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Testing the Pecking Order Theory on Technology Firms

ABSTRACT

This paper tests the pecking order theory of corporate leverage on publicly traded American high-technology firms for 2007 to 2017. The technology industry is known for its low debt-to-equity ratios. Young firms have low debt in contrast to mature tech companies that have much debt. The difficult and fast pacing knowledge of technology creates a lot of asymmetric information. According to the pecking order theory, these firms should have large amounts of internal capital funds. Otherwise tech firms will raise debt in order to match their financing deficit. Support for the pecking order theory on the technology firms is weak, especially for small firms.

Keywords: Pecking order theory; Capital structure; Technology firms; Financing deficit
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1. INTRODUCTION

The pecking order theory of capital structure is among the most influential theories of corporate leverage besides the trade-off theory. According to Myers (1984) and his introduction of the pecking-order theory, firms prefer internal to external finance because of adverse selection. However, most firms do not have enough internal funds to finance their assets and therefore have to issue external funds.

In this case, adverse selection is a concept that describes a situation where investing is affected by asymmetric information. Managers have better private information about the condition of the company. When managers issue new equity, investors believe that managers think that the firm is overvalued and are taking advantage of this over-valuation. This causes investors to place a lower value on the new equity issuance. The pecking-order theory predicts that firms will have relatively more debt than outstanding equity because of higher asymmetric information costs associated with equity issues.

Technology firms are becoming more attractive for investors. Research on the capital funds of technology firms is therefore interesting. Investments in technology firms have boomed: the amount is almost tripled the past three years (Erdogan et al., 2017). Financial databases show that the technology sector comprises nearly one quarter of the S&P 500's market value. This is the highest share amount for the tech sector in more than 16 years (Ovide, 2017). Also, the technology industry has low debt-to-equity ratios relative to the average of other industries. The S&P 500 Information Technology Index has a debt-to-equity (D/E) ratio of 33.7%. The S&P 500 is much more highly leveraged, with a debt-to-equity ratio of 106.6%, implying more debt than equities. Clearly, technology stocks are, in general, far less leveraged than the other stocks in the S&P 500 (Richardson, 2017).

Tech firms finance their projects with internal funds at first, but since they grow rapidly, this could lead to a financing deficit. The financial facts stated above say that technology firms do not have a priority of issuing debt when in need of external funds. These statements seem to be in contradiction to the pecking-order theory. This means that large information costs in terms of asymmetric knowledge about the products do not seem to apply in the technology sector according to the theory. On the other hand, the industry is known for its fast-pacing and difficult type of knowledge that is required for their products and projects, which could lead to more adverse selection.

Technology firms are also of relatively young age. This and the difficult type of knowledge could lead to an overestimation of the growth rate and thus the stock prices by irrational investors. Since the technology sector is booming and perhaps harder to valuate, a bubble could grow. High price-to-earnings (P/E) ratios can be an indicator of stock overvaluation, but this varies from industry to industry. The technology sector is a fast-growing sector that is known for their high R&D investments and depreciation costs. The earnings will be negatively influenced by this amount and could cause a higher P/E ratio on the short-term. However, in the long run the high growth of earnings and less depreciation over time could lead to a drop of the P/E ratios when the earnings rise. If the earnings do not make up for this increase in P/E ratio over time, an actual bubble in the tech sector has been created.

Table 5 in Appendix A shows the P/E ratios for the total S&P 500 and the technology index. The average from June 2013 until June 2017 does not differ significantly (20.14 and 20.32) and the recent ratios in June 2017 is exactly the same amount (25.8) (Gurufocus, 2017). This means that the highest share amount for the tech sector in more than 16 years is driven by relatively more start-ups, especially unicorns that go public, and not by the relatively high share prices. A unicorn is a start-up company valued at over $1 billion (Divestopedia, 2017). This does not mean that there is an absence of the development of a bubble in the sector, because a higher demand for good tech firms can lead to the raising of capital funds as if they are great firms. Investors expect a great return, while some firms can only achieve good returns (Chafkin, 2017).

