth option value. However, as Danbolst, Hirst and Jones (2002) state that this model needs some refinement, as it is not able to cope with real interest rates. For the calculation of the PVGO I therefore use a slightly different approach as the main method of this paper, similar to the TRP model and the model of Smit et al. (2017). Main difference between the approach of this paper and the TRP model is the inclusion of inflation. As estimating the PVGO bottom up requires a lot of unobservable information, I calculate the PVGO using the top down approach, which means that an estimation of the present value of assets in place (PVA) is subtracted from the value of the firm *(V)*. The value of the firm is known from financial markets. The present value of growth options is calculated as follows

$$PVGO_{i,t} = \frac{V_{i,t} - PVA_{i,t}}{V_{i,t}} \tag{3}$$

In (3) the present value of assets in place is calculated by the following equation

$$PVA_{i,t} = CI_{i,t} + PVEP_{i,t} \tag{4}$$

Capital invested (CI) is calculated by subtracting accounts payable and other current liabilities from the total assets, it stands for the total amount that shareholders and creditors allocated to the firm (Tong et al., 2008). The present value of economic profit (PVEP) consists of the following elements

$$PVEP_{i,t} = \frac{NOPLAT_{i,t} - CI_{i,t} \times WACC_{i,t}}{WACC_{i,t} - \pi_t} \quad (5)$$

In which π_t is the change in consumer price index in year t compared to year t-1. To calculate the influence of inflation I retrieve the yearly *Rate of Change Consumer Price Index* (CPI) from the CRSP US Treasury and Inflation Series (CTI) from 2012-2017, retrieving the CPI of the year 2011 is not necessary since I take this year as a benchmark. The CPI is the most widely used measure of inflation in the US (Bryan and Cecchetti, 1993). In this formula $WACC_{i,t}$ stands for the firm specific WACC at time t, and $NOPLAT_{i,t}$is calculated by the following equation

$$NOPLAT_{i,t} = EBIT_{i,t}(1 - TAX) + (DTAX_{i,t} - DTAX_{i,t-1}) \quad (6)$$

$NOPLAT_{i,t}$ is a financial metric that calculates a firm`s operating profit less adjusted taxes (Damodaran, 2007). The $EBIT_{i,t}$ is equal to earnings before taxes for firm i at time t, and $DTAX$ is deferred taxes. TAX stands for tax rate. I assume a tax rate of 35%. For the estimation of the WACC I refer to Smit et al. (2017) who estimate the WACC by the following equation

$$WACC_{i,t} = \frac{D_{it}}{D_{it} + E_{it}} k_{it}^{d}(1 - TAX) + \frac{E_{it}}{D_{it} + E} k_{it}^{e} \quad (7)$$

In this equation D stands for debt and E stands for equity, TAX stands for tax rate, k_{it}^{d} is the cost of debt and k_{it}^{e} is the cost of equity. I use the CAPM to determine the cost of equity

$$k_{i,t}^{e} = r_{Ft} + \beta(R_{mt} - r_{Ft}) + SFP_i \quad (8)$$

In this equation r_F is defined as the risk-free rate and R_m the market return on the S&P 500 in year t. The factor $R_{m,t} - r_{F,t}$ is the market risk premium, which is the premium that investors obtain for investing in stocks rather than investing in risk-free objects against the risk-free rate. I gather data on market-risk premia $(R_{mt} - r_{Ft})$ and risk-free rates from several surveys (Fernandez et al., 2011; Fernandez et al., 2012; Fernandez et al., 2013; Fernandez et al., 2014; Fernandez et al., 2015; Fernandez et al., 2016; Fernandez et al., 2017). In these surveys several finance professors, but also financial analysts and managers of companies who are considered being reliable sources document market risk premia and risk-free rates. The authors control for outliers and then report the average risk-free rate (RF) and market risk premium (MRP) of al correspondents. In these surveys only the years 2013, 2015, and 2017 have data on the risk-free rate, in the missing years I assume a risk-free rate of 2.5% . In this formula SFP stands for small firm premium, since the CAPM cannot fully capture the cost of equity, especially for small firms. I use an SFP of 3.3%, 1,4% or 0.7% for firms with a market capitalization below 270,000,000; 1,200,000,000 and 5,300,000,000 respectively (Damodaran, 2002). From Beta

Suite by WRDS I retrieve the firm's 60-month CAPM Beta ($\beta_{i,t}$) that follow from the following regression

$$R_{i,t} - r_{Ft} = \alpha_{i,t} + \beta_{i,t}(MRP_t) + \varepsilon_{i,t} \tag{9}$$

In which $R_{i,t}$ is the 60 month return of firm i at time t, $\alpha_{i,t}$ is the 60-month abnormal return of firm i at time t, MRP_t is the Fama-French excess return on the market at time t, and $\varepsilon_{i,t}$ is the error term. For simplicity reasons I assume that the β of growth opportunities is equal to the β of assets in place, therefore I use

Under the assumption that the cost of debt is equal for firms having have the same S&P credit rating, the cost of debt is calculated by the following formula

$$k_{it}^{d} = r_{Ft} + CS_i \tag{10}$$

In this equation CS is defined as a firms' credit spread, which is determined by the S&P credit rating, this rating is a proxy for a firm's credibility to meet its debt obligations. I retrieve long term S&P credit ratings from Compustat and link the long-term S&P credit ratings to a default risk which I retrieve from the *Spreads and Interest Coverage Ratios* dataset from data archives of Stern NYU. This method is suggested by Damodaran (2002). However, this dataset does not provide a percentage of default risk for all S&P credit ratings, therefore I gather the default risks from Moody's equivalent credit ratings, which are also provided by the data archive of Stern NYU. After having calculated all variables I can derive the PVGO from equation (3). In this equation V stands for enterprise value, which I define as the market value of equity plus total book value of debt, following Smith and Watts (1992) and Smit et al. (2017). Since the market value of debt is very hard to measure and suffices a lot of data that is hard to retrieve I use the book value of debt (Adam and Goyal, 2008).