The technology sector shows thus the phenomenon of financial unicorns. Today's software environment reflects a new dynamic between private and public markets: more companies than ever reach valuations of $1 billion through private financing (Erdogan et al., 2017). Venture capital or angel finance, is probably the most appropriate external finance source for high-technology start-ups because venture capitalists tend to specialise in industries in which informational asymmetries are particularly acute (Gompers & Lerner, 2003). This phenomenon could be in contradiction to the pecking order theory, since in a situation where large asymmetric information occurs more external equity is issued and not debt.

Frank & Goyal (2003) made the distinction between large and small market capitalized firms. They found that the pecking-order theory works best on large firms. This paper does the same for tech firms to find support for earlier statements. Tech firms have remarkable characteristics according to the pecking-order theory as mentioned above and is therefore interesting for industry-specific research. The main research question is: *Do tech firms with an internal financing deficit solve for this deficit in accordance with the pecking order model?*

The results show poor support for the pecking order model. Since the pecking order does not fully explain patterns of corporate finance for technology firms, it is natural to examine narrower sets of firms (Frank & Goyal, 2003). The theory says that financing behavior is driven by adverse selection costs. Thus, the model should perform best among firms that face particularly severe adverse selection problems. Small firms are often thought of as firms with large information asymmetries. Contrary to this hypothesis, small technology firms do not behave according to the pecking order theory. Medium and large firms tend to follow the pecking order model more, but the support is also not strong.

The structure of the rest of this paper is as follows. Section 2 presents the pecking-order theory with the associated empirical hypotheses and related literature. Methodology is described in Section 3 and data in section 4. Section 5 presents the empirical results. Conclusions are presented in Section 6.

2. THEORY AND RELATED LITERATURE

2.1 The pecking order theory

Myers (1984) and Myers and Majluf (1984) introduced the pecking-order theory. Firms have to take information asymmetry into account and choose to follow a pecking order in their financing decisions (Myers, 1984). The theory is about the capital funds of a firm. Companies can raise their capital internally and externally. Internal funds consist of retained earnings. External funds are debt and outstanding equity. Adverse selection determines the pecking order of the capital. The term refers to a situation where investors (buyers) have different information than firms (sellers) about some aspect of product quality. Technology products and services are commonly hard to understand and many technology firms are of young age. Retained earnings do not have an adverse selection problem. Equity is subject to serious adverse selection problems while debt has only a minor adverse selection problem (Myers, 1984). Equity is riskier than debt, therefore investors demand a higher adverse selection risk premium and thus a higher rate of return. Debt also has an adverse selection premium, but this is lower.

The pecking order is as follows. Retained earnings are a better source of funds than debt. Financing with debt is a better deal than with equity. According to this order, firms will fund all assets with internal funds if possible. Debt financing will be used if there is an insufficient amount of retained profit. Equity is never used for firms in normal projects. The financing deficit matches the net debt issues (Myers, 1984).

2.2 Tests of the pecking order theory

Frank & Goyal (2003) state that in reality, company operations and the associated accounting structures are more complicated than the standard pecking order description. Aggregation of the accounting cash flows must be used in order to test the pecking order theory.

The cash flows are defined as follows:

DIV_t cash dividends in year t;

I_t net investment in year t (i.e., I_t = capital expenditures + increase in investments + acquisitions + other use of funds - sale of Property Plant & Equipment (PPE) - sale of investment);

ΔW_t change in working capital in year t (i.e., ΔW_t = change in operating working capital + change in cash and cash equivalents + change in current debt);

C_t cash flow after interest and taxes (i.e., C_t = income before extraordinary items + depreciation and amortization + extraordinary items and discontinued operations + deferred taxes + equity in net loss - earnings + other funds from operations + gain (loss) from sales of Property Plant & Equipment (PPE) and other investments);

R_t current portion of the long-term debt in year t;

ΔD_t net debt issued in year t (i.e., ΔD_t = long-term debt issuance - long-term debt reduction);

ΔE_t net equity issued in year t (i.e., ΔE_t = sale of common stock minus stock repurchases).

The funds raised besides the retained earnings are called financing deficit, abbreviated as DEF_t. The defined cash flows are used to get a partially aggregated equation of flows of funds deficit (Frank & Goyal, 2003):

$$DEF_t = DIV_t + I_t + \Delta W_t - C_t = \Delta D_t + \Delta E_t. \quad (1)$$

The pecking order theory declares that the financial deficit will equal the net debt issues. Shyam-Sunder and Myers (1999) discussed that under the pecking order hypothesis subsequent public equity issues are only used in extreme circumstances after an Initial Public Offering (IPO). Eq. (2) is not an accounting identity because DEF_t does not include equity issues or repurchases (Shyam-Sunder & Myers, 1999). Accordingly, the empirical specification for panel data is given as

$$\Delta D_{it} = a_i + b_{PO} DEF_{it} + e_{it}, \quad (2)$$

where e_{it} is a well-behaved error term. The pecking order hypothesis is that a = 0 and b_{PO} = 1. Shyam-Sunder and Myers (1999) have tested the pecking order model and find that the hypothesis that (a = 0, b_{PO} = 1) is statistically rejected. However, it does provide a good first-order approximation for the data of technology firms.

Shyam-Sunder and Myers (1999) include the current portion of long-term debt (R_t) as part of the financing deficit (DEF_t^{SSM}) beyond its role in the change in working capital:

$$DEF_t^{SSM} = DIV_t + I_t + \Delta W_t + R_t - C_t. \quad (3)$$

The function contains an extra current debt part. The working capital has current debt already included. Also, DEF_t in Eq. (2) does not include equity issues or repurchases. This is in contrast to the original accounting definition (Shyam-Sunder & Myers, 1999). Frank & Goyal (2003) tried both approaches and have found empirically that the current portion of long-term debt does not appear to belong in the original definition. The added explanatory variable does not affect their conclusions. This paper will only focus on the partially aggregated equation of financial deficit DEF_t and ignore DEF_t^{SSM}. The main research question is: *Do tech firms with an internal financing deficit solve for this deficit in accordance with the pecking order model?*

2.3 Studies on the pecking order theory

The pecking order theory has been discussed in many previous studies. There is no accordance on the superiority of the pecking order theory and the static trade-off model. Both theories try to explain the firms' financing behavior. In table 1, one can see an overview of papers that studied the pecking order theory. Each paper shows results of which factors determine the capital structure. These determinants can be firm characteristics and/or macro influences.

Table 1: Overview of papers that tested the pecking order theory.
The column 'Financing Deficit' shows the results of the capital structure of each paper. The control variables of the firm characteristics and the macro-economic influences show signs of determinants for capital structure. Each paper has their set of control variables that have significant effects on capital structure decisions. Variables with an added '^' to the sign do not have a significant effect in the model.

Author(s)	**Region, time period**	**Financing deficit**	**Control variables firm characteristics**	**Control variables macro**
De Jong, Verbeek & Verwijmeren (2011)	US 1985–2005	Use repurchases to move towards their target debt ratio according to the static trade-off theory. The pecking order theory is more important in issuing decisions.	(-) Profitability (-) market-to-book ratio (-) depreciation (+) firm size (+) tangibility (+) log(total assets) (-) R&D expenses (+) industry leverage	(+) 1-year stock return S&P 500 yield 10-year Treasury bond (+) credit spread Moody's Baa corporate bond yield and yield 10-year Treasury bond (-) composite index of leading indicators
Shyam-Sunder & Myers (1999)	US 1971-1989	Results suggest greater support for the pecking order theory than for the static trade-off theory. If their sample of companies did have optimal debt ratios, it seems that their managers were not much interested in achieving them.	Only descriptive statistics of the following variables: - Return on assets - market value of equity - book value of assets - book debt ratio No specific signs.	Not mentioned.
Frank & Goyal (2009)	US 1950-2003	The pecking order theory provides an explanation for the fact that more profitable firms tend to have lower leverage. However, the pecking order does not directly predict the importance of industry which is the most important single empirical factor.	(+) Industry median leverage (-) market-to-book ratio (+) tangibility (-) profitability (+) log(total assets) (-) dividend payout	(+) Expected inflation
Imtiaz, Mahmud & Mallik (2016)	BD 2009-2013	Both the pecking order theory and static trade-off model can help describe the capital structure.	(-) Tangibility (-) profitability (-) operating leverage	Not mentioned.