PVGOK

Since this paper uses the book value of debt as the market value of debt is hard to estimate I also perform regressions using the KBM model next to the TRP model, again with the inclusion of inflation. Advantage of the KBM model is that growth option value is calculated as a percentage of the market cap, therefore an estimation of the market value of debt is not needed. The KBM model focuses on the present value of growth opportunities in percentage of market cap rather than enterprise value. I calculate this variable as follows

$$PVGOK_{i,t}\ per\ share = Price_{i,t} - \frac{EPS_{i,t}}{k_{i,t}^{e} - \pi_t} \tag{11}$$

In this equation $Price_{i,t}$ is the closing price of stock i at year t. EPS stands for earnings per share which is equal to net income divided by the amount of shares outstanding. π_t, again, stands for inflation. Then the $PVGOK$ is calculated as a percentage of the market value of equity

$$PVGOK_{i,t} = \frac{PVGOK_{i,t}\, per\ share * Shares\ Outstanding_{i,t}}{Market\ Capitalization_{i,t}} \tag{12}$$

4.1.3 Data description

Table 1 reports medians of the raw data of the different measurements of growth opportunities, leverage, and the short-term debt ratio across industries. Since the variables most likely contain outliers I report medians instead of means. Each industry division consists of closely related industries. The division is based on the SIC Division Structure by the Occupational Safety and Health Administration from the United States Department of Labor. In this sample most firms compete in division D which consists of manufacturing firms. Division A, in which agricultural, forestry, and fishing firms are active, has the smallest number of competitors. Worth noting is the division G which reports the lowest growth option value and has the second lowest reported median of leverage, as this is rather contrasting given previous literature. Division B consists of mining companies and reports the highest medians on average. Brennan and Schwartz (1985) state that one can consider the value of a copper mine as a real option, suggesting that one can use the bottom up approach of real option valuation to calculate the value of a mine. Since mining companies are obliged to make information regarding their mines public, investors and option valuators do have more information regarding the (growth option) value of mining companies (Adam and Goyal, 2008). Adam and Goyal (2008) state that the mining industry is the only industry that has such regularities regarding information disclosure. The top down estimation procedure of growth option value relies under the assumption that investors have sufficient information regarding growth opportunities. Since the mining industry discloses relatively more information than other industries, investors have more information regarding growth opportunities. The latter might lead to the mining industry reporting significantly higher growth option values compared to other industries in this sample. The findings on growth option value for division B in the years 2015 and 2016 are worth noting as this industry reports significantly higher median growth option values in these two years for both PVGO and PVGOK. From the table it becomes clear that the median values of the two measurements for growth option value differ between industries. This is in line with earlier work on growth opportunities (Kester, 1984; Tong and Reuer, 2006; Tong et al., 2008). Interestingly, the median

Table 1

Median values per industry division

Division	SIC	Leverage	STD Ratio	PVGO	PVGOK	Obs.
A	01-09	.1151	.0310	.4246	.3738	7
B	10-14	.3033	.0088	.8046	.8206	436
C	15-17	.3720	.0694	.6575	.4232	111
D	20-39	.2097	.0647	.4778	.3786	1,976
E	40-49	.3387	.0400	.3811	.2961	581
F	50-51	.2645	.0623	.3481	.2872	157
G	52-59	.2045	.0261	.2512	.2295	302
H	60-67	.2959	.0437	.7185	.3369	1,092
I	70-89	.2511	.0271	.5165	.4465	592

Sample includes 5,254 firm-year observations in the period 2011-2017. SIC reports the range of SIC in which belong to the specific divisions. Leverage is defined as book value of total debt divided by enterprise value. *STD ratio* is the ratio of short-term debt to long term debt. PVGO is the measure of the present value of growth opportunities used by Tong et al. (2008) and Smit et al. (2017). PVGOK is the measure of the present value of growth opportunities used by Brealy and Myers (1981) and Kester (1984). Obs. stands for the total number of firm-year observations. Division A consists of agriculture, forestry, and fishing companies. Division B consists of mining companies. Division C consists of construction companies. Division E consists of transportation, communication, electric, gas, and sanitary service companies. Division F consists pf wholesale trade companies. Division G consists of retail trade companies. Division H consists of finance, insurance, and real estate companies. Division I consists of service companies.

values for PVGO and PVGOK differ significantly for division H, consisting of finance, insurance, and real estate companies. In further analysis of the data I find that the growth option value also varies among years. For the variable PVGO each industry reports a positive median value in each year. The variable PVGOK reports a negative median value for industry F in the year 2012. Finding growth option values varying among years is in line with earlier work of Tong et al. (2008). Thereby does the table also show that interindustry differences regarding the leverage ratio do exist. The latter is in line with early work on the capital structure (Schwartz and Aronson, 1967; Scott, 1972; Bowen et al., 1982; Hall et al., 2004). Also, do leverage ratios vary reasonable between years, indicating that also time might be a factor with explanatory power. However, Hall et al. (2004) state that these differences are most likely due to firm-specific differences rather than industry-specific differences.

4.2 Research design

This section describes the regression models and control variables that the models include.

4.2.1 Panel data

Drawing causal inferences from observational data is an important matter in current research, but faces several difficulties (Shiffrin, 2016). To be able to draw causal inferences the variable of interest should be exogeneous. When the latter is not the case the model suffers from endogeneity, meaning that $E(\varepsilon_i, x_i) \neq 0$. A common approach to mitigate endogeneity in current literature is the use of a panel data model (Semykina and Wooldridge, 2010). The use of panel data models reduces the omitted variable bias, one of the causers of endogeneity. Some other advantages of using panel data is that it reduces both individual heterogeneity and the multicollinearity problem (Green, 2008). Thereby does the model control for individual heterogeneity (Green, 2008). When using panel data one can use a fixed-effects or random-effects model.

Fixed-effects vs random-effects

In a fixed-effects panel data model estimates the following regression

$$Y_{i,t} = \beta X_{i,t} + \alpha_i + \sum controls_{i,t} + u_{i,t} \tag{13}$$

In this equation $X_{i,t}$ is the dependent variable, and β is the coefficient of interest. The factor α_i captures the time-invariant firm specific intercept, and $u_{i,t}$ are the unique error-terms. The intercept α_i captures all unobserved variables and therefore all changes in the dependent variable must be caused by different factors than these fixed effects (Stock and Watson, 2003). Therefore, does the use of fixed-effects models reduce the omitted variable bias as there will not be any omitted factors. Because the fixed-effect subsumes all time-invariant effects the use of this model is only plausible when having reasonable within-variation in the variable of interest (Stock and Watson, 2003). The fixed-effects model also assumes that the time-invariant effects are uncorrelated between firms. A disadvantage of using a fixed-effects regression model is that one cannot add variables that do not vary over time. In the fixed-effects model the fixed-effects are assumed to be correlated with the independent variables. On the contrary, the random-effects model relies on the assumption that the between-entity error terms are not correlated with the regressors (Green, 2008). The regression that the random-effects model estimates is as follows

$$Y_{i,t} = \beta X_{i,t} + \alpha + u_{i,t} + \sum controls_t + \varepsilon_{i,t} \tag{14}$$

In this equation $X_{i,t}$ is the dependent variable and β the corresponding coefficient. The intercept, α is time-invariant and not firm-specific as in the fixed-effects model. The random-effects model regression consists of a between-entity error $u_{i,t}$ and a within-entity error $\varepsilon_{i,t}$. An advantage of the random-effects model over the fixed-effects model is that it allows for adding time-invariant control variables, which would have been subsumed using a fixed-effects model. The factor $controls_t$ stands for the control variables at time t. I use robust standard-errors to control for heterogeneity and autocorrelation, suggested by Wooldridge (2002). The Hausman test basically tests whether to use as fixed-effects or random-effects model. The null-hypothesis states that the unique error terms ($u_{i,t}$) are uncorrelated with the independent variables, the alternative hypothesis states that they are not (Green, 2008). Therefore, does rejecting the null-hypothesis suggest that that the fixed-effects model is the favoured model. However, the Hausman test assumes that the random-effects model is efficient under the null-hypothesis, and using robust standard errors violates that assumption. Therefore, I use a robust version of the Hausman-test to compare the random-effects and fixed-effects models (Arellano, 1993; Wooldridge, 2002; Wooldridge, 2010). Performing this test leaves a Sargan-Hansen statistic with a corresponding p-value. The hypotheses of this test are equal to those in the standard Hausman test, meaning that rejecting the null-hypothesis suggests that the fixed-effects model is the preferred model.

4.2.2 Empirical tests

Below I outline the regression models this paper uses to test the hypotheses.

Hypothesis 1

To test the first hypothesis, I use the leverage ratio as the dependent variable. For the leverage ratio I use the following equation

$$\frac{D}{EV}$$

For the value of D I use the book value of total debt, since the market value of debt is hard to estimate, and estimations are likely to contain errors (Adam and Goyal, 2008). EV stands for enterprise value which is defined as market cap plus total book value of debt. I use both PVGO and PVGOK as dependent variables in separate regression models, and I expect the corresponding coefficient to be negative. The regression equations in order to test the first hypothesis is are follows

$$Leverage_{i,t} = \alpha_i + \beta_1 PVGO_{i,t} + \beta_2 PE_{i,t} + \beta_3 \ln(Size)_{i,t} + \beta_4 MTBindustry_{i,t} + \beta_5 EPS_{i,t} + u_{i,t} \quad (15)$$

$$Leverage_{i,t} = \alpha_i + \beta_1 PVGOK_{i,t} + \beta_2 PE_{i,t} + \beta_3 \ln(Size)_{i,t} + \beta_4 MTBindustry_{i,t} + \beta_5 EPS_{i,t} + u_{i,t} \quad (16)$$

In these equations $PVGO_{i,t}$ stands for the present value of growth opportunities of firm i at time t, $PE_{i,t}$ stands for the PE ratio of firm i at time t, $\ln(Size)_{i,t}$ is the natural logarithm of total assets of firm i at time t, $MTBindustry_{i,t}$ is the industry market-to-book ratio of firm i at time t, and $EPS_{i,t}$ is the earnings per share ratio of firm i at time t.

Hypothesis 2

For the second hypothesis I use a slightly different approach, referring to Johnson (2003). In his research Johnson (2003) adds an interaction term between growth option value and short-term debt ratio (*STD Ratio*) to the regression with leverage as dependent variable, apart from the two terms separately. The *STD Ratio* is defined as

$$\frac{STD}{LTD}$$

In which STD is the book value of short-term debt, and LTD the book value of long-term debt. If short term debt mitigates the negative effect of leverage on the growth option value, I expect the interaction variable to positively influence the leverage ratio. I do expect the coefficient of growth option value to be positive and the coefficient of the interaction term to be negative, as this would indicate that short term debt mitigates the negative relation between leverage and growth option value (Johnson, 2003). The regression equations to test the second hypothesis are as follows

$$Leverage_{i,t} = \alpha_i + \beta_1 PVGO_{i,t} + \beta_2 STDRatio_{i,t} + \beta_4 PVGO_{i,t} * STDRatio_{i,t} + \beta_4 PE_{i,t} + \beta_5 \ln(Size)_{i,t} + \beta_6 MTBindustry_{i,t} + \beta_7 EPS_{i,t} + u_{i,t} \quad (17)$$

$$Leverage_{i,t} = \alpha_i + \beta_1 PVGO_{i,t} + \beta_2 STDRatio_{i,t} + \beta_3 PVGO_{i,t} * STDRatio_{i,t} + \beta_4 PE_{i,t} + \beta_5 \ln(Size)_{i,t} + \beta_6 MTBindustry_{i,t} + \beta_7 EPS_{i,t} + u_{i,t} \tag{18}$$

In these equations β_1 is the coefficient of interest, and β_{2-7} capture the control variables. $PVGO_{i,t}$ stands for the present value of growth opportunities of firm i at time t, $STDRatio_{i,t}$ is the short term debt ratio of firm i at time t, $PE_{i,t}$ stands for the PE ratio of firm i at time t, $\ln(Size)_{i,t}$ is the natural logarithm of total assets of firm i at time t, $MTBindustry_{i,t}$ is the industry market-to-book ratio of firm i at time t, and $EPS_{i,t}$ is the earnings per share ratio of firm i at time t.

4.2.3 Control variables

Both theoretical and empirical literature on capital structure provide several factors that might influence the leverage ratio. To incorporate these theoretical constructs, I add several control variables that can proxy for these effects. Below, I outline the control variables, captured by the factor $\sum controls_t$.

Size

In empirical corporate finance researchers find that firm size tends to influence company capital structure. On the one hand large firms are less prone to bankruptcy, meaning they have relatively lower bankruptcy costs than smaller firms, which would result in larger firms having relatively more debt. On the other hand, is the cost of equity for small firms much larger than the cost of equity for large firms, thereby are the costs of long-term debt also slightly higher (Barclay and Smith, 1995). This would suggest smaller firms having larger leverage ratio, consisting in particular of short-term debt. Additional reasoning for smaller firms having larger leverage ratios consists of the fact that managers of small firms prefer debt over equity since issuing equity leads to losing control to shareholders. While the theoretically the size-leverage relation is ambiguous, most empirical work finds that size and leverage are positively related, see for instance (e.g., Rajan and Zingales 1995; Baker and Wurgler, 2002; Chen, 2003; Kurshev and Strebulaev, 2015). However, in a study using post-crisis data Harrison and Widjaja (2014) document a negative effect of size on leverage. To control for size, I add the natural logarithm of total assets to the regression analyses. I use the natural logarithm to compress the data. It is unclear whether size will influence leverage positively or negatively.

PE ratio

Past literature finds a negative relation between leverage and the *PE* ratio (e.g. Chung and Charoenwong, 1991; Francis et al., 1999) One reasoning behind this is that debt affects the stock price (nominator) negatively and earnings (denominator) positively. On the other hand, does a high *PE* ratio imply that a firm is overvalued, when a firm is overvalued it is more likely to issue equity rather than debt. Therefore, past theoretical and empirical studies would suggest the *PE* ratio to negatively influence the leverage ratio in this research.