Kayo & Kimura (2011)	40 countries 1997-2007	The majority of leverage variance is due to the firm level. Managers should focus a significant part on intrinsic firm characteristics when making financing decisions. However, they cannot ignore the importance of external environments.	(-) Growth opportunities (-) profitability (-^) distance from bankruptcy (+) firm size (+) tangibility (Industry variables): (-) munificence (-) dynamism (-) HH index	(-) Stock market development (-) bond market development (-) financial system (market vs. bank) (-) GDP growth
Cotei, Farhat & Abugri (2011)	37 countries 1990-2004	The differences in legal traditions across countries lead to different levels of information asymmetry and recapitalization costs. Their results show that firms in civil law countries exhibit a significantly higher degree of information asymmetry, use more short-term debt in their capital structure and have a higher cost of equity. Firms adjust toward an optimal capital structure but at different speeds regardless of the differences in legal systems.	(?) Log(total assets) (?) tangibility (-) market-to-book (-) ratio profitability (?) non-debt tax shield The variables with an unknown sign (?) differs much between countries. This is most likely caused by country differences.	Legal system: - Civil law - Common law Market: - Developed - Emerging

De Jong, Verbeek & Verwijmeren (2011) conluded that firm leverage is on average higher for firms that have the following characteristics: low profitability, large size, high tangibility, low R&D expenses, and high industry leverage. The macro variables that influence the capital structure are the credit spread, interest rate and composite index of leading indicators. The positive sign of the effects of credit spreads is not in line with the pro-cyclicality of leverage. Credit spreads typically peak prior to an economic downturn. Low interest rates are correlated to low leverage. Larger firms are less prone to bankruptcy because of diversification and this causes the relation between firm size and leverage to be positive. Intangible assets in the form of R&D expenses are more difficult for outsiders to value and increase expected distress costs.

Shyam-Sunder & Myers (1999) did not specifically mention the influences of firm characterstics and macro variables. However, they did conclude that the pecking order is an excellent first-order description of corporate financing behavior. Also, managers in their sample are not interested in achieving the firm's optimal debt-ratio if they set one. They did not mention any explicit limitations for managers in realizing their target leverage ratio.

Frank & Goyal (2009) found a difference between the influences of control variables on the book and market-based leverage. The variables market-to-book ratio, firm size and expected inflation lose the dependable impact on book leverage, in contrast to the market-based leverage. The industry median leverage, profitability and tangibility remain reliable and statistically significant. They believe that this is because book-leverage is backward looking while market leverage is forward looking. The effects of the market-to-book assets ratio, firm size and expected inflation apparently capture aspects of the firm's anticipated future and the past in terms of the book leverage.

The pecking order theory provides an explanation that profitable firms tend to have lower leverage according to Frank & Goyal (2009). However, the pecking order does not directly predict the importance of industry which is the most important single empirical factor. The roles of tangibility and firm size also do not easily and directly flow from the basic logic of the pecking order theory. Thus, theoretical development would be needed if a model within the basic pecking order approach is to completely account for the main robust evidence.

Imtiaz, Mahmud & Mallik (2016) did a study on the determinants of the capital structure of high-technology pharmaceutical firms in Bangladesh. Their results indicate that tangibility, profitability and operating leverage were statistically significant at the 1% level. Other firm charactestritics like size, growth and liquidity were not an important explanatory variable of leverage. Both the static trade-off model and pecking order theory can help describe the capital structure in that sector.

Kayo & Kimura (2011) find that the firm characteristics and time levels are the most relevant when explaining the variances of leverage between the 40 countries. The country levels in terms of stock market development, bond market development, financial system (market vs. bank), and GDP growth have relatively low value of leverage explanation. This does not mean that the country characteristics are not relevant as a determinant of leverage for further studies. When they include interactions between the country variables and firm characteristics to their complete models, all factors show significant values with different influences of each country determinant.

Another relevant result concerns the industry variables munificence and dynamism as determinants of leverage. These variables are adapted from Boyd (1995). Munificence was operationalized using a standardized measure of industry sales growth over a 5-year period. Dynamism was operationalized using a standardized measure of the volatility of industry sales growth rate over the same period. Both industry variables have a significant negative effect on leverage.

There are relatively few papers analyzing the influence of industry characteristics, and thus this empirical stream continues to be underexplored. The majority of leverage variance is due to the firm level, which suggests that managers should focus a significant part of their attention on intrinsic firm characteristics when making financing decisions, but they cannot ignore the importance of external environments (Kayo & Kimura, 2011).

Cotei, Farhat & Abugri (2011) concluded that differences in legal traditions across countries lead to different levels of information asymmetry and recapitalization costs. Their results show that firms in civil law countries exhibit a significantly higher degree of information asymmetry, use more short-term debt in their capital structure, have higher cost of equity, rely more on internally generated funds to finance their investments and use more short-term debt as external source of funds relative to those in common law countries. Finally, the results indicate that, regardless of the differences in legal systems, firms adjust toward an optimal capital structure but at different speeds.

Most papers agree on the determinants of firms' leverage. The common factors are profitability, tangibility, market-to-book ratio, the log of the total assets, the firm size, and the industry average leverage. These variables are firm characteristics. Other papers concluded that external determinants of corporate leverage exist: legal system, fixed income financial instruments, stock returns, expected inflation, GDP growth, and developed/emerging market conditions.

3. METHODOLOGY

The yearly financials for technology firms are tested with the pecking order model. The observations are thus considered as panel data. The three methods that will be used to test this panel data are the simple pooled ordinary least squares (OLS) and two individual-specific effect models: fixed effects and random effects. The simple pooled OLS is the fastest regression with the same constant term for all firms, but has an important disadvantage: no heterogeneity is allowed. This means that a dataset cannot have independent groups with a different variance. There could be a bias in the estimates if restrictions are not valid.

The most interesting method is the fixed effects model. It estimates panel data by including a different intercept for each independent variable. So, a_{it} can be correlated with x_{it} in an arbitrary form. Fixed effects explore the relation between the independent and dependent variables within the firm. In the high-technology sector, it is likely that there are some firm-specific characteristics with an effect on the financing decisions, since the firms in this data set differ a lot among each other. Therefore, the fixed effects model is expected to be the most efficient model.

The other individual-specific regression is called the random effects model. The constant a_{it} is assumed to be uncorrelated with x_{it} to avoid omitted variable bias. If we would like to impose a stronger assumption that a_{it} is uncorrelated with X, we can get more efficient estimator. In that case, a_{it} can be treated as part of the error term.

In order to see which model is most appropriate, two tests will be done to check the robustness of the methods on the non-winsorized data. Winsorizing is a transformation of statistics by limiting extreme values in the statistical data to reduce the effect of possibly spurious outliers. The first one will test whether the simple pooled OLS is appropriate with the command 'xttest0'. A rejection of the null hypothesis implies that we should not use it. The second one is called the Hausman test. This test will conclude which individual-specific effects model will regress the most efficient values. The most efficient model will be used in the conclusion.

4. DATA

We need the data from funds flow statements of high-technology firms to test the pecking order theory. The companies are chosen according to Kile & Phillips (2009). They constructed a sample of high-technology firms using three-digit SIC codes. A firm is identified as high-technology if it matches to one of following three-digit SIC codes (industry name in parenthesis): 283 (Drugs), 357 (Computer and Office Equipment), 366 (Communication Equipment), 367 (Electronic Components and Accessories), 382 (Laboratory, Optic, Measure, Control Instruments), 384 (Surgical, Medical, Dental Instruments), 481 (Telephone Communications), 482 (Miscellaneous Communication Services), 489 (Communication Services, NEC), 737 (Computer Programming, Data Processing, etc), and 873 (Research, Development, Testing Services). These codes are put in Compustat North America, to find the balance sheet and cash flow items. The beginning of the test period is set from 2007 and ends with 2017. The conditional statement rule for the query is that every company needs to have at least 50 million common equity to filter the start-ups and penny stocks firms. This resulted in a sample of 373 firms.