Profitability

The pecking order theory predicts a negative relation between profitability and debt since firms rather use internal financing than external financing, thereby are more profitable firms more likely to have a lower leverage ratios since they are able to pay off relatively more debt. These theoretical arguments gain support from several empirical researches (see for example Rajan and Zingales, 1995; Wald, 1999; Fama and French, 2002; Bevan and Danbolt, 2004). I use the variable earnings per share to control for profitability, and predict the coefficient to be negative. As the estimation of PVGOK contains *EPS* as a proxy for assets in place I must interpret the correlation coefficient between PVGOK and *EPS* carefully.

Solvency ratio

As stated by the trade-off theory, bankruptcy costs are regarded to be a disadvantage of issuing debt. Pompe and Bilderbeek (2005) document that the Solvency ratio has strong predictive power for bankruptcy, indicating this ratio can serve as a proxy for bankruptcy costs. The Solvency ratio is defined as follows

$$\frac{Net\ income + Depreciation\ and\ Amortization}{Short\ term\ Liabilities + Long\ term\ Liabilities}$$

The trade-off theory would predict a negative relation between the Solvency ratio and leverage.

Market timing

According to the market-timing hypothesis are firms operating in industries that are valued relatively high by the market more likely to issue equity rather than debt. Underlying reason is that firms who are valued relatively high by the market (‘overvalued’) can get a higher price per share, when firms are valued relatively low by the market (‘undervalued’) firms can buy back their shares against a lower price. I use the industry[4] MTB ratio as a proxy for market

[4] Industries are classified as in table 1

timing, as suggested by Baker and Wurgler (2002). I expect this proxy to have a negative influence on the leverage ratio of a firm.

5. Results

This section provides the results of this paper. First, I give a general overview of the descriptive statistics of the certain variables and I report their Pearson-correlations. Second, I provide the regression outputs and link these outputs to the stated hypothesis, which help to answer the research question. Furthermore, I examine the findings on control variables and aim to link these findings to the capital structure theories.

5.1 Descriptive statistics and correlation coefficients

To deal with outliers I winsorize each variable at the one percent level, following Johnson (2003), Flannery and Rangan (2006) and Lemmon et al. (2008). In this method all observations below the cut-off value of the 1% percentile and above the 99% percentile cut-off value level are replaced by the respective cut-off values. Table 2 reports descriptive statistics of the winsorized data. The mean PVGO is 51.78% (58.75% before winsorization), and the mean PVGOK is 38.82% (71.28% before winsorization), the differences between means indicate the PVGOK variable contains more outliers. The latter is in line with the results of Kester (1984) who also found present values of growth option values approximately equal to 50%. The mean value of PVGO is slightly lower than those found by Tong et al. (2008) and Smit et al. (2017) who found values of 43% and 90% respectively. Rationale behind these differences is most likely the variety in samples as Tong et al. (2008) focus on high-growth firms and the sample of Smit et al. (2017) consist of firms across 34 countries. Apart from the correlation between *PE ratio* and *ln(Size),* the correlation between the STD Ratio and the PE ratio the correlation between Solvency ratio and industry MTB ratio and the correlation of the industry MTB ratio with PVGO all correlations appear to be statistically different from zero. Finding no correlation between the industry MTB ratio and both PVGO and PVGOK is rather contrasting as the MTB ratio is a widely used proxy for growth opportunities. Table 3 shows some other interesting correlation coefficients, it shows that for this sample of firms there is a positive correlation between leverage and the two measurements of the present value of growth opportunities.

Table 2
Descriptive statistics

Variable	Obs.[a]	Mean	Median	s.d.[b]	Min	Max
Leverage	5,254	.30	.26	.01	.00	.98
PVGO	5,254	.17	.18	.01	-.74	1.02
PVGOK	5,254	.48	.46	.01	-.20	1.31
PE Ratio	5,254	16.72	.51	.18	- 6.00	39.45
ln(Size)	5,254	.03	.89	.17	7.28	11.17
Industry MTB	5,254	.21	.32	.03	-.01	7.44
Solvency ratio	5,254	.13	.12	.01	.01	.28
EPS	5,254	.28	.28	.04	-.62	5.98
STD Ratio	5,224	.10	.04	.01	.00	.39

Sample includes 5319 firm-year observations for the period 2011-2017. Leverage is defined as total debt divided by enterprise value. PVGO is the measure of the present value of growth opportunities used by Smit et al. (2017) including an adjustment for inflation. PVGOK is the measure of the present value of growth opportunities used by Brealy and Myers (1981) and Kester (1984) including an adjustment for inflation. *PE ratio* is the closing stock price divided by earnings of the year. *ln(Size)* is the natural logarithm of total assets. Solvency ratio is net income plus amortization and depreciation divided by total liabilities. Industry *MB ratio* is the average of the market value of equity divided by the book value of equity for all firms within the same industry. *EPS* is total earnings divided by total shares outstanding. STD Ratio is short-term debt divided by long-term debt.

[a]Total number of observations
[b]Standard deviation

This finding contradicts the first hypothesis that predicts a negative relation, however one cannot draw causal inferences only focusing on correlations, as this relation is most likely driven by omitted variables. Thereby does the correlation coefficient not consider the panel data characteristic of this sample. Table 3 also shows the correlations between the *STD Ratio* and the PVGO and PVGOK respectively being negative, indicating that overall firms with higher growth option values have relatively less short-term debt. As expected the two measurements of the PVGO are positively correlated and the correlation is significantly different from zero, however the correlation being lower than the correlation between these two measurements found by Tong et al. (2008), who find a correlation coefficient of .8600. Franke (2010) states that correlations above 0.8 between regressors might be an indicator of multicollinearity, however after computing the correlation coefficient matrices I find the highest correlation between two regressors being -.5425. I also compute the conditioning number of the independent variables of the regression models following Belsey et al. (1980). I do find the highest conditioning number being 8.42, which is below the threshold of 30 (Belsey et al. 1980). Also, Green (2008) states that multicollinearity is not a big concern in panel data models. Therefore, I do not consider multicollinearity as a threat in the regression models.

In addition, besides multicollinearity, Stock and Watson (2015) argue that in order to be able to use fixed-effects two other assumptions need to be satisfied. First, I test whether the conditional mean of the error terms of regressions is equal to zero. I find that for all the regressions the conditional mean is equal to zero. Second, the sample should not contain outliers, since I winsorize all variables at 1% I do not consider outliers a as a threat. To control for heteroskedasticity and autocorrelation I use robust standard errors, suggested by Wooldridge (2002).