The observations of the high-technology firms are panel data because of the multi-dimensional yearly measurements of cash flows and balance sheet items. This data is imported into Excel. The original data contains missing values of cash flow and balance sheet items in certain years. In order to deal with this, the data is edited to only companies that recorded their financials in all the 10 years. This might create some selection bias in combination with the conditional statement rule. Also, several balance sheet and cash flow statement items are recoded as zero if they were reported missing or combined with other data items in Compustat.

The descriptive statistics of the dependent and independent variables in the regression equation are shown in table 6 in Appendix B. All variables contain a positive skewness which means that there is an asymmetry in the distribution. In this case, there are more smaller observations than large ones. The kurtosis values are relatively high compared to the normal value of 3. In order to reduce the skewness and kurtosis, the data is winsorized at a p-value of 0.01 which is shown in table 7. Some extreme values of kurtosis are reduced. The output of the regressions on technology data are likely to be more efficient on winsorized data.

5. RESULTS

5.1 Simple pooled OLS, fixed effects, and random effects models

Table 2 shows the regression outputs of the simple pooled ordinary least squares (OLS), fixed effects and random effects for 373 firms. All methods show significant positive effects of the financing deficit on the net debt issued. However, one needs to find the most efficient model. The first test with the command ´xttest0´ in Stata rejects the simple pooled OLS model as appropriate with a p-value of 0.000. Subsequently, we need to find the most efficient individual-specific model using the Hausman test. This test rejects the null hypothesis which means that the most efficient coefficient estimator is obtained from the fixed effects model.

Table 2: Pecking order tests for high-technology firms.

The sample period is 2007-2017. The full sample is tested in three different ways. Column (1) shows results of a simple pooled ordinary least squares (OLS) regression. Column (2) shows results of a fixed effects model. Column (3) show results of a random effects model. The following regression is estimated: $\Delta D_{it} = a_i + b_{PO}DEF_{it} + e_{it}$, where ΔD_{it} is the net of debt issued, and the financing deficit, DEF_{it}; is the sum of dividends, investment, change in working capital (change in operating working capital + changes in cash + changes in short term debt), minus the cash flow after interest and taxes. The coefficients are rounded to three decimals. Standard errors are reported in parentheses.

	Simple pooled OLS (1)	Fixed effects model (2)	Random effects model (3)
Constant	0.015** (0.001)	0.015** (0.001)	0.015** (0.001)
Financing deficit	0.239** (0.008)	0.280** (0.009)	0.244** (0.009)
R^2	0.1759	within = 0.2088 between = 0.0652 overall = 0.1759	within = 0.2088 between = 0.0652 overall = 0.1759

* Indicates significance at the 0.05 level;

** Indicates significance at the 0.01 level.

The estimated coefficient for this sample is a significant positive value of 0.280 and the overall R^2 is 0.1759 according to the fixed effects model. Support for the pecking order theory is weak in this case. Technology firms tend to issue debt when in need for external capital, but not as much as expected with such high asymmetric information. The pecking order hypothesis states that a = 0 and b_{PO} = 1 and is statistically rejected. The following regressions will provide more insight of the output in table 2.

5.2 Fixed effects model with sub-samples of small, medium and large firms

To apply robustness checks on the total sample, four sub-samples are computed according to the relative size of the technology firms. The bottom 25% percentile represents small firms, the top 25% large firms, medium small firms between the bottom 25% and middle 50% percentiles, and medium large firms between the middle 50% and top 25% percentiles.

The results in table 3 show an increasing support for the pecking order theory with firm size until the maximum coefficient of the medium large firms. The output shows more support for the pecking order theory for medium and large firms than for the whole sample. This is caused by the relative low value and support for small firms.

Table 3: Pecking order tests for high-technology firms with sub-samples in different sizes.