5.2 Fixed-effects models

All models are significant at the 1% level, indicating that for all models the coefficients are jointly unequal to zero. The Sargan-Hansen statistics of the robust Hausman test suggest that the fixed-effects model is the preferred model for all regressions, as the test statistics is highly significant for all models. For all models the null hypothesis of no correlation between the errors and regressors is rejected and therefore this study uses a fixed-effects panel data model. The fixed-effects model drops all time-invariant regressors, since it assumes that time-invariant regressors cannot have a causal effect on the dependent variable. Therefore, the fixed-effects model is more appropriate drawing causal inferences. Besides the firm-fixed effects I also add year fixed-effects, since leverage ratios appear to differ significantly across years. I conclude the latter from the test-statistic following from Wald test for joint significance of year fixed-effects, table 4, 5, 6 and 7 report these statistics. From the first and third column of table 4 I can draw conclusions regarding hypothesis 1. The first column of Table 4 shows the results of the regressions with PVGO as independent variable. The coefficient is significant at the 5% level, suggesting that PVGO negatively influences the leverage ratio. The coefficient states that if the variable PVGO increases by one unit, the leverage ratio decreases with .0108. The findings are in line with the static trade-off theory that states that firms do trade-off various costs and benefits of debt and equity. On the one hand do firms with higher growth option values have higher costs of financial distress, and on the other hand do agency costs lower the optimal debt ratio for firms with a higher growth option value. The coefficient of PVGOK is significantly negative at the 1% level, which indicates the results hold under the two methods of estimating the growth option value. Compared to PVGOK the coefficient of PVGO seems to be relatively low, as the coefficient of PVGOK is roughly six times higher.

Firm-fixed effects are jointly significant, which emphasizes leverage ratios do vary reasonably between firms. The second and fourth column of table 4 report the regression outputs when an interaction term between growth option value and the short-term debt ratio is added. Interestingly, I do find that short-term debt negatively affects the leverage ratio in the model with PVGOK as predictor variable. This means that the relative amount of short-term debt firm i has at time t does negatively influence the ratio of overall debt to enterprise value. If short-term debt mitigates the negative relation of growth option value on leverage I expect the coefficients of PVGO and PVGOK to be negative and the coefficients of the interaction terms PVGO**STD Ratio* and PVGOK**STD Ratio* to be positive (Johnson, 2003). However, I do find the coefficient of PVGO to be significantly negative, I do not find statistically significant coefficients for the interaction terms between the two measures of growth option value and short-term debt. Although the coefficients are statistically not significant, for both measures the interaction term reports a positive sign which suggests that economically speaking the interaction term are significant. I interpret this result as weak evidence that short-term debt attenuates the negative effect of growth option value on leverage. The fact that the interaction term does not reach statistical significance result might depend on the sample one uses to test this specific relation, this study only includes firms with S&P bond ratings. Both Johnson (2003) and Barclay and Smith (1995) state that rated firms have relatively more long-term debt than unrated firms since unrated firms are most likely of lower credit quality, which might be

the reason that I do not find strong evidence for hypothesis 2. In addition, larger firms do relatively have more long-term debt than small firms.

5.3 Findings on control variables

Assuming my control variables capture the underlying theoretical constructs well enough, I aim to draw conclusions from the outcomes on control variables included in the models. In the models with PVGO as predictor variable *EPS* is statistically insignificant, in the models with PVGOK as predictor variable *EPS* does influence the leverage ratio significantly negative. This indicates that profitability does negatively influence leverage in the PVGOK model, but does not in the PVGO model, finding weak support for the pecking-order theory. All other control variables have their expected signs and are significant at the 1% level. The statistically significant and negative coefficients for both *PE ratio* and MTB ratio both are in line with the market-timing theory. The coefficient of the Solvency ratio, which is significantly negative in all models, supports the static trade-off theory. At last, the *size* coefficient, influencing the leverage ratio significantly positive does support both the static trade-off theory and the pecking-order

Table 3

Pearson correlation coefficients for selected variables

Variable	Leverage	PVGO	PVGOK	PE Ratio	ln(Size)	Industry MTB Ratio	Solvency Ratio	EPS
Leverage								
PVGO	.2639***							
PVGOK	.3278***	.6049***						
PE Ratio	-.2842***	-.0730***	-.1363***					
ln(Size)	-.1026***	-.2842***	-.2517***	-.0062				
Industry MTB Ratio	-.1155***	-.0506***	-.0166	.0499***	-.0437***			
Solvency Ratio	-.5541***	-.4188***	-.4681***	.1556***	-.0268**	.1380		
EPS	-.4473***	-.4471***	-.6999***	.1079***	.3013***	.0279**	.4342***	
STD Ratio	-.1074***	-.0791***	-.1573***	-.0007	.2926***	.0431***	.0298**	.1650***

Sample includes 5254 firm-year observations for the period 2011-2017. Leverage is defined as total debt divided by enterprise value. *PVGO* is the measure of the present value of growth opportunities used by Tong et al. (2008) and Smit et al. (2017) including an adjustment for inflation PVGOK is the measure of the present value of growth opportunities by Brealy and Myers (1981) and Kester (1984) including an adjustment for inflation . *STD-Ratio* is the ratio of short term debt divided by long term debt. *PE ratio* is the closing stock price divided by earnings of the year. *ln(Size)* is the natural logarithm of total assets. *Solvency ratio* is net income plus amortization and depreciation divided by total liabilities. *Industry MB ratio* is the average of the market value of equity divided by the book value of equity for all firms within the same industry. *EPS* is total earnings divided by total shares outstanding. The table reports the Pearson correlation coefficients of the selected variables. ***,**,* indicate statistical significance at the 1%, 5%, and 10% respectively.

Table 4
Regression results with leverage as dependent variable

	Predicted sign	(1)	(2)	(3)	(4)
Intercept	?	-.0520	-.0485	-.0050	-.0023
		(-.67)	(-.62)	(-0.06)	(-.03)
PVGO	(-)	-.0104**	-.0131**		
		(-2.03)	(-2.24)		
PVGOK	(-)			-.0522***	-.0531***
				(-11.16)	(-10.01)
STD Ratio	?		-.0324*		-.0221*
			(-1.93)		(-1.85)
PVGO*STD Ratio	(+)		.0260		
			(0.85)		
PVGOK*STD Ratio	(+)				.0086
					(.37)
PE Ratio	(-)	-.0009***	-.0009***	-.0010***	-.0010***
		(-8.52)	(-8.51)	(-8.98)	(-8.96)
ln(Size)	?	.0486***	.0467***	.0495***	.0495***
		(5.61)	(5.61)	(5.78)	(5.79)
Solvency ratio	(-)	-.5746***	-.5773***	-.7025***	-.7048***
		(-14.44)	(-14.53)	(-16.13)	(-16.14)
Industry MTB ratio	(-)	-.0011***	-.0010***	-.0010***	-.0010***
		(-2.75)	(-2.69)	(-2.80)	(-2.75)
EPS	(-)	-.0003	-.0002	-.0085***	-.0084***
		(-.18)	(-.11)	(-5.23)	(-5.17)
Firm fixed effects[a]		328.60***	326.36***	267.83***	268.81***
Year fixed effects[b]		39.38***	46.32***	39.50***	33.77***
Within R^2		.2881	.2707	.3208	.3214
Model F[c]		71.40***	58.34***	76.37***	65.18***