The sample period is 2007-2017. The small firm sub-sample is shown in column (1). The sub-sample in column (2) is about medium small firms. The sub-sample in column (3) is about medium large firms. The large firms sub-sample is shown in column (4). Small firms are determined as the bottom 25% percentile, medium small firms between the bottom 25% and middle 50% percentiles, medium large firms between the middle 50% and top 25% percentiles, and large firms as the top 25% percentile. The following regression is estimated: $\Delta D_{it} = a_i + b_{PO} DEF_{it} + e_{it}$, where ΔD_{it} is the net of debt issued, and the financing deficit, DEF_{it}; is the sum of dividends, investment, change in working capital (change in operating working capital + changes in cash + changes in short term debt), minus the cash flow after interest and taxes. The coefficients are rounded to three decimals. Standard errors are reported in parentheses.

	Fixed effects models			
	Small firms (1)	Medium small firms (2)	Medium large firms (3)	Large firms (3)
Constant	-0.002 (0.002)	0.013** (0.003)	0.027** (0.002)	0.026** (0.002)
Financing deficit	0.123** (0.013)	0.322** (0.020)	0.406** (0.023)	0.316** (0.022)
R^2	within = 0.0961 between = 0.0677 overall = 0.0907	within = 0.2492 between = 0.1373 overall = 0.2245	within = 0.2834 between = 0.5878 overall = 0.3104	within = 0.2065 between = 0.0843 overall = 0.1577

* Indicates significance at the 0.05 level;

** Indicates significance at the 0.01 level.

According to Frank & Goyal (2003), larger firms show more support for the pecking order theory than smaller firms do. Small firms are commonly thought to be particularly subject to adverse selection problems. The small firms section shows a weaker support for the pecking order theory than the medium and large firms with a significant coefficient of 0.123. This conclusion of Frank & Goyal (2003) is in line with these results. However, the largest firms do not show more support than medium firms (0.316 to 0.406 and 0.322). As already said, the support is not a linear line in relation to the size of the tech firms, but a specific parabola. The sub-sample with the strongest support for the pecking order theory is the medium large firms column. The financing deficit is matched by around 40 percent of net debt.

5.3 Winsorized fixed effects model with sub-samples small, medium and large firms

Another robustness check is done for the total sample. Table 4 shows the outputs of fixed effects model on winsorized sub-samples of small, medium and large firms. The sample is winsorized at a p-value 0.01. The coefficient values for small firms does not change. The support for the pecking order theory does slightly increase on winsorized data for medium and large firms, but is still not strong. The fixed effects model on winsorized data for small, medium large and large firms fits the set of observations better than on the original data. That is why the conclusion will be based on the these results.

Table 4: Pecking order tests for high-technology firms with winsorized samples.

The sample period is 2007-2017. The sample is winsorized at a p-value of 0.01. The total sample is shown in column (1). The small firm sub-sample is shown in column (1). The sub-sample in column (2) is about medium small firms. The sub-sample in column (3) is about medium large firms. The large firms sub-sample is shown in column (4). Small firms are determined as the bottom 25% percentile, medium small firms between the bottom 25% and middle 50% percentiles, medium large firms between the middle 50% and top 25% percentiles, and large firms as the top 25% percentile. The following regression is estimated: $\Delta D_{it} = a_i + b_{PO} DEF_{it} + e_{it}$, where ΔD_{it} is the net of debt issued, and the financing deficit, DEF_{it}; is the sum of dividends, investment, change in working capital (change in operating working capital + changes in cash + changes in short term debt), minus the cash flow after interest and taxes. The coefficients are rounded to three decimals. Standard errors are reported in parentheses.