Sample includes 5,254 firm-year observations for the period 2011-2017. Leverage is defined as total debt divided by enterprise value. Model 1 is the model with PVGO as dependent variable. Model 2 includes the *STD Ratio* and an interaction term between PVGO and *STD Ratio*. Model 3 is the model with PVGOK as dependent variable. Model 4 includes the *STD Ratio* and an interaction term between PVGOK and *STD Ratio*. PVGO is the measure of the present value of growth opportunities used by Tong et al. (2008) and Smit et al. (2017). PVGOK is the measure of the present value of growth opportunities used by Brealy and Myers (1981) and Kester (1984). *PE ratio* is the closing stock price divided by earnings of the year. *ln(Size)* is the natural logarithm of total assets. Solvency ratio is net income plus amortization and depreciation divided by total liabilities. Industry MTB ratio is the average of the market value of equity divided by the book value of equity for all firms within the same industry. *EPS* is total earnings divided by total shares outstanding. The table reports the coefficients of the fixed-effects regressions and z-statistics (in parentheses) based on robust standard-errors (Wooldridge, 2002). ***,**,* indicate statistical significance at the 1%, 5%, and 10% respectively.

[a] Table reports the Sargan-Hansen statistic following from the robust Hausman test
[b] Table reports the F-statistic of joint significance of fixed-effects
[c] Table reports the F-statistic of joint significance of all regressors

theory. The positive sign for *size* suggests that the size of a firm does cause a firm to have relatively more debt. However, the theoretical rationale behind this relation is debatable, this finding is consistent with earlier empirical work (e.g. Rajan and Zingales, 1995; Wald, 1999; Fama and French, 2002; Bevan and Danbolt, 2004).

5.4 Robustness tests

In this subsection I provide robustness tests. First, I show that my results are robust to the use of different proxies. Second, I show that my results are robust to the inclusion of inflation to the estimations of PVGO and PVGOK.

5.4.1 MTB ratio

As mentioned before, panel data regression models offer several advantages over cross-sectional and time-series models. Researchers have not come to a consensus regarding how to measure growth opportunities, suggesting that growth opportunities are hard to measure. Thereby do the measures that I use rely on a large set of assumptions. For this reason, I repeat all regressions with the MTB ratio as dependent variable, since Adam and Goyal (2008) argue that this measure is the best proxy for growth opportunities. I drop all firm-year observations with a negative MTB ratio, since negative MTB ratios result from negative book values. Given the book value is negative, the higher the market value, the more negative the MTB ratio. This is counterintuitive since higher market values should lead to higher MTB ratios. Table 5 in the appendix shows the results of these additional regression analyses. Columns 1 reports the outcomes regarding the regression model to test hypothesis 1, and column 2 reports the outcomes regarding hypothesis 2. The use of a different proxy for growth opportunities does not harm the results, since the coefficient of MTB ratio appears to be significantly negative at the 1% level. Again, the coefficient of the interaction term positive, but statistically insignificant in column 2, indicating that this result is robust to different measurements.

5.4.2 Inflation

Danbolt et al. (2002) state that the KBM model is sensitive to the incorporation of inflation. They state that results lack credibility after an adjustment for inflation, since inflation affects the denominator in the calculation of value of assets in place in the KBM model. Logical reasoning following from this assertion is that inflation also affects the credibility of the TRP model, since the inclusion of inflation also leads to an adjustment of the denominator in the calculation of the present value of assets in place in their model. However, to test whether inflation does lead to significantly different results I create two new variables: KMB without inflation and TRP without incorporation of inflation. I do find a mean value of .3883 for the KBM model, and a mean value of .1316 for the TRP model. These values are both logically lower than the mean values from the models with inclusion of inflation. To test whether the inclusion of inflation affects the relation between leverage and growth option value I repeat the regression models with the two new variables. Table 6 in the appendix reports the regression outputs. I do find that the results also hold when I do not account for inflation, meaning that in this sample inflation does not affect the relation between growth option value and leverage. Concluding, based on all previous regression models I do find sufficient evidence to conclude that the growth option value does negatively influence the leverage ratio, finding empirical support for the static trade-off theory. The results are robust to all five measurements of the growth option value. I do find some evidence that the short-term debt ratio mitigates the negative effect of the growth option value on leverage.

6. Conclusion

The long history of literature in the field of corporate finance provides much evidence against the claim of Modigliani and Miller (1958) that the value of a firm is independent of the financial policy. Theoretical evidence against this assertion follows from the four main theories that scientists developed, although none of these theories is dominant and Myers (2001) states there is no reason to believe that one ever will be. Further research found several factors that influence capital structure, one of them being the MTB ratio. Two opposing explanations lie behind this relation: some argue MTB proxies for market timing, while most papers state that the MTB ratio proxies for growth opportunities. The latter finds support from two main theories. First, the underinvestment theory of Myers (1977) states that equity is preferred over debt in firms with relatively many growth opportunities since debtholders attempt to reap benefits from these investment opportunities. Second, Jensen (1986) asserts that the collateral value of growth opportunities is lower than the collateral value of assets in place, indicating firms do finance growth opportunities with equity and assets in place with debt. Both theories clearly point out the direction of the relation. Therefore, the aim of this research was to find a relation between growth option value and leverage. The use of the fixed-effects panel data model helped drawing statistical inferences as it excludes the relation being driven by unobservable variables. Using this model, I do find the growth option value negatively influencing the leverage ratio. However, statistically I cannot fully rule out the problem of reverse causality, I do not consider this a reasonable explanation since theoretically it is not plausible to believe that the relative amount of leverage a company contains would influence the growth option value. Therefore, my findings suggest that higher levels of growth option value cause lower leverage ratios. I do find the results being consistent under the inclusion of inflation, which was a concern of Danbolt et al. (2002). Theory also predicts the negative relation between growth option value and leverage being attenuated by the relative amount of short-term debt. However, the empirical body regarding this assertion is relatively small, it gains some empirical support (Johnson, 2003; Hall et al., 2000). Following the approach of Johnson (2003) I do not find the expected result, I do find the coefficients of the interaction terms to be positive, however, they are not statistically significant. As a reason of that I cannot draw statistical inferences regarding the amount of short-term debt mitigating the negative effect of growth option on leverage. I consider this as weak evidence that the amount of short-term debt attenuates the negative relation between growth option value and leverage. The lack of finding significant results for the second hypothesis following the method of Johnson (2003) might be attributable to the sample. From the results on control variables one can conclude that this paper provides evidence for multiple predictions of theories on capital structure.