Fixed effects models					
	Total sample (1)	Small firms (2)	Medium small firms (3)	Medium large firms (4)	Large firms (5)
Constant	0.015** (0.001)	-0.002 (0.002)	0.013** (0.003)	0.023** (0.02)	0.025** (0.002)
Financing deficit	0.286** (0.009)	0.123** (0.013)	0.324** (0.020)	0.426** (0.024)	0.343** (0.021)
R^2	within = 0.2167 between = 0.0672 overall = 0.1828	within = 0.0964 between = 0.0679 overall = 0.0911	within = 0.2497 between = 0.1297 overall = 0.2252	within = 0.2926 between = 0.6012 overall = 0.3200	within = 0.2535 between = 0.1122 overall = 0.1917

* Indicates significance at the 0.05 level;

** Indicates significance at the 0.01 level.

6. CONCLUSION

The pecking order theory is tested on a broad cross-section of publicly traded American high-technology firms over the period 2007-2017. Technology firms tend to have products or services that have difficult characteristics for a common investor. According to the pecking order theory, these firms will have large amounts of retained earnings. In case of a financing deficit, technology firms will issue debt to match it. Equity is expensive because of the higher adverse selection risk premium and will therefore never be used for normal projects.

This research tests the pecking order theory on 373 high technology firms of different sizes. The results from both the original and winsorized data show weak support. Debt issues are on average only 28% percent of the total financing deficit which is not close to 100% according to Myers (1984).

Furthermore, more specific research has been done on the influence of size. If one splits the sample based on the relative size of the firms, the medium and large firms show more support for the pecking order theory than small firms -- even though small firms are expected to have more adverse selection costs and asymmetric information, especially in the technology sector. Frank & Goyal (2003) also stated that an increase in size shows stronger support. However, the results do not show a linear relationship between size and support for the theory.

A limitation of this research is the selection bias. This is created by the conditional statement rule that every firm needs to have at least 50 million common equity. Also, the data availability is poorer for smaller firms which means that less small firms are chosen. If the selection bias is not taking into account, the conclusions of a study may not be accurate because proper randomization is not achieved.

Additional research could be done on the capital structure of high technology firms. The technology sector might have more financial distress costs because of higher uncertainties of their growth opportunities and thus a lower target debt ratio. One could test the trade-off theory based on this information and that some large tech firms seem to have much debt. The regression should then include a control variable financial constraints or financial distress.

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APPENDIX A

Table 5. Technology and S&P Price-to-earnings ratios

	Average P/E ratio from June 2013 till June 2017	**P/E ratio June 2017**
Technology industries	20,3171767	25,80
S&P 500	20,142692	25,8

APPENDIX B

Table 6: Descriptive statistics of the cash flow accounting items.

Values in columns with the variables mean, standard deviation (std. dev), minimum value (min), maximum value (max) are in millions and fully rounded. Skewness is a measure of the asymmetry of the probability distribution of a real-valued random variable about its mean. Kurtosis is a measure of the "tailedness" of the probability distribution of a real-valued random variable. These columns are rounded to 3 decimals.

	Observations	**Mean**	**Std. Dev**	**Min**	**Max**	**Skewness**	**Kurtosis**
DIV_{it}	3,730	380	1328	0	12150	4.890	29.503
I_{it}	3,730	1087	38923	-5184	56007	5.053	62.631
ΔW_{it}	3,730	53	1579	-43405	50293	3.141	441.390
C_{it}	3,730	1670	5165	-2288	69619	5.390	40.289
ΔD_{it}	3.730	241	1888	-14554	41003	9.720	160.948

Table 7: Descriptive statistics of the winsorized (at p-value of 0.01) cash flow accounting items.

Values in columns with the variables mean, standard deviation (std. dev), minimum value (min), maximum value (max) are in millions and fully rounded. Skewness is a measure of the asymmetry of the probability distribution of a real-valued random variable about its mean. Kurtosis is a measure of the "tailedness" of the probability distribution of a real-valued random variable. These columns are rounded to 3 decimals.

	Observations	**Mean**	**Std. Dev**	**Min**	**Max**	**Skewness**	**Kurtosis**
DIV_{it}	3,730	361	1199	0	7302	4.299	21.792
I_{it}	3,730	1034	3049	-274	19649	4.405	23.489
ΔW_{it}	3,730	51	833	-3859	4276	0.644	16.926
C_{it}	3,730	1621	4550	-97	29258	4.263	22.341
ΔD_{it}	3.730	188	1029	-2285	6423	3.898	22.512