7.1 Discussion

7.1 Contribution

A significant amount of empirical literature has focused on the relation between growth opportunities and leverage, yet to my knowledge is this paper the first to empirically test the effect between measurements of the growth option value on leverage. As most literature focuses on the MTB ratio as a proxy for growth option value, I use two empirical measures that follow from real option theory. With this approach I bridge the gap between theory and empirical work regarding growth opportunities. Therefore, the findings are important for researchers studying the field of real option theory, by linking the option theory to practical matters as financing decisions. This might lead to further research focusing on measuring the growth option value instead of using the MTB ratio as a proxy. Thereby does this paper add to the ongoing capital structure puzzle, relating real option theory to financing policy. This study also adds to the capital structure puzzle, linking control variables to capital structure theories.

7.2 Limitations and implications for further research

The huge amount of literature using proxy variables instead of measuring growth option value emphasizes growth opportunities are hard to measure. To measure growth option value using the PVGO model requires several assumptions. First, I assume that one can derive the cost of equity from the CAPM model. The calculation of the cost of equity also suffices several assumptions such as assuming values for the risk-free rate and the market risk premium. Thereby is the Beta coefficient a regression coefficient itself and therefore likely to contain measurement errors. I also assume the Beta for growth opportunities is equal to the Beta of assets in place. However, Bernardo et al. (2007) argue that the firm's Beta can be decomposed into a Beta for growth opportunities and a Beta for assets in place. This has implications for the cost of capital. I suggest further research to compose the present value of growth opportunities using the cost of capital that includes the Beta of growth opportunities.

Third, I need to estimate the cost of debt by linking a default risk premium to the S&P credit rating of a firm. As the cost of equity and the cost of debt determine the level of the weighted average cost of capital, which is the discount factor in the calculation of the value of net assets in place, it is important that they do not contain errors. These concerns might lead to lower internal validity. Another caveat of this study is the use of the industry MTB ratio as a proxy variable for market-timing. On the one hand the MTB ratio also proxies for growth opportunities, on the other hand the industry classification divisions I use might consist of industries that are not sufficiently close related.

Additionally, this research does use the book-value of debt in the estimation of enterprise value. The use of the market-value of debt instead of the book might lead to significantly different results regarding the value of growth option value. I suggest further research to repeat this study using the market-value of debt, despite its estimation difficulties.

Thereby, this paper uses NASDAQ or NYSE listed firms that have an S&P credit rating only. Since these firms are most likely larger than average, this might harm the external validity of this research. I suggest further research to extend this study to smaller firms, or non-US firms.

In addition, I do allow a firm's growth option value to be negative, an assumption that is debatable since some theorists state real options cannot take on negative values. Allowing growth option values to be negative relies on the assertion that negative growth option values indicate that firms are not able to stay at the current level of enterprise value. However, from a real option theory perspective, growth opportunities cannot be negative since firms do have a choice whether to carry out these options. I suggest further studies to develop new growth option valuation techniques that are more in line with the 'optional' characteristic of growth opportunities.

As this paper lacks statistical evidence on the hypothesis that short-term debt attenuates the negative influence of growth option value on leverage, I suggest further research to investigate this using a different sample, consisting solely of high-growth firms.

At last I suggest further research to compare both methods of measuring growth option value. Danbolt et al. (2002) already tested the empirical validity of the KBM model. As I do find inflation does not harm the results, I suggest following studies to further test this claim. In addition, I propose future research to test the validity of the TRP model (with and without inflation).

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Appendix A: Stata commands

Creation of variables

TRP: winsor BQ, gen(BQW) p(0.1)

PVGO: winsor PVGOInflation, gen(PVGOIW) p(0.1)

PVGOK*:* winsor BV, gen(BVW) p(0.1)

KBM: winsor BW, gen(BWW) p(0.1)

PE ratio: winsor PE, gen (PEW) p(0.1)

Leverage*:* winsor Leverage, gen (LeverageW) p(0.1)

Industry MTB ratio*:* egen MBI = mean(MBRatio), by (SICCLASSYEAR)

winsor MBI, gen (MBIW) p(0.1)

ln(Size): winsor LNSize, gen (LNSizeW) p(0.1)

MTB ratio*:* winsor MBRatio, gen (MBW) p(0.1)

Solvency ratio*:* winsor SolvencyRatio, gen (SolvencyRatioW) p (0.1)

EPS: winsor EPS, gen(EPSW) p(0.1)

Short term debt ratio: winsor STRatio, gen(STRatioW) p(0.1)

Panel data

encode TickerSymbol, gen (TIC)

xtset TIC DataYearFiscal

Table 3

pwcorr LeverageW PVGOIW BVW PEW LNSizeW MBIW SolvencyRatioW EPSW STRatioW, sig

Table 4

xtreg LeverageW PVGOIW PEW LNSizeW MBIW SolvencyRatioW EPSW i.DataYearFiscal, fe vce(robust) xtreg LeverageW BVW PEW LNSizeW MBIW SolvencyRatioW EPSW i.DataYearFiscal, fe vce(robust)

xtreg LeverageW PVGOIW STRatioW c.PVGOIW#c.STRatioW PEW LNSizeW MBIW SolvencyRatioW EPSW i.DataYearFiscal, fe vce(robust)

xtreg LeverageW BVW STRatioW c.BVW#c.STRatioW PEW LNSizeW MBIW SolvencyRatioW EPSW i.DataYearFiscal, fe vce(robust)

Table 5

xtreg LTLEVE BVW PEW LNSizeW MBIW SolvencyRatioW EPSW i.DataYearFiscal, fe vce(robust)

xtreg STLev BVW PEW LNSizeW MBIW SolvencyRatioW EPSW i.DataYearFiscal, fe vce(robust)

xtreg LTLEVE PVGOIW PEW LNSizeW MBIW SolvencyRatioW EPSW i.DataYearFiscal, fe vce(robust)

xtreg STLev PVGOIW PEW LNSizeW MBIW SolvencyRatioW EPSW i.DataYearFiscal, fe vce(robust

Table 6

xtreg LeverageW MBW PEW LNSizeW MBIW SolvencyRatioW EPSW i.DataYearFiscal, fe vce(robust)

xtreg LeverageW MBW STRatioW c.MBW#c.STRatioW PEW LNSizeW MBIW SolvencyRatioW EPSW i.DataYearFiscal, fe vce(robust)

Table 7

xtreg LeverageW BQW PEW LNSizeW MBIW SolvencyRatioW EPSW i.DataYearFiscal, fe vce(robust)

xtreg LeverageW BWW PEW LNSizeW MBIW SolvencyRatioW EPSW i.DataYearFiscal, fe vce(robust)

xtreg LeverageW BQW STRatioW c.BQW#c.STRatioW PEW LNSizeW MBIW SolvencyRatioW EPSW i.DataYearFiscal, fe vce(robust)

```
xtreg LeverageW BWW STRatioW c.BWW#c.STRatioW PEW LNSizeW MBIW
SolvencyRatioW EPSW i.DataYearFiscal, fe vce(robust)
```

Appendix B: Tables

Table 5
Regression results with leverage as dependent variable

	Predicted sign	(1)	(2)
Intercept	?	.0211 (.27)	.0219 (.28)
MTB	(-)	-.0212*** (-11.63)	-.0208*** (-11.02)
STD Ratio	?		-.0048 (-.18)
MTB*STD Ratio	(+)		-.0060 (-.88)
PE Ratio	(-)	-.0007*** (-6.73)	-.0007*** (-6.69)
ln(Size)	?	.0446*** (5.17)	.0446*** (5.17)
Solvency Ratio	(-)	-.5803*** (-15.09)	-.5816*** (-15.14)
Industry MTB Ratio	(-)	-.0004*** (-1.11)	-.0004*** (-1.07)
EPS	(-)	-.0018 (1.26)	.0019 (1.33)
Firm fixed effects[a]		216.56***	65.40***
Year fixed effects[b]		28.14***	28.06***
Within R^2		.3584	.3593
Model F[c]		92.98***	80.08***

Sample includes 5,319 firm-year observations for the period 2011-2017. *Leverage* is defined as total debt divided by enterprise value. Model 1 is the model with leverage as dependent variable and MTB as independent variable. Model 2 includes the STD Ratio and an interaction term between MTB and STD Ratio. *Leverage* is defined as total debt divided by enterprise value. Model *LTD* is defined as long term debt divided by enterprise value. *STD* is defined as short term debt divided by enterprise value. *STD Ratio* is the ratio of short term debt divided by long term debt. *PE ratio* is the closing stock price divided by earnings of the year. *ln(Size)* is the natural logarithm of total assets. *Solvency ratio* is net income plus amortization and depreciation divided by total liabilities. *Industry MTB ratio* is the average of the market value of equity divided by the book value of equity for all firms within the same industry. *EPS* is total earnings divided by total shares outstanding. The table reports the coefficients of the fixed-effects regressions and z-statistics (in parentheses) based on robust standard-errors (Wooldridge, 2002). ***,**,* indicate statistical significance at the 1%, 5%, and 10% respectively.

[a] Table reports the Sargan-Hansen statistic following from the robust Hausman test
[b] Table reports the F-statistic of joint significance of fixed-effects
[c] Table reports the F-statistic of joint significance of all regressors

Table 6

Regression results with leverage as dependent variable

	Predicted sign	(1)	(2)	(3)	(4)
Intercept	?	-.0265 (-.34)	-.0246 (-.32)	-.0071 (-.09)	-.0037 (-.05)
TRP	(-)	-.0257*** (-4.00)	-.0267*** (-3.67)		
KBM	(-)			-.0656*** (-10.80)	-.0674*** (-9.95)
STD Ratio	?		-.0239 (-1.29)		-.0267** (-1.91)
TRP*STD Ratio	(+)		-.0120 (.33)		
KBM*STD Ratio	(+)				.0178 (0.62)
PE Ratio	(-)	-.0009*** (-8.35)	-.0009*** (-8.33)	-.0010*** (-9.00)	-.0010*** (-8.99)
ln(Size)	?	.0466*** (5.38)	.0467*** (5.39)	.0507*** (5.92)	.0507*** (5.92)
Solvency Ratio	(-)	-.5763*** (-14.47)	-.5774*** (-14.53)	-.7197*** (-16.07)	-.7235*** (-16.10)
Industry MTB Ratio	(-)	-.0010*** (-2.76)	-.0010*** (-2.71)	-.0010*** (-2.66)	-.0010*** (-2.61)
EPS	(-)	-.0011 (-.70)	-.0010 (-.65)	-.0088*** (-5.34)	-.0087*** (-5.27)
Firm fixed effects[a]		311.18***	310.17***	260.43***	261.24***
Year fixed effects[b]		37.08***	37.10***	25.35***	25.46***
R^2		.2918	.2923	.3218	.3224
Model F[c]		72.34***	62.45***	75.97***	65.40***

Sample includes 5319 firm-year observations for the period 2011-2017. *Leverage* is defined as total debt divided by enterprise value. Model 1 is the model with PVGOK as dependent variable. Model 2 includes the *STD Ratio* and an interaction term between *PVGOK* and *STD Ratio. PVGOK* is the measure of the present value of growth opportunities used by Tong et al. (2008) and Smith et al. (2017). *STD Ratio* is the ratio of short term debt divided by long term debt. *PE ratio* is the closing stock price divided by earnings of the year. *ln(Size)* is the natural logarithm of total assets. *Solvency ratio* is net income plus amortization and depreciation divided by total liabilities. *Industry MTB ratio* is the average of the market value of equity divided by the book value of equity for all firms within the same industry. *EPS* is total earnings divided by total shares outstanding. The table reports the coefficients of the fixed-effects regressions and z-statistics (in parentheses) based on robust standard-errors (Wooldridge, 2002). ***,**,* indicate statistical significance at the 1%, 5%, and 10% respectively.

[a] Table reports the Sargan-Hansen statistic following from the robust Hausman test
[b] Table reports the F-statistic of joint significance of fixed-effects
[c] Table reports the F-statistic of joint significance of all regressors

Table 7

Market risk premia and risk-free rates from the years 2011-2017

Year	MRP	RF
2011	5.50%	2.50%
2012	5.50%	2.50%
2013	5.70%	2.40%
2014	5.40%	2.50%
2015	5.50%	2.40%
2016	5.30%	2.50%
2017	5.70%	2.50%

This table reports risk-free rates (RF) and market risk premia (MRP) for the years 2011-2017 provided by Fernandez et al. (2011), Fernandez et al. (2012), Fernandez et al. (2013), Fernandez et al. (2014), Fernandez et al. (2015), Fernandez et al. (2016), Fernandez et al. (2017). In the years 2011, 2012, 2014, and 2016 I assume a risk-free rate of 2.5% since the papers do not include data on the risk-free rate of these specific years.

Table 8

S&P credit ratings and respective default spreads

S&P Credit Rating	Default Spread
AAA	0.35%
AA+	0.45%
AA	0.54%
AA-	0.60%
A+	0.65%
A	0.80%
A-	0.95%
BBB+	1.20%
BBB	1.30%
BBB-	2.00%
BB+	4.00%
BB	4.50%
BB-	4.75%
B+	5.75%
CCC+	6.00%
B	6.25%
B-	6.50%
CCC	7.25%
CCC-	8.00%
CC	9.00%
D	12.00%

Table provides S&P credit ratings and the respective default spread.